70-820 UNC RECOVERY SYSTEMS

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

Rec'd w/ ltr dtd 10/31/68

AA-5

PART II

-NOTICE-

THE ATTACHED FILES ARE OFFICIAL RECORDS OF THE INFORMATION & REPORTS MANAGEMENT BRANCH. THEY HAVE BEEN CHARGED TO YOU FOR A LIMITED TIME PERIOD AND MUST BE RETURNED TO THE RECORDS & ARCHIVES SERVICES SECTION P1-22 WHITE FLINT. PLEASE DO NOT SEND DOCUMENTS CHARGED OUT THROUGH THE MAIL. REMOVAL OF ANY PAGE(S) FROM DOCUMENT FOR REPRODUCTION MUST BE REFERRED TO FILE PERSONNEL.

-NOTICE-

accordance with the Freedom of Information Act, exemptions
FOIA-2004-0234

SECTION 900

DOCKET NO. 70-820

Regulatory Suppl File Cy.

Part II

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

Applicable to

UNITED NUCLEAR CORP

Commercial Products Division

Fuel Fabrication Operations
New Haven, Connecticut

Fuel Recovery Operations

Rhode Island Woodlawn

RECEIVED
NOV 4 1968
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

DOCKETED USAEC
NOV 4 1968
REGULATORY MAIL SECTION DOCKET CLERK

Date issued October 31, 1968

ACKNOWLEDGED

4825

SECTION 900 - RECOVERY OPERATION

Subsection 910 - STORAGE (Formerly 500)

TABLE OF CONTENTS

Subpart 911 GENERAL CONSIDERATIONS (Formerly 503.1)

Subpart 912 OUTSIDE STORAGE

912.1 Transfer to Processing Area (Formerly 501 and 502)
912.2 Permanent Storage Containers (Formerly 503.3.2)
912.3 Storage in Schedule 40 Pipes

Subpart 913 PRODUCT STORAGE (Formerly 504.3)

913.1 Storage Area Description
913.2 U Metal Alloy Storage Containers
913.3 Wet and Dry Compounds and Solutions
913.4 Interaction

Subpart 914 OVERHEAD SOLUTION STORAGE

914.1 Overhead Storage Tanks 1-D-9A to F (Formerly 504.2.2)
914.2 Overhead Storage Tank Overflow System and Nitric Acid Feed Tank 1-D-13 (Formerly 504.2.3)
914.3 Mixing Tank 1-D-9H (Formerly 504.2.5)
914.4 OK Liquor Overhead Storage Tanks 1-D-10 A, B, C and 1-D-16 (New)

Subpart 915 CART STORAGE

915.1 11 Liter Bottle Carts (Formerly 504.2.1)
915.2 Calciner Tray Carts (Formerly 504.2.5)
915.3 Bottle, Jar, Can and Bag Carts (New)

Subpart 916 COMPONENT STORAGE

916.1 Element Storage Racks (New)

Subpart 917 INPROCESS STORAGE

917.1 Bay XIII Bunkers (new)

LICENSE:	SNM-777
Docket:	70-820
SECTION: 900	
TABLE OF CONTENTS	
Page 1 of 1	
Approved:	
Issued: October 31, 1968	
Supersedes: New	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 910 - Storage
Subpart: 911 - General Considerations

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

911. General Considerations

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

A portion of the North Yard is paved and the South Yard is gravel.

Incoming uranium materials shall be stored as described in Subsection 704. 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 weighing area to the outside storage area and later in moving into the processing area. Containers are normally moved one at a time and the path of movement will be restricted to roadways and/or aisles to insure safety from interaction.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 910 - Storage
Subpart: 912 - Outside Storage
912.1 - Transfer to Processing Area

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

912.1 Transfer to Processing Area

Incoming materials will normally be stored outside in the "as received" container. In some cases, the containers may be stored inside in accordance with the criteria for outside storage. If the material is removed from the container, it will be stored in an approved storage location in accordance with this subsection (910).

Inner containers are removed from the shipping container and moved to the processing area. When out of a shipping container, only one inner container is moved at a time and then only in aisles or roadways which provide safe distance from other uranium.

Material will be introduced to processing using standard Nuclear Management Techniques as described in Section 500.

912.2 Storage in Permanent Storage Containers

Components composed of multiple plates or rods will be stored one per container. If parts of portions such as fillers, plates, rods, etc., are stored, each inner container will be modified by adding metal inserts which will restrict the cross sectional area to 19.64 sq. inches (a 5 inch diameter cylinder has a circular cross section equal to 19.64 sq. inches). For the storage of uranium-zirconium bearing components, depending on the weight fraction of the material to be placed in the inner container, the safe cross sectional area of the inner containers will be obtained using Figure 309-V. The maximum inner container cross sectional area is 32 sq. inches (8" x 4"). The full 32 sq. inch cross sectional area only will be used with materials having a maximum weight fraction of U-235 equal to or less than 0.04.

These containers are constructed of extended 18 gage steel drums; steel angle iron skids, legs, and braces; 15-gallon steel drum attachments; and standard 18 gage drum lids utilizing standard lock ring and bolt type closure rings. They are all welded construction. Details of construction are shown on Sketch 912.2-I.

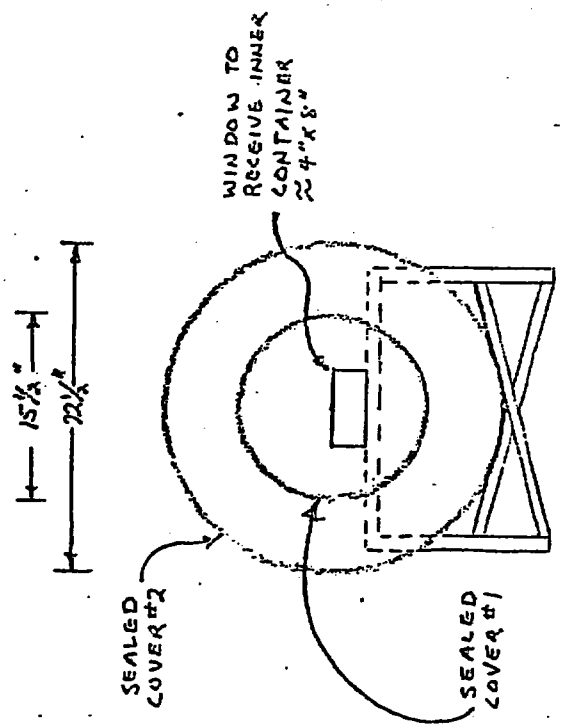
Approximately 30 of these containers will be placed in the Southwest corner of the South Yard. Drums will be placed off the ground on concrete blocks and secured side-by-side forming a planar array. This will allow approximately 18 1/2" edge-to-edge separation between SNM. Only one inner container or component composed of multiple plates or rods will be moved at a time during container loading or unloading.

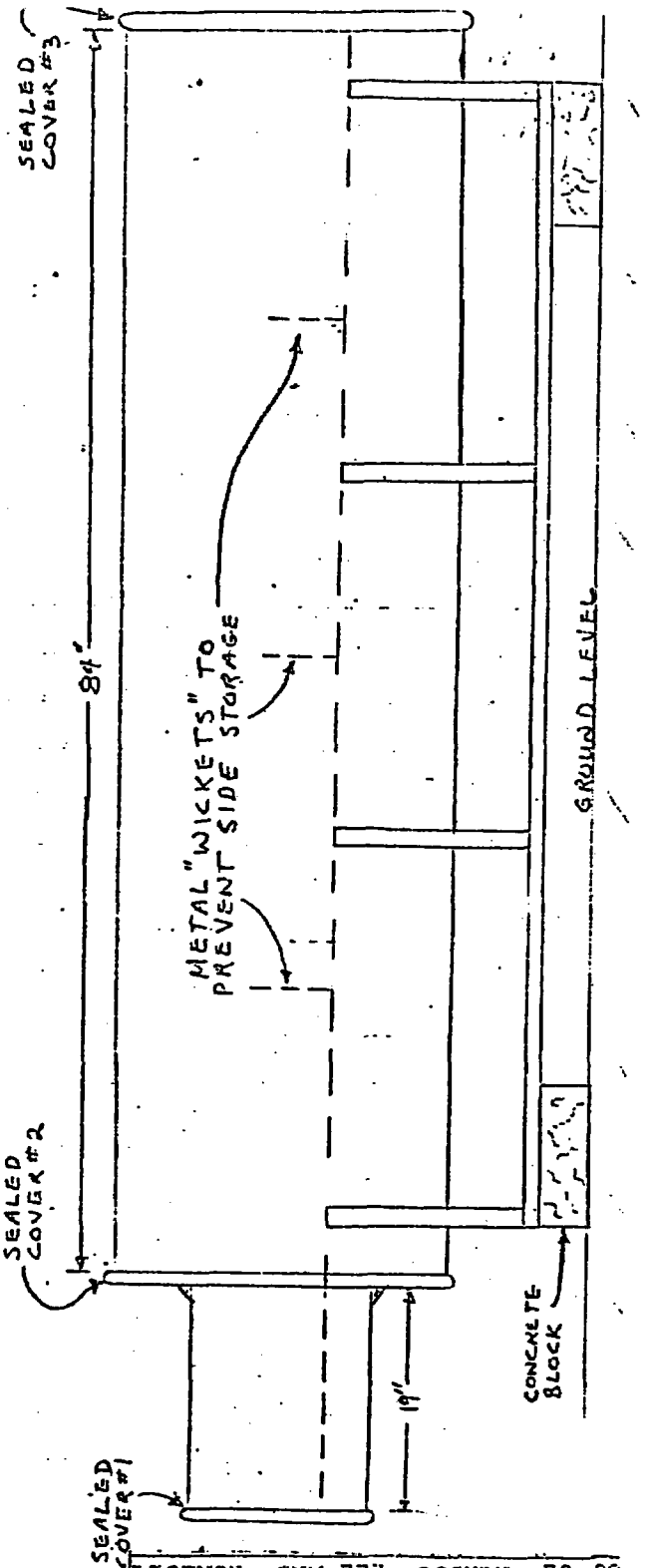
The nuclear safety of individual components or groups of fillers, plates, rods, etc., in inner containers is assured by the use of safe cross-section containers. The solid angle subtended by the centermost inner container will be less than 1.4 steradians.

This storage arrangement will be inside the perimeter fence in areas covered by existing radiation detection monitors and alarms. It will be isolated from other SNM by 12 feet.

MATERIAL OF CONSTRUCTION

1. CONTAINER - EXTENDED STEEL DRUM - 18 GAGE
2. SKID - 1½" x 1½" x 3/16" ANGLE IRON
3. LEGS AND STRINGERS - 2" x 2" x 3/16" ANGLE IRON
4. BRACES - 1" x 1" x ⅛" ANGLE IRON
5. ADDITION - 15 GAL DRUM - 18 GAGE
6. COVERS - 18 GAGE DRUM LIDS
7. COVER SEALS - STD. LOCK RING AND BOLT TYPE RINGS
8. WELDS - 3/16" FILLET





LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 912.2

Sketch: 912.2-I, Details of Construction-Permanent Storage Co

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

OUTSIDE STORAGE IN PERMANENT STORAGE CONTAINERS

CASE I - Centermost Inner Container

A. Assumptions

1. Storage arrangement is a planar array so centermost units "see" only the neighbor on each side.

2. Assume 8" box face to be diameter for solid angle calculation.

B. Calculations

$d = 8''$, $h = 18.5'' + 4'' = 22.5''$, $L = 84'' + 19'' = 103''$, $L/2 = 52''$

$\Omega_1 = \frac{2d}{h} \sin\theta$ where $\tan\theta = \frac{L/2}{h} = \frac{52}{21} = 2.76$ and $\sin\theta = 0.941$

$\Omega_1 = \frac{16''}{22.5''}(0.941) = 0.711 \times 0.941 = 0.699$

$\Omega(\text{total}) = 2 \times \Omega_1 = 1.338$ steradians

C. Allowable Interaction

From Figure 309-V the weight fraction for a 32 sq. inch safe cross-sectional area is .04. From Figure 309-VII, the max. k eff for an unreflected safe cylinder at .04 weight fraction is .655. As shown on Figures 309-V and VII, larger weight fractions require reduced safe cross sectional areas which result in reduced k eff values.

Therefore, the .655 k eff value is the maximum for the inner container.

$\Omega(\text{allowable}) = 9 - 10\,k - 9 - 6.55 = 2.45$ steradians

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 912.2
Interaction Calculations - Outsi Storage in Permanent Storage Con tainers.
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

912.3 Storage in Schedule 40 Pipes

1. Description

Uranium alloy (e.g., U-Al or zirc scrap chips and solids) or uranium oxide or other compounds with a maximum density of 3.2 gms U-235/cc may be stored in a storage area composed of 5-inch ID Schedule 40 steel pipes. These pipes will be arranged side-by-side on 16" centers forming a horizontal plane. Separation between pipes will be provided by concrete blocks at each end or similar rigid non-combustible structural material. Pipes will be supported 6" off the ground minimum. An exclusion distance of 12 feet will be maintained from other SNM by the use of proper barriers and signs.

Secure pipe closure is provided by using standard pipe caps with standard threads. At least 5 threads will be engaged.

2. Nuclear Safety

Individual pipes are nuclearly safe (Ref. Table XV, K-1019, Rev. 5). The allowable solid angle is 3.2 steradians (Ref. Table XVII, K-1019, Rev. 5). With a 5" diameter and 16" center-to-center separation, the solid angle is conservatively estimated as,

$$\Omega = \frac{2d}{h} \sin\theta = \frac{2 \times 5''}{16'' - 2.5''} = \frac{10''}{13.5''} = 0.74 \text{ steradians.}$$

$$\Omega_{total} = 2 \times \Omega = 1.48 \text{ steradians}$$

Therefore, this array is nuclearly safe.

913.1 Storage Area Description

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 combinations of containers of metal, solutions, and wet or dry compounds. The following is a schedule of containers used:

Type Material	Container Size	Maximum Quantity Per Container
Uranium metal	4 1/2" diameter by 5 1/2" 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 6 1/2" high	6.6 kgs U @ 3.2 gms U/cc
Product retainer samples in small poly bottles. Dry production residues in small poly bottles	5 1/4" 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. Storage of in process control or accountability samples is provided by an expanded metal shelf, mounted on the east window ledge of the Foreman's office. This shelf is designed to hold 2 oz. bottles having a maximum I.D. of 1-1/2".

913.2 U Metal Alloy Storage Containers

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		Kg U-235 Per Container	Effective U-235 density kg/liter	
	1	2		1	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) assumes 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 1/2 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.

913.3 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 6 1/2" high steel cans have a smaller volume than the one gallon bottles. The 5 1/2" 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.

913.4 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.

SOLID ANGLE SUBTENDED AT CENTER BOTTLE BY:

1. TWO # 1 BOTTLES

H = 13 H/A = 2.167

A = 6 H/B = 1.300

B = 10 Ω = .325 2Ω = .650

2. TWO # 2 BOTTLES

H = 15 H/A = 2.50

A = 6 H/B = 2.50

B = 6 Ω = 1.55 2Ω = .310

3. FOUR # 3 BOTTLES

$H = \sqrt{(15)^2 + (13)^2} = 19.8$

A = 6 H/A = 3.30

B = 11.7 H/B = 1.69

Ω = .171 4Ω = .684

4. FOUR # 4 BOTTLES

H = 32.6 H/A = 5.43

A = 6 H/B = 2.79

B = 11.7 Ω = .065 4Ω = .260

5. FOUR # 5 BOTTLES

H = 47.4 H/A = 7.900

A = 6 H/B = 4.05

B = 11.7 Ω = .032 4Ω = .128

6. FOUR # 6 BOTTLES

H = 62.8 H/A = 10.47

A = 6 H/B = 5.37

B = 11.7 Ω = .018 4Ω = .072

7. FOUR # 7 BOTTLES

H = 37.3 H/A = 6.22 4Ω = .200

A = 6 H/B = 3.19

B = 11.7 Ω = .050

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 913.4
Solid Angle Calculations - Storage shelves
PAGE 1 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

8. FOUR # 8 BOTTLES

H = 57 H/A = 9.50

A = 6 H/B = 4.87

B = 11.7 Ω = .022 4Ω = .088

9. FOUR # 9 BOTTLES

H = 78.4 H/A = 13.1

A = 6 H/B = 6.70

B = 11.7 Ω = .012 4Ω = .048

10. FOUR # 10 BOTTLES

H = 84.6 H/A = 14.10

A = 6 H/B = 7.23

B = 11.7 Ω = .010 4Ω = .040

11. FOUR # 11 BOTTLES

H = 94.2 H/A = 15.7

A = 6 H/B = 8.05

B = 11.7 Ω = .008 4Ω = .032

12. FOUR # 12 BOTTLES

H = 114.5 H/A = 19.1

A = 6 H/B = 9.79

B = 11.7 Ω = .005 4Ω = .020

13. FOUR # 13 BOTTLES

H = 110 H/A = 18.3

A = 6 H/B = 9.4

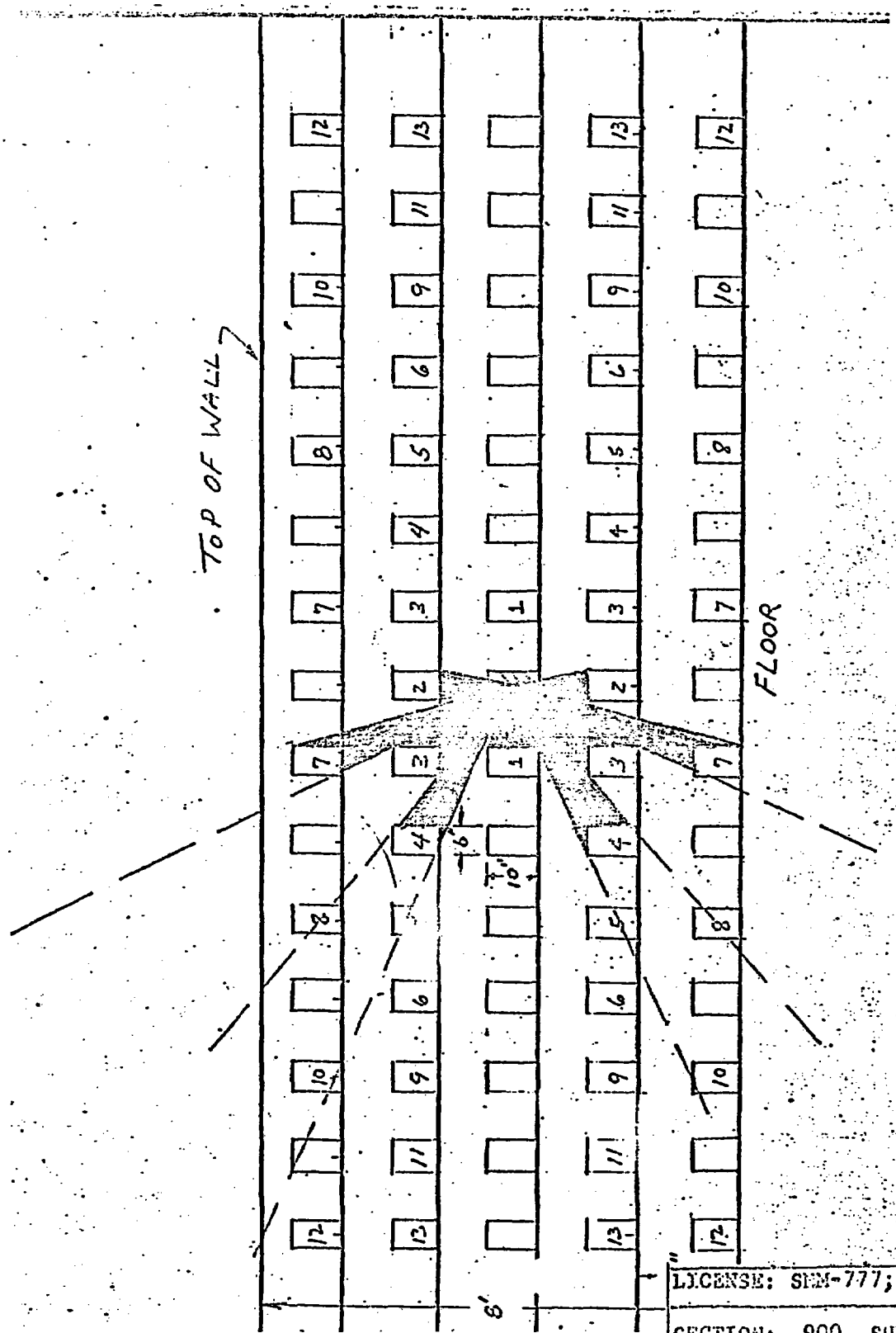
B = 11.7 Ω = .006 4Ω = .024

GRAND TOTAL 2.556

TOTAL FOR BOTTLES 1, 2, 3, 4, 7 IS 2.104 STERADIANS.

THE ABOVE CALCULATIONS WERE MADE ON AN OAK RIDGE GASEOUS DIFFUSTION PLANT. SOLID ANGLE SLIDE RULE.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 913.4
Solid Angle Calculations - Storage shelves.
PAGE 2 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-8

SECTION: 900, SUBPART: 913.4

Solid Angle Calculations - Sto
rage shelves

PAGE 3 OF 3

APPROVED

ISSUED: OCTOBER 31, 1968

914.1 Overhead Storage Tanks 1-D-9 A to F

1. Equipment

The horizontal storage tanks containing uranium liquors which feed the extraction system are located approximately 14 feet, 9 inches above the floor over Bays X, XIII, and XVI and are spaced 30" center-to-center. There are six of these overhead tanks, each 5" I.D. by 45' long.

2. Nuclear Safety

The solid angle subtended at the central tank 1-D-9-D is .616 steradians. The estimated solid angle contributed by nearby equipment and hoods should be less than 1.0 steradians. Therefore, the total solid angle will be approximately 1.6 steradians. From Table XVII, a 5" dia. cylinder has an allowable interaction of 3.2 steradians.

$$d = 5'',\ L = 45'\ (\text{assume } \infty)\ \therefore\ \sin\theta = 1,\ h = 30'' + 2.5'' = 32.5''$$

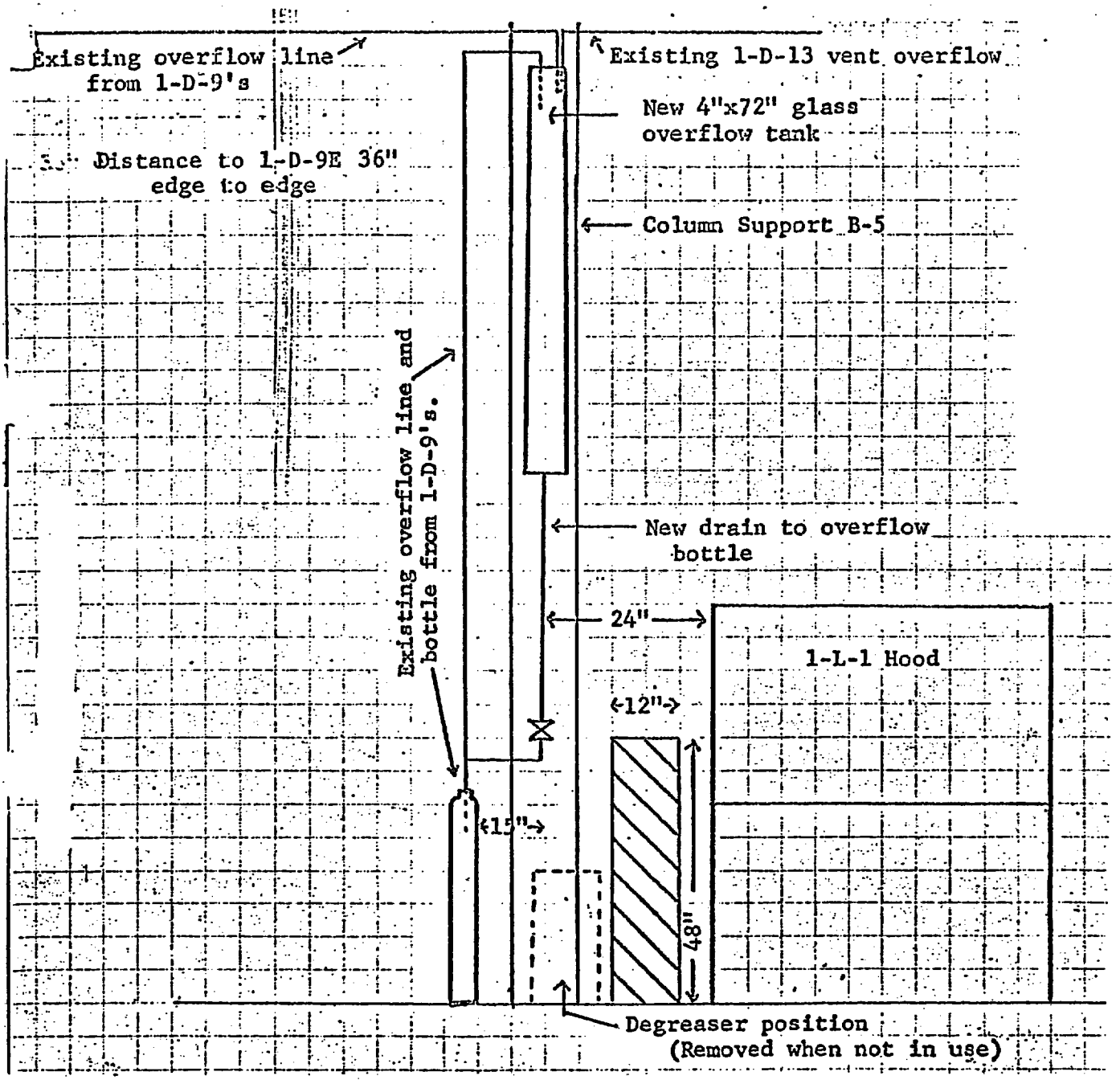
$$= \frac{2d}{h}\ \sin\theta = \frac{10''}{32.5''} = .308$$

$$(\text{Total}) = 2 \quad = .616 \text{ steradians}$$

914.2 Overhead Storage Tank Overflow System

A 4" I.D. x 72" Pyrex glass overflow tank (nominal 3/8" wall thickness) is attached to column support B-5 in between Bays XI and XIV, approximately 7 feet above the floor, with an overflow and a drain line to an 11 liter overflow bottle. This tank is located approximately 3 feet from and at right angles to the overhead storage tanks, 7 feet from Scrubber 2-X-1 and 7 1/2 feet above the floor. Since it is located several feet from surrounding equipment, its interaction is considered negligible. This equipment and its location is shown on Sketch 914.2.I.

The Nitric Acid Feed Tank 1-D-13 is also located at the support column B-5. This is a non-fuel bearing tank and is separated from SNM bearing equipment by an air break.



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 914.2	
Sketch: 914.2-I	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 910 - Storage
Subpart: 914 - Overhead Solution Storage
914.3 - Mixing Tank 1-D-9H

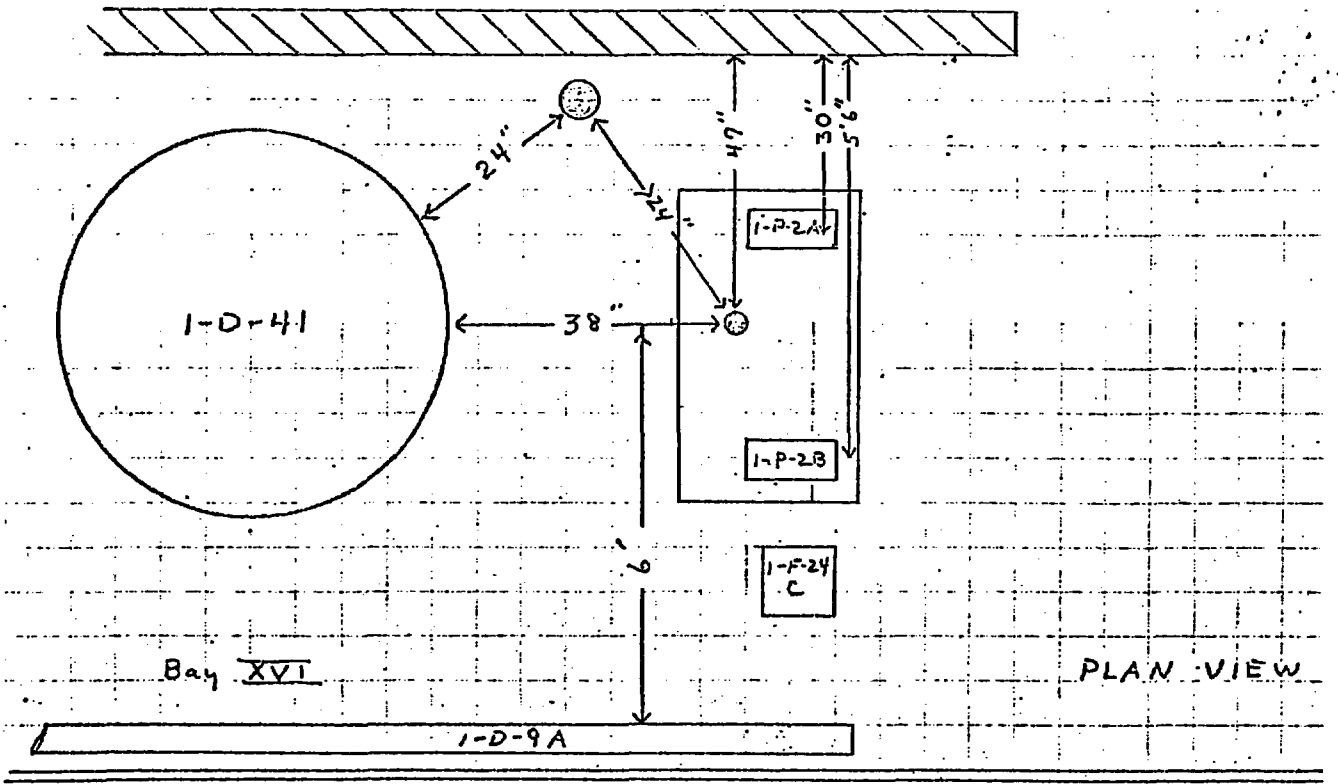
Approved

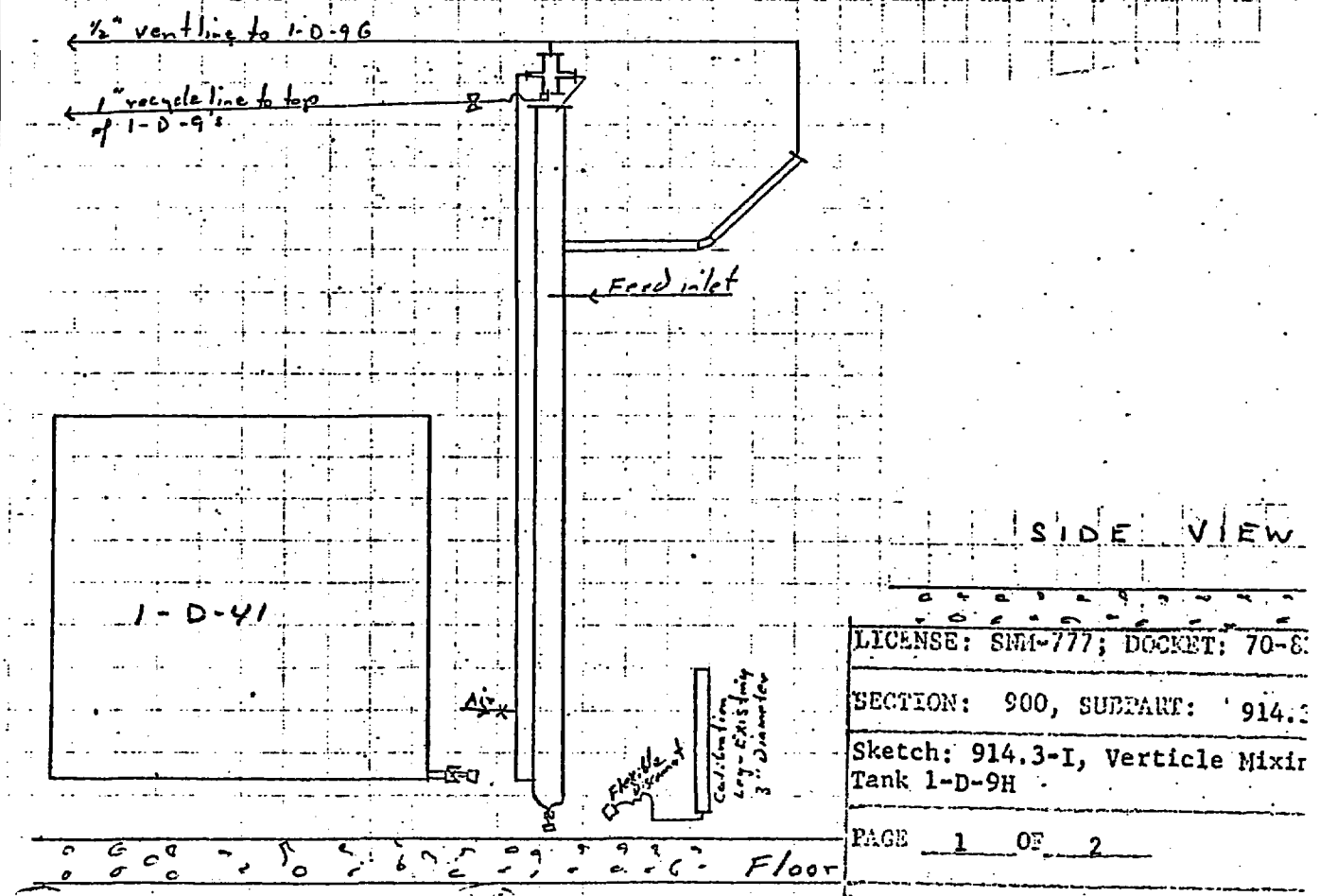
ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

914.3 Mixing Tank 1-D-9H

A 5" I.D. x 204" Mixing Tank is inserted in the 1/2" feed leg pipe from the overhead storage tanks to the metering pumps. The top of the tank will be above the level of the overhead storage tanks to avoid overfilling from them. The tank contents will be agitated mildly with air, the mixing air to be discharged through a 4" x 1" glass cross gas-liquid phase separator located immediately above the mixing tank and discharged into Scrubber 2-X-1. Two 1/2" lines (The Raffinate and Feed Transfer lines) are located at least 6" distant and all other uranium bearing equipment is located more than 2' distant. Therefore, the interaction effects of this equipment are negligible. Since the 1-D-41 contains solutions with concentrations less than 5 grams U-235 per cubic centimeter, its interaction is exempted as indicated in K-1019, Rev. 5. This equipment and its location are shown on Sketch 914.3-I and II.





LICENSE: SNM-777; DOCKET: 70-8

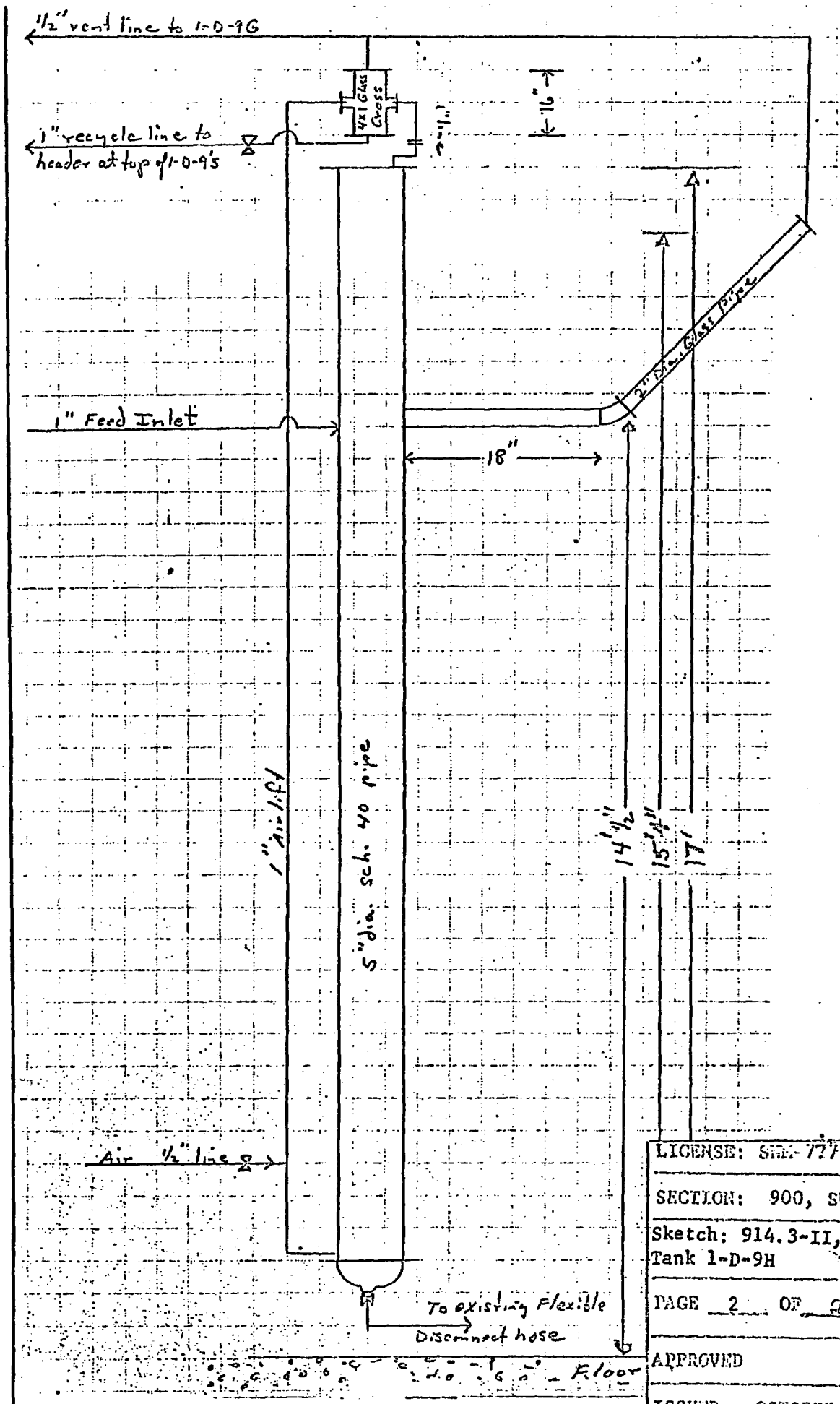
SECTION: 900, SUBPART: 914.3

Sketch: 914.3-I, Verticle Mixir Tank 1-D-9H

PAGE 1 OF 2

APPROVED

ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 914.3

Sketch: 914.3-II, Verticle Mixin Tank 1-D-9H

PAGE 2 OF 2

APPROVED

ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777; Docket: 20-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 910 - Storage
Subpart: 914 - Overhead Solution Storage
914.4 - OK Liquor Overhead Storage Tanks 1-D-10 A,B,C + 1-D-16

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

914.4 OK Liquor Overhead Storage Tanks 1-D-10 A, B, C + 1-D-16

1. Equipment

These tanks contain OK liquor which feeds the precipitator. They are located approximately 14 feet, 9 inches above the floor over bays XV, XVIII and XXI. These tanks are 5" I.D. by 60' long, except the I-D-16 which is 45' long, and are spaced on 30" centers. The Tray and Large Tray Dissolver Storage Tanks 3-D-3 A + B are located between the 1-D-10 A, B + C Tanks on 15" centers.

2. Nuclear Safety

These tanks have a safe 5" diameter. The solid angle subtended by a centermost tank is approximately 1.7 steradians. From Table XVII, a 5" diameter cylinder has an allowable interaction of 3.2 steradians.

1. Contribution from Tank on Either Side

d=5", Assume L=∞, so sin θ = 1, h=15"-2.5" = 12.5"

$$\Omega_1 = \frac{2.1}{h} \sin \theta = \frac{10''}{12.5''} = .81 \text{ steradians per tank}$$

Since the tanks form an inline array, the centermost tank sees only the tank on either side. So

$$\Omega \text{ (Tanks)} = 2 \times \Omega_1 = 2 \times .81 = 1.6 \text{ steradians}$$

2. Contribution from Large Tray Dissolver 3-J-3

a=25", b=73", q=h=135", since q=h, cos θ = 1

$$\Omega_2 = \frac{ab \cos \theta}{q^2} = \frac{ab}{q^2} = \frac{25'' \times 73''}{(135'')^2} = \frac{1825}{18225} = .1 \text{ steradians}$$

3. Total Interaction

Assuming the effects from other equipment to be negligible,

$$\Omega \text{ (Total)} = \Omega \text{ (Tanks)} + \Omega_2 = 1.6 + .1 = 1.7 \text{ steradians}$$

4. Allowable Interaction

From Table XVII, K-1019, Rev. 5, a 5" diameter cylinder has an allowable interaction of 3.2 steradians.

LICENSE:SNM-777, Docket:70-82
SECTION:900, Subpart: 914.4
SOLID ANGLE CALCULATIONS 1-D-10's and 1-D-16
Page 1 of 1 pages
Approved:
Issued: October 31, 1968
Supersedes: New

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 910 - Storage
Subpart: 915 - Cart Storage
915.1 - 11 Liter Bottle Carts

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

915.1 11 Liter Bottle Carts

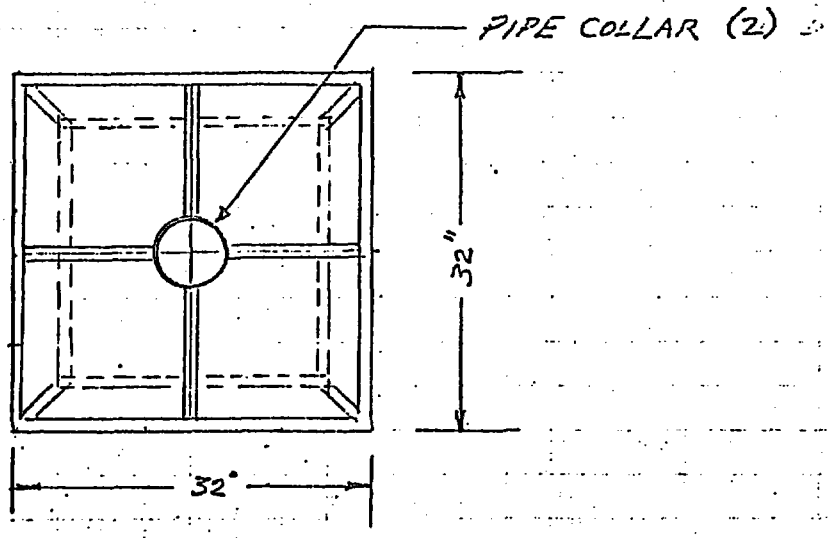
1. Description

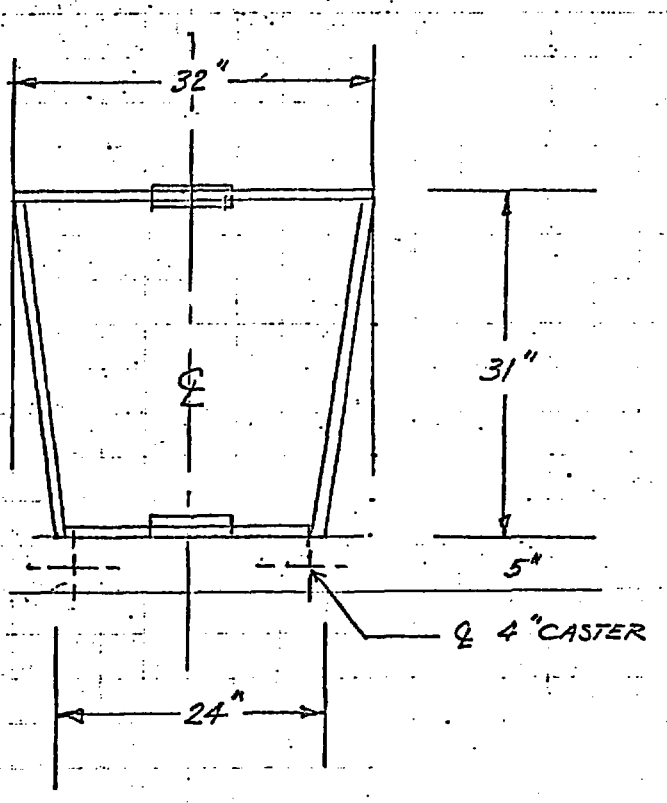
Five-inch outside diameter by 48 inch high (11 liter) polyethylene bottles will be used for the storage of uranium bearing liquors. This includes concentrated (up to limits of solubility) liquors and filtrates (0.01 grams per liter).

Each bottle is stored on an 11 liter bottle storage dolly of rigid steel construction. Carts are designed to hold a restricted (safe) cross-sectional area container with external barriers (birdcaging) maintaining sufficient separation between units that an infinite planar array is safe. This dolly is designed to provide two foot surface-to-surface spacing of the bottles. Space for 22 dollies is designated in Bay XI. Details of dolly construction are shown on Sketch 915.1-I.

2. Nuclear Safety

Carts and their storage arrangement meets the criteria of Table XIX, K-1019, Rev. 5 and is safe.





NOTES:

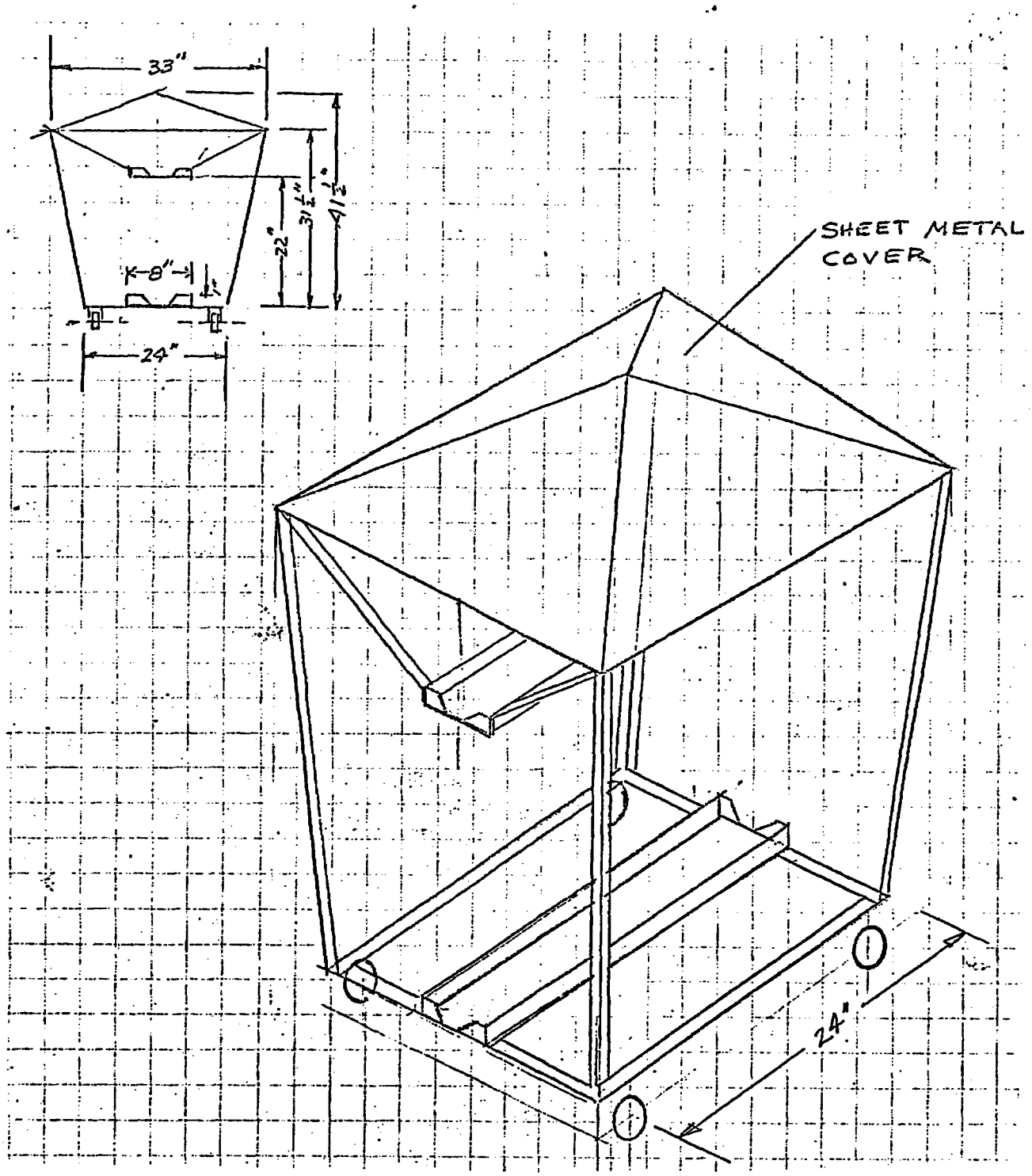
MATERIAL OF CONSTRUCTION:
1.0" ANGLE IRON
ALL WELDED

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 915.1
Sketch: 915.1-I, 5" Diameter Cylinder Dolly
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

915.2 Calciner Tray Carts

24" x 8" x 2" calciner trays from the 1-H-7 Calciner may be stored or transported on special dollies. These dollies are constructed of steel and designed with two shelves, each of which will hold one calciner tray. A sheet metal cover, formed like a pyramid, will be placed on the top to preclude stacking of trays. Trays will be separated from each other by 20". The design also provides 12" end-to-end and 25" side-by-side separation between trays on adjacent carts. Details of construction are shown on Sketch 915.2-I.

The solid angle between trays on one cart and trays or 11 liter bottles on six adjacent carts, is less than 1.3 steradians. There will be no more than seven (7) carts in the processing areas at any one time.



LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 915.2
Sketch 915.2-I, Calciner Tray Dolly
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

CASE I - Cart with six other calciner tray carts adjacent to it.

A. Treating the row of trays on each side of the centermost tray as an infinite cylinder,

d = tray thickness = 2", h = 29"

$$\Omega_{1a} = \frac{2d}{h} \quad \sin\theta = \frac{4}{29} = 0.14$$

Since there are trays on both sides of the centermost trays

$$\Omega_{1a}\ (\text{Total}) = 2 \times \Omega_{1a} = 0.28 \text{ steradians}$$

B. Tray directly above on same cart

a = 8", b = 24", q = 22", q = h since tray directly above

$$\Omega_{1b} = \frac{abh}{q^3} = \frac{8 \times 24}{(22)^2} = \frac{192}{484} = 0.397 \text{ steradians}$$

C. Trays above on adjacent carts

a=8", b=24", r=33", h=21", $q = \sqrt{r^2 + h^2} = \sqrt{(33)^2 + (21)^2} = \sqrt{1530} = 39.5"$

$$\Omega_{1c} = \left(\frac{ab}{q^2}\right) \cos\theta \qquad \text{where } \cos\theta = \frac{h}{q} = \frac{21}{39.5} = 0.532$$

$$= \frac{8 \times 24}{39.5^2}(0.532) = \frac{192}{1560}(0.532) = 0.124 \times 0.532 = 0.066 \text{ steradians}$$

$$\Omega_{1c}\ (\text{total}) = 6 \times \Omega_{1c} = 0.396 \text{ steradians}$$

D. $\Omega_1(\text{Total}) = \Omega_{1a}\ (\text{Total}) + \Omega_{1b} + \Omega_{1c}(\text{Total}) = 0.28 + 0.397 + 0.396 =$ 1.073 steradians

E. Allowable Interaction

Since these trays have a cross-sectional area less than that of a 5" dia. cylinder, assume that the values for a 5" dia. cylinder apply. Then, from Table XVII, K-1019, Rev. 5,

Ω (allowable) = 3.2 steradians.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 915.2
Interaction Calculations - Calciner Tray Carts
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

CASE II - Cart with six 11 liter bottle dollies adjacent to it

A. Tray directly above on same cart

$\Omega_{IIA} = \Omega_{IB} = 0.397$ steradians

B. Bottles in adjacent carts

$d = 5''$, $L = 48''$, $h = 33'' - \frac{d}{2} = 33'' - 2.5'' = 30.5''$

Using formula A.2, Appendix 3, K-1019, Rev. 5

$\Omega_{IIB} = \frac{d}{h} \sin \theta$ where $\tan \theta = \frac{L}{h} = \frac{48''}{30.5''} = 1.574$

$\sin \theta = 0.845$

$= \frac{5}{30.5} (0.845) = 0.164 \times 0.845$

$= 0.139$ steradians

Ω_{IIB} (Total) $= 6 \times \Omega_{IIB} = 0.834$ steradians

C. Total Interaction

Ω_{II} (Total) $= \Omega_{IIA} + \Omega_{IIB}$ (Total) $= 0.397 + 0.834 = 1.231$ steradians

D. Allowable Interaction

From I.E.,

Ω (allowable) $= 3.2$ steradians

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 915.2	
Interaction Calculations - Calciner Tray Carts	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

915.3 Bottle, Jar, Can and Bag Carts

1. Description

Carts similar to the type used for holding 11 liter bottles are provided for holding cans or bottles of SNM and SNM bearing components (e.g., plates, rods, etc.). These carts also may be used for vertical waste collectors.

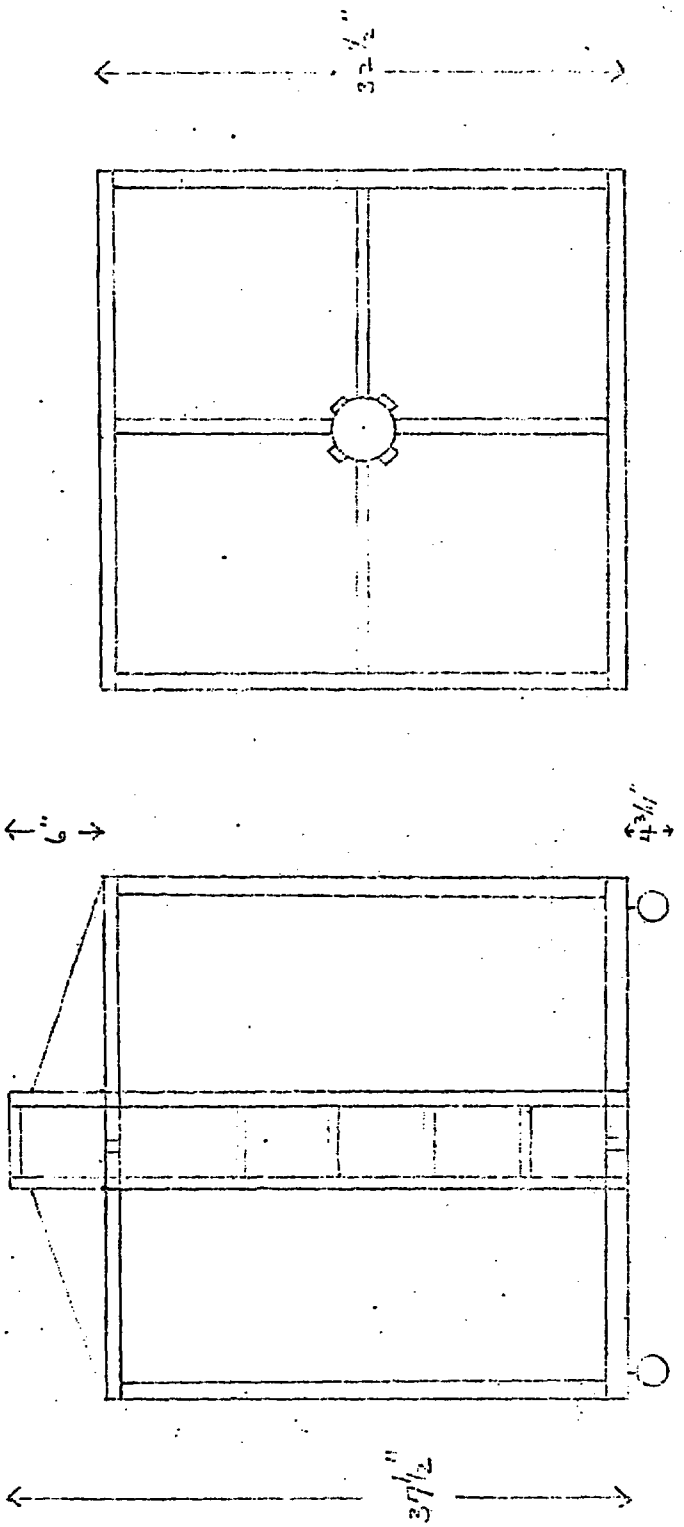
A 6" diameter opening is provided by collars attached to metal strips mounted vertically inside the external barriers (birdcaging) of the cart which are fastened to the base of the cart. This arrangement will allow the placement of 5" diameter or less bottles, jars or cans one on top of another in the opening. Also, an elongated plastic bag of 6" or smaller diameter may be inserted into the opening and used for waste collection.

Details of construction are shown on Sketch 915.3-I.

2. Nuclear Safety

Uranium alloys and compounds will be restricted to materials with densities not greater than 1 gram U-235 per cubic centimeter. The 5" diameter is nuclearly safe for solutions with densities not exceeding 3.2 grams U-235 per cubic centimeter. These values are shown on Fig. 3, TID-7016, Rev. 1.

The solid angle at a central cart is essentially the same as for the 11 liter bottle carts (Subpart 915.1).



LICENSE:SNM-777, Docket: 70-8

SECTION: 900, Subpart: 915.3

SKETCH 915.3-I

Page 1 of 1 pages

Approved:

Issued: October 31, 1968

Supersedes: New

916.1 Element Storage Racks

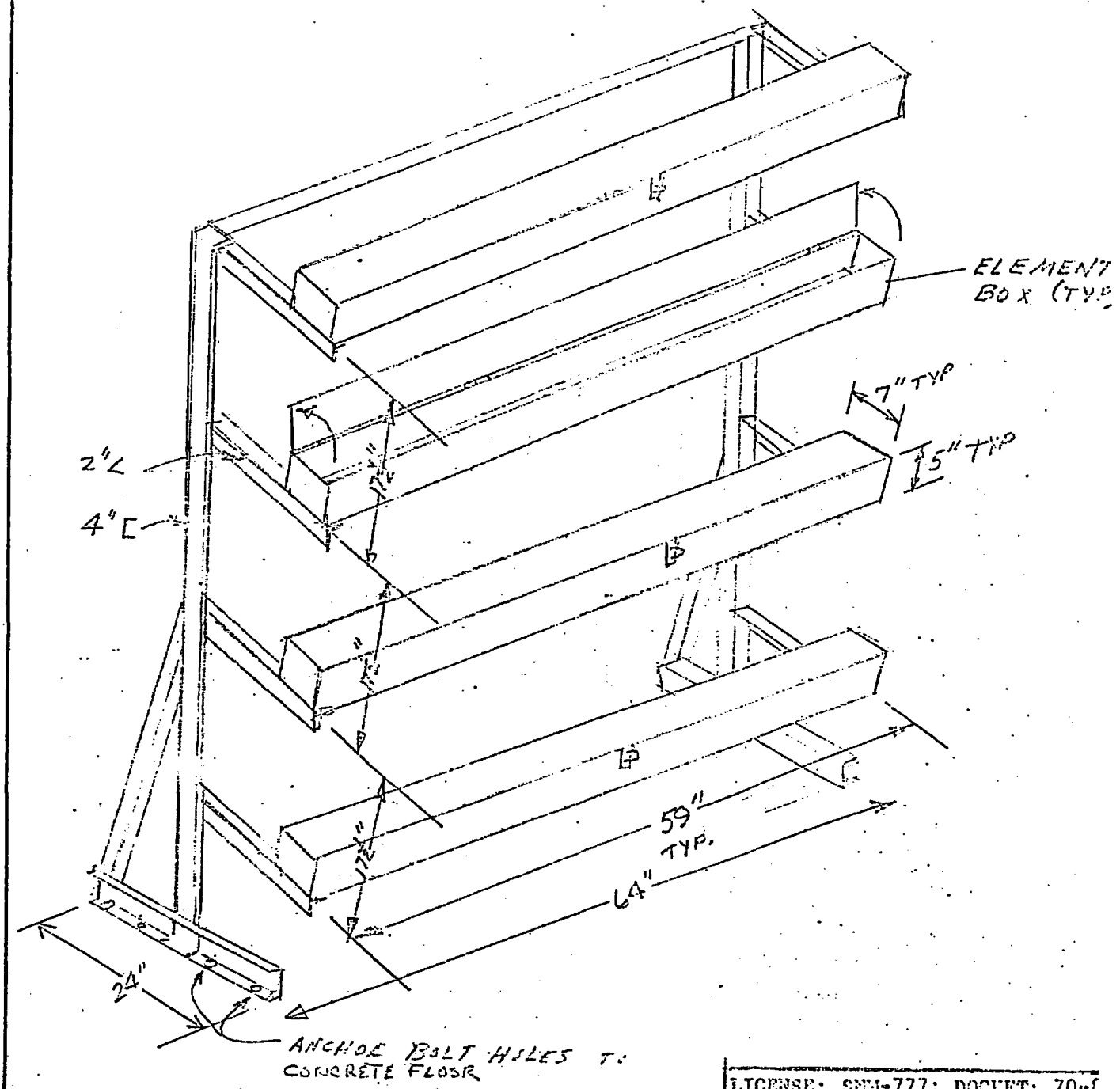
1. Description

These racks will be used to store components or parts or portions of components (usually rods or plates) after removal from their shipping container and prior to processing. These racks are constructed of 4 steel boxes, spaced 17 1/2" center-to-center, welded to a steel frame. Details are shown on Sketch 916.1-I.

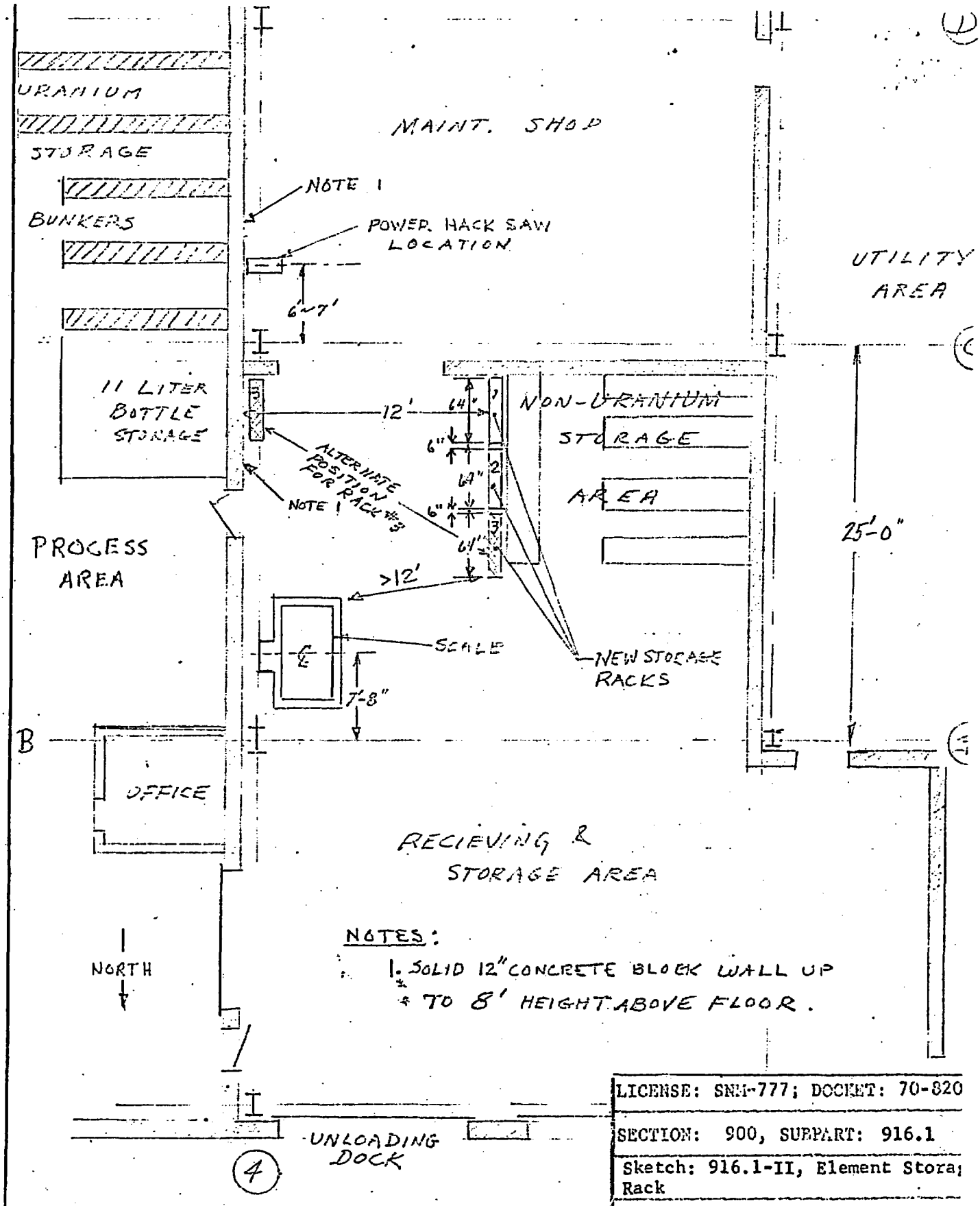
These racks will be located at the Receiving and Storage Area as shown on Sketch 916.1-II.

2. Nuclear Safety

Components composed of multiple plates or rods will be stored one per box. If parts or portions such as fillers, plates, rods, etc., are stored, each box will be modified by adding metal inserts which will restrict the cross sectional area to 19.64 sq. inches (a 5 inch diameter cylinder has a circular cross section equal to 19.64 sq. inches). For the storage of uranium-zirconium bearing components, depending on the weight fraction of the material to be placed in the box, the safe cross-sectional area of the boxes will be obtained using Figure 309-V. The maximum box cross-sectional area is 35 sq. inches (7" x 5").



LICENSE: SNM-777; DOCKET: 70-[	
SECTION: 900, SUBPART: 916.1	
Sketch: 916.1-I, Element Stora Rack	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 916.1	
Sketch: 916.1-II, Element Stora; Rack	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1963	

1. INFORMATION

a. Boxes are at least 12" edge-to-edge from each other

b. Box dimension: 5" high x 7" wide x 59" long

c. Racks lined up together form a long in line array of rectangles 5" x 7" x 177"

2. ASSUMPTIONS

a. Assume 7" box face to be diameter for solid angle calculation.

b. $L = \infty$, $\therefore$ $\sin \theta = 1$

3. CALCULATION

$$\Omega = \frac{2d}{h} \sin \theta$$

$$= \frac{14}{12} = 1.17$$

Since centermost unit sees 2 rectangular units

$$\Omega_{\text{all boxes}} = 2 \times 1.17 = 2.34 \text{ steradians}$$

From Figure 309-V, the weight fraction for a 35 sq. inch safe cross-sectional area is .034. From Figure 309-VII, the max. k eff for an unreflected safe cylinder at .034 weight fraction is .664. As shown on Figures 309-V and VII, larger weight fractions require reduced safe cross sectional areas which result in reduced k eff values.

Therefore, the .664 k eff value is the maximum for the boxes.

$$\Omega \text{ (allowable)} = 9 - 10\,k = 9 - 6.64 = 2.36 \text{ steradians}$$

4. CHECK

Table XVIII of K-1019 (Rev.5) indicates that 5" Ø cylinders (equivalent to a rectangular geometry with a 19.64 sq. in. cross section) are safe when forming an in line array with 1 ft. spacing between units.

5. ALTERNATE POSITION FOR RACK # 3

$$\Omega_{\text{central to central Rack \#3}} = \frac{2' \times 7''}{120''} \sin \theta$$

where h = 10' x 12 in/ft = 120" and,

$$\tan \theta = \frac{1/2\ L}{h} = \frac{32''}{120''} = 0.267 \quad \text{so,}$$

$$\sin \theta = 0.258$$

$$= \frac{14}{120}(0.258) = (0.117)\ (0.258)$$

$$= 0.030 \text{ steradians}$$

Since centermost unit sees four units on Rack #3

$$\Omega_{\text{central to all Rack \# 3}} = 4 \times 0.030 = 0.12$$

steradians, thus

$$\Omega_{\text{all boxes}} = 2.34 + 0.12 = 2.46 \text{ steradians}$$

Therefore, this arrangement also is safe

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 916.1	
Interaction Calculations - Element Storage Rack	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

917.1 Bay XIII Bunkers

1. Description

There are two 8' high x 9' long by 12" thick solid high density concrete block walls providing separation and support for storage located in Bay XIII. Their arrangement is shown on Sketch 917.1-I. The shelves are used for storage of any combinations of containers of metal, solutions, and wet and dry compounds. The containers described in Subpart 913.1 will be used. The individual container storage is arranged to give 1'4" horizontal center to center spacing, and 1'8" vertical center to center spacing. Each storage bunker or wall will have 4 rows of shelves containing 7 storage positions.

2. Nuclear Safety

This storage arrangement is essentially the same as described in Subpart 913.1 and the nuclear safety evaluations of Subparts 913.2,3, and 4 also apply. However, since these bunkers have only 4 rows with 7 storage positions each, the maximum solid angle for a central unit will be:

Two #1 Containers	=	.650 Ω
Two #2 Containers	=	.310 Ω
Four #3 Containers	=	.684 Ω
Four #4 Containers	=	.260 Ω
Four #5 Containers	=	.128 Ω
Two #7 Containers	=	.100 Ω
Two #8 Containers	=	.044 Ω
		2.176 Ω per bunker

NOTE: Details of Ω calculations for each container location shown in Subpart 913.4

The nearest equipment is a 5" diam. x 3' long cyclone plus container located 50" away. The contribution from this unit is:

$$d = 5'', \; L = 36'', \; L/2 = 18'', \; h = 50'' - 2.5'' = 47.5''$$

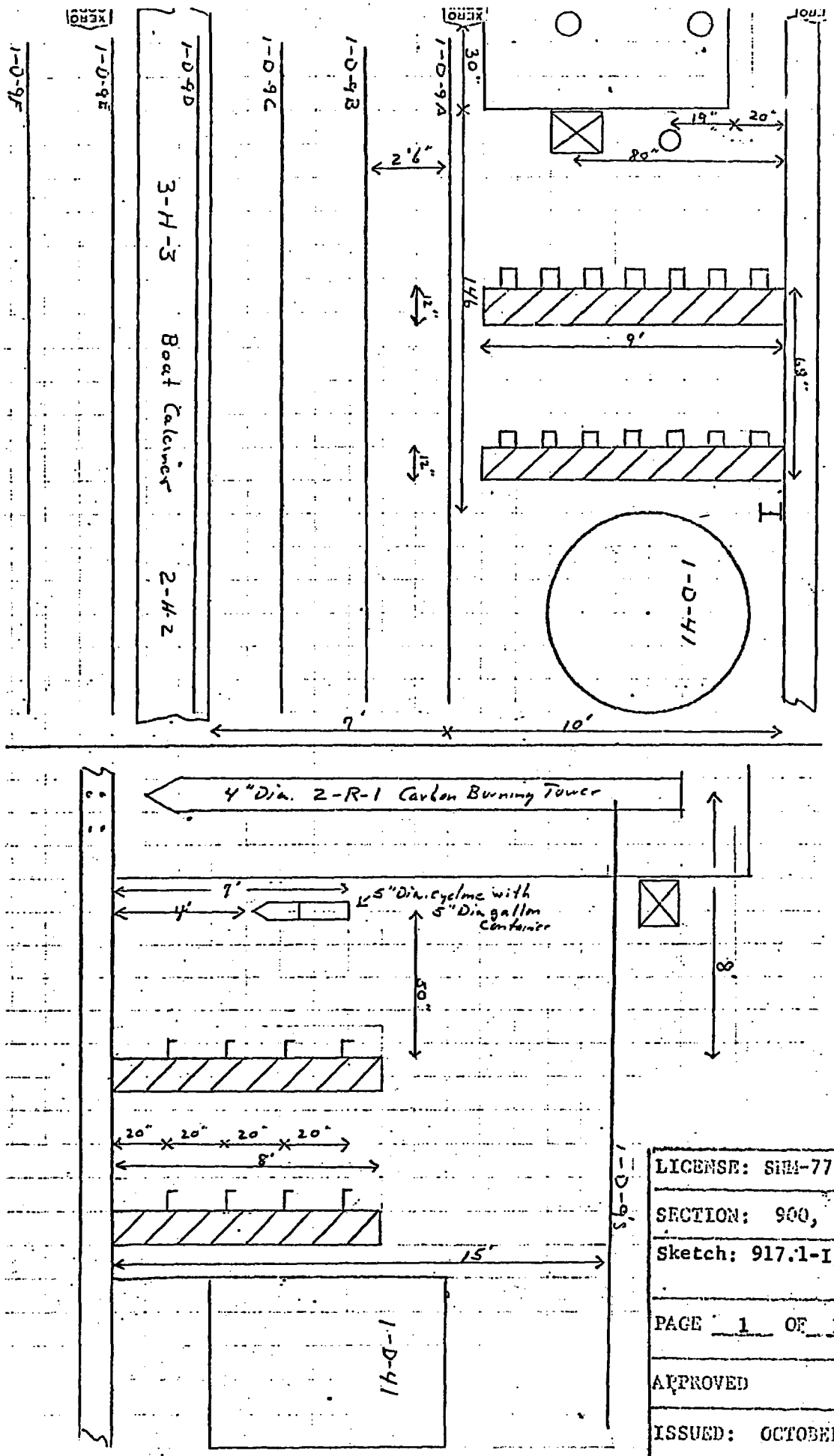
$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{18''}{47.5''} = .38$$

$$= \frac{10''}{47.3''} (.356) = .21 \times .356 = .075 \qquad \sin \theta = .356$$

All other equipment will be located 8' or greater away and their effects will be considered negligible. Therefore, the total interaction for the central unit will be:

$$\Omega \text{ (Total)} = 2.176 + .075 = 2.251 \text{ steradians}$$

This value is less than the allowable interaction of 3 steradians as listed in Subpart 913.4.



Note: Bottle Storage Positions are on 16" horizontal centers + 20" vertical centers.

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 910	
Sketch: 917.1-I, Bay XIII Bunke:	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

SECTION 900 - RECOVERY OPERATION

SUBSECTION 920 - PROCESSING (Formerly 300)

TABLE OF CONTENTS

Subpart 921 GENERAL CONSIDERATION (Formerly 301)

Subpart 922 PREPARATION OF SOLID SCRAPS (Formerly 302)

922.1 General (Formerly 302.1)
922.2 Glove Box 1-L-1 (Formerly 302.2.2)
922.3 Hood 1-L-14 (Formerly 302.2.3)
922.4 Hood 1-L-9A (Formerly 302.2.4)
922.5 Glove Box 1-L-9B (Formerly 302.2.5)
922.6 Degreaser 1-D-22 (Formerly 302.2.6)
922.7 Heads End Calciner System (Formerly 302.2.7)
922.8 Declad Hood 1-L-17 (Formerly 302.2.8)
922.9 All Purpose Hood 1-L-18 (Formerly 302.2.9)
922.10 Dry Solids All Purpose Hood 2-L-3 (Formerly 302.2.10)
922.11 Oxide Burning System (Formerly 302.8)
922.12 DDU System (Formerly 302.9)
922.13 Chloride System (Formerly 302.10)
922.14 Boat Calciner System (Formerly 302.15)
922.15 Hood 2-L-2 & Pulverizer 2-K-1 (Formerly 3.028)
922.16 Wet Cut-Off Saw (New)
922.17 Milling Machine (New)
922.18 Pexto Splitter (New)
922.19 Alligator Shear (New)

Subpart 923 DISSOLUTION OF SCRAP MATERIALS (New)

923.1 General (New)
923.2 Tray Dissolver System (Formerly 302.3)
923.3 Unlined Dissolver System (Formerly 302.4)
923.4 Teflon Lined Dissolver System (Formerly 302.5)
923.5 Assay Tanks 1-D-34 A, B, C, D, + E (Formerly 302.7)
923.6 Acid Insoluble Dissolver System (Formerly 302.11)
923.7 Large Tray Dissolver System (Formerly 302.12)
923.8 Vertical Hold Tanks 3-D-9A + B (New)
923.9 Permanent Assay Tank 3-D-12 (New)

Subpart 924 PREPARATION OF LIQUID SCRAPS (Formerly 302.6)

924.1 General (Formerly 302.1 + 2)
924.2 Pickle Liquor System (Formerly 302.6.3 + 4)
924.3 Other Liquors (Formerly 302.6.5)
924.4 Uranium Solutions System (Formerly 302.6.6)
924.5 Low Level Liquid Waste System (Formerly 302.12)
924.6 Aluminum Nitrate System (Formerly 302.14)

Subpart 925 PURIFICATION (Formerly 303)

925.1 General (Formerly 303.1 and 303.3)
925.2 Extraction Column 1-C-6 (Formerly 302.2.1)
925.3 Scrub Column 1-C-7 (Formerly 302.2.1)
925.4 Stripper Column 1-C-8 (Formerly 303.2.2)
925.5 Organic Feed Tank 1-D-5 (Formerly 303.2.4)
925.6 Scrub Solution Tank 1-D-3 (Formerly 303.2.6)
925.7 Strip Acid Tanks 1-D-6 A + B (Formerly 303.2.6)
925.8 Distilled Water Tank A-9 (Formerly 303.2.8)
925.9 20 Gallon Hot Water Heater (Formerly 303.2.9)
925.10 Waste Treatment Tanks 1-D-14 A + B (Formerly 303.2.1)
925.11 Waste Lagoon (Formerly 303.4.3)
925.12 Miscellaneous Solution Discard Station (Formerly 303.4.4.)
925.13 Slop Tanks 1-D-21 A + B (New)
925.14 Extractor Feed Tank 1-D-41 (New)
925.15 Other Waste Streams (Formerly 303.5)

Subpart 926 END PRODUCT (Formerly 304)

926.1 General (Formerly 304.1)
926.2 OK Liquor Evaporation System (Formerly 304.2)
926.3 Filtrate Tanks 1-D-24 A + B (Formerly 304.3)
926.4 ADU Precipitators 1-D-19 A, B + C and 1-D-20 A, B, C + D (Formerly 304.4)
926.5 ADU Filtration and Drying Hood 1-L-11 (Formerly 304.5
926.6 Reactor Loading Glove Box 1-L-20 (Formerly 304.6)
926.7 Reactor Furnace 1-H-3 (Formerly 304.7)
926.8 Reactor Cooler 1-D-42 (Formerly 304.7)
926.9 Reactor Unloading Hood 1-L-8 (Formerly 304.8)
926.10 Interim Product Weighing (Formerly 304.9)
926.11 Product Blending (Formerly 304.10 + 11)
926.12 ADU Precipitation and Filtration Tanks 1-D-19 A + B (Formerly 305.1)
926.13 ADU Drying and Unloading (New)
926.14 Muffle Boxes (Formerly 305.3)
926.15 Muffle Box Furnace 1-H-4 A + B (Formerly 305.4)
926.16 Muffle Box Storage Rack (New)

921. General Considerations

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

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

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

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

   1.3 Special instructions are provided to the employees for cleanup.

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

   2.1 Air Failure

      2.1.1 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.

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

   2.2 Steam Failure

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

3. For heat exchangers and other equipment dependent on cooling water, water pressure is maintained by the 500 GPM pump which is located 400 ft. from the building (the well has a 700 GPM capacity) and a 10,000 gallon water storage tank on the roof on a 40 foot tower. A water pressure gage (located in Bay IV) is checked at least every three hours by process personnel during the day shift. The security guard checks on off-shifts and equipment is not operated unless attended. Loss of water pressure requires shutdown of all processing and, therefore, is frequently checked.

A listing of equipment including its equipment number and bay location is provided on Table 921-I.

EQUIPMENT LIST

NO.	DESCRIPTION	ASSOCIATED EQUIPMENT	BAY	CAPACITY
AGITATORS				
1-A-1	Raw Liquor Agitator	1-D-12	XIX	
1-A-2	Aluminum Nitrate Agitator	1-D-28	XIX	
1-A-4 A, B	Process Waste Tank Agitator	1-D-14 A, B	XIX	
1-A-5	Solvent Cleanup Agitator	1-C-9	XX(I)	
BLOWERS-EXHAUST FANS				
1-B-2	Counting Degreasing Hoods	1-L-1	XIV	
1-B-3	Tray Dissolver Hood	1-L-3 A, B, C	XIV, XVII	
1-B-4	Dissolver Glove Box	1-L-12		
1-B-5	Various Hoods	1-L-11,1-L-8,1-L-20		
1-B-7	Exhaust Hood; Sample Blender	1-L-6	XV	
1-B-8	Precipitation Vent Box	1-D-20	XXI	
1-B-12	Precipitator Hood	1-D-19	XXI	
1-B-13	Heads End Calciner	1-H-7	XVI	
1-B-14	Mill Hood	1-L-14,1-L-9	XIV	
1-B-15	Declad Hood	1-L-17	XVII	
1-B-16	All Purpose Hood	1-L-18	XVII	
1-B-17	Mill Hood	1-L-16 A, B	XXI	
1-B-18	Incinerator	1-X-23	XVI	
COLUMNS				
1-C-6	Extraction Pulse Column		XX(1)	
1-C-7	Scrub Pulse Column		XX	
1-C-8	Strip Pulse Column		XX	
-C-9	Solvent Cleanup Column		XX	
1-C-10	O K Liquor Cleanup Column		XX	
1-C-12	Organic Phase Separator 4" dia. x 48" long		XX	
TANKS				
1-D-1	NH_4OH Storage Tank 28%	Outside		5,000 gal.
1-D-2	NH_4OH Head Tank	1-D-12	XIX	55 gal.
1-D-3	Scrup Solution Tank	1-D-6	XX(3)	400 gal.
1-D-5	Solvent Feed Tank	Outside		80 gal.
1-D-6 A, B	Strip Acid Tanks	1-D-3	XX(3)	400 gal.
1-D-9 H	Mixing Column			
1-D-9 A-F	Extractor Feed Tanks		XIII	45 gal.
1-D-9 G	Extractor Feed Tanks Overflow			
1-D-10 A, B	O K Liquor Storage Tanks	1-D-16	XVIII	60 gal.
1-D-10 C	Concentrated O K Liquor Storage Tank	1-D-16	XVIII	60 gal.
1-D-12	Raw Liquor Tank	1-D-2	XIX	90 gal.
1-D-13	Wash Tank	1-L-1	VII, X	10 gal.
1-D-14 A, B	Process Waste Treatment Tanks	1-D-28	XIX	750 gal.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900; SUBPART: 921
TABLE 921-I
PAGE 1 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

NO.	DESCRIPTION	ASSOCIATED EQUIPMENT	BAY	CAPACITY
1-D-16	O K Liquor Storage Tank	1-D-10	XVIII	45 gal.
1-D-19 A-C	Precipitator	1-H-2	XXI	5 gal.
1-D-20 A-D	Precipitator	1-H-1	XXI	8 gal.
1-D-21 A, B	Slop Tanks	Outside		1,200 gal.
1-D-22	Degreaser	1-L-1	XIV	
1-D-24 A, B	Filtrate Tanks	1-P-17	XVIII	500 gal.
1-D-27	Nitric Acid Gage Tank	1-J-1	XVII	12 gal.
1-D-28	Aluminum Nitrate Makeup Tank	1-D-14	XIX	500 gal.
1-D-29	HNO_3 Storage Tank	Outside		5,000 gal.
1-D-30	HF Gage Tank	1-J-1	XVII	4 gal.
1-D-34 A-G	Assay Tanks	1-W-2	XVII	8 gal.
1-D-35	Head Tank HF, H_2O_2	1-L-3 B	XIV	40 gal.
1-D-36	Tray Dissolver Storage Tank	1-L-3 A	XIV	8 gal.
1-D-41	Extractor Feed Tank		XVI	1,500 gal.
1-D-42	Reactor Water Spray Cooler		XVIII	55 gal.
1-D-43	Misc. Solution Hold Tank	1-L-17	XVII	8 gal.
1-D-44	Organic Head Tank	1-C-6	XX	
1-D-45		1-C-8		
EXCHANGERS - EVAPORATORS				
1-E-1	Condensor	1-D-20	XXI	
1-E-2	O K Liquor Evaporator	1-D-20	XXI	
1-E-7	Dissolver Vent Condenser	1-J-4	XIV	
FILTER-SCRUBBERS				
1-F-1	Pickle Liquor Extractor Feed	1-D-12	XIX	10 gpm
1-F-4	ADU Pressure Filter	1-L-11	XXI	5 gpm
1-F-6	Tray Filter	1-L-3 B	XIV	
1-F-15	Polishing Filter	1-H-1	XXI	5 gpm
1-F-24 A	Extractor Feed	1-J-1	XVII	10 gpm
1-F-24 B	Extractor Feed	1-J-4	XVII	10 gpm
1-F-24 C	Extractor Feed	1-P-2	XVI	
1-F-2	Oblique Filler	1-P-32	XX	
OVENS - FURNACE				
1-H-1	Drying Oven	1-L-11, 1-L-20	XXI	
1-H-2	Misc. Cake Drying Oven	1-L-16 A, B	XXI	
1-H-3	Verticle Tube Furnace		XVIII	
1-H-4	Muffle Pre-Fire Furnace		XVII	
1-H-5	Muffle Transfer Cart		XVII	
1-H-6	Muffle Cooler			
1-H-7	Heads End Calciner		XVI	
1-H-8	Heads End Dryer	1-K-4, 1-L-14	XIV	

LICENSE: SNM-777; DOCKET: 70-82(

SECTION: 900; SUBPART: 921

TABLE 921-I

PAGE 2 OF 5

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDED: NEW

NO.	DESCRIPTION		ASSOCIATED EQUIPMENT	BAY	CAPACITY
DISSOLVERS					
J-1	Teflon Lined Dissolver			XIV	
1-J-4	Unlined Dissolver			XIV	
1-J-5 A, B	Tray Dissolver		1-L-3 A, B, C	XIV	
PULVERIZERS - MILLS					
1-K-1	Ball Mill		1-L-9A	XVII	1/2 pint
1-K-2	Pulverizer		1-L-8	XV	50-100 lbs/hr
1-K-3	Hammer Mill		1-L-9B	XVII	50-100 lbs/hr
1-K-4	Ball Mill		1-L-14	XIV	1/2 pint
HOODS-GLOVE BOXES					
1-L-1	Glove Box	1-W-1	Counting Hood	XIV	
1-L-3 A-C	Hood		Tray Dissolver	XIV	
1-L-4	Glove Box		S.S. Dissolver	XIV	
1-L-6	Glove Box	1-X-14	Sample Blender	XV	
1-L-7	Hood Precipitator	1-D-19	Precipitator	XXI	
1-L-8	Glove Box		Reactor Unload	XV	
1-L-9 A	Hood		Blending	XVII	
1-L-9 B	Glove Box	1-K-3	Milling	XVII	
1-L-11	Hood	1-H-1	Filter Drying	XXI	
1-L-13	Glove Box		Teflon Dissolver	XIV	
1-L-14	Hood	1-K-4	Milling Drying	XIV	
1-L-16 A	Hood	1-H-2	Drying	XXI	
1-L-16 B	Glove Box	1-H-2	Loading	XXI	
1-L-17	Hood		Declading	XVII	
[illegible]-L-18	Hood		All Purpose	XVII	
[illegible]-L-20	Glove Box	1-H-1	Reactor Loading	XXI	
PUMPS					
1-P-1	NH_4OH Feed Pump		Outside		15 GPM
1-P-2 A, B	Extractor Feed Pumps		1-D-41	XVI	0-1
1-P-3	Process Waste Transfer Pump		1-D-14	XIX	25
1-P-4	Raffinate Pump			XX	1
1-P-5	Filter Feed Pump		1-D-20	XXI	5
1-P-6	Adj. Liquor Transfer Pump		1-D-12	XIX	10
1-P-8	Dissolver Pump, Teflon		1-J-1	XVII	10
1-P-17	Filtrate Recovery Pump		1-D-24	XVIII	10
1-P-20	HNO_3 Pump		Outside		15
1-P-21	Slop Pump		Outside		10
1-P-23	Conc. Liquor Feed Pump			XXI	0-2
1-P-28	Raffinate Pump			XX	

LICENSE: SNM-777; DOCKET: 70-8

SECTION: 900; SUBPART: 921

TABLE 921-I

APPROVED:

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

NO.	DESCRIPTION	ASSOCIATED EQUIPMENT	BAY	CAPACITY
1-P-29	Stripper Feed Pump		XX	0-1
P-30	Scrup Sol'n. Recirculating Pump		XX	0-1
P-32	O K Liquor Pump		XX	2
1-P-33	Solvent Feed Pump		XX	0-1
1-P-34	Extractor Feed Recirculating Pump		XVI	
REACTORS				
1-R-1 A, B	Reactor Box			
1-R-2	Reactor Tube			
WEIGHING SCALES				
1-W-1	Scale, Counting Hood	1-L-1	XIV	5 KG
1-W-2	Scale, Assay Tank	1-D-34	XVII	250 KG
1-W-4	Scale, Dissolver Trays	1-L-3	XIV	500 lbs.
1-W-5	Scale, Shipping		VII	2,400 lbs.
1-W-6	Scale, Drum	1-D-12	XIX	800 lbs.
1-W-7	Scale, Finished Product	1-L-6	XV	5 KG
1-W-8	Scale	Misc.		5 KG
MISCELLANEOUS				
1-X-1	Cyclone			
1-X-2	Cyclone			
1-X-13	Portable Hoist-Raw Liquor 55 gallon drum capacity		XIX	
1-X-14	Can Sealer	1-W-7	XV	
1-X-16	Reactor Loading Cart		XVIII	
1-X-17	Monorail Hoist for Reactor		XVIII	
1-X-18	Reactor Holding Rack	1-R-2	XV	
X-22	Drum Tilter		XIX	
1-X-23	Incinerator Scrubber		XVI	
NEW EQUIPMENT				
2-C-1	Chloride Column			
2-F-1 A, B	Exhaust Filters			
2-F-2	Primary Filter Housing			
2-F-3 A, B	Chloride Column Scrubber			
2-F-4	DDU Scrubber			
2-F-5	Chloride Column Filter Plate & Frame			
2-F-6	Carbon Tower Hood Filter			
2-H-1	DDU Furnace			
2-J-1	Chloride Column Dissolver			
2-L-1	Chloride Column Dissolver Hood			
2-P-1	Chloride Column Pump			
2-P-2	Chloride Column Scrubber Pump			
2-P-3	Scrubber Pump - 2-X-1 Scrubber			

NO.	DESCRIPTION	EQUIPMENT	BAY	CAPACITY
2-R-2	DDU Retort			
2-R-1	Carbon Burning Tower			
2-X-1	Scrubber w/2-P-3 Pump			
2-L-2	Milling and Weighing Hood			
2-L-3	Dry Solids All Purpose Hood			
2-L-4	Inlet Glove Box			
2-L-5	Exit Glove Box			
2-L-6	O_2 Glove Box Top			
2-H-2	Pre-heat Furnace 600°F			
2-H-3	High Heat Furnace 1800°F			
2-H-4	Cooling Tube			
2-W-1	3-D-12 Assay Tank Scale			
3-D-2	5" Dia. x 11' S.S. Filtrate Tank AID	3-J-2	XIV	12 Gals.
3-D-3 A, B	5" Dia. x 50' Polypro Head Tanks MIN	1-D-10's	XV & XVIII	52 Gals.
3-D-4	6" Dia. x 4' glass ANN Head Tank	1-J-1	XVII	6 Gals.
3-D-5	" " " " " " " "	1-J-5	XIV	6 Gals.
3-D-6	" " " " " HNO_3 " "	1-J-5	XIV	6 Gals.
3-D-7	" " " " " HC_1 " "	1-J-5	XIV	6 Gals.
3-D-8	" " " " " " " "	1-L-17	XVII	6 Gals.
3-E-2	Dupont teflon Condenser AID	3-J-2	XIV	
3-E-3	Dupont teflon Heat Exchanger, ANN	3-J-3	XV	
3-F-2	Polypropylene Tray Filter AID	3-J-2	XIV	
3-F-3	Polypro Filter ANN	3-J-3	XV	
3-J-2	Teflon Acid Ins. Dissolver AID			
3-J-3	6' long Polypro Dissolver Tray ANN	3-L-4	XV	
3-L-1	3' long Polypro Hood AID	3-J-2	XIV	
3-L-2	S.S. Glove Box AID	3-J-2	XIV	
3-L-3	Polypropylene Storage Housing AID	3-J-2	XIV	
3-L-4	8' long Polypro ANN Hood	3-J-3	XV	
3-P-3	No. 120 Vanton Pump ANN	3-J-3	XV	
3-X-1	Fume Scrubber ANN	1-D-27	XIX	
3-X-2	Vent Trap AID	3-J-2	XIV	
3-X-3	Air Heaters AID	3-J-2	XIV	
3-X-4	Moisture Trap Alarm AID	3-J-2	XIV	
3-L-5	Hood for 3-F-5 Tray Filter	3-J-3	XVI	
3-F-5	Tray Filter in 3-L-5 Hood	3-J-3	XIV	
3-D-10	Hold Tank for 3-F-5 Filter		XVI & XVIII	
3-D-11 A, B	Hold Tank for 3-F-5 Filter		XVI & XVIII	
3-D-12	New Assay Tank		XVI & XVIII	
3-P-4	Aluminum Nitrate Pump	1-D-28	XIX	

LICENSE: SNM-777; DOCKET: 70-28

SECTION: 900; SUBPART: 921

TABLE 921-I

PAGE 5 OF 5

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

922.1 General (Dwg. A-602, Dwg.Y-601, Bays X,XI,XIII,XIV,XVI,XVII,XIX)

This area is designed for the safe processing of uranium or uranium bearing materials up to and including full enrichment in the U-235 isotope. Safety is assured through the use of geometrically safe equipment or by the use of 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.

1. Process Description

Activities include, but are not limited to, the following:

a) Preparation of scrap materials for dissolution or transfer of solutions for processing which involve the preliminary handling, sorting, sampling, crushing, degreasing, oxidation, calcining, etc. of scrap feed materials.

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

2. Handling

Solid scrap materials require different treatment depending on their physical and chemical form. This may consist, for example, of weighing out batches for dissolution, oxidation, calcination, or mechanical crushing and cutting wet or dry milling of such batches, and packaging of the batches in a safe process container for transfer to a subsequent process step. Operations will typically be done in glove boxes or hoods such as 1-L-1, 2-L-2, 1-L-14, 1-L-17, 1-L-18, or 1-L-9A, depending on the "as received" container or treatment required. Solid combustible wastes are handled in a special destructive distillation unit described in Subpart 922.12.

3. Identification

Incoming shipments will be identified in accordance with the techniques set forth in Section 500. For nuclear safety reasons, it will be assumed that all material is fully enriched until proven otherwise.

922.2 Glove Box 1-L-1

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. Material having a density greater than 3.2 grams of U-235 per cubic centimeter will be handled in containers where the total volume will be restricted to 3.6 liters and a mass content of 3.6 kgs U-235.

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.

Other materials for calcining or further processing may be loaded into trays or into safe geometry containers, for example, high density oxide to be reduced in density by calcination may be loaded on the trays that are safe by thickness not to exceed 2" depth of material in the tray for insertion into the calcining furnace.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.3 - Hood 1-L-14

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.3 Hood 1-L-14

1. General

This hood is equipped with rollers (1-K-4) for ball milling or blending. Also, this hood may be used as an alternate station for drying ADU in an oven similar to the 1-H-8 Drying Oven. Also, a bottle filling compartment is located under the hood.

Only one of the following listed jobs will be permitted at one time, with the exception that a single cake of ADU may be dried in the drying oven, 1-H-8, while ballmilling or blending or other operations are being performed in the rest of the hood, as indicated below:

a) Lot Blending and Packaging

b) Unloading "as received" containers too large for glove Box 1-L-1.

c) Wet or dry ball or rod milling and drying.

d) Loading and unloading muffle boxes.

e) Shearing of fuel plates or rods.

2. 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 Subpart 926.11).

3. 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.

4. Ball or Rod Milling

Milling will be done in one gallon poly bottles. Bottles are placed on a single set of rollers. No more than 2 bottles will be placed on the rollers with 10" spacing between filled bottles being provided by an empty bottle. The empty bottle will be painted red or otherwise distinctively market for positive identification. One gallon is a safe volume for materials having densities less than 3.2 grams uranium per cc. For materials having densities greater than this, a mass limit of 3.6 kg U-235 is imposed.

5. Drying

The oven 1-H-8 will hold two 12" x 12" x 1-1/4" trays or one 10-1/2" dia. (max.) x 4" Buchner Filter. This oven will be used to dry solids as required for further processing.

6. 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 Subpart 926.14.

7. Shearing of Fuel Plates or Rods

When shearing fuel plates or rods, only one plate or rod will be processed at a time. The parts or pieces from the shearing will then be removed and placed in storage or introduced to one of the dissolution systems.

8. 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.

calculated on OAK RIDGE GASEOUS DIFFUSION PLANT solid angle slide rule

Solid Angle subtended from area in front of oven + muffle box where a bottle could possibly be present in storage. Solid Angle subtended by:

1. Ball mill

$h_1 = 3.3'$ $\quad h/a = 3.3/3.0 = 1.1$

$h/b = 3.3/0.42 = 0.79$ $\quad \Omega_1 = 0.89$

2. Muffle box

$h_2 = 1.2'$ $\quad h/a = 1.2/0.67 = 1.8$

$h/b = 1.2/0.67 = 1.8$ $\quad \Omega_2 = 0.29$

3. Bottle Compartment

$h_3 = 1.5'$ $\quad h/a = 1.5/.5 = 3.0$

$h/b = 1.5/0.5 = 3.0$ $\quad \Omega_3 = 0.11$

4. Oven

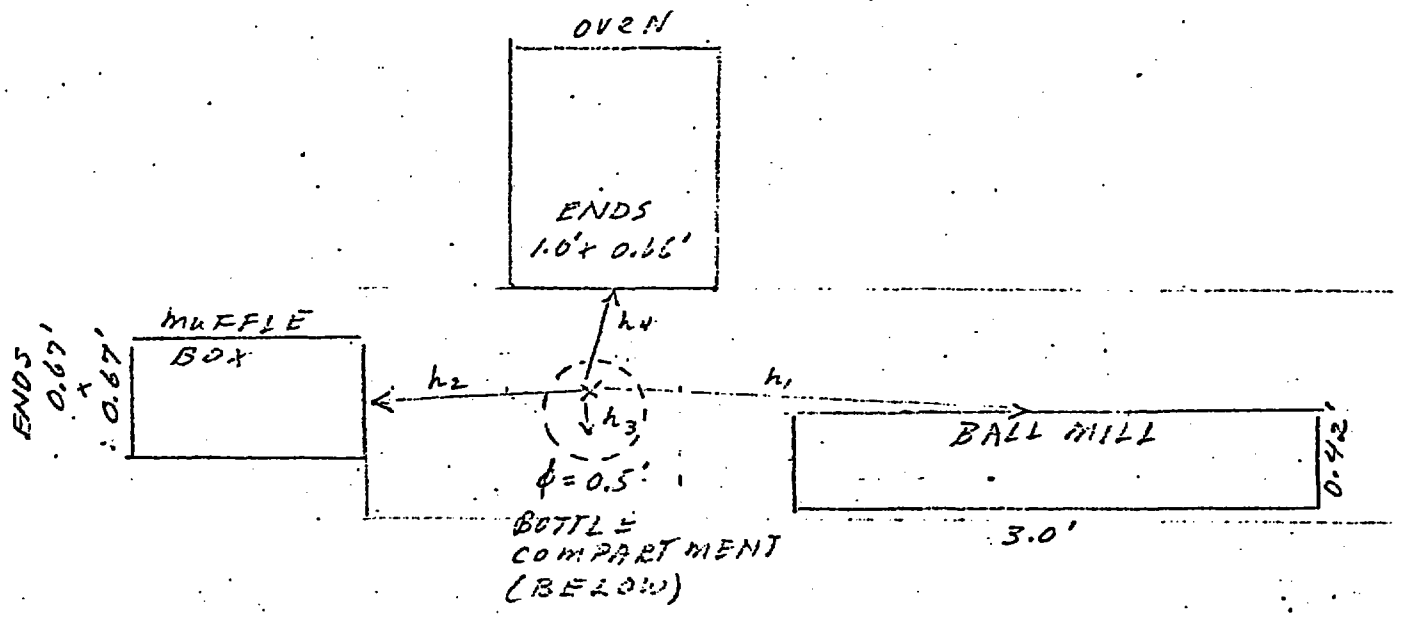
$h_4 = 1.0'$ $\quad h/a = 1.0/1.0 = 1.0$

$h/b = 1.0/0.66 = 1.5$ $\quad \Omega_4 = 0.57$

5. Total Solid Angle Subtended

$$\Omega_1 + \Omega_2 + \Omega_3 + \Omega_4 = 1.86$$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 922.3
Solid Angle Calculations - Hood 1-L-14
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968



$h_1 = 3.3'$

$h_2 = 1.2'$

$h_3 = 1.5'$

$h_4 = 1.0'$

NOT TO SCALE

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 922.3
Solid Angle Calculations - Hood 1-L-14
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.4 - Hood 1-L-9A

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.4 Hood 1-L-9A

This hood is equipped with a bottle filling compartment under the hood. Only one of the following will be done at a time:

a) Unloading "as received" containers.

b) Loading, unloading, or cooling calciner trays.

c) Equipment clean up.

d) Miscellaneous operations required in a ventilated hood, i.e., shearing, sorting, etc.

The nuclear safety discussion of Subparts 922.3 or 922.7 are applicable here.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.5 - Glove Box 1-L-9B

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

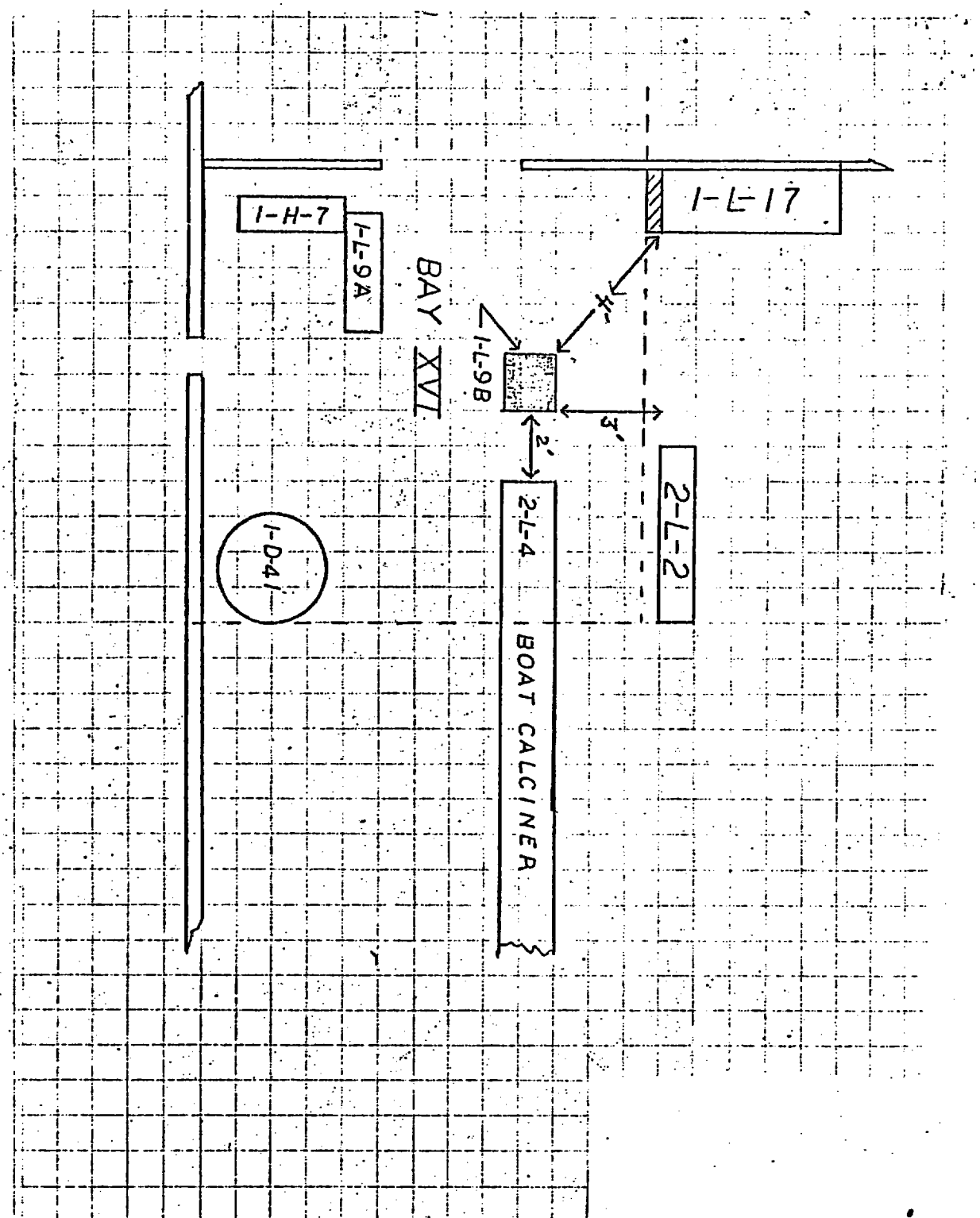
922.5 Glove Box 1-L-9B (See Sketch 922.5-I)

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-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 than a one gallon volume.

For materials having densities greater than 3.2 gms U-235 per cc, the total volume of materials will be restricted to 3.6 liters and a mass content of 3.6 kgs U-235.

This hood is separated from all other equipment by at least 2' and the interaction is considered negligible.



LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 922.5
Sketch: 922.5-I - Location of 1-L-9B Hood
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

922.6 Degreaser 1-D-22

1. General

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

2. Equipment and Nuclear Safety

A fine screen basket of such size as to fit the 7 1/4" x 7 1/4" cleaning section of the Degreaser, is placed on a tray one inch or less in depth. The contents of the incoming container, 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.

The interaction between the 1-D-22 Degreaser and the Overhead Storage tank Overflow System (reference Subpart 914.2) is considered negligible.

922.7 Heads End Calciner System

1. Calciner 1-H-7

Combustible uranium bearing residues, either generated within the plant or off-site, will be transferred to calcining trays, size 2" x 8" x 24" long (bottom dimensions) one (1) tray at a time in a ventilated hood, usually the 1-L-9A (reference Subpart 922.4). The trays, covered when transferred in the open, are charged to the Tube Calciner (10 1/8" diameter by 66" long) one at a time, end to end. The face flange is sealed and the tube furnace is heated (15 KW furnace) to distill off low boiling organics and to oxidize residual combustible material to an ash. Air and/or O_2 are introduced into the retort. The trays are removed one (1) at a time upon completion of the cycle, covered, cooled and unloaded. The ash is transferred to safe volume or geometry containers for storage and further processing.

2. Scrubber 1-X-23

Gases from the distillation and burning will be scrubbed with an aqueous solution in the 1-X-23. The scrubber will be periodically sampled, drained, and recharged with water.

Frequency of sampling will be administratively controlled through the SOP and operating documents.

3. Nuclear Safety

The cross-sectional area of the Calciner Tray (2" deep x 8" wide) is less than that of a 5 inch diameter cylinder.

The scrubber is 6" I.D. and is less than 47 inches in length. Though this solution is normally less than 1 gm U/l, the solution is sampled at frequent intervals to insure a maximum concentration of 5 g U/l. The 6" tees in the vapor section are wrapped with 1/8" thick cadmium sheets. The sheet is painted with epoxy paint to insure protection from corrosion. The nuclear safety of 6" diameter cylinders wrapped with at least 0.020" of cadmium is contained in Subpart 923.4.

922.8 Declad Hood 1-L-17

1. General

This hood is designed for, but not limited to the removal of the cladding materials from uranium bearing materials and the re-working of residues that have been generated in other parts of the plant.

Equipment utilized is of laboratory type complying with the safe volume requirements or of geometrically safe design.

Proper sizing and spacing plus the added restrictive barriers placed about the equipment, permit nuclearly safe utilization of all equipment at any one time.

2. Equipment

This hood is equipped with hot plates, 4 liter or smaller containers and Buchner filtration stations. At any one time dimensionally restricted (1-1/2" deep x 12"x 20") trays may be substituted for hot plates and beakers, and/or Buchner filtering stations. A restricted dimension digester, for example a 5" pipe, may also be substituted for one or more of the stations as required.

Pre-weighing of residues will be carried out in already licensed hoods or glove boxes. Where charges are specified of an approximate weight or volume, they may be transferred in the hood per se.

Centerline of the equipment in the hood will be the centerline of the hood or 16" inside the front face.

Diagrammatic sketches are attached. (Sketches 922.8-I, II and III.)

3. Safety and Criticality Control Considerations

a) This hood has a stainless steel pan bottom and flat top. Depth of the bottom pan is 2" with openings totaling one square inch to cause solution overflow at one inch depth.

b) Physical barriers separating installed equipment prevent loading at the side, front or back of each.

c) Pad for equipment set up is 10" square, eliminating the possibility of side by side placing of equipment.

d) Buchner filtering flasks standard 8" across the base, the funnels are stainless steel or porcelain, having diameters 9" and 10-1/2" respectively.

e) Process piping inside the hood will normally be no larger than 1". Larger sizes have been made a part of the criticality consideration.

922.8 (Continued)

f) In the adjacent room behind the hood, process piping and equipment are not in contact with the column wall which is 12" solid concrete block construction.

g) This hood has a plexiglass front with minimum openings to maintain required air flow velocity with not more than 2 doors opened at any one time.

h) Air exhaust from the hood is filtered through absolute filters.

i) All operations in this hood will be performed according to standard operating procedures which have had prior internal reviews and approvals.

j) Trays for the hot plates will be of stainless steel, 10" square, by 1" deep up to a maximum 1-1/2" deep, or of a cross-sectional area equivalent to a 5" pipe.

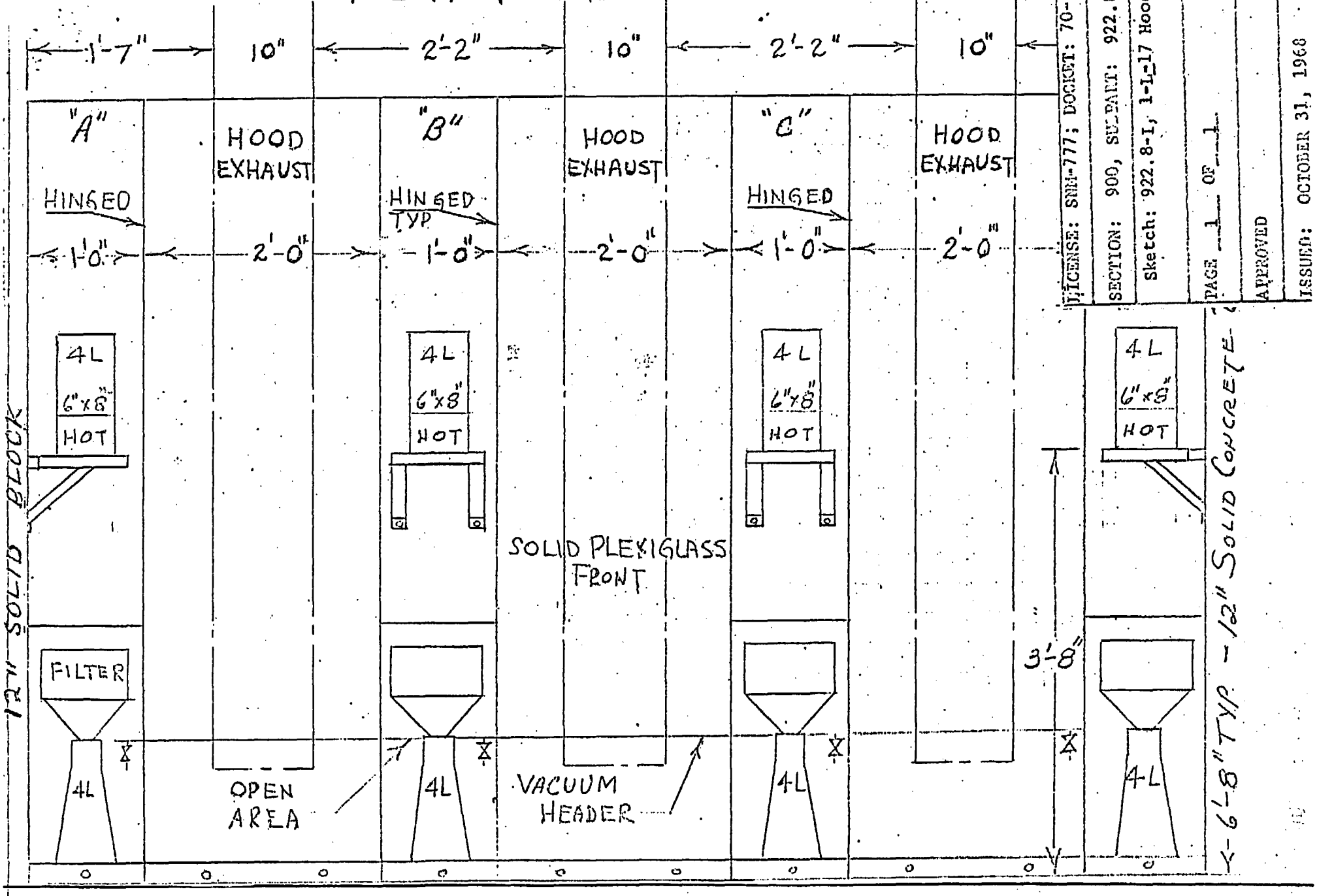
k) Previous installation of an 11/2 (5" diam.) overflow bottle has been removed from the hood.

l) Vacuum trap in an approved location above hood 1-L-18.

m) In-process storage will be located on the outside of the north wall (barrier) of this hood. The wall is 12" solid concrete block. The storage arrangement will be as described in Subpart 913.

n) 8" X 8" X 1 1/2" deep sand baths will be placed on top of hot plates for heating 4 liter or 5" diameter teflon beakers. The use of these sand baths will allow the heating of teflon beakers without damaging them.

1-L-17 HOOD



LICENSE: SNM-777; DOCKET: 70-82

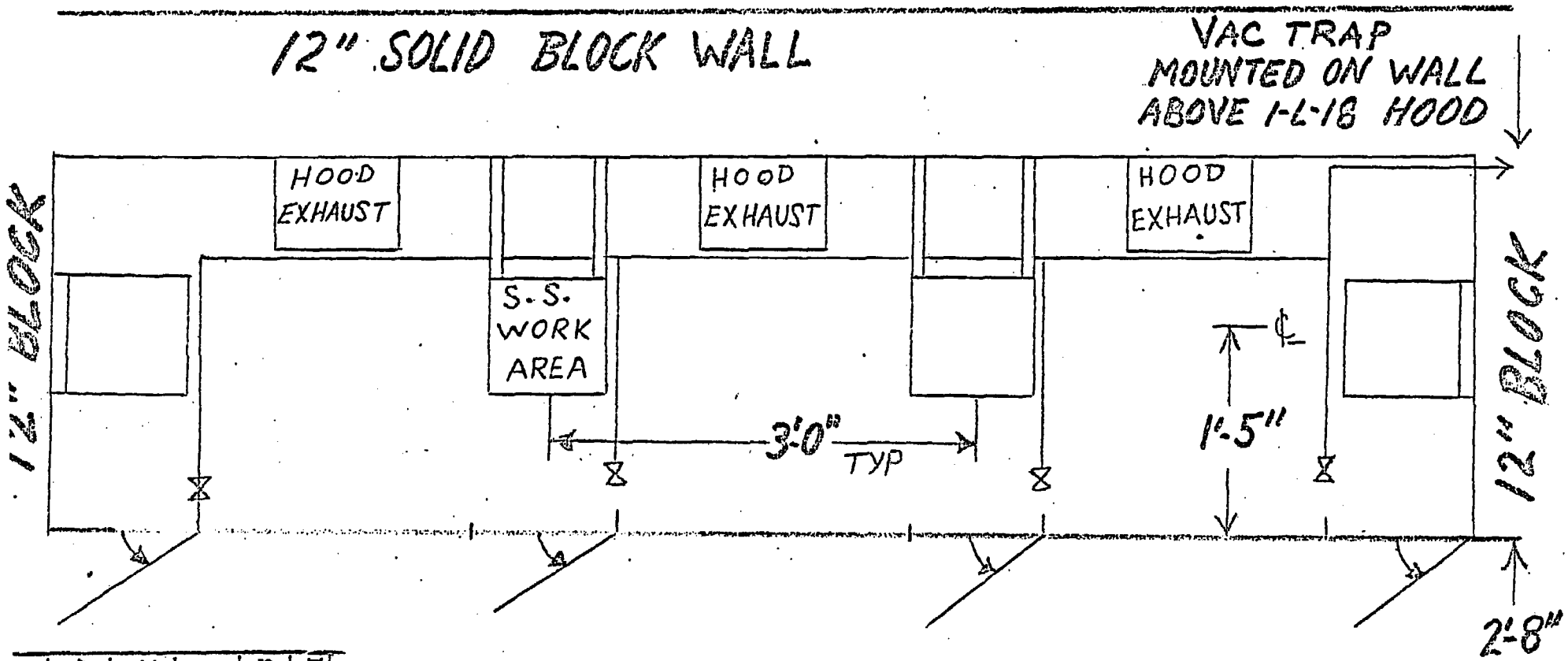
SECTION: 900, SUBPART: 922.8

Sketch: 922.8-I, 1-L-17 Hood

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



I-L-17 HOOD

LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900; SUBPART: 922.8

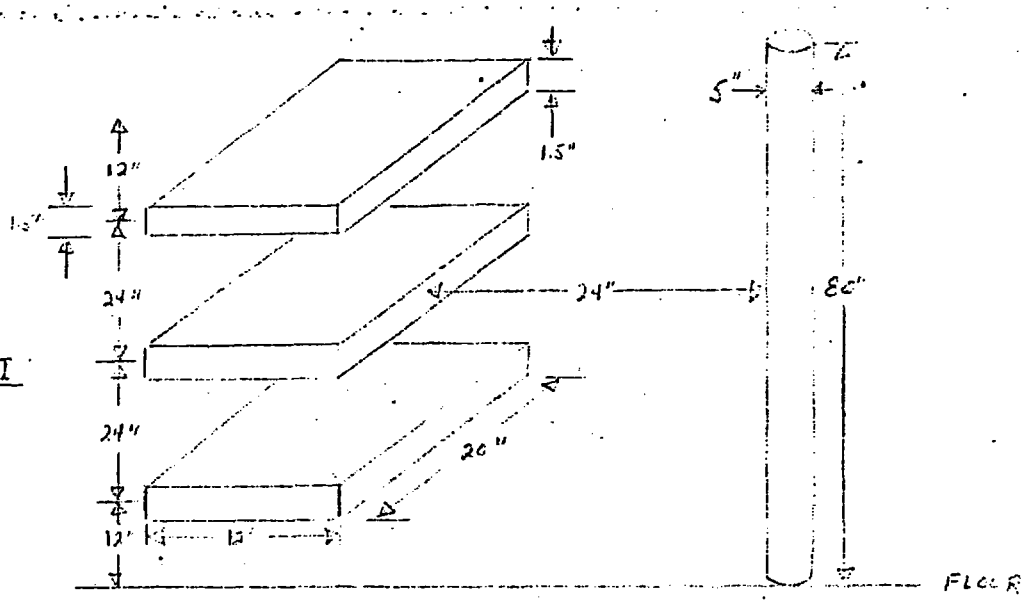
Sketch: 922.8-II

PAGE 1 OF 1

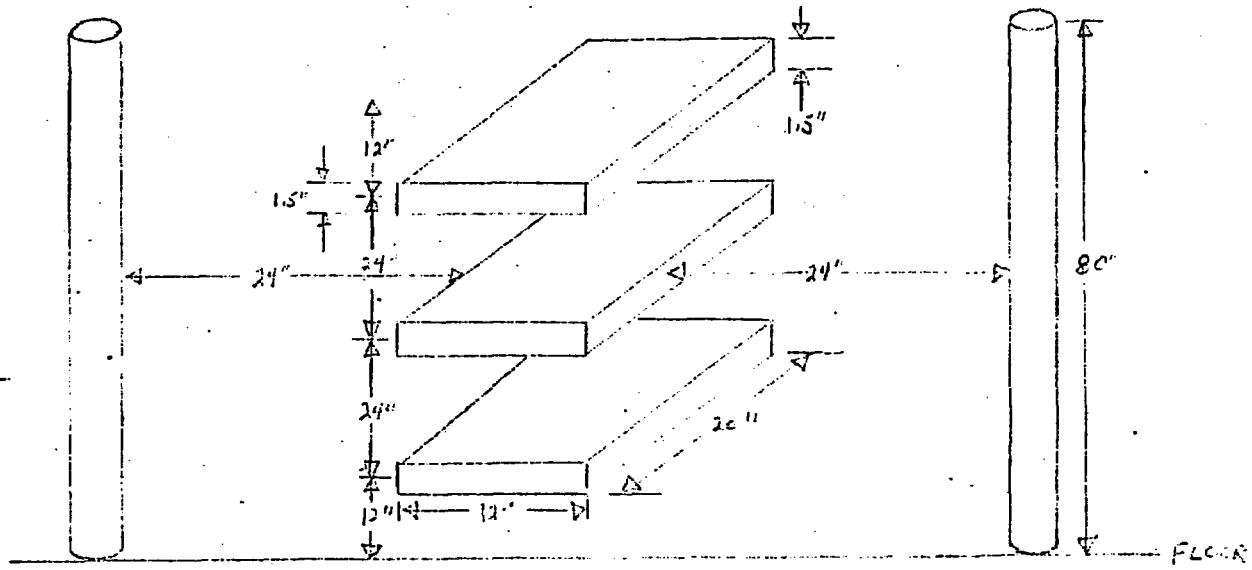
APPROVED

ISSUED: OCTOBER 31, 1968

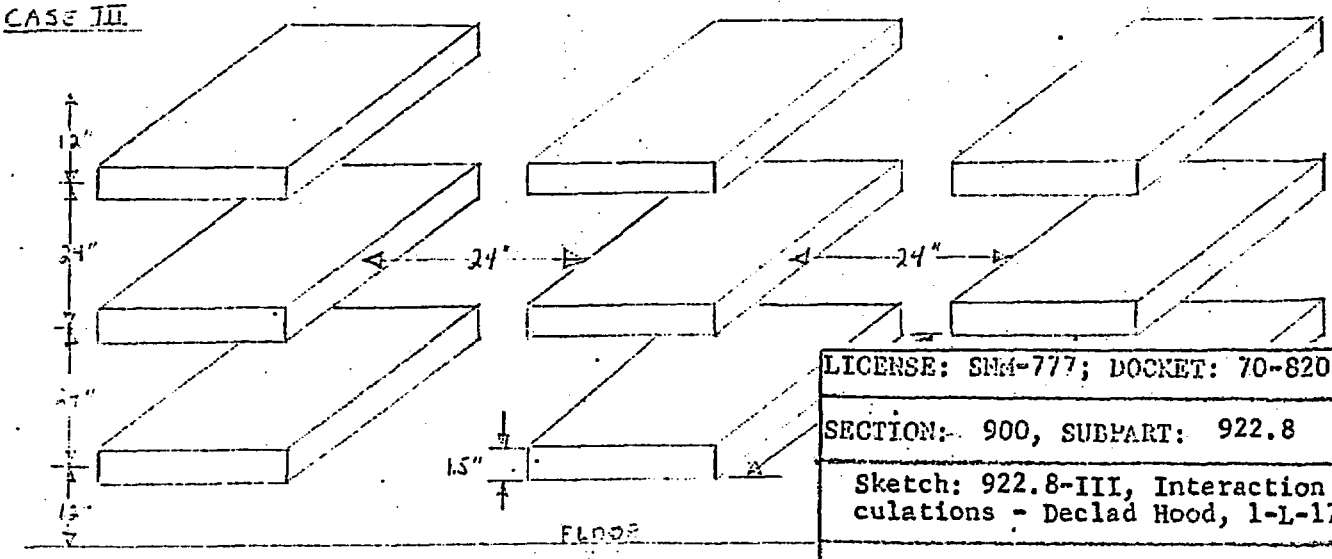
CASE I



CASE II



CASE III



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 922.8	
Sketch: 922.8-III, Interaction Calculations - Declad Hood, 1-L-17	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

INTERACTION CALCULATIONS - DECLAD HOOD (1-L-17)

CASE I - 3 Trays and one 5" I.D. x 80" Pipe

A. Center tray to nearest trays in same column

1. Tray Dimension: 1-1/2" x 20" x 12"

2. Separation Distance: 24" centers

$$\Omega_{1\ tray} = \frac{\text{cross-sectional area}}{(\text{separation distance})^2} = \frac{12" \times 20"}{(22.5")^2} = \frac{240}{506} = 0.474$$

Since tray above and below:

$$\Omega_{2\ Trays} = 2 \times 0.474 = 0.948$$

B. Center tray to 5" I.D. x 80" Pipe

1. Pipe Dimensions: 5" I.D. x 80"

2. Separation Distance: $24" + \left(\frac{12" - 5"}{2}\right) = 24" + 3.5 = 27.5"$ (center to surface)

h=27.5", d=5", l=80"

$$\tan\theta = \frac{1/2\ l}{h} = \frac{40}{27.5} = 1.45$$

$$\sin\theta = 0.814$$

$$\Omega = \left(\frac{2d}{h}\right)\sin\theta = \frac{10}{27.5}\ (0.814) = (0.364)(0.814) = 0.296$$

C. Total solid angle subtended to center tray by tray above, tray below and 5" I.D. x 80" Pipe = 0.948 + 0.296 = 1.244 steradians

D. Allowable interaction = 5.9 steradians (K-1019, Rev. 5, Table XVII)

CASE II. - 3 Trays and one 5" I.D. x 80" Pipe Each Side

A. Same as I.A. above

B. Same as I.B. above

C. Total solid angle = 0.948 + 0.296 + 0.296 = 1.54 steradians

D. Allowable interactinn = 5.9 steradians

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 922.8
Interaction Calculations - Deca Hood 1-L-17
PAGE 1 OF 2
APPROVED

CASE III. - 3 Trays Each Station

A. Same as I.A. above

B. Center Tray to Center Trays of Station Each Side

1. Tray Dimensions: 1-1/2" x 12" x 20"

2. Separation Distance: 24" Edge-to-Edge

$$\Omega_{1\ tray} = \frac{1.5" \times 20"}{(24")^2} \quad \frac{30}{576} = 0.052$$

$$\Omega_{2\ trays} = 2 \times 0.052 = 0.104$$

C. Center tray to top and bottom trays in station each side

1. Tray Dimension: 1-1/2" x 12" x 20"

2. Separation Distance: $\sqrt{(24")^2 + (24")^2} = \sqrt{576 + 576} = \sqrt{1152} = 34$

Assume max. cross sectional area = 12" x 20" = 240 in^2

$$\Omega_{1\ tray} = \frac{240\ in^2}{(34")^2} = \frac{240}{1152} = 0.208$$

Since 4 trays:

$$\Omega_{4\ trays} = 4 \times 0.208 = 0.83$$

D. Total solid angle = 0.948 + 0.104 + 0.83 = 1.88 steradians

E. Allowable interaction = 5.9 steradians

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 922.8
Interaction Calculations - Decl Hood 1-L-17
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

922.9 All Purpose Hood 1-L-18

1. General

This all purpose hood is designed for, but not limited to, the reworking of residues generated in other parts of the plant. The equipment may be utilized for small scale pilot operations prior to full scale processing. The glass columns and associated piping and equipment will be used to handle the various solutions that are generated and are designed to permit such operations as two or three stage extractions, acidity adjustments, air sparging, precipitation, leaching of solids and filtering of solutions. The size, spacing and fixed position of the equipment in the hood will permit nuclearly safe utilization of all equipment at one time.

2. Equipment

This hood is equipped with three 4-inch diameter pyrex glass columns, mixers for each column, a centrifugal pump with associated piping to transfer or circulate solution to or from any or all of the columns, restricted slots under each column for Buchener filter assemblies, a solution charge funnel to the suction side of the pump; air and ammonia lines to permit the addition of either or both of these gases to the columns, and three additional restricted slots for safe volume equipment such as 4 liter beakers or filter assemblies.

Solutions will enter the system through a standpipe in the suction side of the pump. They may be recycled by way of the pump through the columns and at the same time be agitated by means of the air driven mixer in each column. By means of valving the solutions may be recycled to the same column or transferred to another.

A filter will be installed in the system. Since it is unlikely that both filters 1-F-24 A & B units of the dissolver system will be in use at the same time, for the present one of these filters will be used in 1-L-18. The center line of the equipment in the hood has been set back 15 1/2" to minimize interaction with portable storage carts containing filled 11-liter bottles should they be inadvertently placed against the face of the hood. Diagrammatic sketches showing the layout of the hood, both plan view and elevation are attached. A typical utilization of this hood is as follows: For solution rework, wash solutions such as sodium carbonate which contain recoverable quantities of uranium will be generated in the extraction system. This solution will be stored temporarily in safe geometry 11-liter bottles. The sodium carbonate solution will be transferred to the columns in the 1-L-18 hood by means of the solution charge funnel to the pump suction. Acid will be added to the system via this same column. The acidified sodium carbonate solution will be air-sparged to remove the CO_2 and then ammonia added to the solution, precipitating the uranium as an impure ammonium diuranate (ADU). After

2. Equipment (continued)

precipitation, the ADU slurry will be drained from the column into the Buchener filter assembly located below the column. As required, the ADU will be transferred from the Buchener funnel to a one-gallon storage jar for future processing and the filtrate will be transferred to the safe geometry 11-liter bottle and analyzed to determine its disposition.

3. Safety and Criticality Control Considerations

a) This hood has a stainless steel bottom and top. The depth of the bottom is 2 inches. The 3/8" diameter holes have been drilled one inch from the bottom to overflow at one-inch solution depth.

b) Physical barriers between Buchener funnels under the columns have been installed to prevent loading at side, front, or back of each.

c) Shelf for hot plate and filter is to be 12-inches wide. Barrier installed between hot plate and filter on shelf.

d) Buchener under hot plate and beside pump to be physically isolated by barriers the same as the Bucheners under columns.

e) Position of Buchener and hot plate with 4-liter beaker are to be inter-changeable.

f) There is to be a "quick connect" line from pump discharge to fill 11-liter bottles in the portable storage cart. Since the line is nearastandpipe which is outside the hood, an adaptor will be made to cover the standpipe while filling the bottles thus preventing standpipe and bottle interaction.

g) The standpipe has a diameter of 5" or less.

h) Air and ammonia lines pass through a check valve to prevent back-flow.

i) Buchener funnels standard 8 inches across the base, the funnel is stainless steel or porcelain, 9 inches or 10-1/2" respectively.

j) Pump volume less than 4.8 liters.

k) All piping inside the hood is 1/2" diameter stainless steel.

3. Safety & Criticality Control Considerations (continued)

l) In the adjacent room behind the hood, there is no process piping or equipment against the column wall which is laid of 12" solid concrete blocks.

m) This hood has 1/4" thick plexiglass front panel with openings adjacent to the filters and the hot plate.

n) All exhaust air from the hood is filtered.

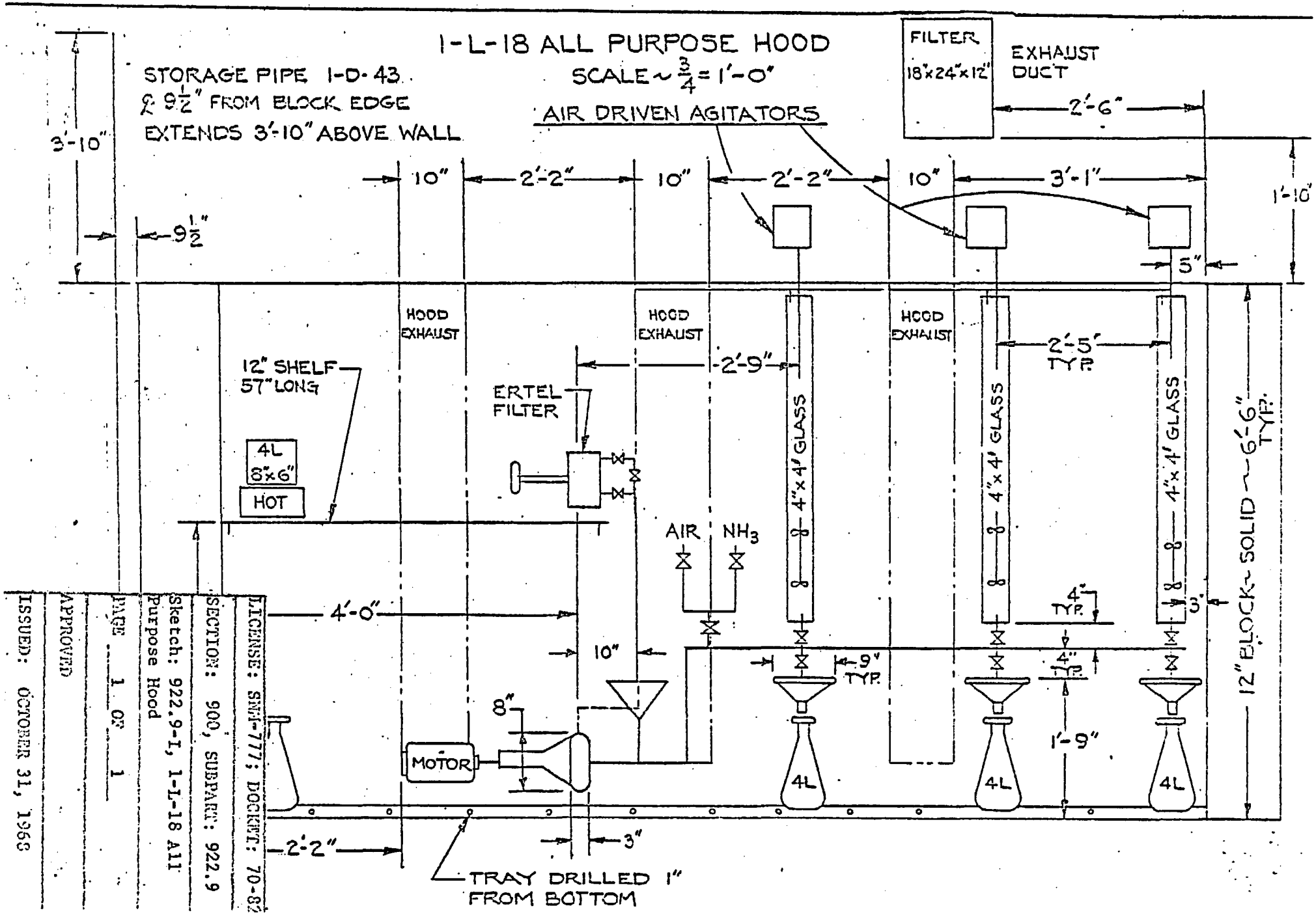
o) Solutions are fed to the columns through the funnel.

p) The recycle line has been connected to Tank 1-D-43 which connects to Assay Tanks.

q) Pan under filter and/or pump to be 1/2" in depth.

r) Agitators have steady rests at the bottom to prevent whipping action of the shaft.

s) All operations in this hood will be performed according to standard operating procedures which have had prior internal review and approval.



LICENSE: SNM-777; DOCKET: 70-82

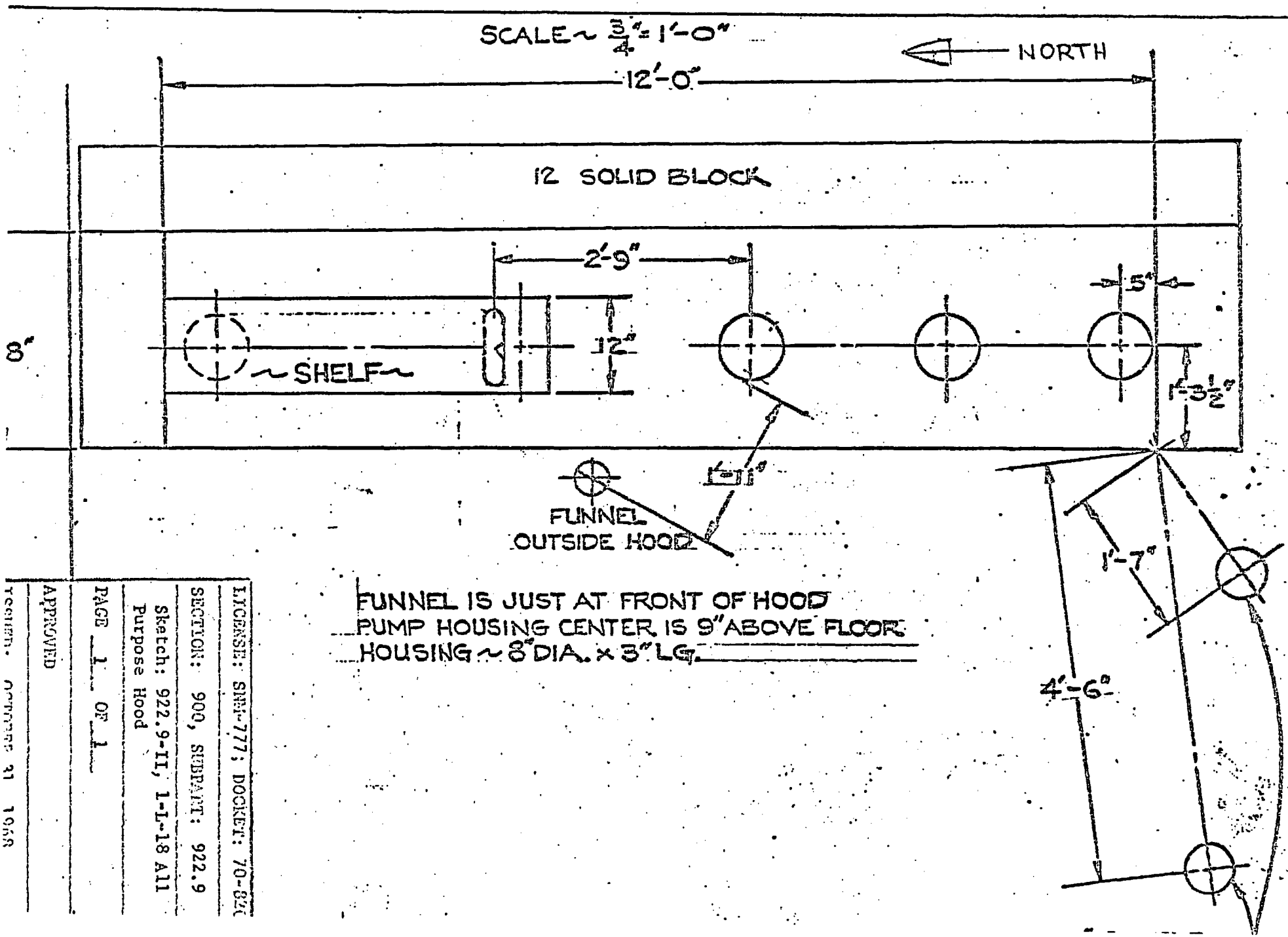
SECTION: 900, SUBPART: 922.9

Sketch: 922.9-I, 1-L-18 All Purpose Hood

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



FUNNEL IS JUST AT FRONT OF HOOD
PUMP HOUSING CENTER IS 9" ABOVE FLOOR
HOUSING ~ 8" DIA. x 3" LG.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 922.9
Sketch: 922.9-II, 1-1-18 A11
Purpose Hood
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31 1968

INTERACTION SUMMARY 1-L-18 HOOD

Item	Max K eff	Ref.	Allowable Solid Angle
4" Columns	.425	Fig 4 K-1317	4.75
Funnel 10.5" diam x 4"high	.623	Fig 4 K-1317 ($\lambda = \frac{4}{10.5} = 0.381$)	2.77
9" diam x 4" high	.572		3.28
4-liter flask	.63	Assume equivalent to 7" ID cyl 6.34" high ($\lambda = 0.906$) conservative since 8" ID cyl or 6" ID cyl of same volume have K eff=.605 and .59 respectively	2.7
Filter Press	.670	Equiv. to 8.18" diam cyl 6" high	2.3
5" diam 11 liter bottle in cart	.58		3.2
1 Gal bottle	.596		3.04

Ω to central column representad as a 9" diameter cylinder with filter flask and funnels included the total solid angle is 1.24 steradians. The contribution from surrounding assay tanks is $\approx$ 0.198 steradians, from 2-11 liter bottles in two adjacent carts is 0.44 steradians. Total is 1.88 steradians max.

Similarly, the filter press as the most reactive component could be represented as a squat cylinder between a 6" cylinder on the left and a 9" cylinder on the right, each 78" tall. The total solid angle is then 1.102 steradians including 2-11 liter bottles in carts adjacent to hood.

INTERACTION CALCULATIONS FOR 1-L-18 HOOD

Ω at central glass column

$\Omega = \frac{2d}{h} \sin \theta$

d= 4"
h= 29-2 = 27"
L= 48;L/2 = 24"

$\tan \theta = .8889$

$\sin \theta = .6644$

$\Omega = \frac{2\ (4)}{27}\ (.6644)$ = 0.197 steradians/column

2 columns, Ω = 0.394 steradians

However, representing each 4" column with associated filter flasks and funnels as 9" diam cylinders with a height equal to that of the hood = 77"

then d = 9"
h = 29-4.5 = 24.5"
L/2 = 38.5 in

$\tan \theta = \frac{38.5}{24.5} = 1.571$ $\sin \theta = 0.8436$

$\Omega = \frac{2\ (9)}{24.5}\ (0.8436)$ = 0.620 steradians/column

Ω due to adjacent column = 1.24 steradians max

Contribution from assay tanks

assume ∞ long d = 5"
h = 15.5 (9) + 15.5-25 = 152.5 in

$\Omega = \frac{2d}{l}\ (1)$ = .066 steradians/tank

Ω due to 3 tanks $\approx$ 0.198 steradians

Contribution from an 11 liter bottle in a cart placed directly in front of hood. Cart frame insures 13.5" from edge of frame to surface of bottle.

d = 5" h=15.5 + 13.5 = 29"
L = 48" L/2 = 24"

$\tan \theta = \frac{24}{29} = 0.8276$ $\sin \theta = 0.6376$

$\Omega = \frac{2(5)}{29}\ (0.6376)$ = 0.220; 2 bottles in 2 carts = 0.44 steradians

Ertel Filter

Assume filter is a squat cylinder for solid angle calculations

d = 7.25$\sqrt{2}$ = 10.25" L = 6" L/2 = 3"

36" distance (h) to left hand column (representing 4 liter beaker and flask 6" diam. X 78" tall).

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 922.9
Interaction Calculations For 1-L-18 Hood
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

33" distance (h) to right hand column representing 4" column and associated funnel and flask (9" diam x 78" tall)

Ω from LH $= \frac{2\ (6)}{36}\ .735 = 0.245$

Ω from RH $= \frac{2\ (9)}{33}\ .768 = 0.417$

Ω from possible 2-11 liter bottles in carts .44

1.102 steradians

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 922.9	
Interaction Calculations For 1-L-18 Hood	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

922.10 Dry Solids All Purpose Hood 2-L-3 (See Sketches 922.10-I & -II)

1. Process and Equipment Description

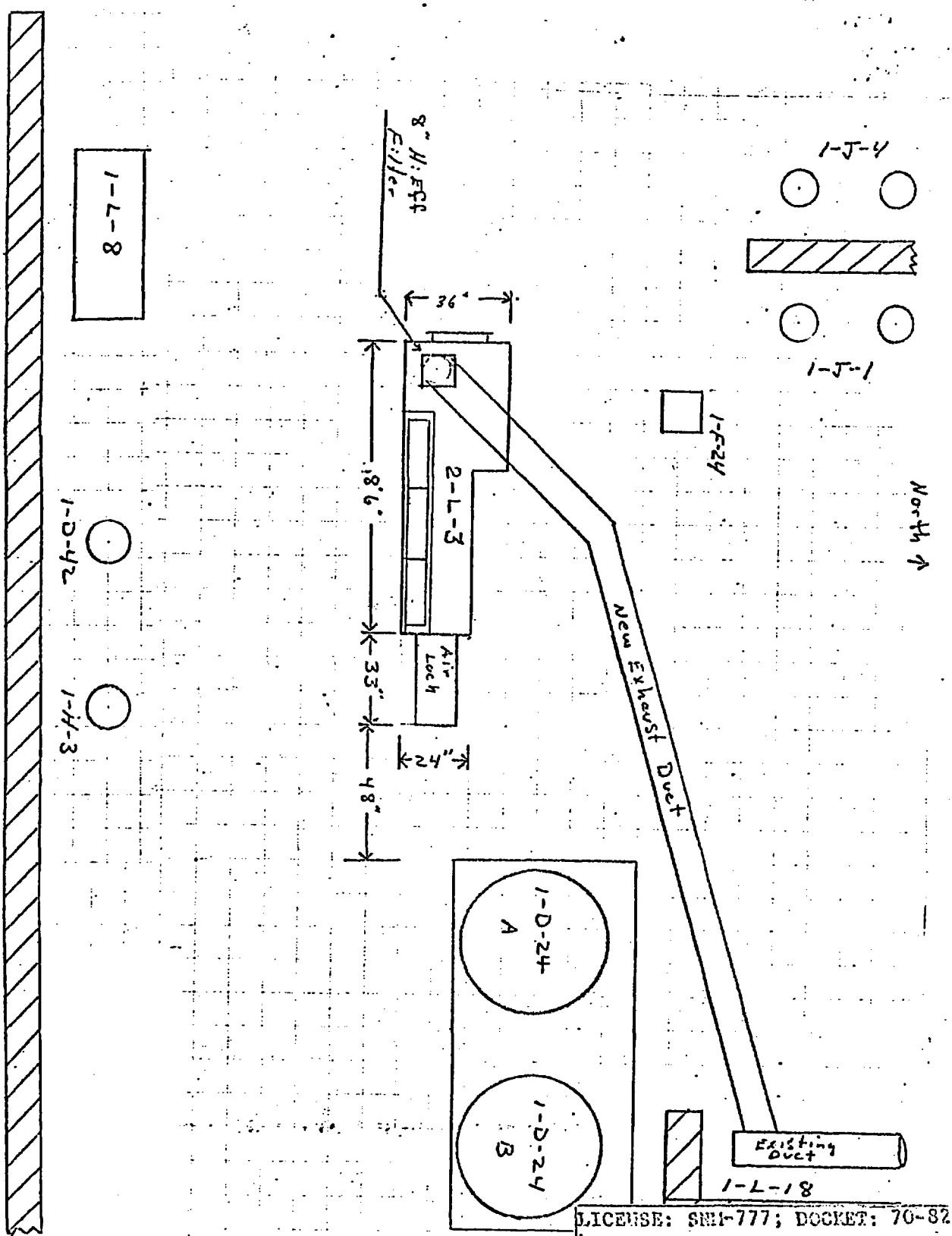
This hood is a completely enclosed glove box, 9-1/2 feet in length, with a 13" x 14" x 33" air lock located at one end, and a 21" x 20" opening panel at the other. Dry uranium bearing materials such as metals, alloys (U-Zr), and uranium compounds will be subjected to such head end pre-treatment as batching, cutting, weighing, screening, etc.

One as-received container, or contents of one shipping container and one process container will be in this box at a time. The material "as received" will be handled as required to prepare a batch for further processing. The hood will also be used for transfer of uranium metal, alloys of uranium or uranium compounds, from one process vessel to another process container.

Example: Transfer of ash from one calciner tray to one gallon bottle. One end of the hood will be modified to position a pyrohydrolysis reactor box against the hood for loading and unloading.

2. Nuclear Safety

Since this operation is dry, a maximum limit of 10 kgs of U-235 will be maintained. If the material composition includes moderating elements (e.g., UC, UO_2 + BEO_2, etc.) it will be processed in individual containers restricted to either 5" diameters or a total volume of one gallon. Only two containers will be allowed in the hood and they will be separated by one foot edge-to-edge from each other. Therefore, their interaction is negligible.



LICENSE: SNM-777; DOCKET: 70-82

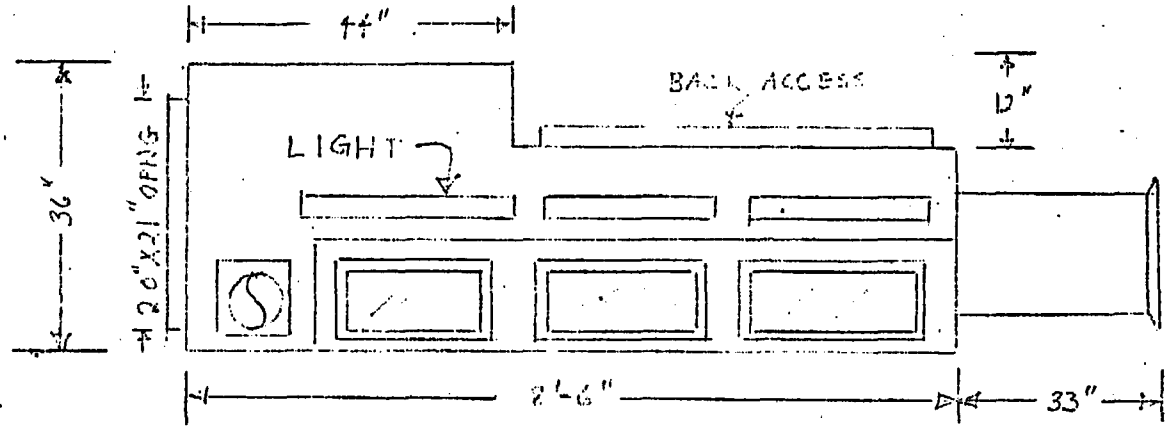
SECTION: 900, SUBPART: 922.10

922.10-I. 2-L-3 Hood

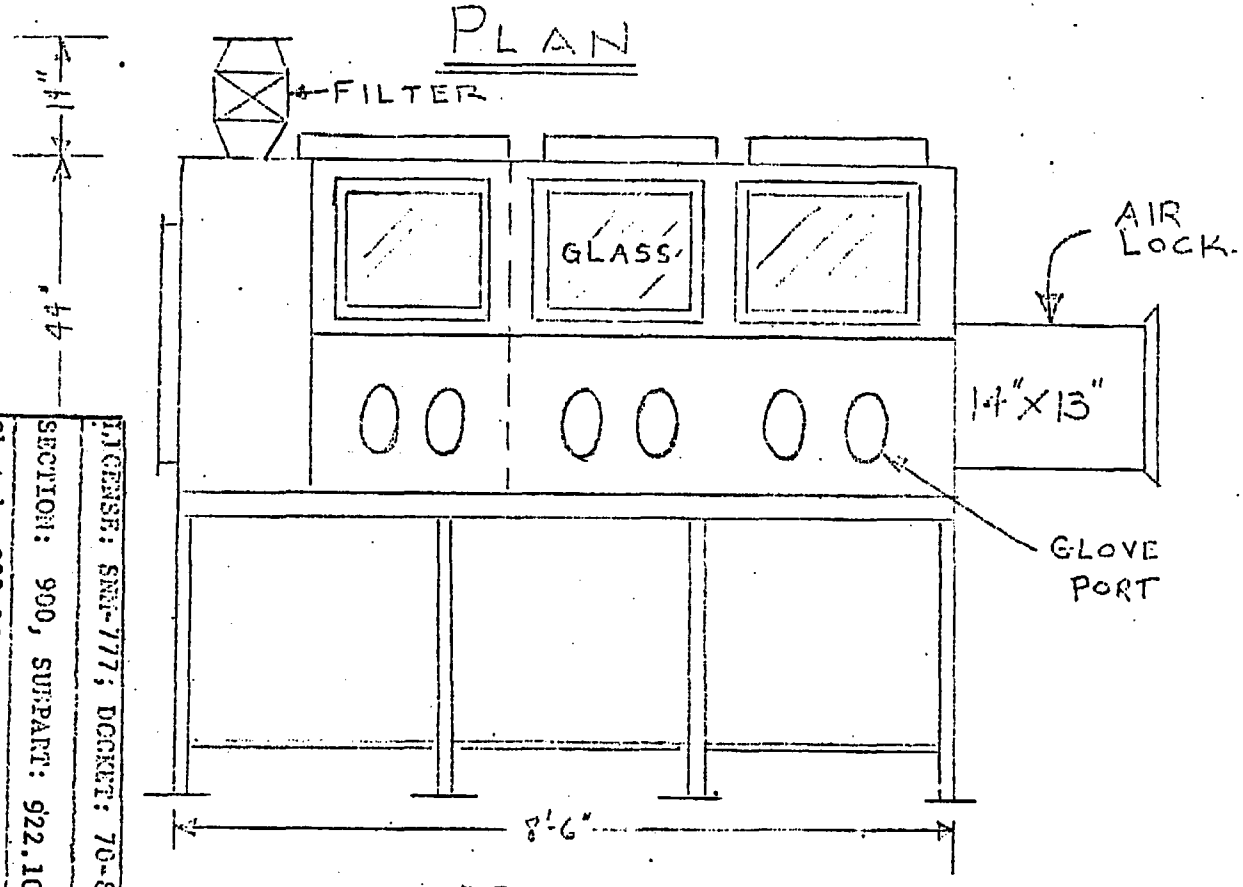
PAGE 1 OF 1

APPROVED

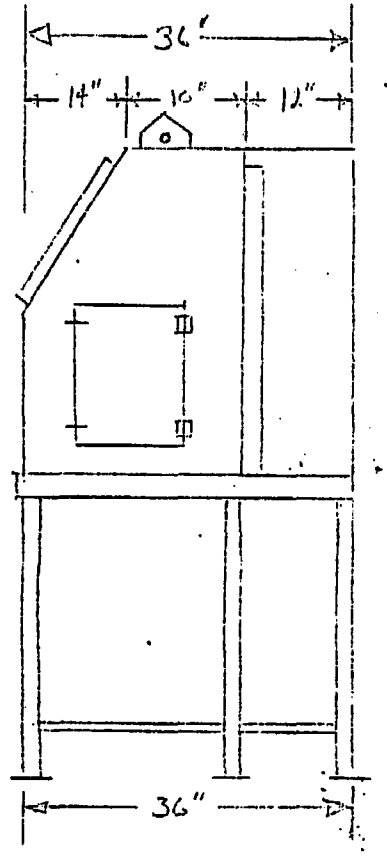
ISSUED: OCTOBER 31, 1968



PLAN



FRONT



END

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 922.10
Sketch: 922.10-II, Hood 2-L-3
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.11 - Oxide Burning System 2-R-1 and 2-F-2

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.11 Oxide Burning System 2-R-1 and 2-F-2

1. General Description Oxygen Burning System (See Sketch 922.11-I)

Uranium compounds with uranium density equal to or less than 3.2 gms/cc will be converted to uranium oxides, by discharging the powder into a vertical tube together with oxygen rich gas, collected in portable containers, and dissolved in nitric and/or other acids to make uranium solutions which will be processed as described elsewhere in the license.

A 2-X-1 container or 1 gallon bottle material is inverted and attached to the feed hopper at the top of the Tower Reactor 2-R-1. The materials fall vertically thru the heated oxygen rich atmosphere in the Tower and are collected at the base in a Container 2-X-1.

This cross over pipe terminates at the Filter Housing 2-F-2 which is a maximum 5" diameter Sch 40 pipe, 8' long.

1. General Description Oxygen Burning System (continued)

This Filter Housing contains a metallic filter insert. The Reactor Tower and Filter Housing are separated by 60"

At the bottom of the Filter Housing is another 2-X-1 container which further collects any solids that may carry over from the Tower Reactor and also collects fines that do not pass the filter.

Gases pass out the filter through the filter, a pressure control valve, a secondary cyclone and through two 8" x 8" x 5-7/8" absolute filters (2-F-1A, 2-F-1B) and are discharged into a 1-1/2" dia. stack to the atmosphere. Ventilation boxes enclose the three attached hopper containers and are exhausted through a separate system of ducts through an Absolute Filter 2-F-6.

2. Equipment

2.1 Containers 2-X-1

These special containers are used interchangeably for transfer, feed hoppers, and collectors. Each container is a maximum of 5" ID x 12" long with a tapering neck from 5" to 3" (approx. 30° taper 4" long). Containers are fabricated from metal of all welded construction, generally of a stainless steel or monel.

2.2 Tower Reactor 2-R-1

The Tower Reactor is a 4" ID x 8' long Sch 40 pipe with a 1' 10" long 5" ID section at the bottom to which the Hopper Container 2-X-1, 2, 3, 4, 5 is attached to receive the uranium rich ash or fines. This Tower Reactor is insulated and electrically heated.

2.3 Filter Housing 2-F-2

This Filter Housing is a vertical 4" schedule 40 pipe approximately 8' long. The filter insert is 2" max. diameter sintered metal pipe.

3. Nuclear Safety Considerations

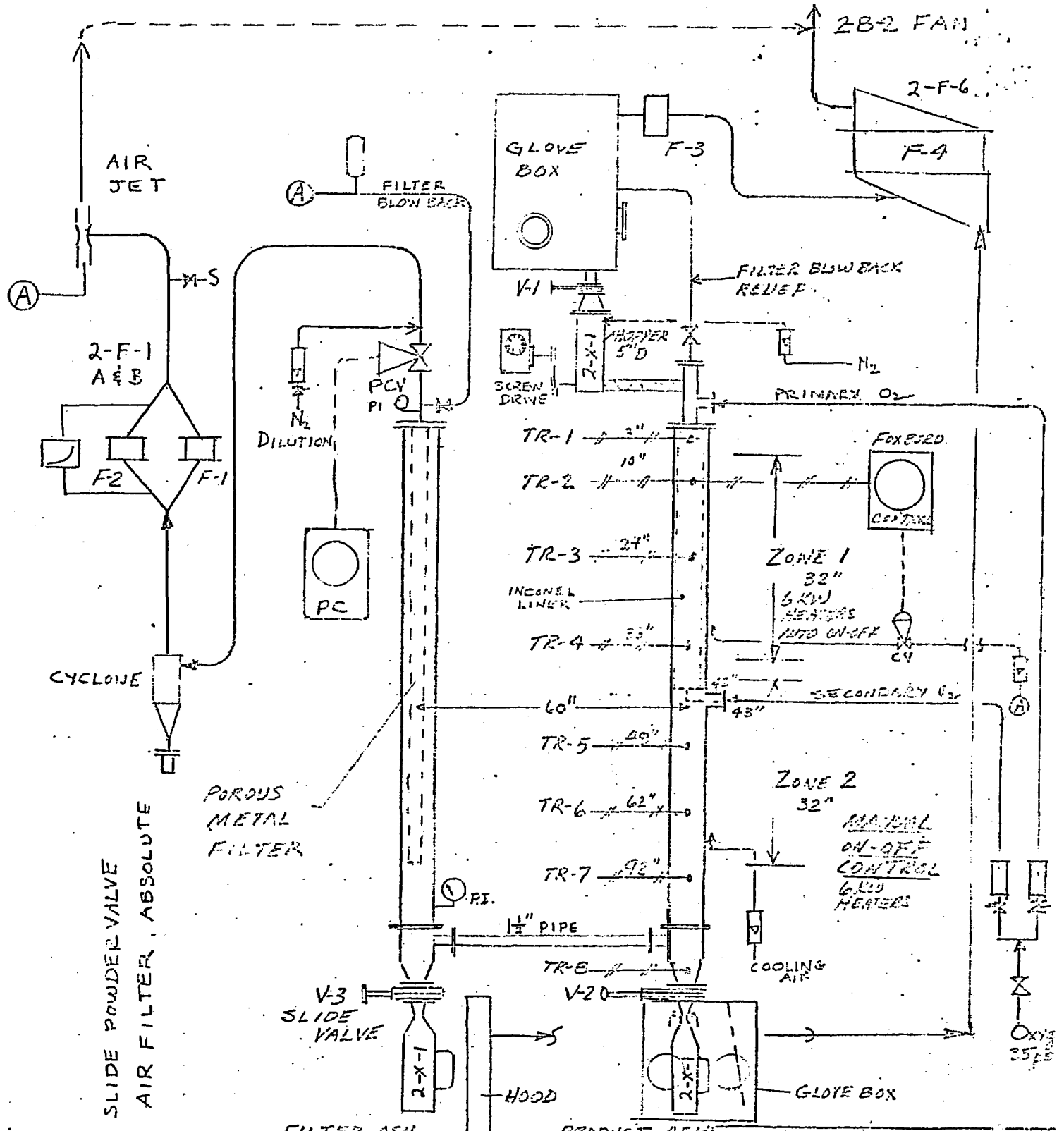
Each individual unit is restricted to either 5" diameter cylinders or a total volume per container of one gallon. Interaction between units is negligible. The solid angle between the Tower Reactor 2-R-1, which is considered as the most reactive unit, the overhead storage pipes and the adjacent 4" diam. Filter 2-F-1 less than 2 steradians. (Between 2-R-1 and 2-F-1 conservatively assumed as infinitely long, Ω is 0.162 steradians, between 2-R-1 and overhead pipes< 1 steradian).

3. Nuclear Safety Considerations (continued)

(The intersections of the 1-1/2" diameter Crossover Pipe conservatively evaluated as tees following the method described on page 20, TID 7016, Revision 1, have an equivalent diameter of 4.2 inches each.)

4. Health Physics

Ventilation and filtration of the exhaust air are provided as shown in the attached Sketch 922.11-II.



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 922.2

Sketch: 922.11-I, 02 Tower Flow Sheet

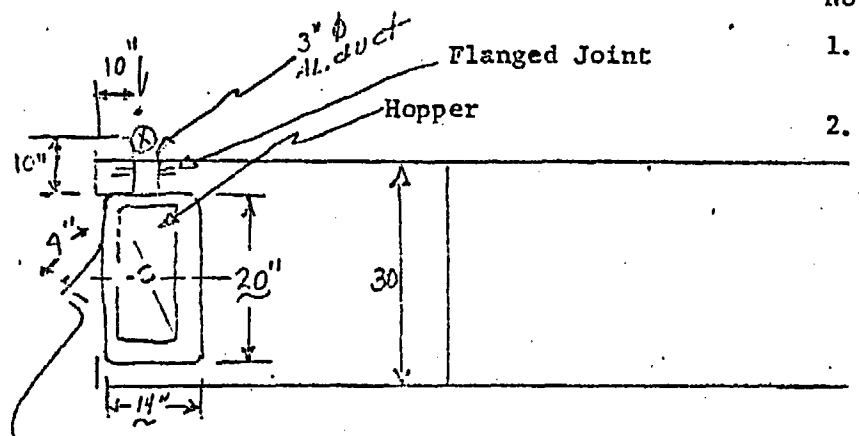
PAGE 1 OF 1

APPROVED

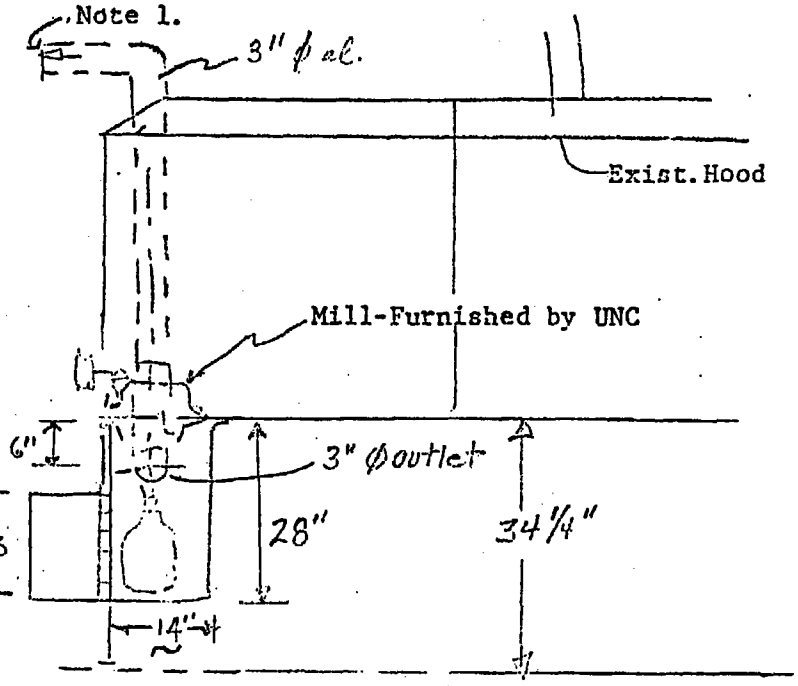
ISSUED: OCTOBER 31, 1968

Notes:

1. Connect 3" Ø Al duct to 6" duck as shown on R.I. 386 Inquiry
2. Material of Const 18-8 Type S.S.



Door opening 8" wide x 12" high
hinged with continuous piano hinged S.S. and detached at top & bottom



LICENSE: SNM-777; DOCKET: 70-820

SECTION: 900, SUBPART: 922.11

Sketch: 922.11-II. Hood 2-L-2, Hopp
Housing and exhaust duct.

PAGE 1 OF 1

APPROVED

922.12 Destructive Distillation Unit

1. Process Description

Combustible wastes such as rags, sponges, mops, paper, air filters and other material will be charged to the DDU retort 2-R-2. Only one (1) container of scrap material may be introduced into the DDU retort 2-R-2 for any one furnacing operation. The unit is cleaned of any previous residue using Vacuum Cleaner 2-X-6 then visually inspected prior to loading. The organic matter in the charge is decomposed to various volatile hydrocarbons which distill off and exit from the DDU retort through a 4" outlet nozzle. The volatile tars, etc. are scrubbed in a water filled Scrubber 2-F-4 downstream of the unit. An overflow 11-liter bottle catches the solution overflow. The non-condensed gases, scrubbed through Scrubber 2-F-4 are fed into the exhaust air from the Hoods surrounding the equipment. Absolute Air Filter 2-F-5 removes entrained particulate matter from the hood exhaust air.

The run is complete and the unit is cooled to room temperature, the lid is removed and the residual ash is vacuumed into Vacuum Cleaner 2-X-6 or Dry Solids Vacuum Collection System (See Subsection 933.3) prior to reloading.

The ashes are collected in 5" dia. or in 1 gallon bottles or cans and transferred to storage or further processing as described in Subsections 910 and 920. Details of this system are shown on Sketch 922.12-I.

2. Process Equipment

2.1 DDU Retort 2-R-2

This Retort is box-shaped and fabricated of 1/4" plate type 316 stainless steel and open at the top. External dimensions of the box are 25" x 25" x 41-1/2" high. A 4" schedule 40 type 316 stainless steel outlet nozzle is mounted 4-1/2" on center from the top and the vertical wall. A square lid 29" x 29" x 3/4" thick fastens to the top to seal the unit. The retortis heated in 2-H-1.

2.2 Scrubber

The 4" ID schedule 40 stainless steel vent pipe from the DDU is flanged to a 4" tee mounted on top of a 5" schedule 10 vertical tank 3'4" long. A 2" diameter schedule 40 dip leg extends 2" below the over flow level which provides passage of the distillate vapors to bubble through water. The bottom of the 5" dia. pot is reduced to 1" diameter with a drain valve at the bottom. The tank is filled with water through a 1/2" nozzle at the top and the level is set visually. A 2" schedule 40 pipe nozzle attached perpendicular to the wall of the 5" pot and 2" above the bottom of the dip leg serves as an overflow for excess water and condensed organic materials. The overflow solution will be caught in an 5" diameter bottle fastened to a permanent rack.

The overflow solution will be tested for uranium content. If the uranium content is below discard limits, the solution will be released to a discard system such as the Waste Lagoon. If the uranium content is above discard limits, the solution will be transferred to approved safe storage bottles and stored for future recovery. The scrubbed gas is then exhausted to the atmosphere.

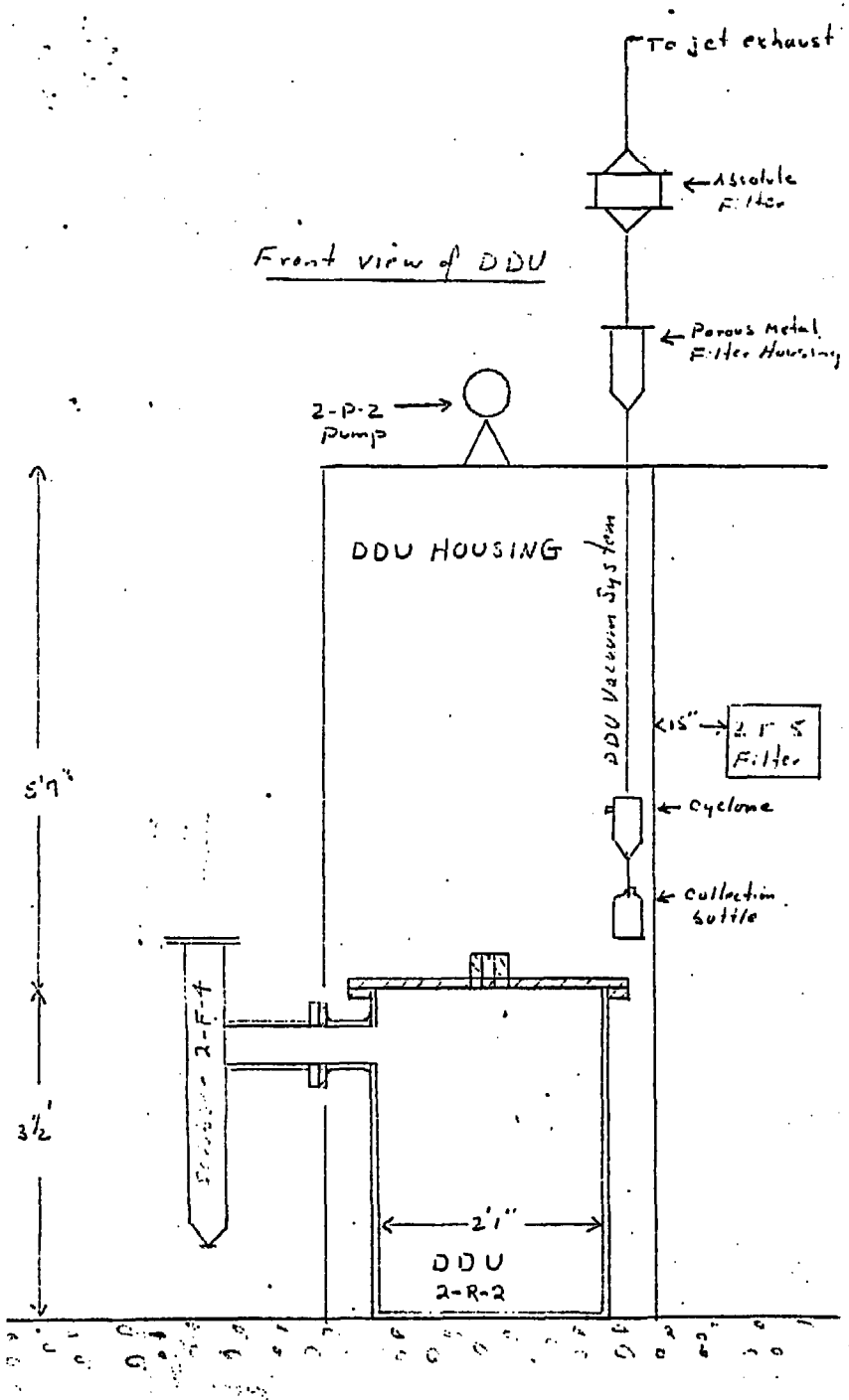
2. Drum Rod Mill

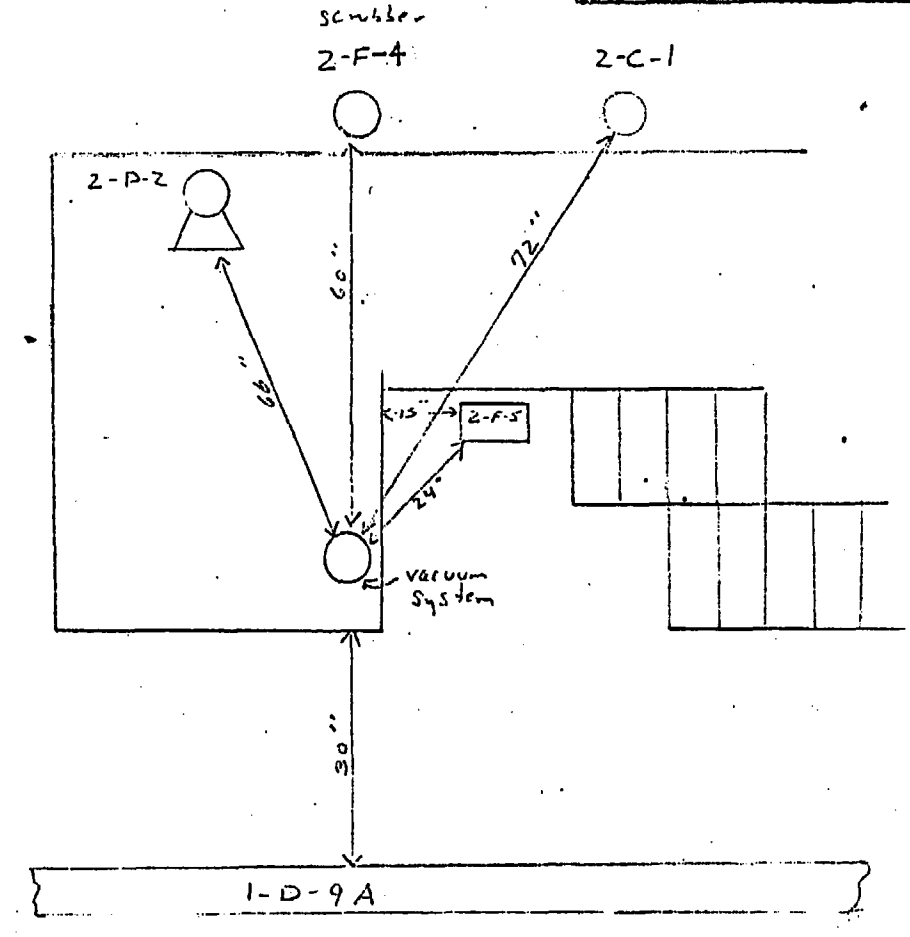
A roller mill unit for milling non-combustible materials such as asbestos fiber board and separators will be placed in the DDU process area. This milling will help separte dust from filters to be burned thereby reducing the required combustion. The charge to this mill will not exceed the limits listed in Subpart 922.12.3 and only one drum will be processed at a time. Also, the drum will be excluded from wet processing area. Transfers of material into and out of drums will be done inside hoods (i.e., 1-L-14, 2-L-3, etc.) Mechanical seals and typing of the lids will be done to insure that there will be no leakage during actual milling.

3. Nuclear Safety Considerations

The maximum quantity of U-235 which may be introduced into the Retort 2-R-2 at any one time shall be 350 grams and only one (1) container of scrap material may be introduced into the Retort 2-R-2 for any one furnacing operation. An isolation distance of approximately 4 feet is maintained around Retort 2-R-2.

To minimize the possibility of placing any significant quantity of U-235 in the retort 2-R-2, the contents of individual drums will be searched and un-burnable or highly contaminated material removed, prior to incineration. During this sorting, an olpha survey meter is available for the operator to check any suspicious item.





LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 922.1	
Sketch: 922.12-I	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

922.13 Chloride System

1. Process Description

Uranium compounds containing chlorides will be brought to the Dissolving Hood 2-L-1 and will be unloaded into the 6" Pyrex Pot 2-J-1. Nitric acid will be added until all feed material is dissolved. Additional acid or water will be added to increase the volume of solution in the column to about 8 gallons total. Gases generated in the dissolution phase will be exhausted through the Hood 2-L-1 above the Pyrex Pot into the DDU duct exhaust up stream of Particulate Filter 2-F-5, or may be diverted to the fume scrubber servicing the Hoods 1-L-3 and other equipment, whichever system is in service at the time. The dissolved feed material will be drained by gravity to a vertical column 3'-9" on center distance. The solution will enter the 6" Pyrex Column 2-C-1 through a 1" side inlet located 11-3/4" above the operating platform deck.

Dissolution solutions from other sources may also be processed in the Chloride Column and will be transferred to the system by hand dumping into Pyrex Pot 2-J-1, or may be piped directly from either the source of dissolution or a transfer container by means of pumping or air ejecting. From this point, the solution from solids dissolution, regardless of source, will be treated as one.

If required approximately 1 to 2 gallons of liquid N_2O_4 will be pressurized from its shipping container into the bottom of the column and permitted to react with the liquid already in the column. N_2O_4 cylinders are normally stored out of doors and connected to the feed and gas lines which are normally extended through the building siding.

Once the reaction has been completed, the excess N_2O_4 will be sparged with air and the solution sampled for the presence of chlorides before transferring the solution for assay.

Pump 2-P-1 transfers the solution through a Filter 2-F-5 to the Assay Tanks 1-D-34. The off gases from the Pyrex column are scrubbed in either the two 5" I.D. Caustic Scrubbers 2-F-3A and 2-F-3B, or diverted to the scrubber servicing the Hood 1-L-3. The nearest caustic scrubber is 3'-1" from the 6" Boron glass column and are 30" on centers.

1. Process Description (continued)

Caustic solution is added to the scrubber and is recycled by Pump 2-P-2 to the two scrubbers. All scrubbers are equipped with spray nozzles and the scrubbed gas vented to the atmosphere through Exhaust Fan 2-B-1 or 1-B-3 depending on the unit employed. All solutions are sampled for uranium periodically and are discarded or recycled depending on uranium concentration.

If the solution is below uranium discard limits, it will be pumped to the Filtrate Tanks 1-D-24A or B for final uranium determination or, in the case of the Hood 1-L-3 fume scrubber, returned to the process. The 6" column is fitted with a 1" overflow which drains to an 11 liter bottle permanently mounted at floor level and away from the column, a minimum distance of three feet on center.

2. Equipment (Sketches 922.13-I & II)

2.1 Column 2-C-1

A vertical column approximately 14-1/2 feet in height consists of 6 sections of standard conical end 6 inch Pyrex Corning type 7740 pipe (double tough). Glass column is protected by SS screen to prevent damage from an outside source.

The bottom section, a 6" x 1" bell reducer, rests on an SS plate which supports the column. Above this piece is a 6" x 6" x 1" reducer cross. Next is a 6 foot straight section, with a 6" x 6" x 1" tee above it. The 1" nozzle serves as a feed inlet from the dissolving tank. Above this section is another straight piece, four feet in length. A 6" x 6" x 2" reducer tee mounted at the top of the column serves as a gas outlet and overflow. Each tee and cross is 18" in length with the nozzles mounted in the longitudinal center of the piece.

Pump 2-P-1 is connected to the column by a 1" line and to the assay tanks by a 1/2" stainless steel line. The pump itself will have a 1" drain line.

The overflow line will immediately, upon exiting from the top of the column, pass through a 2" tee and a 2" x 1" reducer; overflow line drains by gravity into the permanently located 11 liter overflow bottle. The solution in the 11 liter bottle will be transferred to 1 gallon bottles when necessary and either first stored or transferred directly to the Dissolving Hood 2-L-1 and re-introduced into the Pyrex Pot 2-J-1.

Column may be used for Nitric Acid intermediate storage tank when not processing Chloride containing solutions.

2.2 Dissolver 2-J-1

The Dissolver Unit 2-J-1 is a Pyrex pot of dimensions 12" x 6" I.D. A Teflon basket liner fits within the Pyrex Pot. The top of the dissolver Pyrex pot is flanged to the bottom of the PVC Hood 2-L-1. The dimensions of the hood are 12" x 18" x 24".

The gases pass through Absolute Filter 2-F-5, a glide pack filter or a fume scrubber. HNO_3 solution is introduced through the side of the hood in a 1/2" stainless steel pipe. The face of the hood is open and under negative pressure. A Pyrex 6" x 1" reducer at the bottom of the pot is attached to 1" flexible tubing and then to the Column Nozzle 2-C-1 by means of a glass or additional length of the flexible tubing.

2.3 Scrubbers 2-F-3A and 2-F-3B

The vent gases will exit from the 6" x 6" x 2" Pyrex tee on Column 2-C-1 to a pair of 5" diameter scrubbers six feet high on 30" centers. The exhaust line is 2" stainless steel and ties into a 2" across piece connecting the two scrubbers. NaOH is introduced in a 4" funnel into a vertical 3/4" line that connects to the 1" bottom cross piece connecting the two scrubbers. The bottom cross piece runs into Pump 2-P-2 and re-introduces the solution to the scrubbers through 4 spray nozzles, and two 1/2" cross pieces. The 2" exhaust cross-piece is at the top of the scrubbers and passes through a 2" x 3" expansion to the duct work leading to Blowers 2-B-1 on the roof.

The scrub solution will be sampled for uranium content and if within discard limits, it will be pumped to Waste Treatment Tanks 1-D-14A and B. If solution is above discard limits, the solution will be drained into 1 gallon bottles and stored for further processing. Fume Scrubber 2-X-1 may be used as an alternate (See Subpart 923.2)

2.4 Filter 2-F-5

Filter 2-F-5 is similar to Filters 1-F-24A and B described in Subpart 923.3 and 923.4.

3. Nuclear Safety Considerations

The Pyrex Glass Column 2-C-1 has been calculated to have a maximum K eff of 0.83 with optimum moderation and reflection. An unreflected but moderated system had a K eff of 0.72. A multigroup transport theory code DTF was used to calculate the reactivity for range of solutions. The same code was used to calculate a critical 6" diameter pipe (no boron) and a 6" diameter cylinder wrapped with Cadmium sheet 0.020" thick. The cadmium wrapped pipe was found to have a higher K eff than the Boron containing glass pipe.

3. Nuclear Safety Considerations (continued)

The results of these calculations are contained in Nuclear Safety Evaluation 922.13-III.

Interaction between Column 2-C-1 and other units are as follows:

To Filter 2-F-1

diameter = 4"
height = 8 feet
separation = 98"
Ω = 0.0359

To Reactor 2-R-1

diameter = 5"
separation = 117.5"
height = 96"
Ω = 0.0323

To Dissolver 2-J-1

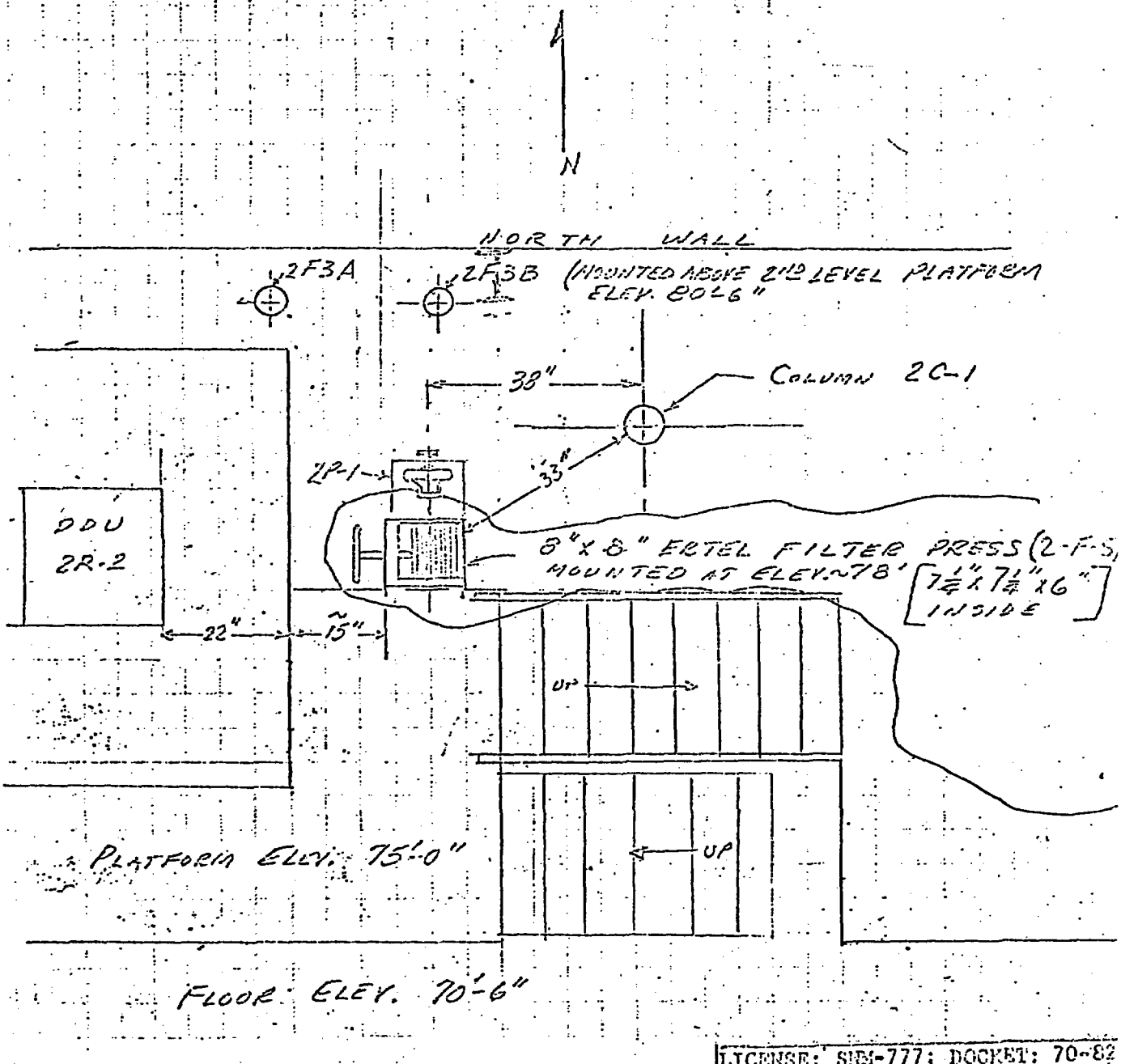
diameter = 6"
height = 12"
separation = 44"
Ω = 0.0368

To 11 L Bottle (overflow)

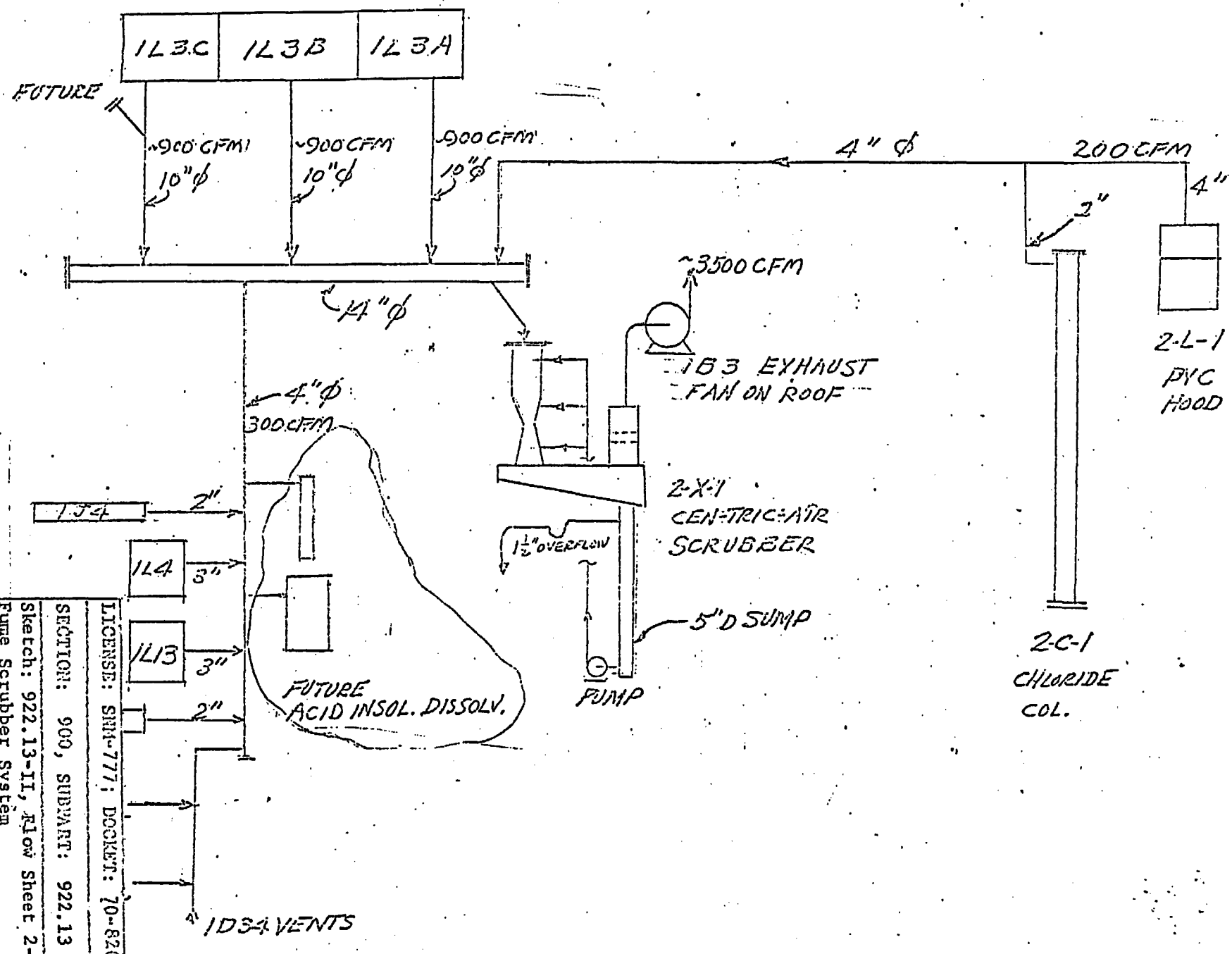
diameter = 5"
height = 48"
separation = 48"
Ω = 0.093

To Ertel Filter Press 2-F-5

Ω = 0.417 (Reference Section 902.9)
Ω = 0.615 steradians



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 922.13	
Sketch: 922.13-I, Installation 8 x 8 Ertel Filter Press	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	



LICENSE: SNM-777; DOCKET: 70-820

SECTION: 900, SUBPART: 922.13

Sketch: 922.13-II, Flow Sheet 2-X

Fume Scrubber System

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

EFFECTS OF WALL MATERIAL ON THE REACTIVITY OF 6-INCH DIAMETER CYLINDER CONTAINING URANIUM SOLUTION.

1. INTRODUCTION AND SUMMARY

This study was performed to determine whether the boron contained in commercially available boro-silicate glass pipe would reduce the reactivity of enriched (93.5% U_{235}) uranium solutions contained in a 6-inch diameter cylinder sufficiently for its use in chemical processing plants.

A maximum value of k_{eff} of 0.83 was obtained for a range of UO_2F_2 solution concentrations in 6-inch diameter boro-silicate glass pipe. It was assumed to be reflected by an effectively infinite water reflector. The maximum k_{eff} for an unreflected system was 0.72.

Comparison was made between the boro-silicate glass pipe, and a 6-inch diameter cylinder of UO_2F_2 solution wrapped with 0.020 inches of cadmium and surrounded by effectively infinite water reflector. The latter was found to have a slightly higher k_{eff} (0.836) than the maximum value obtained for the standard boro-silicate glass pipe.

The DTF multi-group transport theory code was used with the Hansen-Roach cross-section library except for silicon cross-sections (not in the Hansen-Roach library). Silicon cross-sections were computed using the GAM-1 code for the top 14 energy groups. Hand calculations were made of the bottom two groups from thermal neutron cross-section data.

2. DESCRIPTION OF STANDARD 6-INCH BORO-SILICATE GLASS PIPE

ID = 6.0 ± 1/32 inches
OD = 6.656 inches
Wall thickness = 0.328 inches
Weight of glass per linear foot = 6.3 lb.
Density = 2.23 gm/cm^3
Typical Analysis (Corning 7740 or Kimble KG-33)

MATERIAL	WT. % IN GLASS
SiO_2	80.6
B_2O_3	11.9
Al_2O_3	2.0
Na_2O	3.8
CaO	0.8
K_2O	0.2

The above weight percent B_2O_3 corresponds to 3.7 weight percent B in the glass.

3. REACTIVITY CALCULATION METHOD

The DTF code (Reference 2) is a one-dimensional multigroup program written in FORTRAN for solving the neutron transport equation utilizing the Sn approximation. The program can determine the regular or adjoint solution for slab, cylindrical, or spherical geometry. Isotropic or anisotropic scattering may be considered. The allowable maximum order of Sn is 23 for slabs and spheres, and 8 for cylinders due only to computer memory limitations. This code is the DIK code adapted to FORTRAN 63 for the Control Data Corporation 1604-A computer.

Various boundary conditions are allowed so that cell calculations or time absorption calculations may be performed. Finite as well as infinite cylinders and slabs may be treated. As many as 75 space intervals, 75 materials, and 18 velocity groups may be specified. The program also contains a number of search options whereby one can vary dimensions or concentrations in order to arrive at a predetermined eigenvalue. Distributed or shell sources may be specified at any position in the configuration.

The program supplies as output, the eigenvalue, angular fluxes, total fluxes, fission distributions and other quantities of interest.

A library of cross sections is available on magnetic tape. Cross section may be read in from the library and/or tape from cards.

All calculations were performed using the Hansen and Roach cross section library described in Reference 3. This is a sixteen group cross section set for use in DSN calculations. The cross sections are averaged as follows: The first five (high energy) groups are obtained by fission spectrum weighting. The next ten groups are obtained essentially by flat collision density weighting except for the heavy element resonance cross sections. The heavy element resonance cross sections are obtained from the resonance integral and therefore account can be taken of resonance self-shielding. The thermal group is a Maxwellian average.

Table 1 presents a description of the group structure used in this library.

Several sets of nuclide cross sections are provided for U-235 and U-238. The choice of a proper set depends on the potential scattering cross section of the medium per atom of U-235 or U-238. In computing the scattering cross section of the medium, the following epithermal microscopic scattering cross sections were used.

	σ_s, barns
U-235	10
U-238	8.3
H	20
O	3.8
F	3.4

The following cross section sets were used.

H/U-235 atom ratio	U-235 set no.	U-238 set no.
27.1	7R	12
55.4	8R	13
83.1	9R	14

The DTF code, together with the Hansen-Roach library has been checked against a wide variety of critical experiments, including UO_2F_2 solution experiments. In general, this code is capable of predicting the reactivity of these experiments to within + 2% for both fast and thermal systems. Table 2 presents the results of some checks against UO_2F_2 solution experiments. The experimental data were obtained from Ref. 4.

Table 1. SIXTEEN GROUP SPECIFICATIONS FOR HANSEN-ROACH LIBRARY

Group	Energy Range	Δu	Fission Spectrum
1	3 - Mev		.204
2	1.4 - 3 Mev	.762	.344
3	0.9 - 1.4 Mev	.442	.168
4	0.4 - 0.9 Mev	.811	.180
5	0.1 - 0.4 Mev	1.386	.090
6	17 - 100 Kev	1.772	.014
7	3 - 17 Kev	1.735	
8	0.55 - 3 Kev	1.696	
9	100 - 550 ev	1.705	
10	30 - 100 ev	1.204	
11	10 - 30 ev	1.099	
12	3 - 10 ev	1.204	
13	1 - 3 ev	1.099	
14	0.4 - 1 ev	.916	
15	0.1 - 0.4 ev	1.386	
16	Thermal (.025)		

Table 2. CALCULATION OF UO_2F_2 SOLUTION CRITICAL EXPERIMENTS, ALUMINUM-WALLED SPHERES. (EXPERIMENTAL DATA FROM REF. 4)

Core Diameter, cm	H/U^{235} Atom Ratio	U^{235} Concentration, g/cm^3 sol.	Critical* Mass kg U^{235}	Reflector**	Sphere Wall Thickness, cm	Calculated k_{eff} (Using S_4 and Anisotropic H)
23.0	76.1	0.325	2.08	H_2O	0.16	0.997
23.6	126.5	0.199	1.39	H_2O	0.16	0.991
55.8	1112	0.0234	2.13	None	0.20	1.010
55.8	1270	0.0205	1.86	H_2O	0.20	1.009
69.2	1393	0.0186	3.25	None	0.32	1.009

Uranium 93.2% enriched in U^{235}; spheres constructed of type 1100 aluminum; no correction made for container thickness.

* Volume known to within ± 0.5%; concentration to within ± 1%.

** Where present, water reflector was effectively infinite.

4. CROSS SECTIONS FOR SILICON

The Hansen-Roach library discussed above does not contain cross sections for silicon, a major constituent of glass. Silicon cross sections for use in DTF were computed using the GAM-1 code. (Reference 5) GAM-1 is a multigroup code for the calculation of fast neutron spectra and multigroup constants. Silicon cross sections for the top 14 energy groups of the Hansen-Roach scheme were computed by running a GAM problem on a system that consisted of the 6-inch diameter boro-silicate glass pipe filled with UO_2F_2 solution at a concentration of 437 gm U-235/cm^3 (H/U-235 = 55.4) and surrounded by a 2-inch thick water reflector. These three regions were homogenized in the GAM problem. The silicon cross sections obtained in this manner are averaged over a neutron spectrum computed by GAM for this homogeneous system.

Silicon cross sections for the bottom two groups of the Hansen-Roach scheme were computed by hand from thermal neutron cross section data.

The multigroup silicon cross sections were supplied to the DTF code on cards. The same cross sections were used for all solution concentrations.

The effect on reactivity of possible inconsistencies between the silicon cross section set and the Hansen-Roach library was investigated and found to be negligible. (See Section 6.2).

5. CALCULATIONS AND RESULTS

Table 3 presents a summary of the reactivity calculations performed in this study. Unless otherwise specified in the table, the following assumptions were made in each calculation:

1. The pipe I.D. was taken to be 6 1/32 inches, the conservative value within tolerance limits.
2. The pipe O.D. was taken to be 6.656 inches.
3. The pipe is surrounded by a 15 cm. thick reflector of water.
4. A uranium enrichment of 93.5% U-235 was assumed.
5. The small quantities of Ca and K in glass were neglected.

All problems were run in the S_4 approximation, and anisotropic scattering by hydrogen was taken into account.

5.1 Maximum k_{eff} for Reflected Pipe

Problems 1, 2, and 3 yield k_{eff} as a function of solution concentration for reflected conditions. These data are plotted in Figure 1. The maximum value of k_{eff} is 0.83. Even allowing for a 3% non-conservative calculational bias, which is not warranted by the results of the checks against UO_2F_2 solution critical experiments, the maximum k_{eff} would be 0.855. This is sufficiently below unity to assure a sub-critical system regardless of solution concentration or presence of a water reflector.

It should be noted that the use of UO_2F_2 solutions in these calculations is conservative because $UO_2(NO_3)_2$ solutions, rather than UO_2F_2 solutions, will actually be processed in the proposed equipment at the Fuels Recovery Plant. $UO_2(NO_3)_2$ solutions are less reactive than UO_2F_2 solutions.

5.2 Effect of Cross Section Incompatibility

Problems 4 and 5 (See Table 3) were run to determine the effect on reactivity of possible incompatibilities between the silicon cross sections obtained from GAM-1 and the Hansen-Roach library. In Problem 4, the Hansen-Roach cross sections for aluminum were used for silicon. In Problem 5, aluminum cross sections obtained from the same GAM-1 problem that the silicon cross sections came from were used for silicon. The eigenvalues obtained from the two problems are virtually identical, indicating that incompatibilities between Si or Al cross sections obtained from GAM-1 and those of the Hansen-Roach library have a negligible effect on reactivity in this particular situation. The close agreement among the eigenvalues from Problems 1, 4 and 5 indicates that reactivity is not sensitive to moderate variations in the scattering and absorption cross sections of the glass constituents other than boron.

5.3 k_{eff} of Unreflected Pipe

Under normal conditions, the pipes will not be reflected by water. It will be necessary to take into account interaction between a given pipe and other nearby fuel-containing pieces of equipment. In order to do this, it may be convenient to utilize the interaction criteria of TID-7016 Rev. 1. The use of these interaction criteria requires the knowledge of k_{eff} for each unit when it is unreflected. A single DTF calculation was run (Problem No. 7) to provide an estimate of the maximum k_{eff} of the 6-inch diameter boro-silicate glass pipe when it is not reflected. An H/U-235 ratio of 55.4 (437 gm U-235/liter) was specified. This should be close to the optimum value, and since keff is not a

very strong function of uranium concentration, the k_{eff} value obtained should be close to the maximum value. (It is expected that the optimum H/U-235 ratio for the bare pipe will be somewhat higher than that for the reflected pipe. This is born out by critical experiment data in Reference 6. For the reflected pipe, the optimum H/U-235 ratio, corresponding to 725 gm U-235/liter, is about 31. See Figure 1.) The value of bare k_{eff} computed by the DTF code at an H/U-235 ratio of 55.4 is 0.70.

Figure 4 of Reference 7 shows k_{eff} values for bare cylinders with an H/U-235 ratio of 44.3. This figure yields a k_{eff} value of 0.72 for an infinitely long 6-inch diameter cylinder. This is in close agreement with the result obtained for the boro-silicate glass pipe using DTF. It is recommended that a k_{eff} value of 0.72 be used in interaction calculations in order to be conservative.

It should be noted that the boron in the glass has almost no effect on the reactivity of an unreflected pipe.

5.4 Other Calculations

The check calculations on UO_2F_2 solution critical experiment data discussed in Section 4 cover a range of H/U-235 ratios above 76. Since the optimum reactivity of the boro-silicate glass pipe occurred at an H/U-235 ratio of about 30, it was considered desirable to check the DTF code against critical experiment data for very concentrated UO_2F_2 solutions. Figure 13 of Reference 8 presents estimated critical diameters for infinite cylinders of UO_2F_2 solutions. These data were obtained from critical experiments on finite cylinders by transformations of buckling to convert these finite cylinders to infinite cylinders. For an H/U-235 ratio of 27.1, this figure gives a critical diameter of 5.7 inches for an infinite cylinder surrounded by a thick water reflector. This system was calculated with the DTF code. (See Problem No. 6 of Table 3.) The computed value of k_{eff} was 0.992. Since this is very close to the expected value of 1.0, this calculation demonstrates the ability of the DTF code to accurately predict the reactivity of concentrated UO_2F_2 solution systems.

A final calculation was performed on a reflected boro-silicate glass pipe containing UO_2F_2 solution at an H/U-235 ratio of 55.4 with no boron in the glass. The k_{eff} of this system was computed to be 1.034. The DTF code predicts that a reflected 6-inch diameter Pyrex pipe can be made critical. The glass constituents other than boron are not strong enough neutron poisons to provide criticality safety in the event of full reflection. This points out the necessity of firmly establishing that the specified concentration of boron is present in the glass pipes installed in the plant.

6. COMPARISON WITH UO_2F_2 SOLUTION CYLINDER WRAPPED WITH CADMIUM

The safety of a 6-inch diameter, fully reflected, infinite cylinder of uranium solution is generally accepted for all uranium concentrations in solution when the cylinder is wrapped with a sheet of cadmium 0.020 inches or more thick. Experimental data presented in Reference 6 show that the minimum critical diameter of a cadmium-wrapped infinite cylinder would be 7 inches or more. In order to further demonstrate the safety of the proposed 6-inch-boro-silicate glass pipe, a DTF calculation was performed on a cadmium-wrapped cylinder of UO_2F_2 solution, and the K_{eff} obtained for this cylinder was compared with the maximum value obtained for the boro-silicate glass pipe.

The boron surface density of the Pyrex pipe was computed from data given in Section 3 to be:

$$\frac{2.23\ gm\ glass}{cm^3} \times \frac{0.037\ gm\ B}{gm\ glass} \times \left[\frac{6.656\ in. - 6.03125\ in.}{2}\right] \times \frac{2.54\ cm}{in.} = 0.0655\ \frac{gm}{cm^2}$$

Experimental data on relative effectiveness of various control materials, including cadmium and borosilicate glass of the type used in Pyrex pipe, are given in Reference 9. These data show that borosilicate glass having this boron surface density is a slightly more effective absorber than a 0.020 inch thick cadmium sheet. Since the difference in effectiveness is not large, however, it may be expected that the maximum K_{eff} for a cadmium-wrapped cylinder will occur at approximately the same uranium concentration in solution that gives the maximum K_{eff} for this glass pipe. (See Fig. 1). A value of 724 gm U-235/cm^3 solution was selected for this calculation. This corresponds to an H/U-235 ratio of 31.6.

A DTF problem was run on a system that consisted of the following concentric regions

1. UO_2F_2 solution core, with H/U-235 = 31.6; outer radius = 7.660 cm (diameter = 6-1/32 in., same as pyrex pipe).
2. 1/16-inch thick stainless steel wall, with composition assumed to be 71% Fe, 11% Ni and 18% Cr by weight.
3. A 0.020 inch thick cadmium region, with a cadmium density of 8.65 gm/cm^3. This corresponds to a cadmium surface density of 0.44 gm/cm^2.
4. A 15-cm. thick reflector of liquid water density - gm/cm^3.

A k_{eff} value of 0.836 was predicted by DTF. This is greater than the maximum value of 0.829 given by Figure 1 for the boro-silicate glass pipe. It is, therefore, concluded that the proposed boro-silicate glass pipe is at least as safe for uranium solutions as a 6-inch diameter cylinder wrapped with cadmium. The results of this comparison are also consistent with the relative effectiveness data given in Reference 9.

LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 922.13

922.13-III, Nuclear Safety Evaluation

APPROVED

ISSUED: OCTOBER 31, 1968

References

1. C. R. Tipton, Ed. Reactor Handbook 2nd Ed., Vol. 1, Materials, Interscience Publishers Inc., New York, New York, 1960.

2. B. G. Carlson, W. J. Worlton (LASL), and W. Guber, M. Shapiro (UNC), DTF Users Manual, UNC Phys/Math-3321, November 1963.

3. L. P. Connolly, Los Alamos Group - Averaged Cross Sections, LAMS-2941, September 1963.

4. Reactor Physics Constants, ANL-5800 Second Ed., July 1963.

5. G. D. Joanow and J. S. Dudek, GAM-1: A Consistent P-1 Multigroup Code for the Calculation of Fast Neutron Spectral and Multigroup Constants, GA-1850, June 1961.

6. C. D. Beck, et al., Critical Mass Studies Part III, K-343, April 1949.

7. H. F. Henry, et al., Self-Consistent Criteria for Evaluation of Neutron Interaction, K-1317, December 1956.

8. H. C. Paxton, Correlations of Experimental and Theoretical Critical Data, LAMS-2537, May 1961.

9. J. L. Russell, Jr., et al, Relative Effectiveness of Reactor Control Materials, GEAP-3201 and GEAP-3201-2 (Suppl), July 1959 and Jan. 1961.

922.14 Boat Calciner System

1. General

The drying and/or calcining of liquid and solid residues containing uranium will be done in the equipment shown on Sketch 922.14-III. No known material with explosive or pyrophoric characteristics will be processed in this system. This system is located in Bays X, XIII and XVI as shown on Figure 922.14-IV; a minimum of 4' north of Hoods 2-L-2, 1-L-14, and 1-L-1 Hoods and a minimum of 6' south of 1-D-41 Tank, O_2 Tower Chloride Column and DDU unit.

The equipment consists of an inlet and exit glove box, a low temperature furnace, a high temperature furnace, a cooling chamber and a return tube for empty furnace boats. The equipment is built as an enclosed loop.

2. Process

In brief, the process consists of loading individual furnace boats in the inlet glove box. The boats are pulled through the furnace and emerge in the exit glove box. The residue remaining in the boats is removed, bottled and placed in storage. The empty boats are recycled to the inlet glove box through the return tube.

The filled boats in the hood will next be connected to boats already in the furnace tube by means of hooked links on the boat ends. The operator will then manually advance all the boats in the tube one position. This will serve also to pull no more than two boats from the furnace into the outlet glove box. The furnace slide valves may be closed isolating the furnace from the inlet glove box and cooling section in the furnace.

The boats in the discharge hood will be inverted, tapped, and scraped to empty them of as much of the residue adhering to them as possible. This material will be brushed into the discharge funnel through which it will fall into a container not exceeding 4.8 liter capacity. The empty boats will then be hooked to the chain of boats already in the return tube. When boats are required in the inlet hood, they will be removed from the return tube.

As containers not exceeding 4.8 liter capacity are filled with residue material they will be capped and placed in the storage bunker for further processing.

The combustion gases from the furnaces will be exhausted to the existing 2-F-3 A & B Chloride Column Scrubber. This scrubber will remove any uranium or other contaminants carried in the gases. This scrubber is described in Subpart 922.13.

3. Nuclear Safety

3.1 Inlet Glove Box 2-L-4

A single safe volume, safe geometry, or as received container of feed is introduced into the glove box for loading into furnace boats. Due to the method of operation, no more than one boat will be in the glove box at one time. Since the operation does not require (nor is it practicable) the lifting of the boats off the floor of the glove box, the possibility of stacking or spilling boats has been neglected.

The safety of the hood is assured since only one feed container and one furnace boat (cross sectional area less than an equivalent 5" diameter cylinder) are allowed in the glove box.

3.2 Furnace System 2-H-2 and 2-H-3

Dimensions of the furnace tube, boat return tube and boats are set forth in Table 922.14-I. All have cross sectional areas less than that of an equivalent 5" diameter cylinder. Therefore, they are individually safe for conditions of optimum moderation and reflection. It should be noted, however, that there are no water connections to this furnace system and it may be considered dry.

3.3 Slide Valves Between Glove Boxes and Furnace

The slide valves are geometrically safe per Table XV of K-1019, Fifth Revision. The discussion of Subpart 922.14.3.1 above, is applicable here.

3.4 Exit Glove Box 2-L-5

The discussion of Subpart 922.14.3.1 above, is applicable here.

In addition, the material entering this glove box will have been through the furnace and should be dry.

3.5 Product Collection and Storage Bottle

The calcined residue will be scraped from the boats and transferred to a safe volume bottle, not exceeding 4.8 liter capacity, through a funnel in the floor of the Outlet Glove Box. This is shown on Sketch 922.14-III. Therefore, these are safe individual units.

3.6 Interaction

The results of the interaction components of the glove box furnace systems have been calculated:

Even with all the conservative estimates that were made, Table No. 922.14-II shows that the maximum solid angle any subcrit will be is 2.36 steradians.

The most reactive unit would be a 1 gallon bottle (6" dia. 10" height). From Fig. 4, K-1317, this unit would have a base multiplication factor of approximately .6. This would allow a solid angle of

Ω (Allowable) = 9-10K = 9-6.0 = 3.0 steradians

GEOMETRY OF SUBCRITS

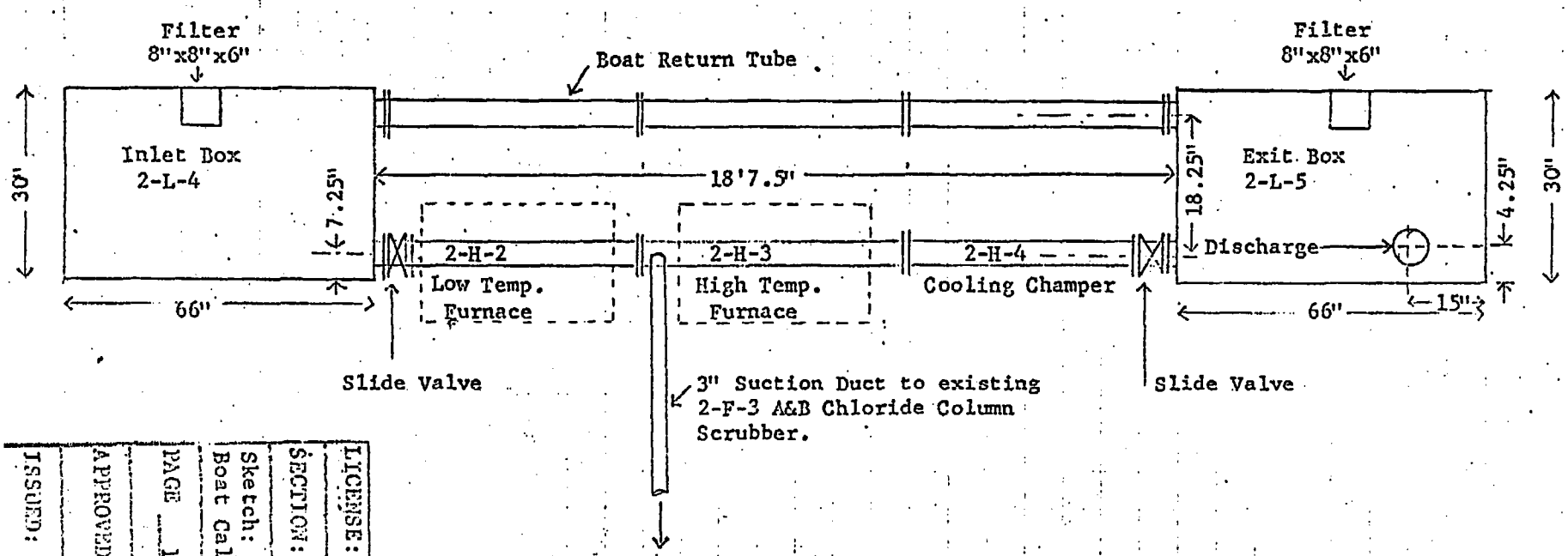
Subcrit	Configuration (Cross Section)	Volume	Cross Section Area (Inside)	Equiv. Dia.
Furnace Tube	4½" wide x 3-3/4" high with 6" radius at top		18.2 sq. in.	4-13/16"
Boat Return Tube	4½" wide x 4¼" high		19.1 sq. in.	4-9/16"
Furnace Boats	3-3/8" wide x 3¼" high x 24" long	4.25 liters	10.95 sq. in.	3-3/4"
Furnace and Hood Filters	7¼" x 7¼" x 5-7/8" high			
Unloading Hood Discharge Chute	Conical - 8" I.D. at top x 2" I.D. at bottom x 8½" high	3.04 liters		
Containers	6" O.D. x 11-1/8" overall height	4.4 Liter		
Slide Valve at Inlet to Furnace	6" diameter x 4-3/4" wide	2.19 liters		
Slide Valve at End of Furnace	4½" wide x 4¼" high x 7/8" thick			

SOLID ANGLE SUMMARIZATION

Subcrit subtending the angle / Subcrit @ which the angle is subtended	Furnace Tube	Return Tube	Inlet Filter	Outlet Filter	Filter on Tube	Hi-Temp. Filter	Overhead Storage Tanks 1-D-9 A-F	Bottle	Total
Furnace Tube	--	.52*	.05	.05	.05	--	<.48	.126	< 2.12
Return Tube	.52	--	.05	.05	.05	<.05*	<.48	<.126*	< [illegible].17
Filter on Inlet Box	<.234*	.234	--	small*	small*	small*	<.48	≪.126*	< 1.92*
Filter on Outlet Box	<.234*	.234	small*	--	small*	small*	<.48	≪.126*	< 1.92*
Filter on Furnace Tube	.234	<.234*	small*	small*	--	.178	<.48	≪.126*	< 2.09*
High Temp. Filter on Furnace	≪.234*	≪.234*	small*	small*	.178	--	<.48	≪.126*	< 2.09*
[illegible]idue Bottle	<.52*	<.52*	small*	small*	small*	small*	<.48	--	< 2.36*

*Conservative estimates based on the actual calculations.

PLAN VIEW OF BOAT CALCINER



Elevations:

Bottom of Hoods, Furnace Tubes & Return = 38"

LICENSE: SUB-777; DOCKET: 70-82

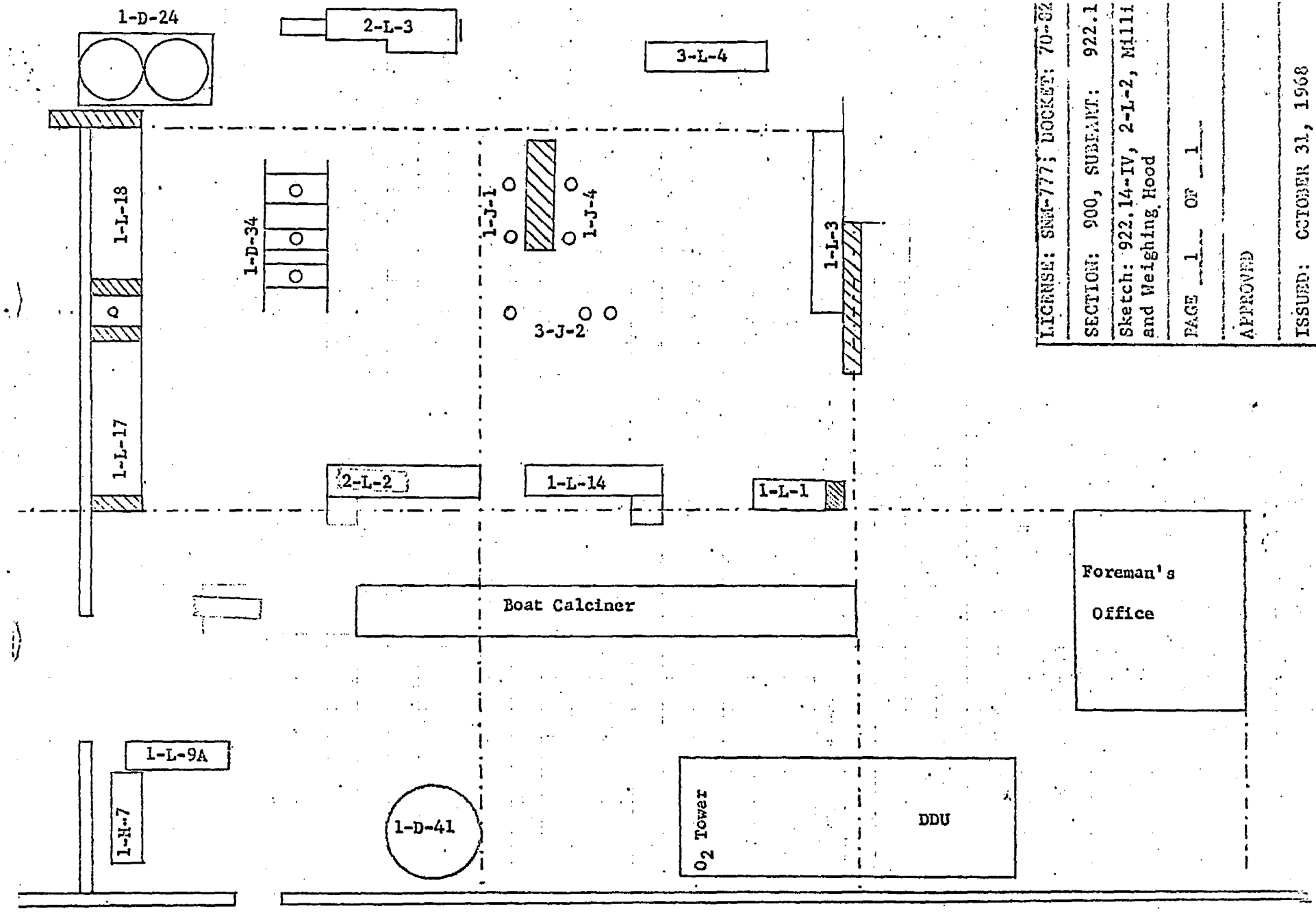
SECTION: 500, SUBPART: 922.14

Sketch: 922.14-III, Plan View of Boat Calciner

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBSAMT: 922.1

Sketch: 922.14-IV, 2-L-2, Milli and Weighing Hood

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

INTERACTION CALCULATIONS - BOAT CALCINER SYSTEM

SOLID ANGLE CALCULATIONS

Formula used throughout the calculations - except as noted:

$$\Omega = 4 \sin^{-1} \frac{\left(\frac{A}{2}\right) \left(\frac{B}{2}\right)}{\sqrt{\left(\frac{A}{2}\right)^2 + H^2} \sqrt{\left(\frac{B}{2}\right)^2 + H^2}}$$

See K-1019, Fifth Revision, Page 44, Formula A.1.4.B for Nomenclature.

1) Of the furnace tube at the return tube - with boats being loaded and unloaded:

Where: A = 33 1/2 feet (From the end of the boat being loaded to the far end of the discharge hood. The assumption is made that all boats will be on the centerline of the furnace tube).

B = 4.2" (The overall height of the domed furnace tube).

H = 16" (The center to surface distance of the return to the furnace tube).

$$\Omega = 4 \sin^{-1} \frac{\frac{4.2}{(2)(12)} \quad (33.5)}{\sqrt{\left(\frac{2.1}{12}\right)^2 + \left(\frac{16}{12}\right)^2} \sqrt{\left(\frac{33.5}{2}\right)^2 + \left(\frac{16}{12}\right)^2}}$$

Ω = .52 steradians.

Note: In Table 902.14-II, the solid angle of the return tube subtended at the furnace tube is also indicated as being .52 steradians. This same type of extrapolation has been used on the angles subtended by the other pieces of equipment.

2) Of the furnace and return tubes at the absolute filters:

A = 33.5 feet

B = 4 1/2"

C = 37-3/4" (77" + 1/2 (5-7/8") - 38" - 4-1/4")

$$\Omega = 4 \sin^{-1} \frac{\left(\frac{33.5}{2}\right) \left(\frac{.375}{2}\right)}{\sqrt{(16.75)^2 + (3.15)^2} \sqrt{(.188)^2 + (3.15)^2}}$$

Ω = .234 steradians

3) Of one of the absolute filters at either the return tube or the furnace tube:

A = 8"

B = 8"

H = 36-7/8" (77" -38" - 2-1/8")

Ω = .05 steradians

4) Of the high temperature filter at the absolute filter on the furnace tube - and conversely:

A = 8"

B = 8"

H = 18" (98" - 77" - 3")

Ω = .178 steradians

5) Of the storage rack at the furnace tubs:

Note: For this calculation, the storage rack was considered to be a rectangular solid.

A = 98" = 8'2"
B = 72" = 6'0"
H = 6'9-1/4"

Ω = .84 steradians

6) Of the residue bottle at the funace tube:

The formula used in this calculation was:

$\Omega = 2\pi\ (1-\cos\theta)$:

Formula A.3, K-1019, Fifth Revision, Page 44

Where: $\cos\theta = \dfrac{15''}{\sqrt{(15)^2 + (3)^2}}$

Ω = 6.28 (1-.98) = .126 steradians

7) The Overhead Storage Tanks have a 5" diameter and are separated by at least 10 feet, assuming infinite length.

$\Omega = \dfrac{2d}{h} \sin\theta = \dfrac{10''}{120''} \approx .08$

Since there are 6 tanks,

Ω (Total) = 6 x Ω = 6 x .08 = .48 steradians

8) Other equipment such as the 1-L-1 Hood, the 1-L-14 Hood, etc., are separated from this system by greater than 5' and their interaction effects are considered negligible.

922.15 Hood 2-L-2 and Pulverizer 2-K-1

1. Process and Equipment Description

1.1 Hood 2-L-2

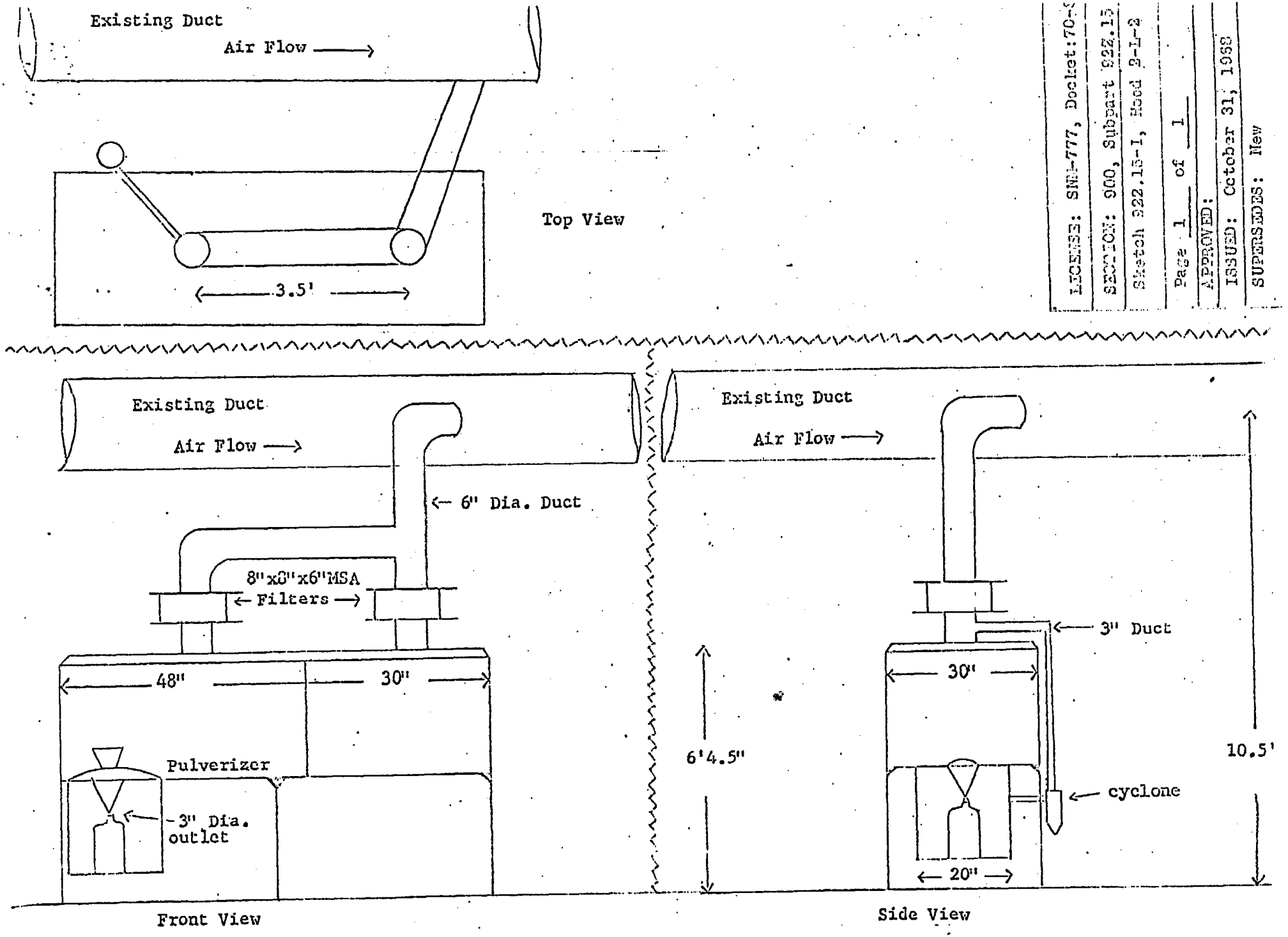
This Hood is 30" deep x 84" long x 42" high. The section housing the Pulverizer is 48" long and is connected to the adjacent chamber by a sliding vertical door. The drive motor for the Pulverizer is externally mounted. Ventilation to the Hood is provided by three ducts leading from each end of the Hood and the withdrawal chamber to an existing exhaust system. The air from the Pulverizer chamber is filtered through an absolute filter before entering the present exhaust system which has additional filtering. The air from the entrance and withdrawal chamber passes into the present exhaust system before additional filtering. See Sketches 922.15-I and II. Materials are collected in the 5" ID x 12" long hopper containers 2-X-1 or 1-gallon bottles.

1.2 Pulverizer 2-K-1

The Pulverizer 2-K-1 will be located in Hood 2-L-2. A total of one gallon will be permitted as a batch. The material is hand fed from one gallon containers into the Hopper at the top of the Pulverizer. The receiver vessel for the Pulverizer is a 5" dia. x 12" long container with 3" diameter neck which also serves as a transfer container for further processing of the powder. The same vessels are used as hopper containers and are designated as 2-X-1. As an alternative, a standard one-gallon container may be used.

2. Nuclear Safety

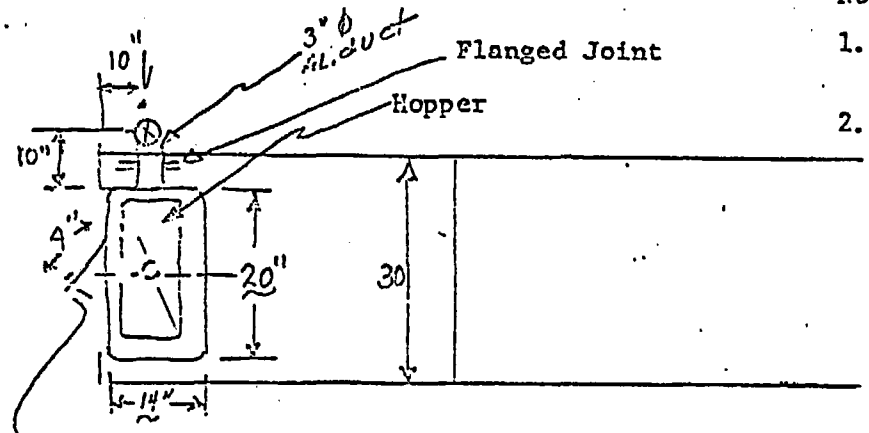
Individual containers will be either 5" in diameter or one-gallon in capacity. Only two containers will be allowed in the hood and they will be separated by one foot edge-to-edge from each other. This hood is located at least 5' from any other equipment with SNM in it and its interaction effects are considered negligible.



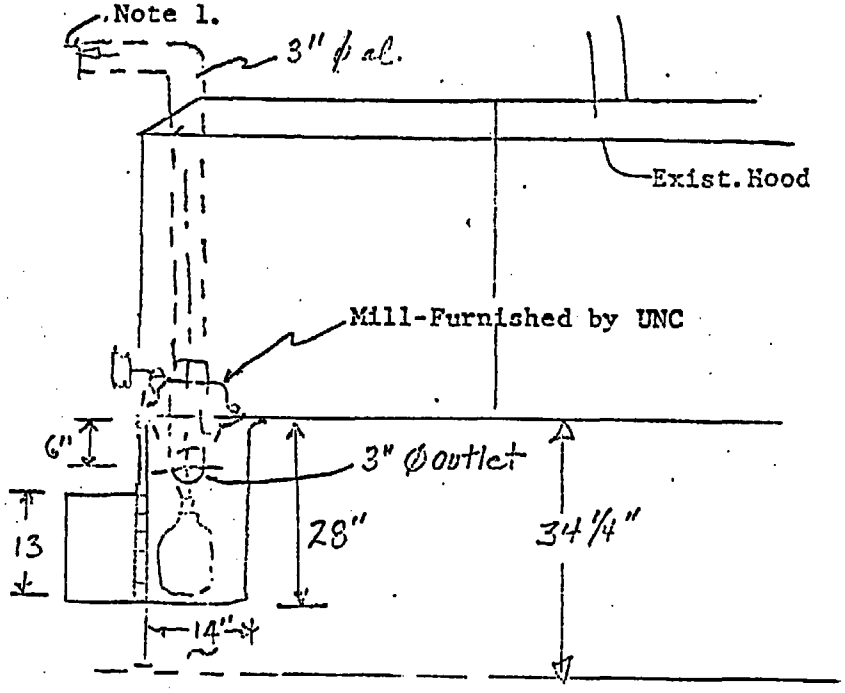
LICENSE: SNM-777, Docket:70-
SECTION: 900, Subpart 922.15
Sketch 922.15-I, Hod 2-I-2
Page 1 of 1
APPROVED:
ISSUED: October 31, 1968
SUPERSEDES: New

Notes:

1. Connect 3" Ø Al duct to 6" duck as shown on R.I. 386 Inquiry
2. Material of Const 18-8 Type S.S.



Door opening 8" wide x 12" high
hinged with continuous piano hinged S.S. and detached at top & bottom



LICENSE: SNM-777, Docket: 70-82	
SECTION: 800, Subpart: 822-13	
Sketch 822.15-II Hopper Housing & Exhaust Duct	
Page 1 of 1	
APPROVED:	
ISSUED: October 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.16 - Wet Cut-off Saw

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.16 Wet Cut-off Saw

1. General

A modified power hack saw located in the Maintainence Shop may be used to disassemble fuel units. The saw is modified by the addition of a sump drain, settling bulb (capacity one quart) and a 5 gallon reservoir tank for coolant liquid. The coolant tank will be packed with Raschig Rings. A recirculating pump will provide coolant flow from the coolant tank to the part in the hack saw. The coolant flows by gravity from the saw table through the settling bulb back to the reservoir.

2. Nuclear Safety

Only one unit at a time will be processed. Disassembled pieces will be immediately removed, cleaned, wiped dry and transferred to storage or introduced to the process line.

The coolant will be limited to not more than 350 grams U-235. This will be accomplished by checking the settling bulb for building of solids and subsequent clean out. This check and cleanup will be performed at least daily when the equipment is in use. However, it is expected that most of the solids will be retained on the saw table which will be cleaned off after each individual use. The coolant tank will be checked with a Gamma Portable Monitor to note material buildup.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Sold Scraps
922.17 - Milling Machine

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.17 Milling Machine

1. General

A wet milling machine located in the Maintainence Shop may be used to disassemble fuel units, remove excess cladding, etc. This mill is modified to use the Wet Cut Off Saw Coolant System as described in Subpart 922.15. Also, a coolant system consisting of 4 - 5" diameter pipes, 36" long, spaced a minimum of 18" center-to-center apart may be used. This array of pipes will be located a minimum of 4' away from the milling machine. This alternate coolant system is shown in Sketch 922.17-I.

2. Nuclear Safety

Same as Subpart 922.15. The pipe coolant system will have a solid angle of .88 steradians. From Table XVII, K-1019, Rev. 5, a 5" cylinder has an allowable interaction of 3.2 steradians.

Contribution From Nearest Pipes

d=5", L=36", L/2=18", h=18" + 2.5" = 20.5"

$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{18''}{20.5''} = .88$$

$$= \frac{10''}{20.5''} (.67) = .49 \times .67 \qquad \sin \theta = .67$$

$$= .326$$

Contribution From Furthest Pipes

d=5", L=36", L/2=18", $h = \sqrt{18''+18''} = \sqrt{648} = 25.4''$

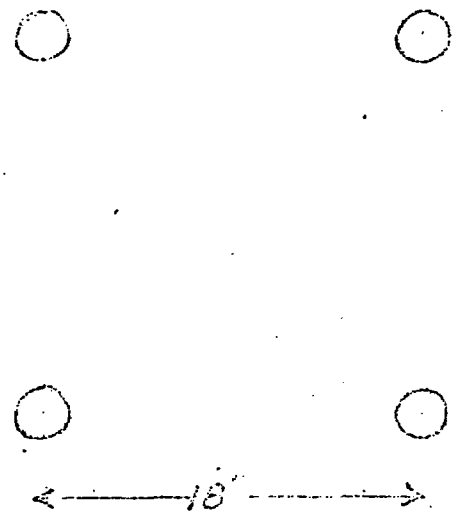
$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{18''}{25.4} = .71$$

$$= \frac{10''}{25.4''} (.58) = .394 \times .58 \qquad \sin \theta = .58$$

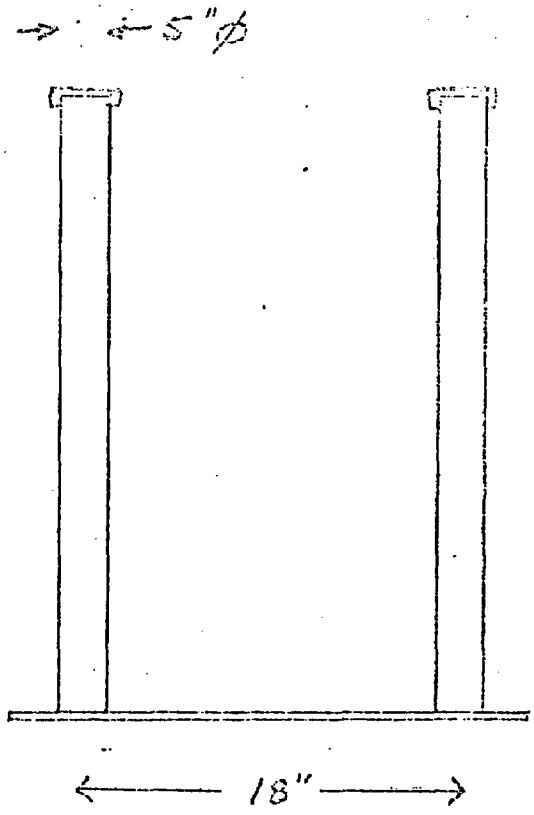
$$= .228$$

Total Interaction

$$\Sigma \Omega = .326 + .326 + .228 = .880 \text{ steradians}$$



TOP VIEW



SIDE VIEW

MILLING MACHINE COOLANT CONTAINER ASSY

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 922.1
Sketch: 922.17-I
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 922 - Preparation of Solid Scraps
922.18 - PEXTO Splitter

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

922.18 PEXTO Spliter

1. General

This splitter is used to remove fuel plates from fuel units which are roll swaged together, etc. It is also located in the Maintenance Shop.

2. Nuclear Safety

Only one unit will be processed at a time. Disassembled pieces will be immediately transferred to storage or introduced to the process line.

922.19 Alligator Shear

1. General

This shear is used to cut fuel plates or units. It is located in the Maintenance Shop.

2. Nuclear Safety

Only one unit or plate will be processed at a time. The cut pieces will be immediately transferred to storage or introduced to the process area.

923.1 General

This equipment is used for the safe dissolution of solid scrap materials containing uranium up to and including fully enriched. These materials may have been previously prepared for dissolution in other areas of the plant or may be in the form as received from the shipper. Safety is based on either safe geometry equipment or by the use of batch limitations utilizing administrative controls.

1. Process Description

Activities include, but are not limited to, the following:

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

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

c) Dissolution of UO_2-ZrO_2 type scrap materials

d) Dissolution of U-Zr or U-Al type plates or rods.

923.2 Tray Dissolvers System

1. General

The tray dissolvers are typically used for the dissolution of solid uranium bearing scrap. A batch is weighed, measured and packaged in Glove Box 1-L-1 or Hoods 1-L-14, 1-L-9A, 2-L-2, or 2-L-3, (ref: Subpart 922.2, 922.3, 922.4 and 922.10 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 or other solvent 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-3 or 3-D-12.

2. Equipment and Nuclear Safety

2.1 Tray Dissolvers 1-J-5 A and B

The trays are 4 inches high by 26-1/4" wide outside dimensions. A drain pipe is located near one corner of the tray for solution and solid removal.

The dissolution batch will be limited to 0.887 kg U-235.

All solids will be removed from the tray before recharging. Solution and solids are drained from the tray through a one inch pipe.

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

The nuclear safety of these trays is demonstrated in the Nuclear Safety Evaluation for the Tray Dissolvers.

2.2 Filter 1-F-6

This filter is similar to the dissolvers, being 21" square and 2" deep. It is located in Hood 1-L-3B. 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 inch pipe to 1-D-36.

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

2. Equipment and Nuclear Safety (continued)

2.3 Tank 1-D-36

This tank is 5 inches in diameter and hence nuclearly safe. The tank is filled by means of vacuum transfer from the pan filter and is emptied by gravity or low pressure air. A moisture alarm is installed in the vacuum line to detect any liquid entrained to the vacuum system.

2.4 Fume Scrubber 2-X-1 (See Sketch 923.2-II)

Vapors, dust and mist from the 1-L-3 hoods are washed in a 14" diameter vertical venturi type scrubber with internal spray nozzles. A horizontal pan 45" long by 20" wide and 6" sloping to 12" in depth serves as a plenum for separating the liquid from the scrubbed gas. This pan drains to a 5" diameter vertical sump approximately 5' long. The liquid level in this sump is assured by a 1-1/2" diameter overflow pipe return to the tray 1-J-5. A vertical demister section in the exhaust duct from the plenum removes entrained droplets from the gas.

The sump is 5" in diameter. The overflow position prevents build-up of solution into the plenum chamber. Frequent inspection and/or cleaning of the plenum chamber will prevent any accumulation of material. The sump will be periodically drained and recharged with fresh solution to insure a concentration of less than 5 g U/l.

2.5 Hood 1-L-3 A, B, C

These hoods contain the Tray Dissolvers 1-J-5 A and B. Fumes from these hoods are washed in the Fume Scrubber 2-X-1.

2.6 Physical Air Breaks

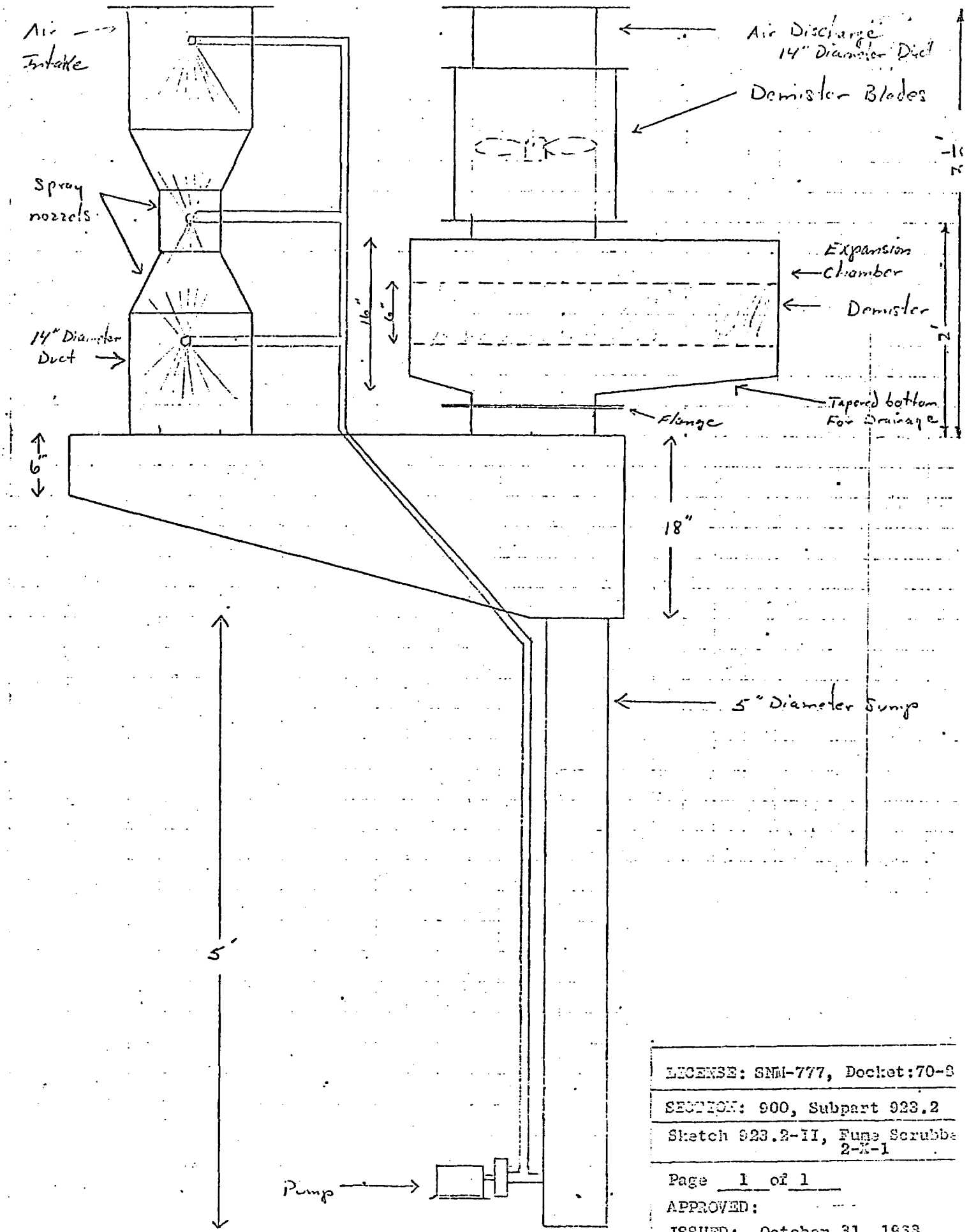
Chemical reagent tanks of unsafe geometry will be separated from the uranium process stream by a physical air break.

2.7 Beaker or Bottle Storage

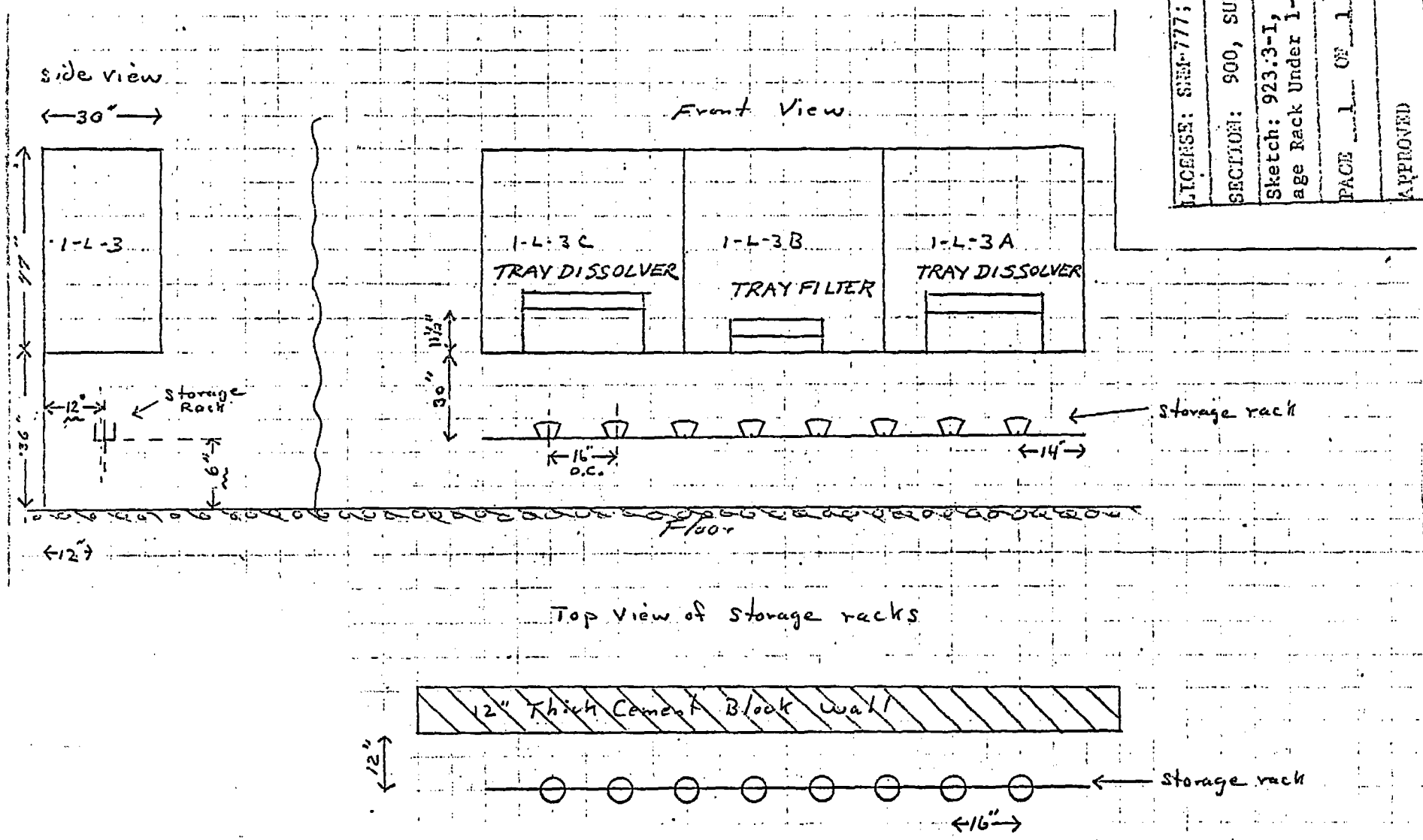
A fixed beaker or bottle storage rack will be installed under the Hoods 1-L-3 A, B, and C. The rack will be approximately 30" from the bottom of the hoods, 6" off the floor, 12" from the wall and 12" from the front of the hoods.

The rack will accomodate up to eight covered containers of 1 gallon volume or less. Bottle or beaker stations will be located on 16" centers.

The containers are a safe volume and the centermost bottle subtends a solid angle of 1.96 steradians and has an allowable solid angle of 2.36 steradians. Details of the rack location are shown on Sketch 923.2-I.



LICENSE: SNM-777, Docket:70-8	
SECTION: 900, Subpart 923.2	
Sketch 923.2-II, Fume Scrubbe 2-X-1	
Page 1 of 1	
APPROVED:	
ISSUED: October 31, 1963	
SUPERSEDES: New	



LICENSE: SNM-777; DOCKET: 70-320

SECTION: 900, SUBPART: 923.2

Sketch: 923.3-I, Location of Storage Rack Under 1-L-3 Hood

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

I. GENERAL

The tray dissolvers have inside dimensions of 24" x 24" x 4" with a volume of 37.7 liters. The nuclear criticality safety of the tray dissolvers will be checked using data in TID-7028. This evaluation will be performed by determining the minimum critical mass for the trays.

II. CONCLUSIONS

The calculations which follow indicate that the minimum critical mass with full reflection top and bottom is 1.387 kgs U-235. This occurs with a 13.2 liter system which has a 4 in. height corresponding to the maximum tray thickness. Since the tray height is 4 in., top reflection is considered essentially impossible. Therefore, under actual conditions (full bottom reflection and no top reflection), the critical mass is greater than 13 kgs U-235. A maximum batch size of 0.887 kg U-235 was selected so that the tray would be subcritical if either double batching or full top reflection should occur, or double batched & partially reflected.

III. CALCULATIONS

The following formulas were used:

$$B_g^2 = \left(\frac{2.405}{r + \lambda}\right)^2 + \left(\frac{\pi}{h + 2\lambda}\right)^2$$

$$r_c = \frac{2.405}{\sqrt{B_g^2}} - \lambda \text{ inf. cyl.}$$

For a 10" Ø x 4" cylinder

$V = 1.287\ \ell/\text{in} \times 4" = 5.14\ \ell$ from Table B-13, Y-1272

$r = 5" \times 2{,}54\ \text{cm/in} = 12.7\ \text{cm}$

$h = 4" \times 2.54\ \text{cm/in} = 10.16\ \text{cm}$

$h/d = 4"/10" = .4$

$\lambda \approx 6$ cm from Fig. 3, TID-7028

$$B_g^2 = \frac{5.8}{(12.7 + 6)^2} + \frac{9.8}{(10.16 + 12)^2} = \frac{5.8}{(18.7)^2} + \frac{9.8}{(22.16)^2} = \frac{5.8}{350} + \frac{9.8}{490} =$$

$0.0166 + 0.0200 = 0.0366\ \text{cm}^2$

$$r_c = \frac{2.405}{0.191} - 6.35 = 12.6 - 6.35 = 6.25\ \text{cm} = 2.46\ \text{in.}$$

$d_c = 4.92$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c \approx 2.0$ kg U-235/ℓ

$M_c = V\rho_c = 5.14\ \ell \times 2.0$ Kg U-235/ℓ =

10.28 kg U-235

LICENSE: SNM-777; DOCKET: 70-82(	
SECTION: 900, SUBPART: 923.2	
Nuclear Safety Evaluation - Tra Dissolvers	
PAGE 1 OF 6	
APPROVED	
ISSUED: OCTOBER 31, 1968	

III. CALCULATIONS (Continued)

For a 14" Ø x 4" cylinder

$V = 2.523\ \ell/\text{in} \times 4" = 9.29\ \ell$ from Table B-13, Y-1272

$Y = 7" \times 2.54\ \text{cm/in} = 16.4\ \text{cm}$

$h = 10.16\ \text{cm}$

$h/d = 4"/14" = .285$

$\lambda = 6\ \text{cm}$ from Fig. 3, TID-7028

$$B_g^2 = \frac{5.8}{(16.4 + 6)^2} + \frac{9.8}{(10.16 + 12)^2} = \frac{5.8}{(22.4)^2} + \frac{9.8}{(22.16)^2} = \frac{5.8}{504} + \frac{9.8}{490} = 0.0115 +$$

$$0.0200 = 0.0315\ \text{cm}^2$$

$$r_c = \frac{2.405}{0.177} - 6.35 = 13.6 - 6.35 = 7.25\ \text{cm} = 2.86\ \text{in}$$

$d_c = 5.72$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.223$ Kg U-235/ℓ

$M_c = 9.29\ \ell \times 0.223$ Kg U-235/ℓ = **2.07 Kg U-235**

For a 16" Ø x 4" cylinder

$V = 3.295\ \ell/\text{in} \times 4" = 13.2\ \ell$ from Table B-13, Y-1272

$r = 8" \times 2.54\ \text{cm/in} = 20.3\ \text{cm}$

$h = 10.16\ \text{cm}$

$h/d = 4"/16" = 0.25$

$\lambda = 6.05$ from Fig. 3, TID-7028

$$B_g^2 = \frac{5.8}{(20.3 + 6.05)^2} + \frac{9.8}{(10.16 + 12.1)^2} = \frac{5.8}{(26.35)^2} + \frac{9.8}{(22.26)^2} = \frac{5.8}{695} + \frac{9.8}{496} =$$

$$0.0084 + 0.0200 = 0.0284\ \text{cm}^{-2}$$

$$r_c = \frac{2.405}{0.168} - 6.35 = 14.30 - 6.35 = 7.95\ \text{cm} = 3.125\ \text{in}$$

$d_c = 6.25"$

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.105$ Kg U-235/ℓ

$M_c = 13.2\ \ell \times 0.105$ Kg U-235/ℓ = **1.387 Kg U-235**

III. CALCULATIONS (Continued)

For a 18" ϕ x 4" cylinder

$V = 4.17\,\ell/\text{in} \times 4'' = 16.7\,\ell$ from Table B-13, Y-1272

$r = 9 \times 2.54$ cm/in $= 22.86$ cm

$h = 10.16$ cm

$h/d = 4''/18'' = 2.22$

$\lambda = 6.1$ from Fig. 3, TID-7028

$$B_g^2 = \frac{5.8}{(22.86 + 6.1)^2} + \frac{9.8}{(10.16 + 12.2)^2} = \frac{5.8}{(28.96)^2} + \frac{9.8}{(22.36)^2} = \frac{5.8}{840} + \frac{9.8}{500} =$$

$0.0069 + 0.0196 = 0.0265\ \text{cm}^{-2}$

$$r_c = \frac{2.405}{0.163} - 6.35 = 14.80 - 6.35 = 8.45\ \text{cm} = 3.33\ \text{in}$$

$d_c = 6.66$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.09$ Kg U-235/ℓ

$M_c = 16.7\,\ell \times 0.09$ Kg U-235/ℓ = **1.503 Kg U-235**

Now check for a cylinder with a 3.5" height

For a 10" x 3.5" cylinder

$V = 1.287\,\ell/\text{in} \times 3.5'' = 4.5\,\ell$ from Table B-1.3, Y-1272

$r = 12.7$ cm

$h = 3.5$ cm x 2.54 cm/in $= 8.89$ cm

$h/d = 3.5''/10'' = .35$

$\lambda \approx 6$ cm from Fig. 3, TID-7028

$$B_g^2 = 0.0166 + \frac{9.8}{(8.89 + 12)^2} = 0.0166 + \frac{9.8}{(20.89)^2} = 0.0166 + \frac{9.8}{436} = 0.0166 + 0.0224$$

$= 0.0390\ \text{cm}^{-2}$

$$r_c = \frac{2.405}{0.198} - 6.35 = 12.15 - 6.35 = 5.80\ \text{cm} = 2.28\ \text{in}$$

$d_c = 4.56$ in

From Fig 10, TID-7028, the critical density is

$\rho_c \approx 4$ Kg U-235/ℓ

$M_c = V\rho_c = 4.5\,\ell \times 4$ Kg U-235/ℓ = **18.0 Kg U-235**

III. CALCULATIONS (Continued)

For a 14" ø x 3.5" cylinder

$V = 2.523\ \ell/\text{in} \times 3.5\ \text{in} = 8.83\ \ell$ from Table B-1.3, Y-1272

$r = 16.4$ cm

$h = 8.89$ cm

$h/d = 3.5''/14'' = .25$

$\lambda = 6$ cm from Fig. 3, TID-7028

$B_g^2 = 0.0115 + 0.0224 = 0.0339\ \text{cm}^{-2}$

$r_c = \frac{2.405}{0.184} - 6.35 = 13.07 - 6.35 = 6.72\ \text{cm} = 2.65\ \text{in}$

$d_c = 5.3$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.48$ Kg U-235/ℓ

$M_c = V\rho_c = 8.83\ \ell \times 0.48$ Kg U-235/ℓ = **4.24 Kg U-235**

For a 16" ø x 3.5" cylinder

$V = 3.295\ \ell/\text{in} \times 3.5'' = 11.53\ \ell$ from Table B-1.3, Y-1272

$r = 20.3$ cm

$h = 8.89$ cm

$h/d = 3.5''/16'' = .22$

$\lambda = 6.05$ from Fig. 3, TID-7028

$B_g^2 = 0.0084 + 0.0224 = 0.0308\ \text{cm}^{-2}$

$r_c = \frac{2.405}{0.176} - 6.35 = 13.66 - 6.35 = 7.31\ \text{cm} = 2.88\ \text{in}$

$d_c = 5.76$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.2$ kg U-235/ℓ

$M_c = 11.53\ \ell \times 0.2$ Kg U-235/ℓ = **2.31 Kg U-235**

III. CALCULATIONS (Continued)

For a 18" Ø x 3.5" cylinder

$V = 4.17\,\ell/\text{in} \times 3.5'' = 14.6\,\ell$ from Table B-1.3, Y-1272

$r = 22.86$ cm

$h = 8.89$ cm

$h/d = 3.5''/18'' = .19$

$\lambda = 6.2$ cm from Fig. 3, TID-7028

$B_g^2 = 0.0069 + 0.0220 = 0.0289\ \text{cm}^{-2}$

$r_c = \frac{2.405}{0.17} - 6.35 = 14.15 - 6.35 = 7.8\ \text{cm} = 3.07$ in

$d_c = 6.14$ in

From Fig. 10, TID-7028, the critical density is

$\rho_c = 0.19$ Kg U-235/ℓ

$M_c = 14.6\,\ell \times 0.19$ Kg U-235/ℓ = **2.77 Kg U-235**

As can be seen, the minimum critical mass occurs with a 4" height.

Since the tray height is limited to 4 inches, the addition of sufficient reflector to cause complete reflection is essentially impossible. Evaluating for this condition and using the most reactive arrangement (16" Ø x 4" high cylinder)

$V = 13.2\,\ell$

$r = 20.3$ cm

$h = 10.16$ cm

$h/d = 0.25$

$\lambda_r = 6.05$ cm

$\lambda_b = 2.5$ cm from Fig. 3, TID-7028

$$B_g^2 = \frac{5.8}{(20.3 + 6.05)^2} + \frac{9.8}{(10.16 + 6.05 + 2.5)^2} = \frac{5.8}{(26.35)^2} + \frac{9.8}{(18.71)^2} = \frac{5.8}{695} + \frac{9.8}{350} = 0.0084 + 0.0280 = 0.0364\ \text{cm}^{-2}$$

III. CALCULATIONS (Continued)

$$r_c = \frac{2.405}{0.19} - 6.35 = 12.66 - 6.35 = 6.31 \text{ cm} = 2.49 \text{ in}$$

$$d_c = 4.98''$$

From Fig. 10, TID-7028, the critical density is

$$\rho_c > 1 \text{ kg U-235}/\ell$$

$$M_c > 13.2\ell \times 1 \text{ kg U-235}/\ell > \boxed{13.2 \text{ Kg U-235}}$$

Therefore, under actual conditions, the tray would be subcritical even if double batched.

To evaluate the effects of a partial reflector on the top, an extrapolation length of 4.5 cm was assured:

$V = 13.2\ell$

$r = 20.3$ cm

$h = 10.6$ cm

$h/d = 0.25$

$\lambda_r = 6.05$ cm

$\lambda_p = 4.5$ cm

$$B_g^2 = \frac{5.8}{(20.3 + 6.05)^2} + \frac{9.8}{(10.16 + 6.05 + 4.5)^2} = \frac{5.8}{(26.35)^2} + \frac{9.8}{(20.71)^2} =$$

$$\frac{5.8}{695} + \frac{9.8}{429} = 0.0084 + 0.0228 = 0.0312 \text{ cm}^{-2}$$

$$r_c = \frac{2.405}{.177} - 6.35 = 13.59 - 6.35 = 7.24 \text{ cm} = 2.85 \text{ in}$$

$$d_c = 5.7 \text{ in.}$$

From Fig. 10, TID-7028, the critical density is

$$\rho_c = 0.20 \text{ kg U-235}/\ell$$

$$M_c = 13.2\ell \times 0.20 \text{ Kg U-235}/\ell = \boxed{2.64 \text{ Kg U-235}}$$

Therefore, the tray would be subcritical if double batched and partially reflected.

BEAKER OR BOTTLE STORAGE RACK UNDER 1-L-3 A, B, and C

CASE I - Centermost Bottle in Rack (1 gal. bottles - 6" Ø x 10")

A. Bottles on each side of centermost bottle

$d = 6''$, $L = 10''$, $1/2L = 5''$, h = center-to-center spacing $- \frac{d}{2} = 16'' - \frac{6''}{2} = 13''$

$$\Omega_B = \frac{2d}{h} \sin\theta = \frac{12}{13}(0.36) = 0.923 \times 0.36 = 0.33$$

$$\tan\theta = \frac{1/2\ L}{h} = \frac{5}{13} = 0.39$$

$$\sin\theta = 0.36$$

$$\Omega_B(\text{Total}) = 2 \times \Omega_B = 2 \times 0.33 = 0.66 \text{ steradians}$$

B. Trays above centermost bottle

Assume the 2 trays plus the tray filter form one large tray

$a = 24'' + 24'' + 24'' = 72''$, $b = 24''$, $h = 11.5'' + 30'' - 5'' = 36.5''$

Using Eqn. 4.a, Appendix 3, K-1019, Rev. 5

$$\Omega_T = \frac{a\ b \cos\theta}{q^2}$$

$$\cos\theta = \frac{h}{q}$$

$$\Omega_T = \frac{a\ b\ h}{q^3}$$

Assuming the centermost bottle directly below the center point of the plane formed by the trays,

$$h = q$$

$$\Omega_T = \frac{a\ b}{q^2} = \frac{72 \times 24}{(36.5^2)} = \frac{1728}{1332} = 1.3 \text{ steradians}$$

C. Total interaction

$$\Omega(\text{Total}) = \Omega_B(\text{Total}) + \Omega_T = 0.66 + 1.3 = 1.96 \text{ steradians}$$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.2
Interaction Calculations
PAGE 1 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968

D. Allowable Interaction

For a critical, reflected infinitely long cylinder

$d_{c,r} = 5.4'' = 13.7$ cm, $r = 6.85$ cm and $h_{c,r} =$ from Fig. 10, TID-7028.

$\lambda_{cyl} = 6.35$ cm from Fig. 3, TID-7028

$$B_g^2 = \frac{J_o^2}{(r+\lambda)^2} + \frac{\pi^2}{(h+2\lambda)^2} = \frac{5.8}{(6.85+6.35)^2} + 0 = \frac{5.8}{(13.2)^2} = \frac{5.8}{174.2} =$$

$0.0332\ cm^{-2}$

At criticality

$B_M^2 = B_g^2 = 0.0332\ cm^{-2}$

Assume $M^2 = 30\ cm^2$

For a bare, one gallon container

$d = 6'' = 15.25$ cm, $r = 7.625$ cm and $h = 10'' = 25.4$ cm

$\lambda = 2.5$ cm from Fig. 4, TID-7028

$$B_g^2 = \frac{J_o^2}{(r+\lambda)^2} = \frac{\pi^2}{(h+2\lambda)^2} = \frac{5.8}{(7.625+2.5)^2} + \frac{9.8}{(25.4+5)^2} =$$

$$\frac{5.8}{(10.125)^2} + \frac{9.8}{(30.4)^2} = \frac{5.8}{102.5} + \frac{9.8}{924.2} = 0.0565 + 0.0106 = 0.0671\ cm^{-2}$$

$$K_{eff} = \frac{1 + M^2 B_M^2}{1 + M^2 B_g^2} = \frac{1 + (30 \times 0.0332)}{1 + (30 \times 0.0671)} = \frac{1 + .996}{1 + 2.013} = \frac{1.996}{3.013} = 0.664$$

Ω (allowable) $= 9 - 10K = 9 - 6.64 = 2.36$ steradians

CASE II - Tray to Bottle

A. Nearest Bottle

$r = \frac{6''}{2} = 3''$, $h = 36.5''$

$\Omega_B = 2\pi(1 - \cos\theta) = 2 \times 3.1416\ (1 - .998) = 6.283 \times .002 = 0.0126$ steradia

$\cos\theta = \frac{h}{q}$ where $q = \sqrt{r^2 + h^2} = \sqrt{1341.2} = 36.6''$

$= \frac{36.5''}{36.6''}$

$= 0.998$

LICENSE: SNM-777; DOCKET: 70-3
SECTION: 900, SUBPART: 923.
Interaction Calculations
PAGE 2 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968

B. All Bottles

Assume all bottles are same distance from the trays for ease of calculation

$$\Omega_{Total} = 8 \times \Omega_B = 8 \times .0126 = 0.1 \text{ steradians}$$

C. Allowable interaction

From the "Nuclear Safety Evaluation - Tray Dissolvers" the minimum critical condition occurs with a 1.387 kg mass, 16" diameter, 4" height and geometric buckling of 0.0284 cm^{-2}. Under operating conditions, each tray is limited to .887 kg U-235, So,

$$V = \pi r^2 h = \pi\ (8'') \times 4'' = \pi\ (20.32\ cm)^2 \times 10.16\ cm = 13\ \ell$$

$$\rho_{system} = \frac{\text{Actual Mass}}{\text{System Volume}} = \frac{.887 \text{ kg U-235}}{13} = 0.0682 \text{ kg U-235}/\ell$$

From the data on Table IV, DP-532, for a uranium concentration of 0.0682 Kg U-235/ℓ

$$B_M^2 = 0.0215\ cm^{-2}$$

Assume $M^2 = 30\ cm^2$

For a bare 16" dia. x 4" high cylinder with a max. mass of .887 kg U-235.

$d = 16'' = 40.6$ cm, $r = 20.3$ cm and $h = 4'' = 10.16$ cm

$\lambda = 2.5$ cm from Fig. 4, TID-7028

$$B_g^2 = \frac{5.8}{(20.3 + 2.5)^2} + \frac{9.8}{(10.16 + 5)^2} = \frac{5.8}{(22.8)^2} + \frac{9.8}{(15.16)^2} = \frac{5.8}{519.8} + \frac{9.8}{229.8} = 0.0111 + 0.0426 = 0.0537\ cm^{-2}$$

$$K_{eff} = \frac{1 + M^2 B_M^2}{1 + M^2 B_g^2} = \frac{1 + (30 \times .0215)}{1 + (30 \times .0537)} = \frac{1 + .645}{1 + 1.611} = \frac{1.645}{2.611} = 0.63$$

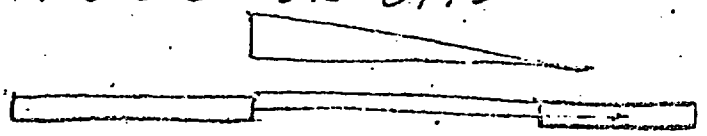
$$\Omega\ (\text{allowable}) = 9 - 10\ K = 9 - 6.3 = 2.7 \text{ steradians}$$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.2	
Interaction Calculations	
PAGE 3 OF 3	
APPROVED	
ISSUED: OCTOBER 31, 1968	

1.) AS ARRAY (ISOLATED)

a) 1-J-5A WITH 1-J-5B OR OPP.

TAKE AS EQUIV. TO 1.75" Ø X 26" CYLS. FOR SOLID ANGLE

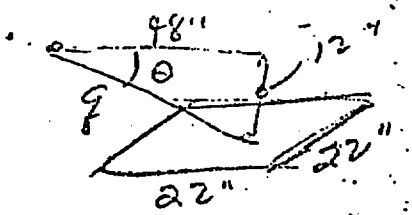


$$\Omega = \frac{d}{h} \sin\theta \qquad d = 1.75 \quad h = 83'' \quad \sin\theta = 0.0214$$

$$\Omega = \frac{0.037}{83} = 0.00045 \text{ (NEGLIGABLE)}$$

b) 1-J-5A WITH 1-F-6 OR 1-J-5B W/ 1-F-6

$$\Omega = \frac{(a)(b)}{q^2} \cos\theta$$



$$q^2 = 2448$$

$$\cos\theta = 0.970$$

$$\Omega = \frac{(22)^2}{2448}(0.970) = 0.192$$

c) 1-J-5A WITH 1-D-36

$$\Omega = \frac{2d}{h} \sin\theta \qquad d = 5'' \quad h = 43'' \quad \sin\theta = 0.7235$$

$$\Omega = \frac{7.235}{43} = 0.169$$

d) 1-J-5A WITH MOIST. ALARM

$$\Omega = \frac{2d}{L} \sin\theta \qquad L/2 = 12'' \quad d = 2'' \quad h = 38'' \quad \sin\theta = 0.3015$$

$$\Omega = \frac{1.206}{38} = 0.0317$$

TOTAL INTERACTION AS ISOLATED ARRAY

$$\Omega = 0.392$$

LICENSE: SNM-777; DOCKET: 70-0	
SECTION: 900, SUBPART: 923.2	
Interaction Calculations - Tray Dissolvers - 1-J-5's	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

2.) AS ARRAY WITH ADJACENT EQUIPMENT

(a) WITH 1-J-4

ISOLATED BY DISTANCE

(b) WITH 1-D-10 A, B-C

$\Omega = \frac{d}{h}(\sin\theta_1 - \sin\theta_2)$ $d = 5''$ $h = 185''$

$\Omega = \frac{5(0.5163)}{185}$ $\sin\theta_1 = 0.9813$ $\sin\theta_2 = 0.465$

$\Omega = 2.58/185 = 0.014$ EA TANK

FOR 3 TANKS

$\Omega = 3(0.014) = 0.042$

3.) TOTAL INTERACTIONS

$\Omega = 0.392 + 0.042 = 0.434$

ALLOWABLE 1.0

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.2
Interaction Calculations - Tray Dissolvers - 1-J-5's
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

1) STORAGE TANK. 1-D-36

2) SIZE: 5" ID x 8'0" SH. SIDE

3) CONTENTS: HI GRADE SCRAP DISSOLVED IN HF & H_2O_2

4) URANIUM CONCENTRATION: 120 gm/l MAX.

5) NUCLEAR SAFETY:

a) AS INDIVIDUAL UNIT

5" Ø - SAFE GEOMETRY

b) WITH ADJACENT EQUIPMENT -

1) WITH MOISTURE ALARM CONTAINER

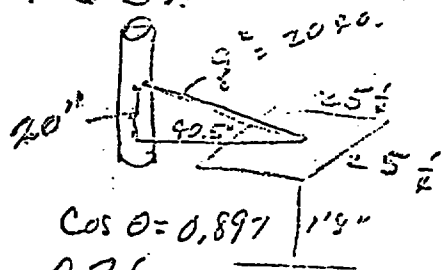
$\Omega = \frac{2d}{L} \sin\theta$ $d = 2$ $L = 13"$

$\sin\theta = 0.6792$ $L_2 = 12$

$\Omega = \frac{2.7128}{13} = 0.209$ ONLY APPLICABLE IF FILLED

2) WITH TRAY DISSOLVER 1-J-5A

$\Omega = \left(\frac{a \cdot b}{\ell^2}\right) \cos\theta =$



$\Omega = \frac{(25.25)^2}{2090}(0.897) =$

$\cos\theta = 0.897$

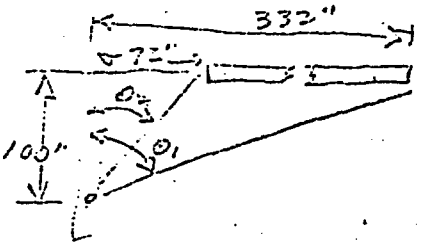
$\Omega = \frac{637.6(.897)}{2090} = \frac{572}{2090} = 0.28$

3) WITH 1-J-5B, 1-F-6, 1-J-4

ISOLATED BY DISTANCE OR BY CONCRETE WALL.

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.2	
Interaction Calculations - Tray Dissolver Storage Tank 1-D-36	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

4) WITH 1-D-10 A, B, C



$$\Omega = \frac{d'}{h}(\sin\theta_1 - \sin\theta_2)$$

$d = 5''$, $h = 100''$

$\sin\theta_1 = 0.9594$ $\sin\theta_2 = 0.594$

$$\Omega = \frac{1.869}{100} = 0.0186 \quad \text{EACH TANK}$$

FOR 3 TANKS

$$\Omega = 3(0.0186) = 0.0558$$

(c) TOTAL INTERACTION

$$\Omega_T = 0.209 + 0.280 + 0.0558 = 0.5448$$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.2
Interaction Calculations - Tray Dissolver Storage Tank 1-D-36
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

1. FILTER 1-F-6

2. SIZE: 20 x 20 x 1 3/2"

3. CONTENTS: URANIUM - ZIRCONIUM SOLUTION

4. NUCLEAR SAFETY

a) AS ISOLATED UNIT:

(1) SAFE GEOMETRY

(a) AREA OF TRAY (PLAN) 20" x 20"
EQUIVALENT TO 22.6" ø CYL.
SAFE HEIGHT FOR 22.6" ø CYL ≅ 1.75"
PER TABLE XV & FIG. 4 K-1019

(b) INTERACTIONS AS ISOLATED ARRAY

1) WITH 1-J-5A
(SEE 1-J-5)

$$\Omega = \frac{(a)(b)}{g^2} \cos\theta$$

$a = 25.25$, $b = 25.25$
$g = 2448$
$\cos\theta = 0.970$

$$\Omega = \frac{(25.25)^2}{2448}(0.970)$$

$$\Omega_1 = 0.253$$

2) WITH 1-J-5-B

$$\Omega_2 = \Omega_1 = 0.253$$

3) WITH MOIST ALARM

$$\Omega = 2d/h \, (\sin\theta)$$

$d = 9"$
$h = 8"$

$$\Omega = \frac{.568}{8"} = 0.007$$

(SIN θ = 0.142)

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 923.2	
Interaction Calculations - Filte 1-F-6	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

(c) INTERACTIONS WITH ADJ. EQUIP.

(1) WITH 1-D-10 A, B, C

$\Omega \cong 0.04$ (REF 1-J-5A)

(2) WITH 1-J-4 – ISOLATED

(d) TOTAL INTERACTIONS

1) ISOLATED ARRAY

$\Omega = 0.5067$

(2) WITH ADJ. EQUIP.

$\Omega = 0.04$

(3) TOTAL INTERACTION

$\Omega = 0.5067 + 0.04 = \cancel{0.5467}$ .5467

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.2	
Interaction Calculations - Filt 1-E-6	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

923.3 Unlined Dissolver System

1. General, Process and Equipment Description

Uranium bearing scrap, either alloy or compound, that does not require the use of a plastic or teflon lined dissolver may be dissolved in this processing equipment. By design, the equipment is nuclearly 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 boxes or hoods such as 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 uranium containing solution is transferred through the Filter 1-F-24A (7-1/4" x 7-1/4" x 6") or similar type to the Assay Tank, 1-D-34 for sampling and weighing.

The filter cake consisting of low uranium acid insolubles will be transferred in safe geometry containers such as 12" x 12" x 1-1/4" trays, 1 gallon bottles, 5" I.D. containers to the appropriate drying oven, for example, 1-H-8 and Hood 1-L-14, dried and the residue handled as described in Subpart 902.3.

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 to the 2-X-1 Scrubber.

Condenser 1-E-7 acts as a reflux condenser returning the condensed liquid to the dissolver. Those 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 a fumes cover before discharge to the atmosphere.

1. General, Process & Equipment Description (continued)

1.1 Glove Box 1-L-14

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

1.2 Dissolver Vent Condenser 1-E-7

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

1.3 Cyclone 1-X-2

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

1.4 Nitric Acid Gage Tank 1-D-27

This tank (12 gallons capacity) meters nitric acid to both the lined and unlined dissolvers. Feed for this tank is from the nitric acid head tank 1-D-6.

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.

1.5 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.

2. Equipment and Nuclear Safety, Unlined Dissolver System

2.1 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 steradians.

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.

2. Equipment and Nuclear Safety, Unlined Dissolver System (continued)

2.2 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.

2.3 Cyclone 1-X-2

The Cyclone 1-X-2 is a 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.

2.4 Filter Press 1-F-24A

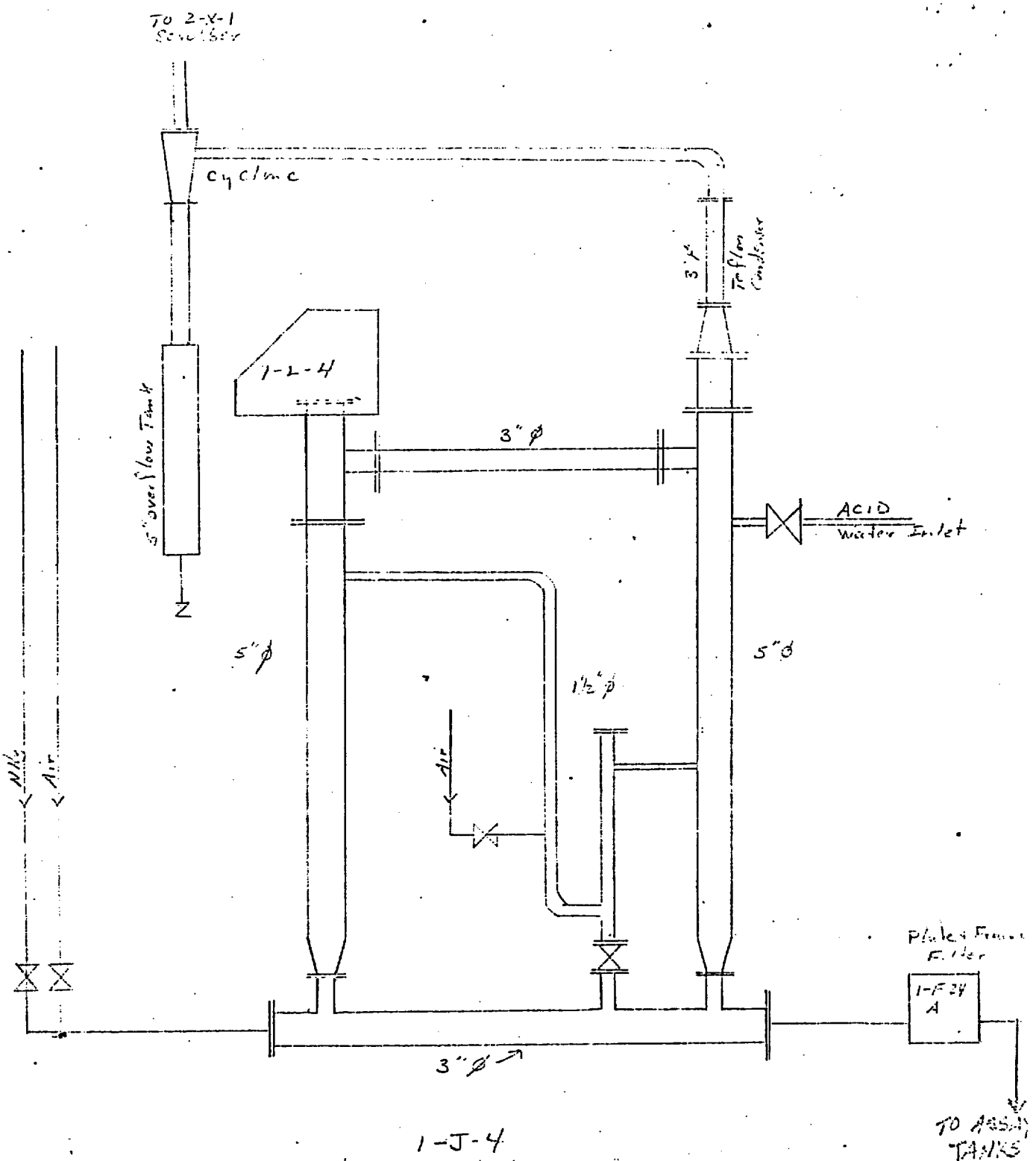
The cooled adjusted solution may be filtered on filter press 1-F-24A, a stainless filter press, to remove acid insolubles. The low uranium filter cake is transferred to safe geometry containers such as 12" x 12" x 1 1/4" trays, 1 gallon volume containers or 5" ID pipes to the 1-H-7 calciner or processed through utility hoods before drying and handled as described in Subpart 923.3.

This filter is 7 1/4" x 7 1/4" x 6", a safe geometry per Table XV of K-1019, 5th Rev. The solid angle subtracted at the filtar is less than 1 steradian.

Two one gallon containers are provided, one for solution in the drip pan under the Filter Press and the other for solids removed from the Filter Press. These containers are separated from each other and durounding equipment by 18".

2.5 Interaction

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



1-J-4
Stainless Steel Dissolver

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.3
Sketch: 923.3-I, 1-J-4 Stainless Steel Dissolver
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

1. NUCLEAR SAFETY

A. AS ISOLATED UNIT

(1) COMPONENTS

a) SAFE GEOMETRY - DIA'S. ≤ 5"

(b) SAFE GEOMETRY INTERSECTS. - TEES ≤ 4.2"
- CROSSES ≤ 3.8"

2) INTERACTIONS (INTERNAL)

5" ϕ BASKET LEG IS MOST REACTIVE
FROM 10-CFR-70 $\Omega = 9-10(.8) = 1.0$

a) BASKET LEG TO OPPOSITE LEG

$\Omega = \frac{2d}{h} \sin\theta$ $d = 5"$ $h = 41.5"$

$L/2 = 48"$

$\Omega = \frac{7.524}{41.5} = 0.182$ $\sin\theta = 0.7524$

b) BASKET LEG TO AIR LIFT PIPE

$\Omega = \frac{2d}{h} \sin\theta$ $d = 1.5$ $h = 27"$

$\sin\theta = 0.7526$

$\Omega = \frac{1.129}{27} = 0.042$

c) BASKET LEG TO CIRC. DOWNCOMER

$\Omega = \frac{2d}{h} \sin\theta$, $d = 1.5$ $h = 28"$

$\sin\theta = 0.336$

$\Omega = \frac{0.504}{28} = 0.018$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.3	
Solid Angle Calculations - Dissolver 1-J-4	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

d) BASKET LEG TO BOTTOM CROSSOVER

$\Omega = \frac{d}{L} \sin \theta$: $d = 3''$ $L = 45.5$

$\sin \theta = 0.6952$

$\Omega = \frac{2.0856}{45.5} = 0.049$

e) TOTAL INTERNAL INTERACTION

$\Omega = 0.182 + 0.042 + 0.018 + 0.049 = 0.289$

3. INTERACTIONS WITH ADJ. EQUIP.

a) BASKET LEG WITH 1-D-10A, B & C

$\Omega = \frac{2d}{L} \sin \theta$ $d = 5''$ $L = 170$

$L/2 = 102''$

$\Omega = \frac{5.13}{170} = 0.0302$ $\sin \theta = 0.513$

FOR 3 TANKS

$\Omega = 3(0.0302) = 0.0906$

b) OTHER EQUIP.

ISOLATED BY DISTANCE <12' OR BY 12" CONCRETE WALL

4) TOTAL INTERACTIONS

$\Omega = 0.289 + 0.0906 \cong 0.38$

5. PLUS CONTRIBUTION BY 1-F-24 a

$= .022$ (REF. 1-F-24 b)

TOTAL = .402 STERADIANS

LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 923.3	
Solid Angle Calculations - Dissolver 1-J-4	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

923.4 Teflon Lined Dissolver System

1. Dissolver Charge Glove Box 1-L-13

The transfer bottle containing the scrap will be transported from the counting glove box 1-L-1, the 1-L-11 hood, or the 1-L-14 hood 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 guage tank 1-D-27, hydrofluoric acid is charged from the HF guage tank 1-D-30, water is charged from the six inch Pyrex measuring tank and aluminum nitrate solution is changed from the 3-D-4 header (6" x 48").

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 the addition of the reagents. Although the guage tanks 1-D-27, 1-D-30, and 3-D-4 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.

2. Teflon Lined Dissolver 1-J-1

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 Subpart 923.4 and a blind flange is used to clase the dissolver charge port. Acid is added through a 2" 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 1-1/2" teflon lined pipe connecting the bottoms of the two vertical legs or an airlift which lifts the solution by air from the 1 1/2" pipe connecting the bottoms of the two verticle legs up to the 3" dia. pipe connecting the tops of the two verticle legs. Tracing around the vertical legs provides the required heating and cooling of the dissolver.

2. Teflon Lined Dissolver 1-J-1 (continued)

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. The non-condensable gases discharge to the 2-X-1 Scrubber 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-24D to the assay tanks for sampling and weighing.

3. Nuclear Safety of the Teflon Lined Dissolver 1-J-1

Figure 3 of TID-7016, Rev. 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 903.4-II. 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 Table 923.4-I.

3. Nuclear Safety of the Teflon Lined Dissolver 1-J-1 (continued)

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 923 4-II. In this case, an 8 inch diameter cylinder was the smallest critical cylinder.

These data have also been plotted in Figure 923.4-III as critical height versus diameter. For purposes of comparison, water reflected, cadmium sheathed-water reflected and unreflected cylinders have been included. From Figure 9234-III, 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 (see attached evaluation) 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.

4. Fume Hood 3-L-6

A 24" x 30" x 48" plastic fume hood is located 24" east of the south leg of the 1-J-1 Teflon Lined Dissolver. This hood will hold either the 1-F-24 B Acid Insolubles Filter or the 3-F-6 Tray Filter. Details of this arrangement are shown on Sketch 923.4 - V.

5. Acid Insolubles Filter 1-F-24B

The cooled adjusted solution may be filtered on filter press 1-F-24B, a stainless filter press, to remove acid insolubles. The low uranium filter cake is transferred in safe geometry containers such as 12" x 12" x 1-1/4" trays, 1 gallon volume containers or 5" I.D. pipes to the 1-H-7 Calciner or processed through utility hoods before drying and handled as described in Subpart 923.3.

This filter is 7-1/4" x 7-1/4" or 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.

6. Tray Filter 3-F-6

Cooled adjusted solution is filtered on a Vacuum Tray Filter 3-F-6 to remove acid insolubles. This filter is the same as the Acid Insoluble Filter 3-F-2 (Subpart 923.6) and is 19" x 25" x 2" deep.

Two one gallon containers are provided, one for solution in the drip pan under the Filter Press and the other for solids removed from the Filter Press. Those containers are separated from each other and surrounding equipment by 18".

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 1/2	47.1	14.4 (7" to 6 1/2")
6	118.4	71.3 (6 1/2" to 6")
5.8	118.4	71.3 (6 1/2" to 5.8") estimated

LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 923.4

Table 923.4-I

PAGE 1 OF 1

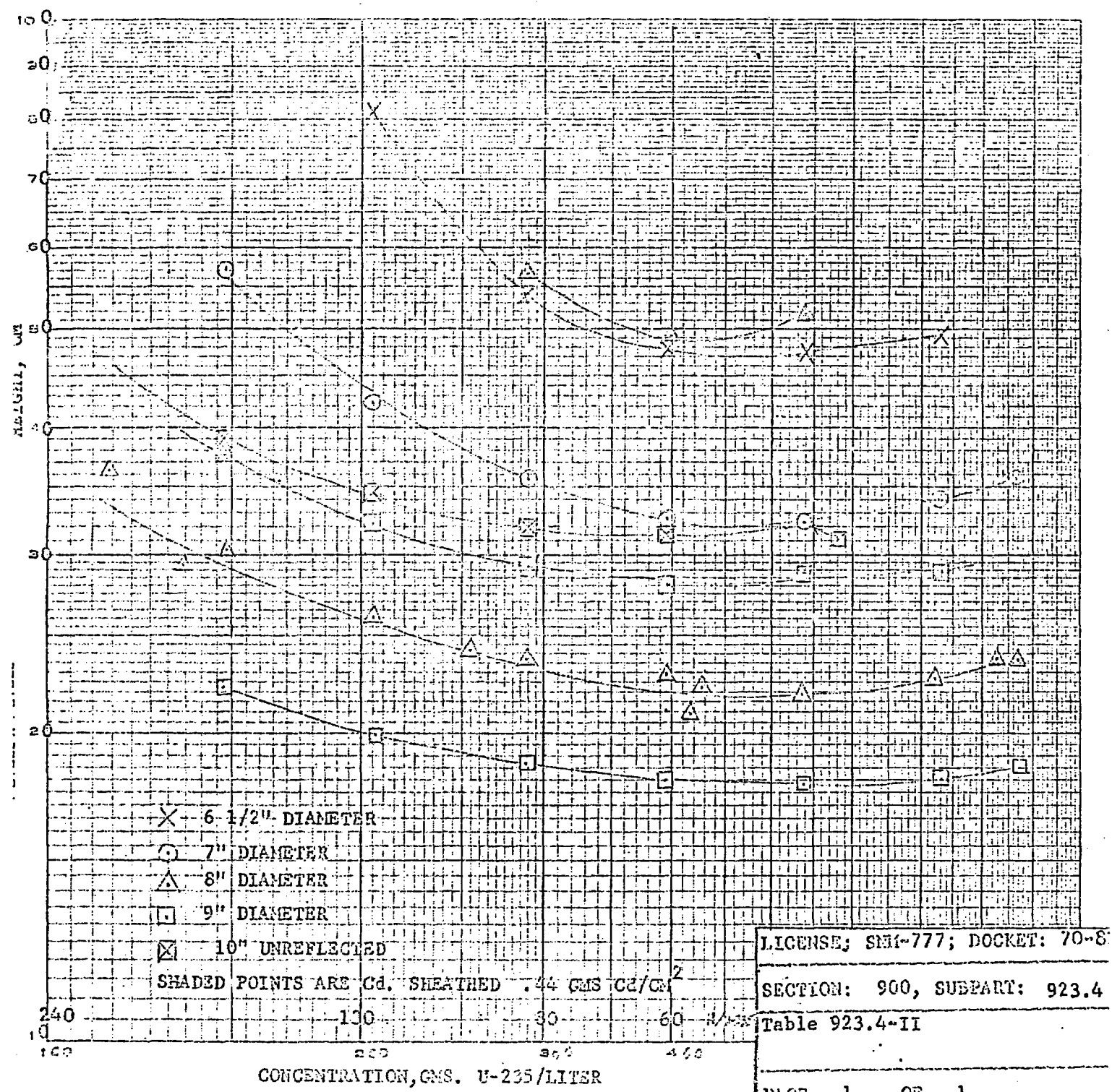
APPROVED

ISSUED: OCTOBER 31, 1968

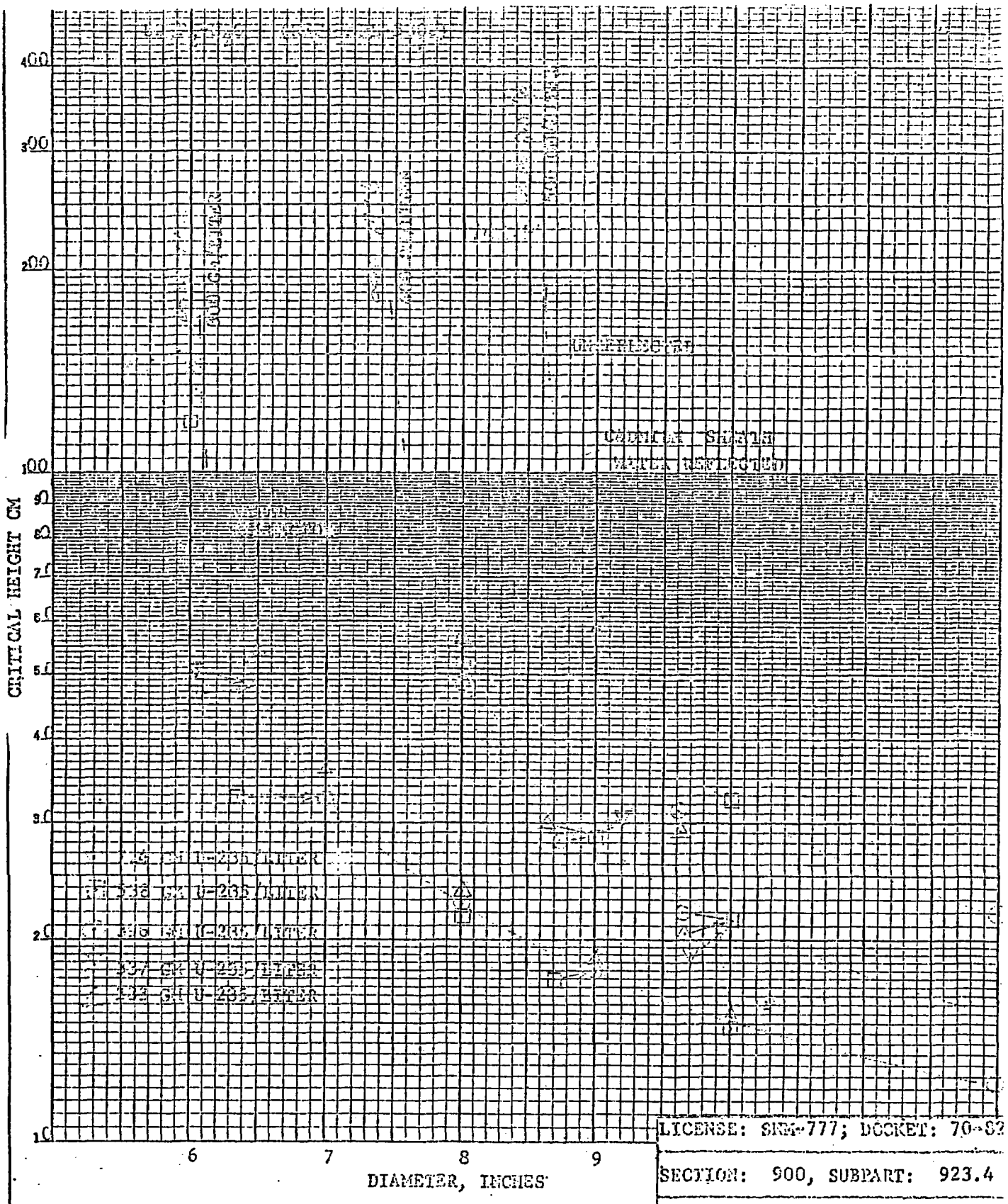
CRITICAL HEIGHT OF WATER REFLECTED

S.S. CYLINDERS OF UO_2F_2-H_2O

(REF: ANL 5800)



LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 923.4	
Table 923.4-II	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	



LICENSE: SNM-777; DOCKET: 70-82

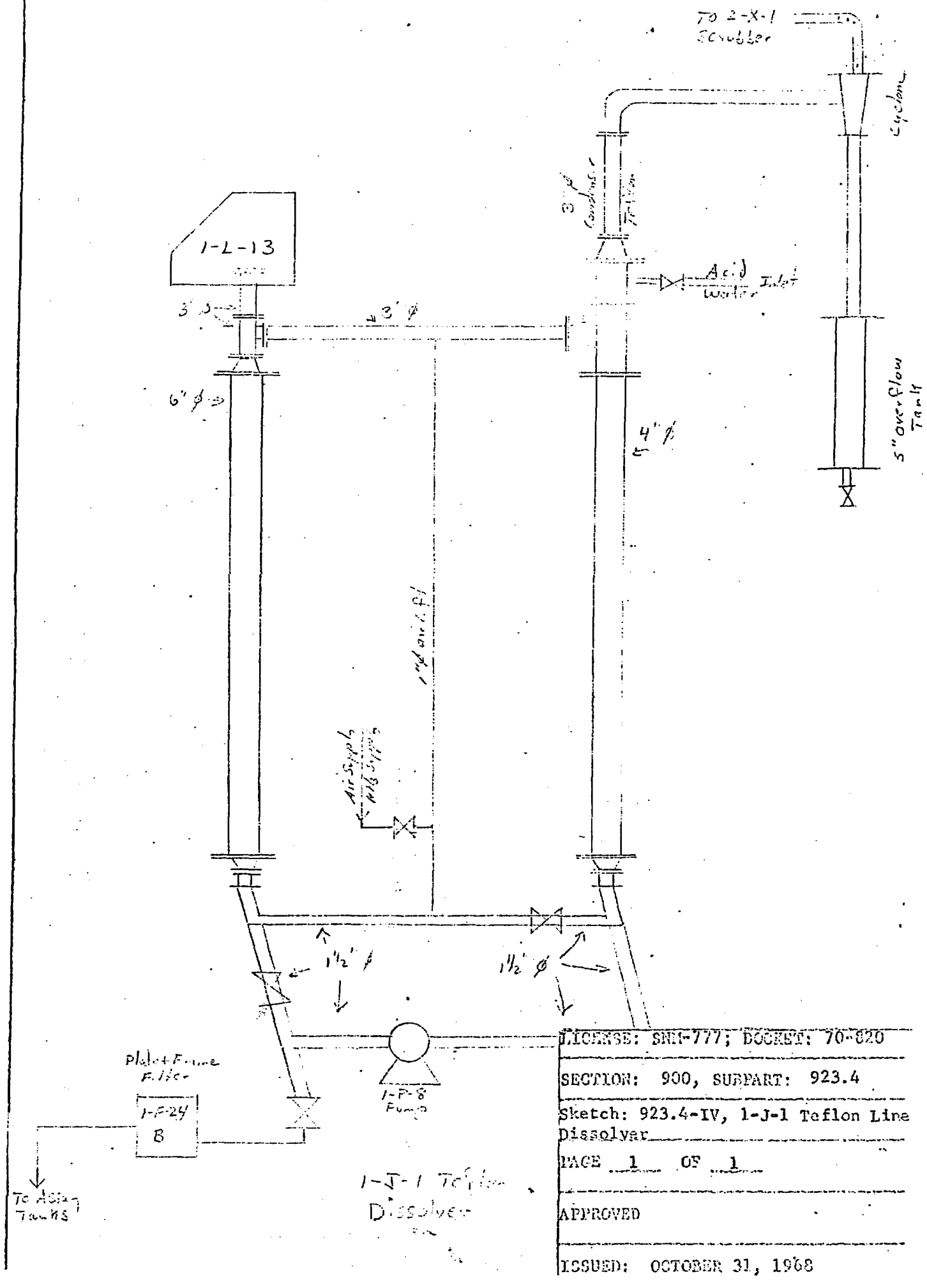
SECTION: 900, SUBPART: 923.4

Figure: 923.4-III

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-820

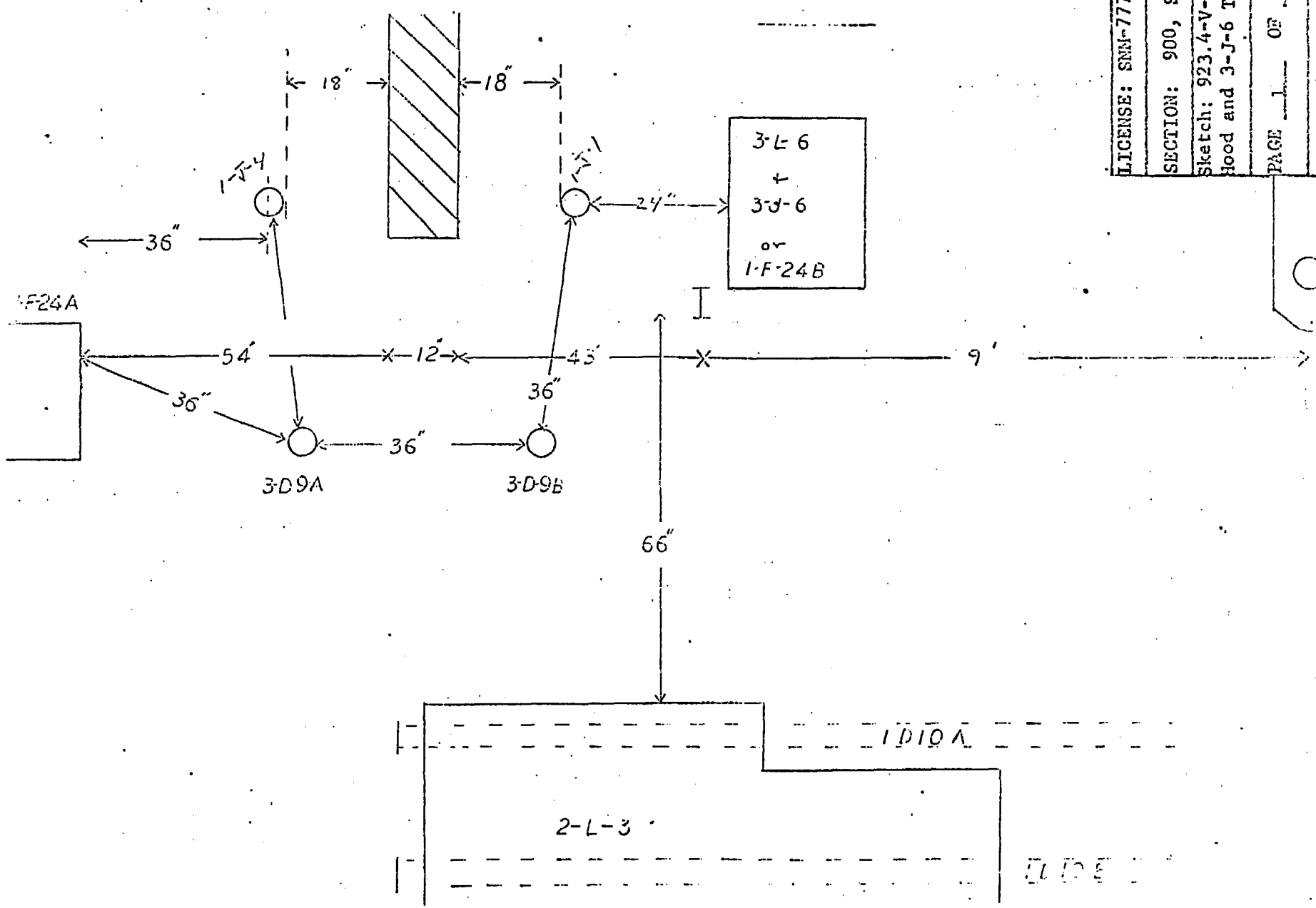
SECTION: 900, SUBPART: 923.4

Sketch: 923.4-IV, 1-J-1 Teflon Line Dissolver

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 923.4

Sketch: 923.4-V-Location of 3-L-Hood and 3-J-6 Tray Filter

PAGE 1 OF 1

APPROVED

ASSAY

ISSUED: OCTOBER 31, 1968

TEFLON LINED DISSOLVER 1-J-1

NUCLEAR SAFETY

1) 6" DIA. DISSOLVING LEG. W/ Cd WRAP.

ACTUAL ID = 5 7/8" ϕ

SAFE GEOMETRY FOR CADMIUM WRAP - SEE JUSTIFICATION PER UNC - "GENERAL INFORMATION AND PROCEEDURES - ETC" DATED JULY 15, 1963. UNDER CONDITIONS OF A DOUBLE BATCH - AND A PUMP FAILURE U CONCENTRATIONS IN THE SOLUTION CAN GO AS HIGH AS 510 gm. U/ PER LITER - & EFFECTIVE DENSITIES IN THE INCREMENT CONTAINING THE CHARGE, CAN GO AS HIGH AS 1.85 gm/cm³ (1.85 Kg/l). FIG'S. 11 & 12 SHOW THAT MINIMUM CRITICAL HEIGHT OCCURS AT H/U ≅ 60 OR ~ 400 gm/l.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.4
Solid Angle Calculations - Tefl Lined Dissolver -1J-1
PAGE 1 OF 6
APPROVED
ISSUED: OCTOBER 31, 1968

2) 4" ϕ LEG.

SAFE GEOMETRY 4" ϕ

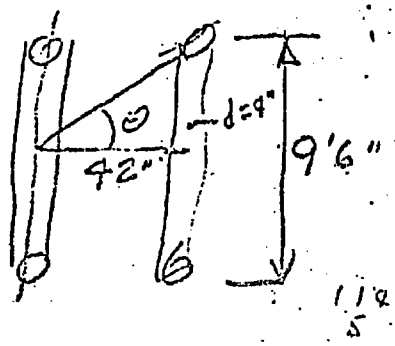
3.) AS ~~TSB4ft~~ ARRAY

a) 6" ϕ LEG.

Ω ALLOW = 9 - .8(10) = 1.0

(1) TO OPPOSITE LEG.

$\Omega = \frac{2d}{h} \sin\theta$



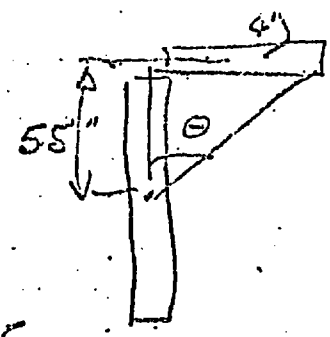
$d = 9''$ $h = 42''$

$\sin\theta = 0.8056$

$\Omega = \frac{6.45}{42} = 0.154$

2) TO CROSSOVER PIPE

$\Omega = \frac{d}{h} \sin\theta$



$d = 9''$ $h = 55''$

$\sin\theta = 0.6248$

$\Omega = \frac{2.499}{55} = 0.0455$

3) TO CYCLONE & DRAIN

TAKE TOGETHER AS 4"ϕ X 8'6" -

d=4 L=36"

Sin θ = .8167

$\Omega = \frac{2d}{h} \sin\theta = \frac{6.54}{36} =$ 0.182

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART:	923.
Solid Angle Calculations - Tefl Lined Dissolver 1-J-1	
PAGE 2 OF 6	
APPROVED	
ISSUED: OCTOBER 31, 1968	

4) To 1-J-4

ISOLATED BY 1' THICK CONCRETE WALL

5) To 1-D-10A, B, C, 1-D-16

$$\Omega = \frac{2d}{h} \sin\theta$$

$d = 5''$ $h = 170''$

$\sin\theta = 0.90446$

$$\Omega_A = \frac{9.0446}{170} = 0.053$$

$$\Omega_B = \frac{8.792}{195} = 0.045$$

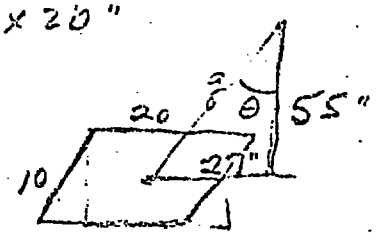
$$\Omega_C = 8.522/221 = 0.038$$

$$\Omega_{16} = 8.235/245 = 0.033$$

$$0.169$$

6) To 1-H-9 10" x 10" x 20"

$$\Omega = \frac{ab\cos\theta}{g^2}$$



$$\Omega = \frac{10(20)(0.898)}{3754} = 0.048$$

7) To 1-H-6

$$\Omega = \frac{ab\cos\theta}{g^2}$$

$a = 10$, $b = 20$

$g^2 = 10138$ $\cos\theta = 0.963$

$$\Omega = \frac{10(20)(0.963)}{10138} = 0.019$$

LICENSE: SNM-777; DOCKET: 70-82(
SECTION: 900, SUBPART: 923.4
Solid Angle Calculations - Tefl. Lined Dissolver 1-J-1
PAGE 3 OF 6
APPROVED
ISSUED: OCTOBER 31, 1968

8) TO 1½" PIPE (PUMP SUCT)

$\Omega = \frac{d}{L} \sin\theta$

$d = 1.5''$ $L = 51''$

$\sin\theta = .685$

$\Omega_8 = \frac{1.03}{51} = 0.02$

9) TO RECIRC PUMP

$\Omega = \frac{2d}{L} \sin\theta$ $d = 12''$ $L = 45''$

$\Omega = .96/5 = 0.02$ $\sin\theta = 0.0392$

TOTAL INTERACTIONS

$\Omega = \Omega_1 + \Omega_2 + \Omega_3 + \ldots + \Omega_9 = 0.657$

4. ASSAY TANK

$h = 132$ $h/A = 27$

$A = 5$ $h/B = 1.07$

$B = 126$ $\Omega = .032$

5. 6" X 7¼" FILTER 1F24B

$h = 45$ $h/A = 7.5$

$A = 6$ $h/B = 6.21$

$B = 7¼$ $\Omega = .022$

6. TOTAL SOLID ANGLE SUBTENDED AT THE 6"

DIAMETER CADMIUM

TOTAL $\Omega = .657 + .032 + .022$

$= .711$ STERADIANS

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 923.4	
Solid Angle Calculations - Teflo Lined Dissolver 1-J-1	
PAGE 4 OF 6	
APPROVED	
ISSUED: OCTOBER 31, 1968	

6) To 1-L-1, 1-L-14, 1-L-9A, 1-L-9B, 1-K-1, 1-K-3

$\Omega = 0$

ISOLATED BY DISTANCE

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.4	
Solid Angle Calculations - Tefl Lined Dissolver 1-J-1	
PAGE 5 OF 6	
APPROVED	
ISSUED: OCTOBER 31, 1968	

1-J-1 DISSOLVER INTERSECTIONS

TAKE AS 3X4X4X2 CROSS

EQUIV. TO 3.4 CROSS < 3.9"

TID-7016 REV. 1

TABLE III

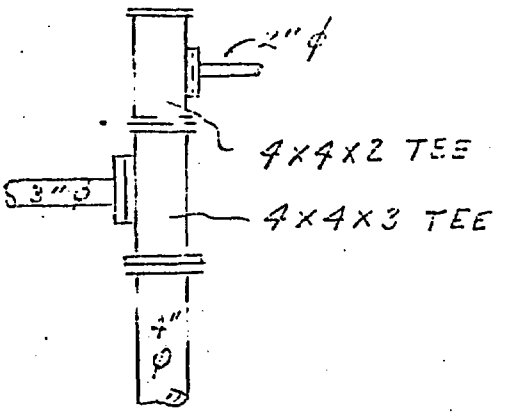


FIG. 1

$$d_e = \sqrt{\frac{4^2+4^2+3^2+2^2}{4}} = \sqrt{\frac{45}{4}} = \sqrt{11.25} = 3.35 \quad \text{OK}$$

ALTERNATE

TAKE AS 6"X3"X3" TEE

$$\left(\frac{6^2+3^2+3^2}{3}\right)^{1/2} = 4.24$$

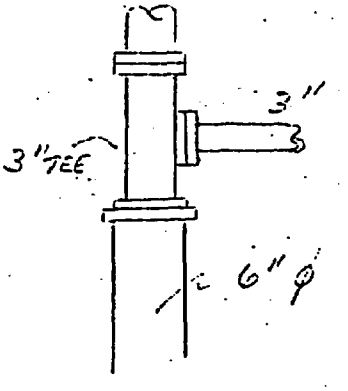


FIG 2

NOTE! ACTUAL DIAS.

5.9, 2.9, 2.9

Then $\left(\frac{5.9^2+2.9^2+2.9^2}{3}\right)^{1/2} = 4.18 < 4.2$

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.4
Solid Angle Calculations - Tefl Lined Dissolver 1-J-1
PAGE 6 OF 6
APPROVED
ISSUED: OCTOBER 31, 1968

SOLUTION: UO_2F_2 . 93% ENRICHED.

400 GMS U^{235}/LITER.

$$\frac{H}{U^{235}} = 63$$

$\sigma_a^{U^{235}} = 687(.981) = 674$ BARNS

$\sigma_a^{U^{238}} = 2.8$ BARNS

$\sigma_s^{U^{235}} = 10$ BARNS

$\sigma_s^{U^{238}} = 8.3$ BARNS

$\sigma_s^{O} = 4.2$ BARNS

$\sigma_s^{H} = 20$ BARNS ?

$\Sigma_a^{H_2O} = .022\ cm^{-1}$

$$K_{eff} = \frac{K_\infty e^{-\tau B_g^2}}{1 + L^2 B_g^2}$$

$$K_\infty = \varepsilon P f \eta$$

$\varepsilon = 1$ FAST FISSION FACTOR

$P = 1$ RESONANCE ESCAPE PROBABILITY

$\eta = 2.1$ NEUTRONS PRODUCED PER ABSORBTION IN U^{235}

$L =$ THERMAL DIFFUSION LENGTH, CM

$\tau = 27\ cm^2 =$ FERMI AGE.

$B_g^2 =$ GEOMETRIC BUCKLING, cm^{-2}

$f =$ THERMAL UTILIZATION.

K_{EFF} = MULTIPLICATION FACTOR OF FINITE SYSTEM.

K_∞ = MULTIPLICATION FACTOR OF INFINITE SYSTEM.

$\overline{\cos\theta}$ = AVERAGE COSINE OF THE SCATTERING ANGLE

W = WATER DENSITY, GM/CC.

$$\frac{H}{U^{235}} = 63 = \frac{W\ gm/cc \times 2\ \frac{\text{ATOMS } H}{\text{MOLE } H_2O} \times 235\ \frac{gm\ U^{235}}{mole}}{18\ \frac{gm\ H_2O}{\text{MOLE } H_2O} \times .4\ \frac{gm\ U^{235}}{cc} \times 1}$$

$W = .965$ gms/cc.

LICENSE: SNM-777; DOCKET: 70-32	
SECTION: 900, SUBPART: 923.4	
Cd Sheathed Cylinder of Infinit Length	
PAGE 1 OF 4	
APPROVED	
ISSUED: OCTOBER 31, 1968	

$$\Sigma_a^{U^{235}} = \frac{.4\ \text{GMS/CC} \times 6.023\times10^{23}\ \frac{\text{ATOMS}}{\text{MOLE}} \times 679\ \text{BARNS}}{235\ \frac{\text{GMS } U^{235}}{\text{MOLE}}} =$$

$$= .69\ \text{cm}^{-1}$$

SIMILARLY:

$$\Sigma_a^{U^{238}} = .00021\ \text{cm}^{-1}$$

$$\Sigma_a^{H_2O} = .022\ \text{cm}^{-1} \times .965 = .021$$

$$f = \frac{.69}{.69 + .021 + .0002} = \frac{.69}{.711} = .971$$

$$K_\infty = 2.1 \times .971 = \underline{2.04}$$

$$\Sigma_s^H = \frac{.965 \times 6.023\times10^{23} \times 2 \times 20}{18} = 1.29\ \text{cm}^{-1}$$

SIMILARLY

$$\Sigma_s^O = .136\ \text{cm}^{-1}$$

$$\Sigma_s^{U^{235}} = .0102\ \text{cm}^{-1}$$

$$\Sigma_s^{U^{238}} = .0006\ \text{cm}^{-1}$$

$$L^2 = \frac{\tau_{tr}}{3\,\Sigma_a}$$

$$\tau_{tr} = \frac{1}{\sum_i \Sigma_s^i (1-\overline{\cos\theta})_i}$$

	Σ_s	$(1-\overline{\cos\theta})$	$\Sigma_s(1-\overline{\cos\theta})$
H	1.290	.333	.430
O	.136	.958	.130
U^{235}	.0102	.997	.0102
U^{238}	.0006	.997	.0006
		TOTAL	.5708

$$L^2 = \frac{1}{3 \times .5708 \times .711} = .756\ \text{cm}$$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART:923.4
Cd Sheathed Cylinder of Infinit Length
PAGE 2 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

LET B_m^2 = MATERIALS BUCKLING.

THEN:

$$K_{eff} = \frac{K_\infty e^{-\tau B_m^2}}{1 + L^2 B_m^2}$$

OR

$$1 = \frac{2.09\, e^{-27 B_m^2}}{1 + .256\, B_m^2}$$

A TRIAL & ERROR SOLUTION FOR B_m^2 YIELDS

$$B_m^2 = .0258\ cm^{-2}$$

@ 396 gms U^{235}/LITER AN 8" DIA. x 48.4 cm HIGH

CADMIUM SHEATHED WATER REFLECTED CYLINDER WAS CRITICAL. (TABLE 3-67, ANL 5800)

WHEN $K_{eff} = 1$, $B_m^2 = B_g^2$

∴ ASSUMING A WATER REFLECTED EXTRAPOLATION DISTANCE FOR THE CYLINDER ENDS = 6.5 cm.

$$B_g^2 = .0258 = \left(\frac{2.405}{R'}\right)^2 + \left(\frac{\pi}{48.4 + 13}\right)^2$$

WHERE R' IS THE RADIUS + EXTRAPOLATION DISTANCE OF THE CADMIUM SHEATHED WATER REFLECTED 8" DIA. CRITICAL CYLINDER.

SOLVING FOR R' & SUBTRACTING THE RADIUS YIELDS A RADIAL EXTRAPOLATION DISTANCE OF

$d = 5.6$ cm.

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 923.4
Cd Sheathed Cylinder of Infini Length
PAGE 3 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

AGAIN USING $B_g^2 = B_m^2 = .0258\ cm^{-2}$ & $d = 5.6\ cm$

THE RADIUS OF AN INFINITELY LONG CADMIUM SHEATHED - WATER REFLECTED CYLINDER CAN BE CALCULATED.

$$\therefore\ B_g^2 = \left(\frac{2.405}{R'}\right)^2 = .0258$$

$$R' = 15\ cm.$$

AND $R = 15 - 5.6 = 9.4\ cm.$
$= 3.7$ INCHES.

THE DIAMETER IS $\underline{\underline{7.4}}$ IN.

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.4
Cd Sheathed Cylinder of Infinit Length
PAGE 4 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

SOLID ANGLE CALCULATIONS FOR THE 1F24b & 1F24a FILTER PRESS

THESE CALCULATIONS WERE MADE ON THE OAK RIDGE GASEOUS DIFFUSION PLANT SOLID ANGLE SLIDE RULE.

A.
1F24b

SOLID ANGLE SUBTENDED AT THE 7¼" x 7¼" x 6" LONG PLATE AND FRAME FILTER PRESS BY:

1. TEFLON LINED DISSOLVER 1J1

   $h = 44.5$ $h/A = 8.90$

   $A = 5$ $h/B = .316$

   $B = 141$ $\Omega = .190$

2. 6" DIA. CADMIUM WRAPPED LEG.

   $h = 79.5$ $h/A = 15.9$

   $A = 5$ $h/B = .564$

   $B = 141$ $\Omega = .084$

3. OTHER NEARBY EQUIPMENT < .5 STERADIAN ESTIMATED (SEE 1-J-1)

4. TOTAL SOLID ANGLE SUBTENDED AT 1F24b:

   TOTAL SOLID ANGLE = .774

B.
1F24a

SAME AS FOR 1F24b

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 923.4
Solid Angle Calculations - Filter Press L-F-24 A & B
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 Processing
Subpart: 923 - Dissolution of Scrap Materials
923.5 - Assay Tanks

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

923.5 Assay Tanks 1-D-34 A, B, C, D, E (Sketch 923.5-I)

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 and 3-J-2, unlined Dissolver 1-J-4, and the Tray Dissolvers 1-J-5A and B, the All Purpose Hood 1-L-18, and the miscellaneous solution Hold Tank 1-D-43 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. The row of tanks form a planar array. 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.

Equipment associated with the Assay Tanks are as follows:

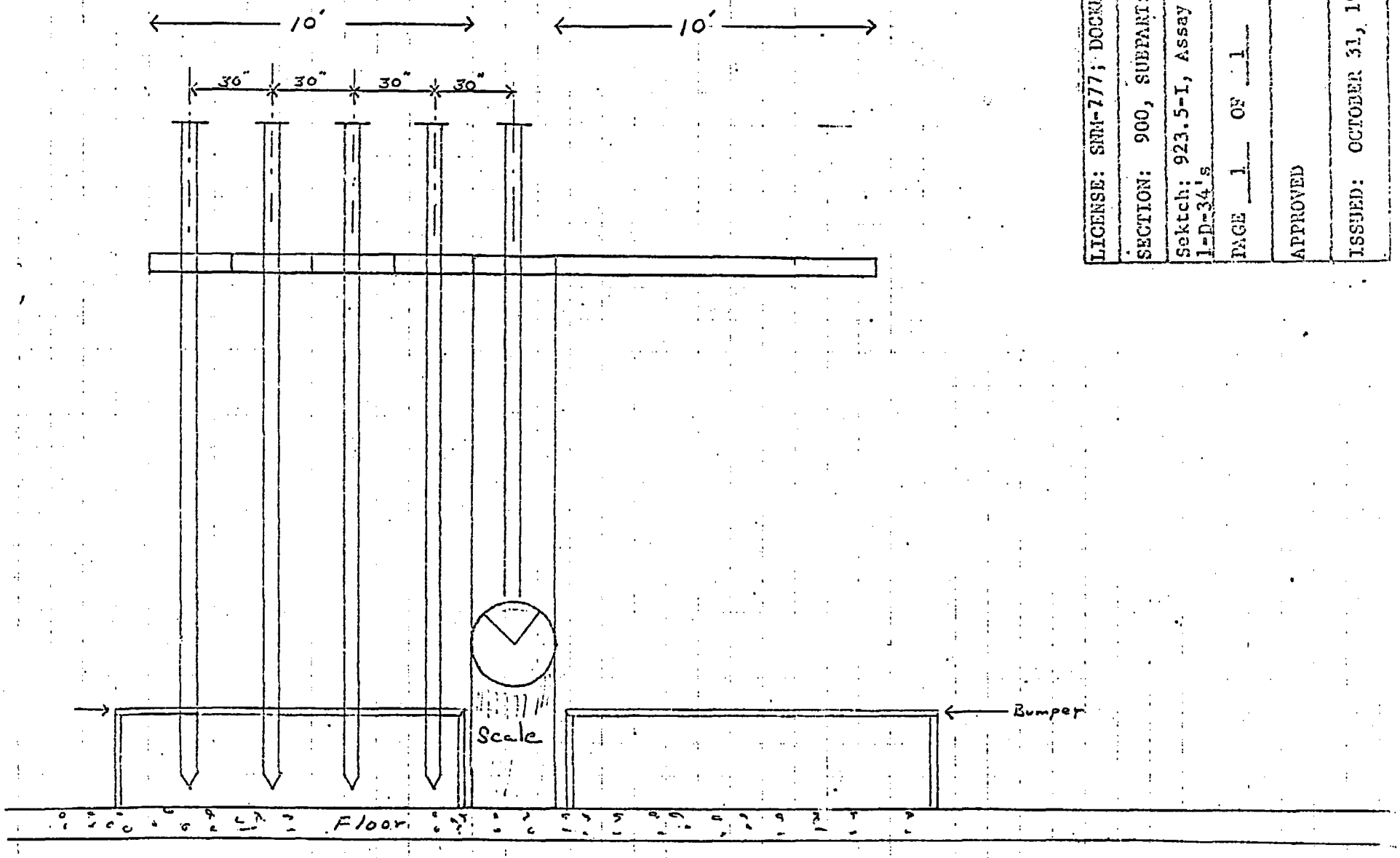
a) Scale 1-W-2, 220 kgs capacity, beam capacity 50 kgs., 1000 g. dial, 2 blank beams to provide tare.

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.

2. Nuclear Safety

The maximum solid angle subtended at the Center Assay Tank 1-D-34C is less than 3.2 steradians.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.4	
Sektch: 923.5-I, Assay System, 1-D-34's	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

1) ASSAY TANKS 1-D-34 A, B & C (3)

2) SIZE: 5" ID x 10'6"

3) CONTENTS: ADJUSTED LIQUOR

4) URANIUM CONTENT = 120 gm/l mx. –

5) NUCLEAR SAFETY –

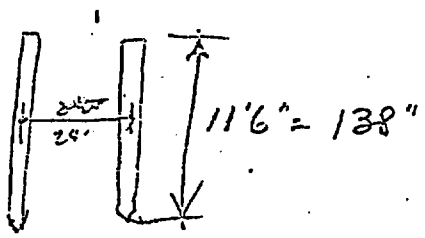
a) AS ISOLATED UNIT

– 5" DIA – SAFE GEOM. ANY CONC, ANY LENGTH

b) AS ISOLATED ARRAY

ASSUME ALL 3 TANKS FILLED –

$$\Omega = \frac{2d}{h} \sin\theta$$



$d = 5"$ $h = 24 - 2\frac{1}{2} = 21.5$

$\sin\theta = 0.9547$

$$\Omega_1 = \frac{9.547}{21.5} = 0.444$$

FOR 1-D-34 B (CENTRAL UNIT)

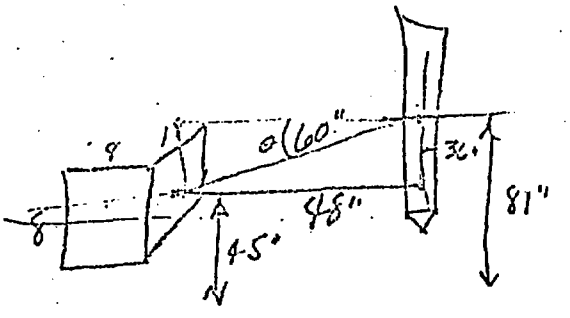
$$\Omega_{5b} = (0.444)(2) = 0.888$$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.5
Solid Angle Calculations - Assa Tanks, 1-D-34's
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

c) (1) WITH MUFFLE COOLER 1-H-6

(MUFFLE BOX = 8" x 8" x 18")

$$\Omega = \frac{a\,b\,\cos\theta}{g^2}$$



$a = 18"$, $b = 8"$

$g = 60"$ $\cos\theta = .8$

$$\Omega = \frac{18(8)(0.8)}{62^2} = 0.032$$

(2) WITH 1-H-8

$$\Omega = \frac{a\,b\,\cos\theta}{g^2}$$

$a = 18$, $b = 8$

$g = 97"$

$\cos\theta = 0.92849$

$$\Omega = \frac{18(8)(.92849)}{97^2} = 0.0142$$

TOTAL Ω WITH ADJ. EQUIP.

$$\Omega = 0.032 + 0.0142 = 0.0462$$

TOTAL INTERACTION

$$\Omega_T = 0.888 + 0.0462 = 0.9282$$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.5	
Solid Angle Calculations - Asss Tanks, 1-D-24's	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

923.6 Acid Insoluble Dissolver System (Sketches 923.6-I, II, & III)

1. Dissolver Charge Glove Box 3-L-2

The transfer container containing the uranium bearing material will be transported from the appropriate glove box, hood or storage area. The transfer container is introduced to Dissolver Glove Box 3-L-2 through the air lock and the material is charged into the charging port of the 3-L-2. Nitric acid is charged to the system from the Nitric Acid Gauge Tank, 1-D-27. Hydrofluoric or Hydrochloric acid is charged from the 5" dia. Acid Gage Tank 1-D-30. Water is charged from the 6" diameter Pyrex measuring tank. Aluminum nitrate solution is charged from the Header 3-D-4.

Nuclear Safety of Glove Box 3-L-2 is assured by the use of a single safe volume transfer container in the glove box at one time. There is also a 1" drain line from the bottom of the glove box to the Tray Filter 3-F-2. Although the HNO_3 Gauge Tank 1-D-27, the Aluminum Nitrate Header 3-D-4 and the water tank are not safe for nuclear solutions containing more than 5 grams U-235 per liter of solution, air gaps incorporated into the piping from the tanks to the dissolver prevents any nuclear solutions from entering these tanks.

2. Acid Insoluble Dissolver 3-J-2

The basic unit consists of Teflon lined steel pipes, all of which are equal to or less than 4" diameter. All tee and cross areas have been reduced to proper diameters to eliminate intersection problems. Criteria from Page 20 and Table III, TID-7016, Rev. 1, were used to evaluate intersections. Except for intersections, all pipes have a minimum separation of 24" so that interaction effects are negligible.

The dissolver is charged as indicated in Subpart 923.61 and a blind flange is used to seal the dissolver charge port. A basket of suitable material will be used when necessary in the charging port of the dissolver. Acid and water are added through a 1" diameter pipe on the 4" diameter charge leg. The solution circulates around the dissolver system by introducing air to the one inch diameter verticle air lifts. Solution heating and cooling is provided by 1" diameter steam jacketed verticle heat exchangers in the air lifts. Additional heating is supplied by pre-heating the air prior to entry to the air lifts.

Fumes and vapors generated during the dissolution process are vented from the top of the dissolver, through a demister and a water cooled Condenser, 3-E-2. The non-condensable gases are discharged to the Fume Scrubber, 2-X-1, and the condensed liquids drain to a 4" diameter

2. Acid Insoluble Dissolver 3-J-2 (continued)

Vent Trap, 3-X-2. Since these condensables have little or no uranium, interaction effect can be neglected, but for additional safety this tank is more than 24" from any other portion of the Acid Insoluble Dissolver. 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, adding complexing chemicals, etc. The solution will be cooled by applying water to the jackets of the air lifts. The batch is transferred through a Vacuum Pan Filter 3-F-2, which is located in Hood 3-L-1, to 5" diameter Filtrate Holding Tanks 3-D-2 A & B. The filtrate tank contents are transferred either directly to Extractor Feed Tanks 1-D-9's, or the Assay Tanks, 1-D-34's.

3. Acid Insoluble Filter 3-F-2

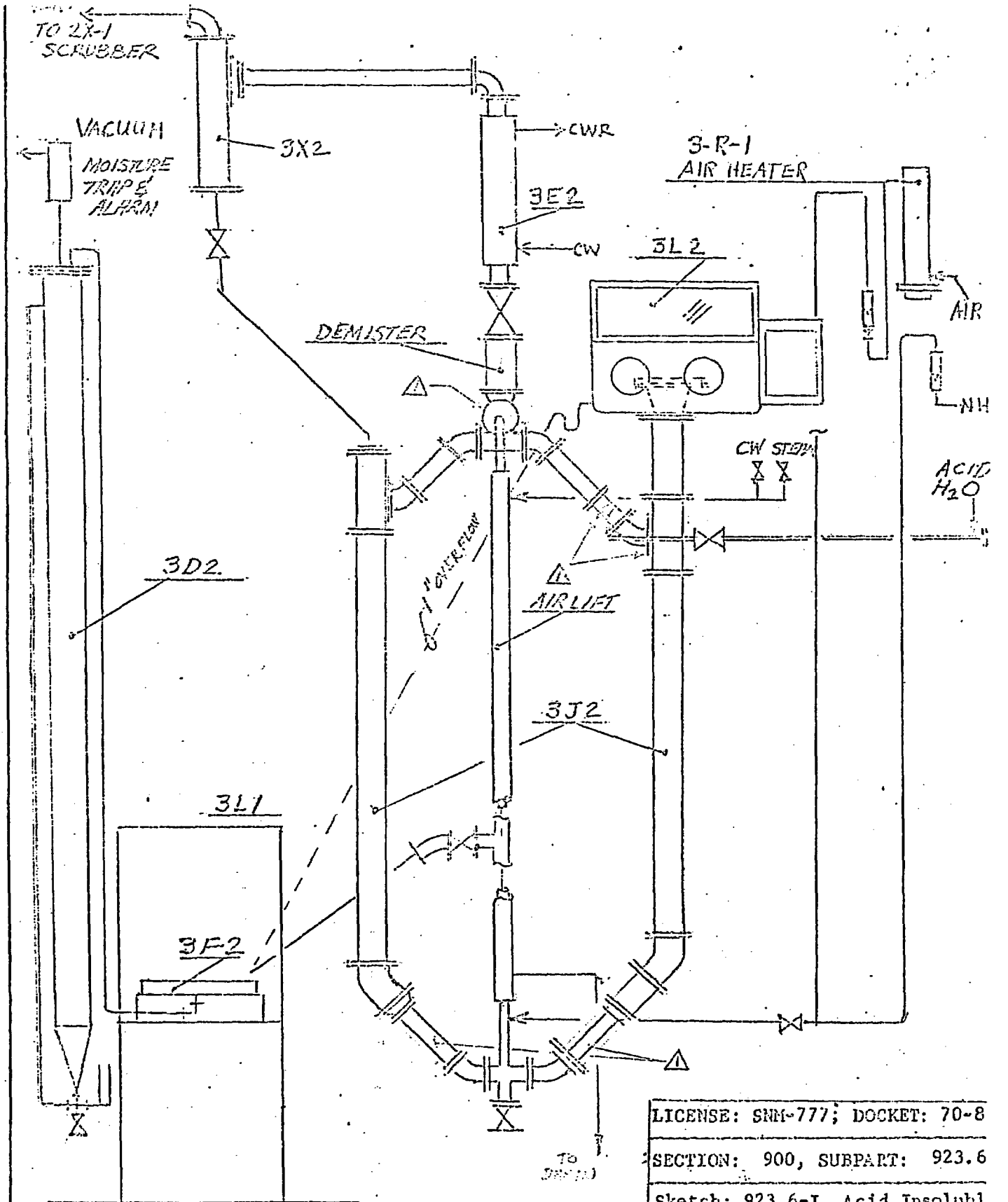
The cooled adjusted solution is filtered on the Tray Filter, 3-F-2 to remove acid insolubles. This filter is similar to the 1-F-6, being approximately 19" x 25" and 2" deep. It is located in the 3-L-1 Hood. Nuclear Safety is assured by the safe slab height. The only solids collected on the filter will be the insolubles from the dissolution step. The solids will be removed, as necessary, to insure that the insolubles do not exceed one inch depth, stored in a safe container and transferred to storage. Details of this equipment are shown on Sketches 923.6-IV & V.

4. Filtrate Storage Tanks 3-D-2 A & B

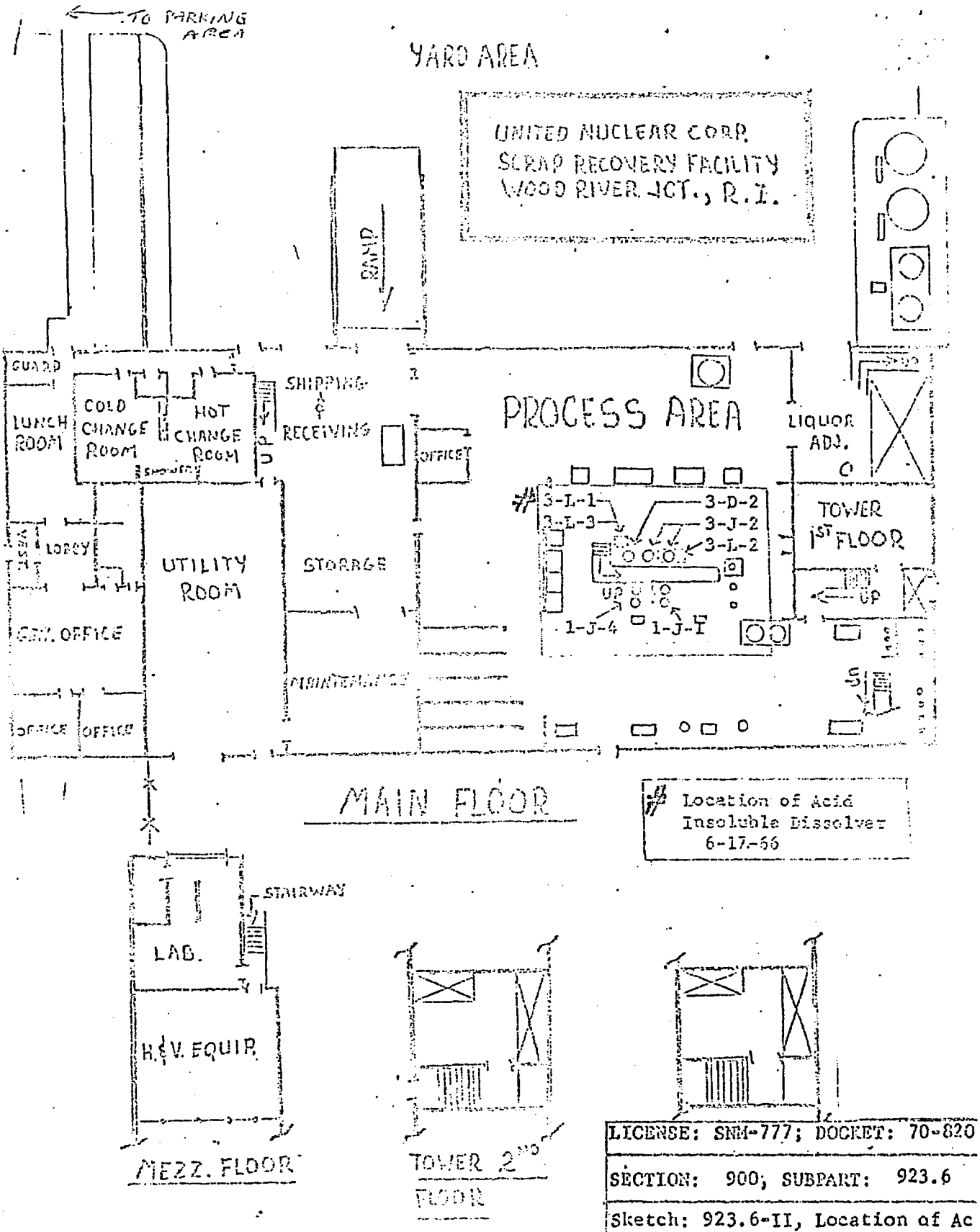
These tanks are nuclearly safe 5" diameter Stainless Steel Tanks. The transfer from the Filter, 3-F-2 to the Filtrate Storage Tanks, 3-D-2, A & B is accomplished by means of vacuum. The vacuum line is equipped with a moisture trap and alarm similar to the one on 1-D-36, the Tray Dissolver Storage Tank, to detect any liquid entrained in the vacuum system. Details of this equipment are shown on Sketch 923.6-VI. The equipment arrangements are shown on Sketch 923.6-VIII.

5. Condenser 3-E-2

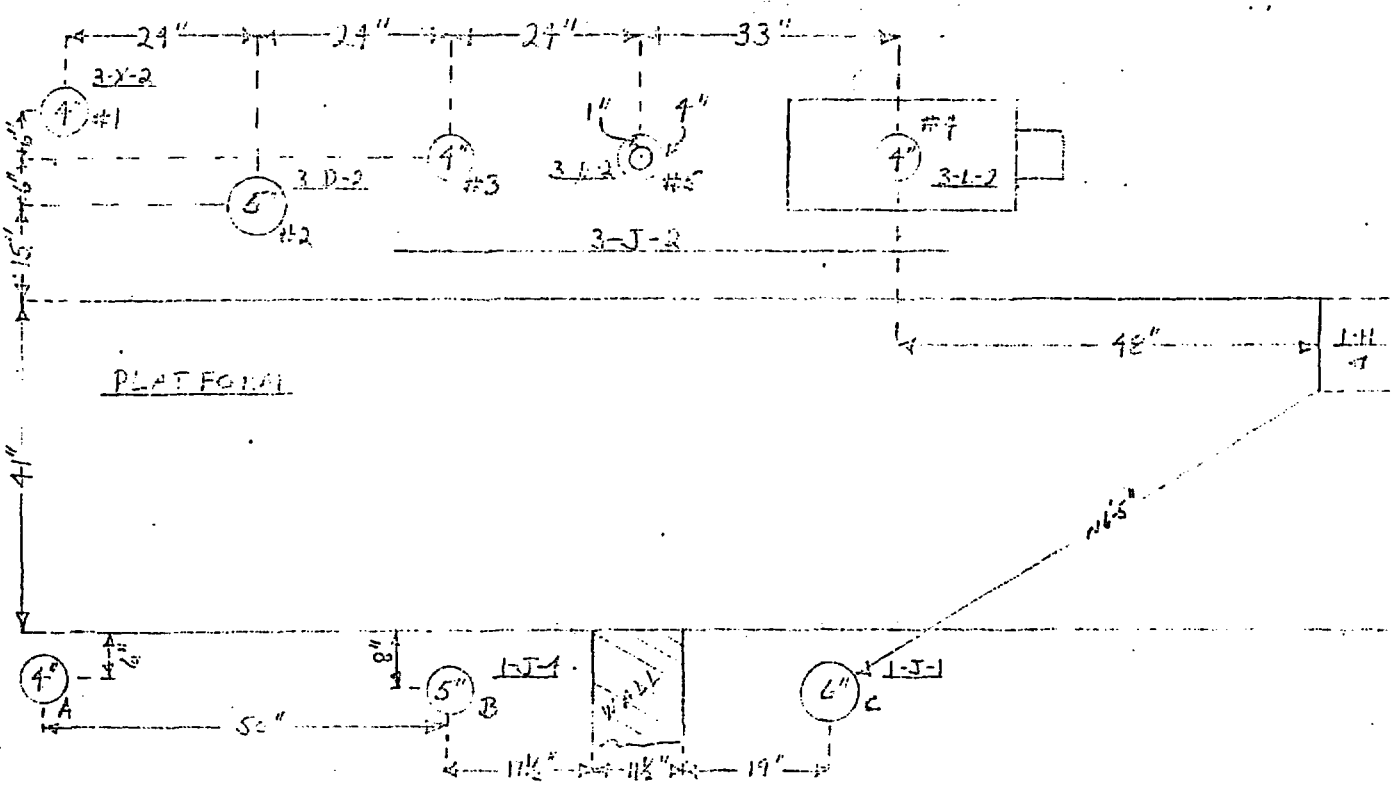
The Condenser 3-E-2 is a safe 4" diameter tube and shell heat exchanger. It is fastened to the top of the demister section, immediately above the dissolver.



LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 923.6
Sketch: 923.6-I. Acid Insolubl Dissolver
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900; SUBPART: 923.6	
Sketch: 923.6-II, Location of Ac Insoluble Dissolver	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	



Distances and Lengths

Dist. from Center of	Equip.	No.	Dia.	Length	Edge of #1	Edge of #2	Edge of #3	Edge of #4	Edge of #5	Edge of A	Edge of B	Edge of C	Edge of 1-H
#1	Condensate	3-J-2	4"	36"	—	24"	46"	102"	69"	72"	87"	118"	146
#2	Storage	3-J-2	5"	132"	24"	—	22"	82"	45"	64"	66"	93"	120
#3	Loop	3-J-2	4"	120"	46"	22"	—	54"	21"	81"	69"	81"	97
#4	Charge	3-J-2	4"	120"	102"	82"	54"	—	30"	124"	87"	67"	43
#5	Teflon Condensate	3-E-2	4"	70"					—				153
A	Charge	1-J-4	4"	60"						—			107
B	Charge	1-J-4	5"	103"							—		68
C	Charge	1-J-1	6"	141"	69"	45"	21"	30"	97"	70"	70"	—	75

LICENSE: SNM-777; DOCKET: 70-32

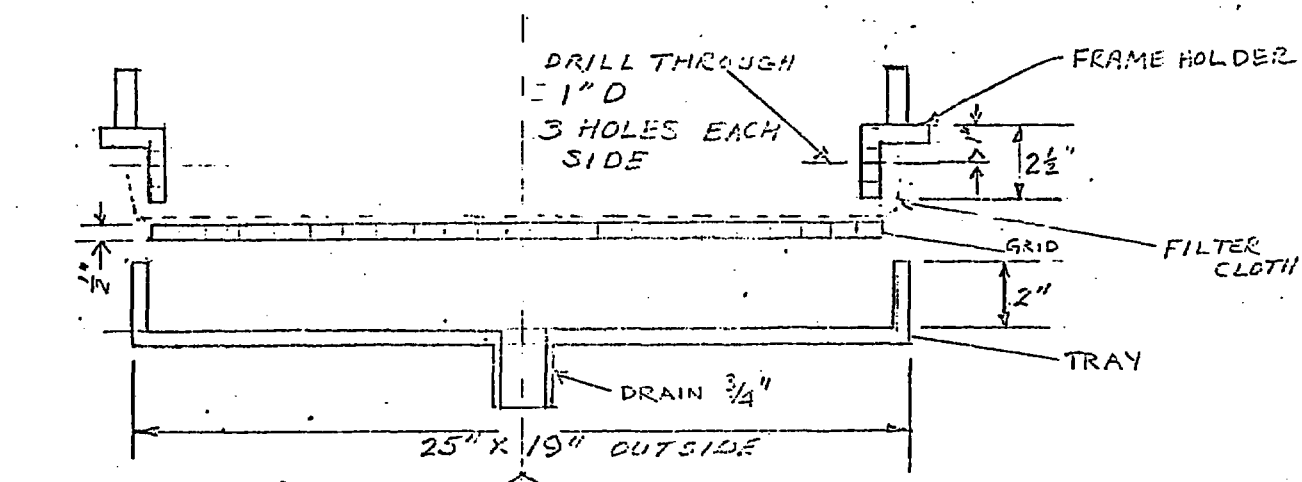
SECTION: 900, SUBPART: 923.6

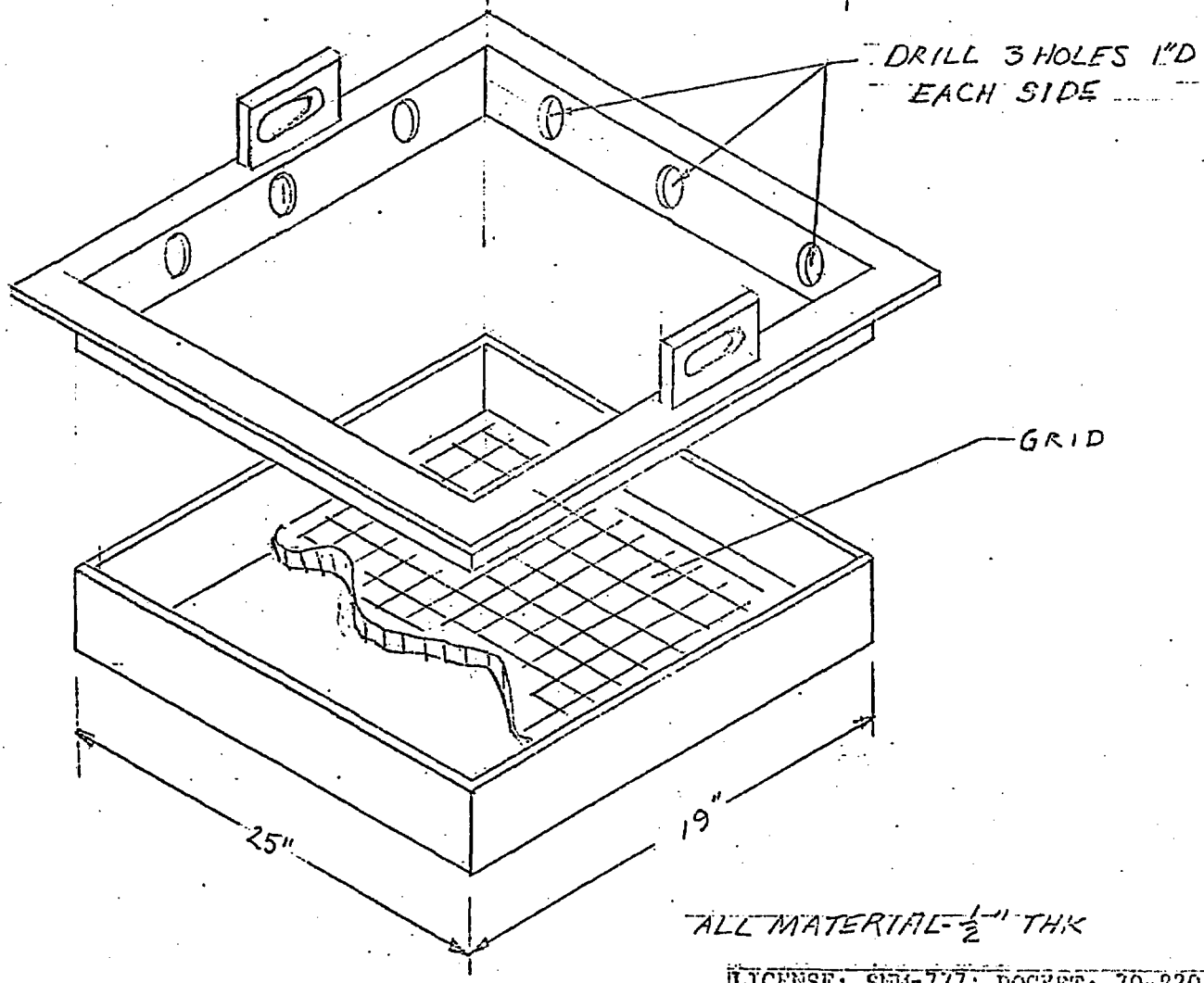
Sketch: 923.6-III, Layout - Acid Insoluble Dissolver

PAGE 1 OF 1

APPROVED

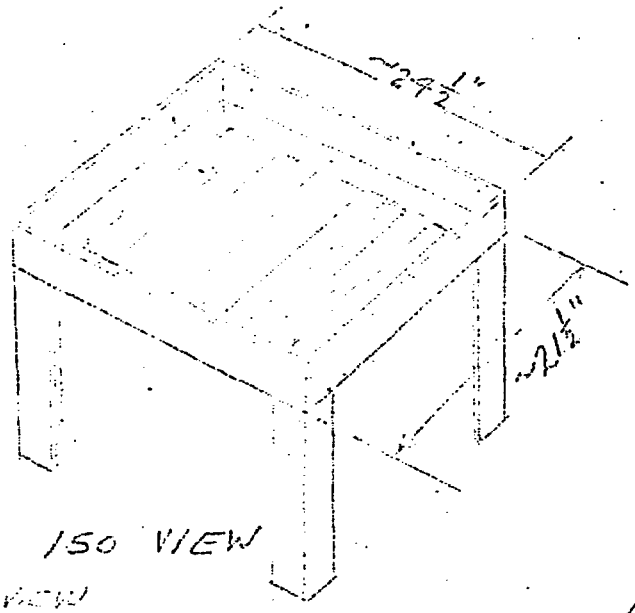
ISSUED: OCTOBER 31, 1968





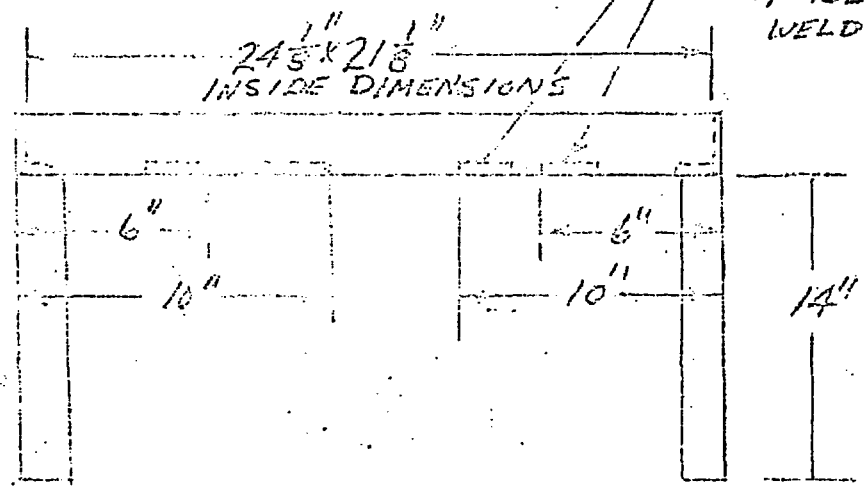
ALL MATERIAL - ½" THK

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 923.6	
Sektch: 9236.-IV, Tray Filter 3-F-	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	



ISO VIEW

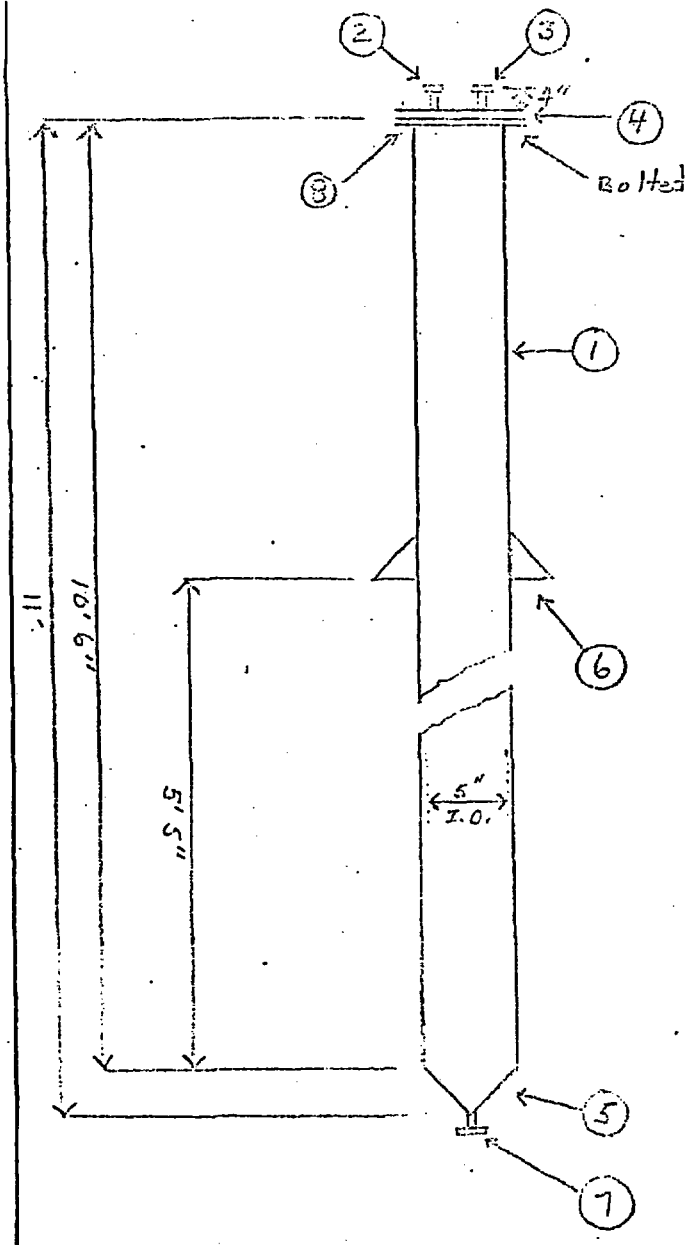
ISO VIEW

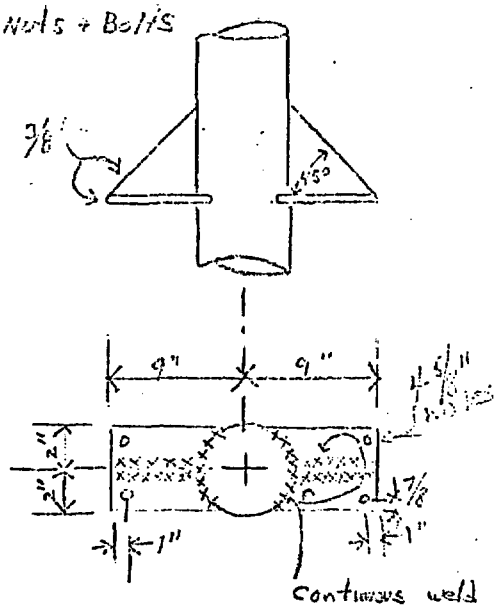


LEGS (4) T 304 S.S. 1¼" X 1¼" X 3/16" ANGLE
WELD TO FRAME

MATERIAL OF CONSTRUCTION:
T 18-8 S.S. (304) 2" X 2" X 3/16" ANGLE AND AS NOTED
ALL WELDED CONSTRUCTION

LICENSE: SNM-777; DOCKET: 70-32
SECTION: 900, SUBPART: 923.6
Sketch: 923.6-V, Filter Rack
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968





Support Bracket Detail
3/8" thick 304 S.S.

MK	QUANT.	DESCRIPTION
8	1	5" S.O. FLG. RF LADISH CORROSION WT

All welds to be T.I.G. with internal gas purge
Hydraulic Pressure: Test - 75 psig Operate - 50 psig @ 250°F

Mark	Quan.	Description
1	1	5" Schedule 40 304L Stainless Steel Tank, 11 Feet long
2	1	1/2" long neck welding flange SS T304L Ladish corrosion wt. & coupling
3	1	1/2" long neck welding flange
4	1	5" Blind Flange 304L SS Ladish Corrosion wt.
5	1	Cone schedule 40 304L S.S. 6" long
6	2	Support Brackets as per detail
7	1	1/2" Socket

LICENSE: SNM-777; DOCKET: 70-82

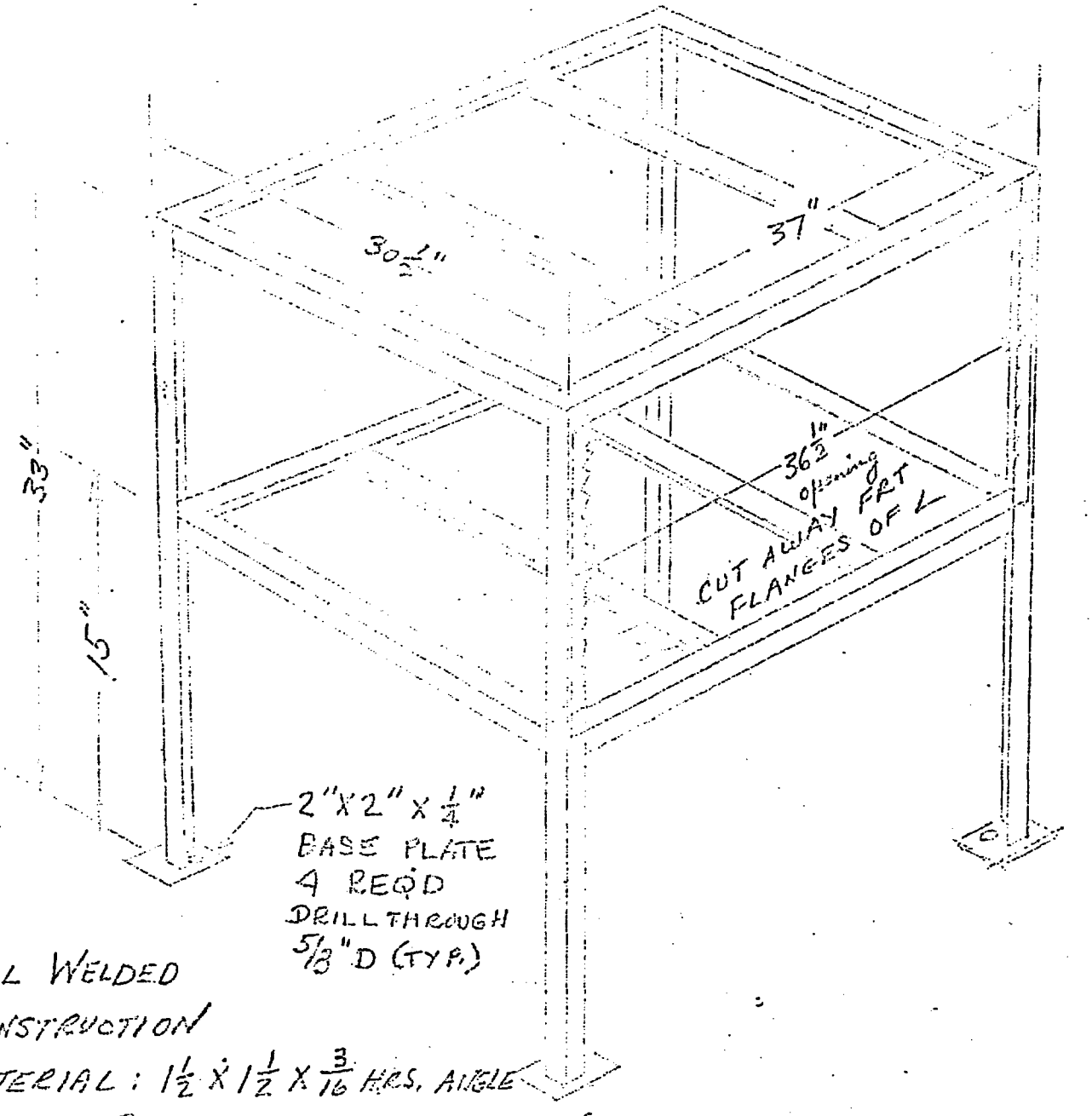
SECTION: 900, SUBPART: 923.6

Sketch: 923.6-VI, Vessel Sketch Tank 3-D-2

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968



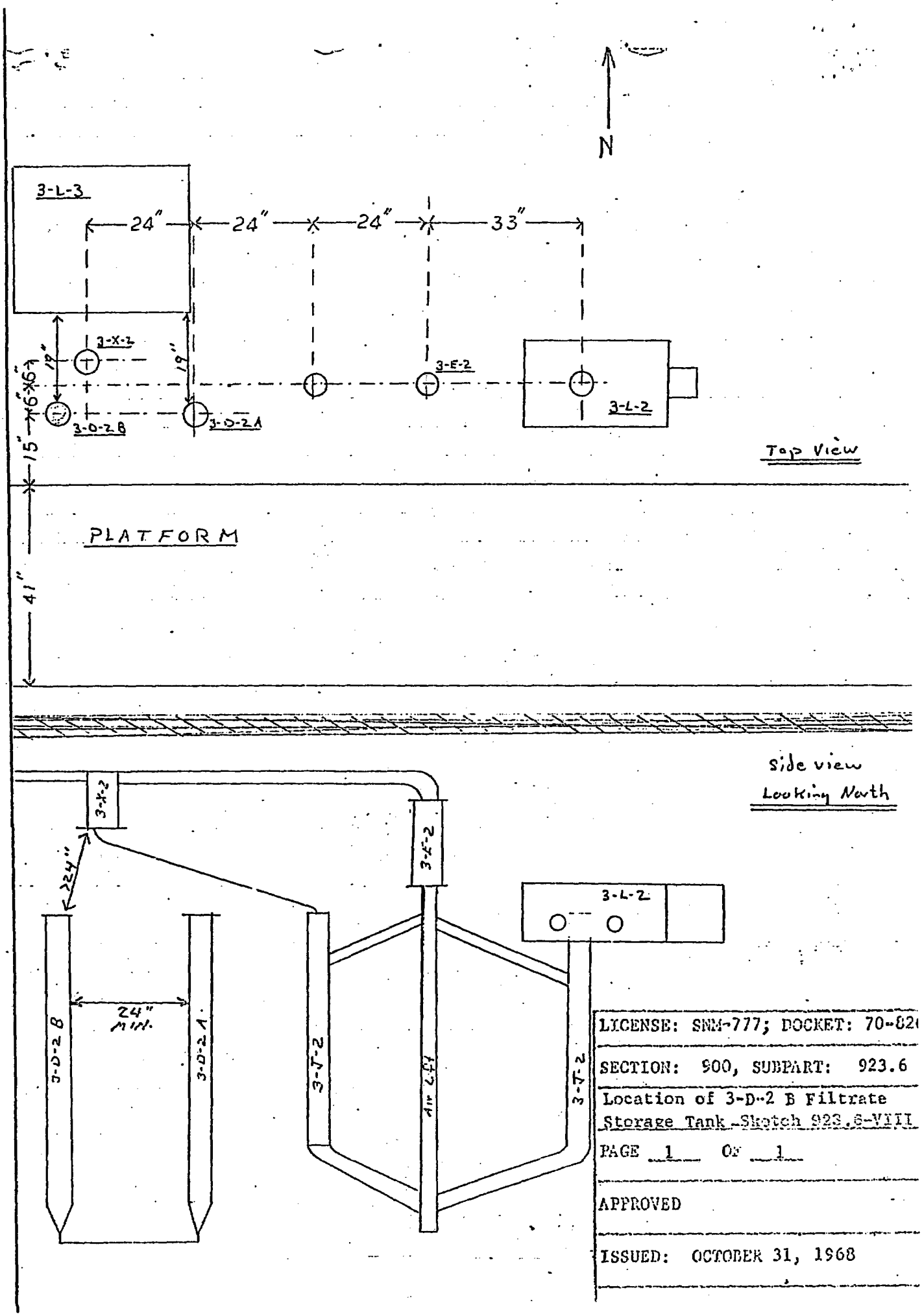
ALL WELDED CONSTRUCTION

MATERIAL: $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16}$ HRS. ANGLE

FINISH: REMOVE BURRS, WELD SLAG etc.

PAINT: 1 PRIME COAT - RUSTOLEUM
1 FINISH COAT GREY - "

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 923.6
Sketch: 923.6-VIII, Hood Table for 3-L-1
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 923.6

Location of 3-D-2 B Filtrate Storage Tank -Sketch 923.6-VIII

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

923.7 Large Tray Dissolver System

1. General

The pre-weighed, prepared uranium bearing fuel material will be transported from the appropriate glove box, hood or storage area to the tray dissolver where it is placed uniformly on the bottom surface of the tray. A measured quantity of dissolving solution is metered over the material into the tray. Acid fumes from the hood are scrubbed in the 2-X-1 scrubber in the vent system. When dissolution is complete, the solution from the tray is transferred by Pump 3-P-3 through the 3-X-3 Trap, a mesh strainer, the 3-F-3 A or B Filter, and 3-E-3 Condenser to the Overhead Storage Tanks 3-D-3 A & B. When the overhead tanks are full, the solution is adjusted as necessary for extraction and the solution is recycled for assay by disconnecting the Pump 3-P-3 from the tray discharge and connecting the Pump 3-P-3 to the overhead tanks for recycle. Undissolved solids are retained in a 2-1/2" D strainer bag. Strainer and cartridge filters serve as a back up to prevent carry over of solids into the head tanks.

Hydrofluoric acid is charged to the system from the 1-D-35 PVC Head Tank. Other acids such as Nitric are charged when required from overhead gage tanks. Water is charged from the 6" diameter Pyrex Measuring Tank. Aluminum nitrate is charged from the 6" diameter Pyrex Gage Tank 3-D-5. The equipment and its arrangement is shown on Sketches 923.7-I and II. A flow diagram is included as Sketch 923 .7-III.

2. Equipment

2.1 Tray Dissolver 3-J-3

The tray is 4 inches high x 73 inches long x 25 inches wide outside dimensions. A 3" D drain cup is equipped with a mesh strainer to retain acid insoluble material. The dissolution batch will be limited to 1 kg. U-235. Overflow from the tray dissolver will be on to the floor of the hood with the lip of the hood not to exceed 1/2", thus not exceeding a safe slab.

2.2 Storage Tanks 3-D-3 A and B

These tanks are 5" in diameter and hence nuclearly safe. They are positioned horizontally between the 1-D-10 A, B, and C Storage Tanks. The tanks are filled by the 3-P-3 Pump and are normally emptied by gravity. The possibility of drainage of the storage tanks back into the tray dissolver will be precluded by disconnecting the discharge line and Pump 3-P-3 after solution transfers from the tray dissolver.

2.3 Tray Dissolver Hood 3-L-4

This hood contains the Tray Dissolver 3-J-3. Fumes from this hood are washed in the Fume Scrubber 2-X-1.

2. Equipment (continued).

2.4 Heat Exchanger 3-E-3

This Cooler, 3-E-3, is a safe 3" diameter tube and shell, single pass heat exchanger. It is located in the back of the hood below the tray level.

2.5 Filters 3-F-3 A and B

Two polishing cartridge type filters remove any solid fines from the solution. Each filter is less than 5" in diameter and one gallon in volume. Filters are spaced a minimum of 12 inches edge-edge from each other and a minimum of 24 inches edge-to-edge from any other uranium bearing equipment.

2.6 Surge Tanks

Two 4" diameter x 12" long all cushion surge tanks located approximately 18" above the 3-F-3 Filters. Pressure indicators are installed at the top of these tanks. These tanks reduce the excess pulsing of the 3-P-3 pump which could cause the pipe welds to break.

2.7 Fume Hood 3-L-5

A 24" x 30" x 48" plastic fume hood is located 30" west of the Large Tray Dissolver Hood 3-L-4. This hood will contain the 3-F-5 Tray Filter. This hood is vented to the 1-B-4 duct.

2.8 Tray Filter 3-F-5

Cooled adjusted solution is filtered on a Vacuum Tray Filter 3-F-5 to remove acid insolubles. This filter is the same as the Acid Insoluble Filter 3-F-2 (Subport 923.6) and is 19" x 25" x 2" deep. The sources of feed to this tray filter may be from the 3-J-3, 1-J-1, 1-J-4 or 1-J-5 dissolvers. The filtrate from this filter may be piped to the 1-D-36, 3-D-3, 3-D-9 or 3-D-10 hold tanks.

2.9 Hold Tank 3-D-10

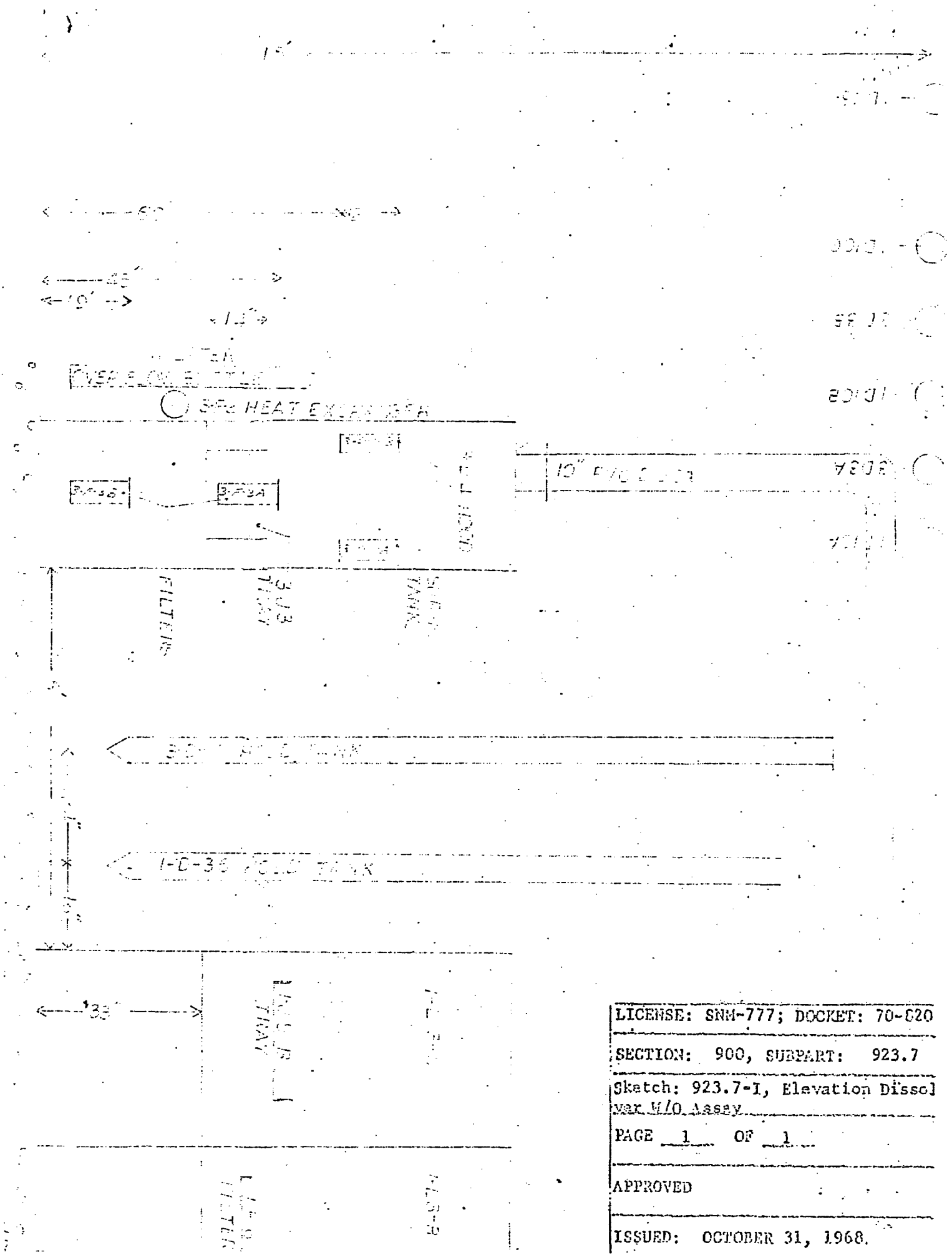
A 5" diameter by 15 foot long (maximum) solution Hold Tank 3-D-10 is located 24" (center to center) south of the 1-D-36 Hold Tank and 36" northwest of the Fume Hood 3-L-5. Filtrate solution will feed into this tank from the 3-F-5 or 1-F-6 filters. This tank will be vented to the 2-X-1 scrubber and will be used primarily to air sparge solutions prior to assay. The feed from this tank will normally go to the 1-D-34 and 3-D-12 Assay Tanks, or the 3-D-3 Overhead Hold Tanks or possibly the 1-D-41 Extractor Feed Tank. A demister and moisture alarm system similar to the 1-D-36 Hold Tank moisture alarm system will be installed in the vacuum line from this tank.

2.10 Overflow Bottle

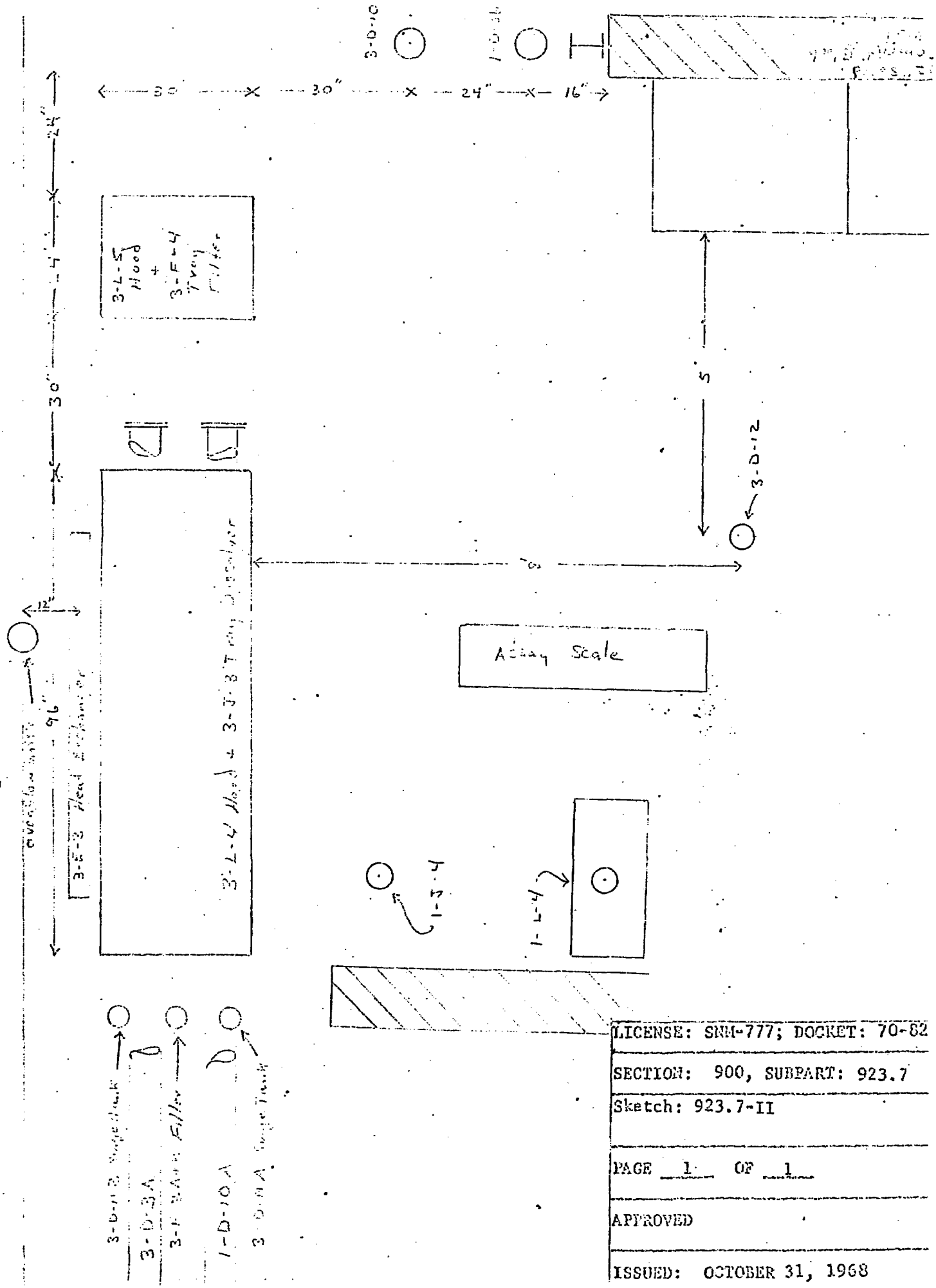
An 11 liter overflow bottle is provided for the 3-D-3 at B Storage Tanks. This bottle is located on the south side of the 3-L-4 Hood a minimum of 12" away from the 3-E-3 Heat Exchanger and 6" above the floor.

3. Nuclear Safety

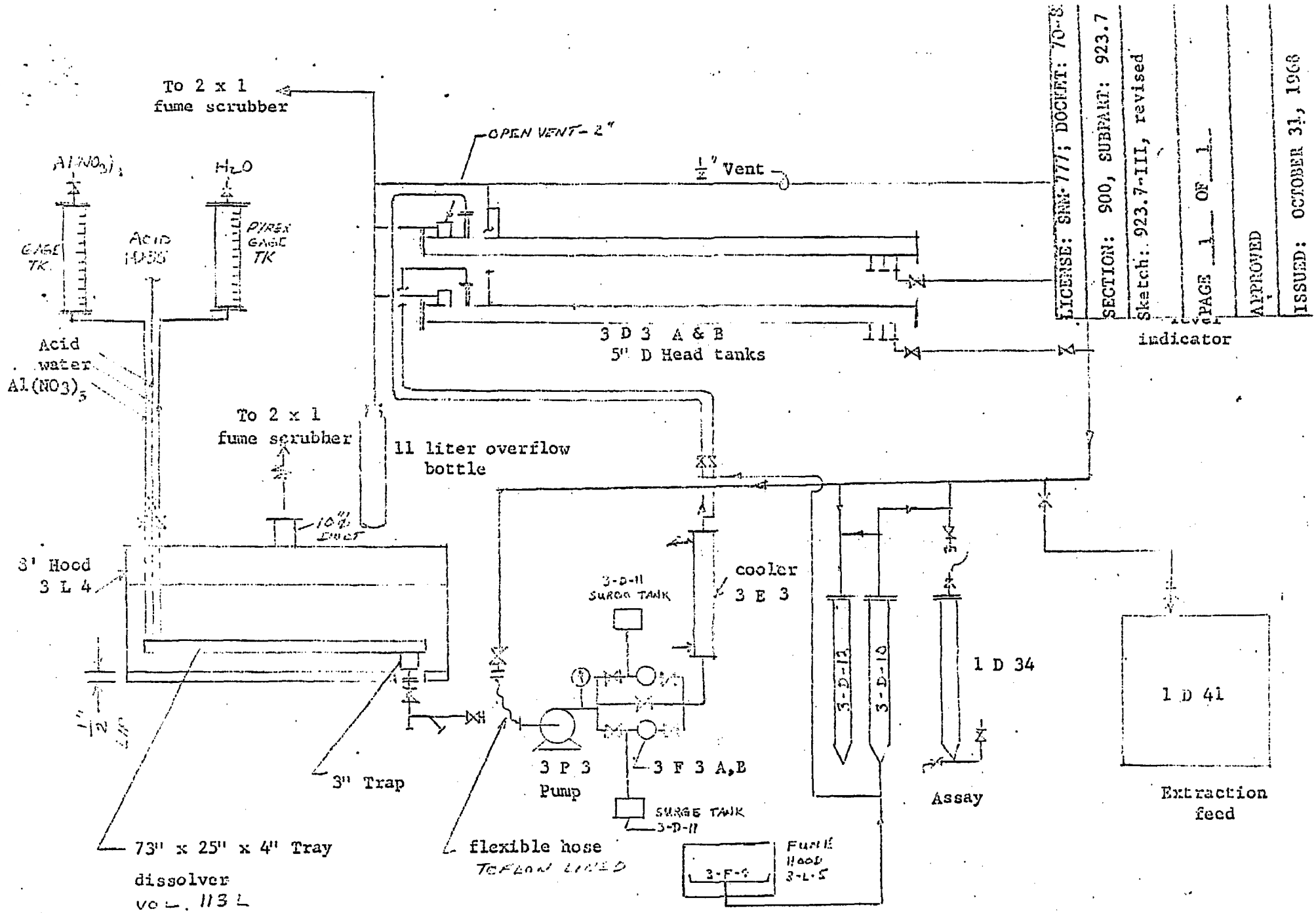
The nuclear safety of the trays is demonstrated in the Nuclear Safety Study for the Large Tray Dissolver. All other equipment in this system has a safe 5" or less diameter or a safe slab thickness. The interaction at the tray dissolver is approximately1.1 steradians.



LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.7
Sketch: 923.7-I, Elevation Dissolver W/O Assay
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.7	
Sketch: 923.7-II	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	


To 2 x 1
fume scrubber
OPEN VENT - 2"
1/2" Vent
Al(NO3)3
H2O
GAGE TK
ACID HOOD
PYREX GAGE TK
Acid
water
Al(NO3)3
3 D 3 A & B
5" D Head tanks
To 2 x 1
fume scrubber
11 liter overflow
bottle
10" DUCT
3' Hood
3 L 4
3-D-11
SURGE TANK
cooler
3 E 3
3-D-12
3-D-10
1 D 34
1 D 41
3 P 3
Pump
3 F 3 A,B
SURGE TANK
3-D-11
3" Trap
73" x 25" x 4" Tray
dissolver
VOL. 113 L
flexible hose
TEFLON LINED
FUME HOOD 3-L-5
3-F-4
Assay
Extraction
feed
LEVEL
indicator
LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 923.7
Sketch: 923.7-III, revised
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

I. GENERAL

The large tray dissolver has inside dimensions of 73" x 25" x 4". The nuclear criticality safety of the large tray dissolver will be checked using the data in TID-7028. This evaluation will be performed by determining the minimum critical mass for the trays.

II. CONCLUSIONS

The calculations in Subpart 923.2 (Nuclear Safety Evaluation - Tray Dissolvers) indicate that the minimum critical mass with full reflection top and bottom is 1.387 Kg U-235. This occurs with a 13.2 liter system which has a 4 inch height corresponding to the maximum tray thickness. Since the tray height is 4 inches, top reflection is considered essentially impossible. Therefore, under actual conditions (full bottom reflection and no top reflection), the critical mass is greater than 13 kgs U-235. A maximum batch size of 1 Kg U-235 was selected so that the tray would be subcritical if either double batched or full top reflection should occur, or double batched and partially reflected.

III. INTERACTION

1. Contribution from 1-D-10's, 3-D-3's and 1-D-16 Overhead Storage Tanks

   d=5", assume L=∞ so sin θ = 1, h= 135"

   $$\Omega_1 = \frac{2d}{h} \sin\theta = \frac{10''}{135''} = .074$$

   since there are 6 tanks overhead

   $$\Omega_1 \text{ (Total)} = 6 \times \Omega_1 = .444$$

2. Contribution from Heat Exchanger 3-E-3

   d=3", L ≈ 72", L/2 ≈ 36", h ≈ 24"

   $$\Omega_2 = \frac{2d}{h} \sin\theta \qquad \text{where } \tan\theta = \frac{L/2}{h} = \frac{36''}{24''} = 1.5$$

   $$= \frac{6''}{24''}(.75) = .25 \times .75 \qquad \sin\theta = .75$$

   $$= .187$$

3. Contribution from Polishing Filters 3-F-3A and B

   d=5", L=2 x length of 1 filter =2x12"=24", L/2=12", h≈36"

   $$\Omega_3 = \frac{2d}{h} \sin\theta \qquad \text{where } \tan\theta = \frac{L/2}{h} = \frac{12''}{30''} = .33$$

LICENSE: SNM-777; DOCKET: 70-82(
SECTION: 900, SUBPART: 923.7
Nuclear Safety Evaluation - Lar; Tray Dissolver
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

III. INTERACTION (Cont.)

$= \frac{10''}{36''}(.316) = .278 \times .316$ $\qquad \sin\theta = .316$

$= .088$

4. Contribution from Hold Tank 3-D-10

d=5", L=15' (assume L=∞ and sin θ = 1), h= 50"

$\Omega_4 = \frac{2d}{h}\sin\theta = \frac{10''}{50''} = .200$

5. Contribution from 11 liter Over Flow Bottle

d=5", L=48", L/2=24", h=36"

$\Omega_5 = \frac{2d}{h}\sin\theta$ $\qquad$ where $\tan\theta = \frac{L/2}{h}$

$= \frac{10''}{36''}(.56)$ $\qquad = \frac{24''}{36''}$

$= .276 \times .56$ $\qquad = .67$

$= .156$ $\qquad \sin\theta = .56$

6. Total Interaction

Ω (Total) $= \Omega_1$(Total) $+ \ldots + \Omega_5 = 1.075$ steradians

7. Allowable Interaction

For a safe mass, K-1019, Rev. 5 indicates K = 0.65

$\Omega_A = 9 - 10K = 9 - 6.5 = 2.5$ steradians

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.7
Nuclear Safety Evaluation - Large Tray Dissolver
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

923.8 Verticle Hold Tanks 3-D-9 A & B

1. General

Two 5" diameter schedule 40 stainless steel verticle hold tanks are provided for premixing and holding of solutions from the various dissolution systems. These tanks are located a minimum of 36" edge to edge from the 1-J-1 and 1-J-4 dissolvers and the 3-L-4 and 2-L-3 hoods. The tanks are spaced 36" edge-to-edge from each other and one located at the south end of the solid concrete block wall which separates the 1-J-1 and 1-J-4 dislovers. Details of these tanks and their location are shown Sketches 923.8 - I&II.

SNM bearing acid solutions will be transferred to these tanks from either the 3-F-2 Acid Insoluble Tray Filter, 3-F-3 A & B Large Tray Dissolver Cartridge Filters, 3-F-5 Large Tray Dissolver Tray Filter, 1-F-24 A Stainless Steel Dissolver Filter, 1-F-24B Teflon Lined Dissolver Filter or 1-F-6 Tray Dissolvers Filter. The two tanks will be vented to the 2-X-1 Scrubber. The feed from these tanks will normally go to the 1-D-34 Assay Tanks, but an alternate route would be to the 3-D-3 A & B Overhead Hold Tanks or the 1-D-41 Extractor Feed Tank. A demister and moisture alarm system similar to the 1-D-36 Tank system will be installed in the vacuum line from the 3-D-9 tanks.

2. Nuclear Safety

Each tank has a nuclearly safe 5" diameter. The solid angle subtended at the 3-D-9B tank is .73 steradians.

1. Contribution from 3-9-9A

d=5", L=180", L/2=90", h=36" + 2.5" = 38.5"

$= \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{90"}{38.5"} = 2.32$

$\sin \theta = .92$

$= \frac{10"}{38.5"} (.92) = .26 \times .92 = .24$ steradians

2. Contribution from 1-J 1

d=6", L=144", L/2=72", h= 36" + 2.5" = 36.5"

$= \frac{2d}{h} \sin \theta$ Where $\tan \theta = \frac{L/2}{h} = \frac{72"}{325"} = 1.92$

$\sin \theta = .89$

$= \frac{12"}{38.5"} (.89) = .31 \times .89 = .28$ steradians

3. Contribution from 1-J-4

d=5", L=120", L/2=60", $h = \sqrt{36^2+36^2} = \sqrt{1296+1296} = \sqrt{2592} = 51" - 2.5" = 48.5"$

$= \frac{2d}{h} \sin \theta$ Where $\tan \theta = \frac{L/2}{h} = \frac{60"}{48.5"} = 1.24$

$\sin \theta = .79$

$= \frac{10"}{48.5"} (.79) = .206 \times .79 = .17$ steradians

4. Contribution from 1 Gal. Bottle in 2-L-3

d=6", L=10", L/2=5", h=36"+2.5 = 38.5"

$= \frac{2d}{h} \sin \theta$ Where $\tan \theta = \frac{L/2}{h} = \frac{5"}{38.5} = .13$

$\sin \theta = .129$

$= \frac{12"}{38.5"} (.129) = .31 \times .129 = .04$ steradians

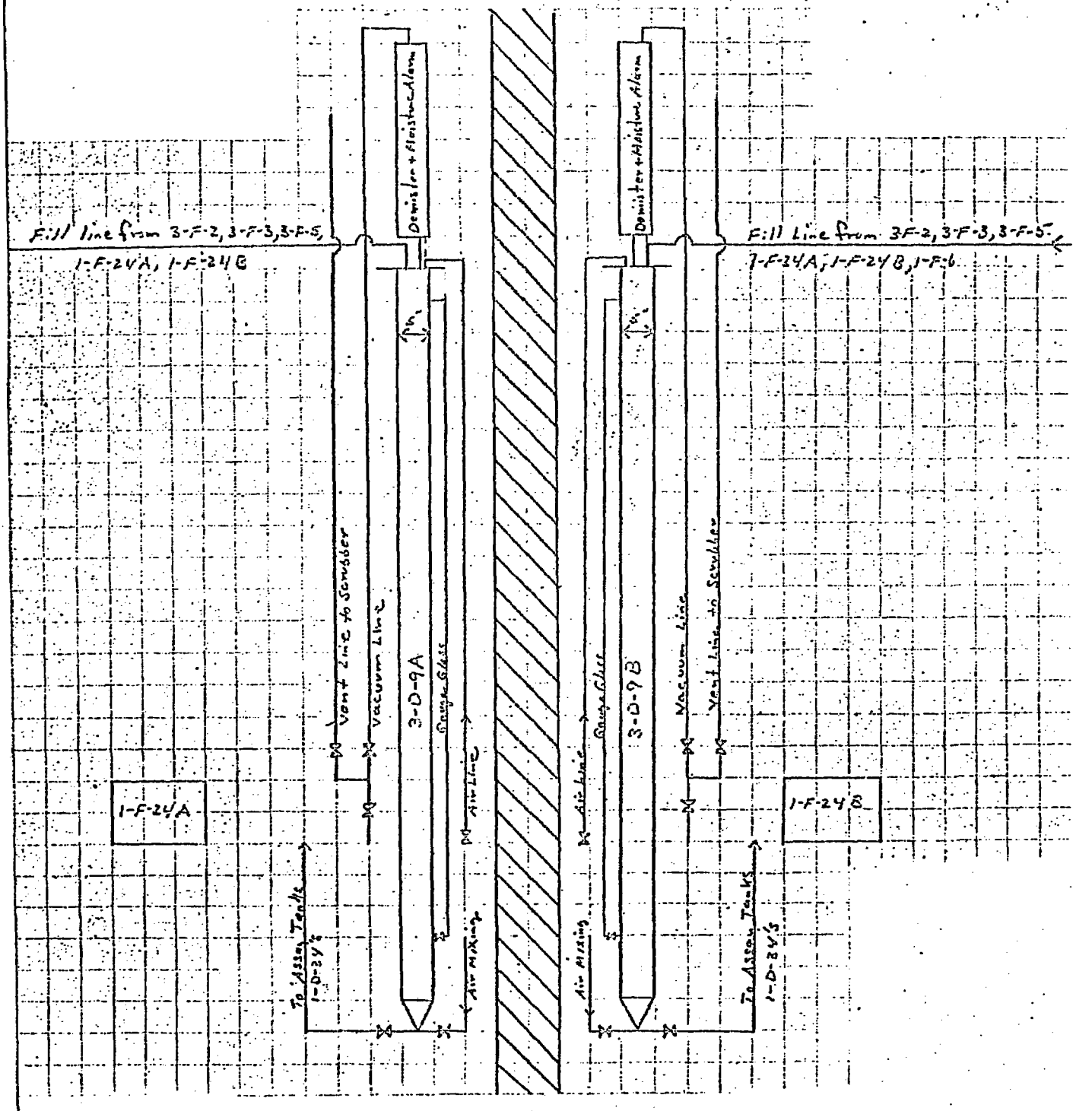
5. Total Interaction

$\Omega_T = .24 + .28 + .17 + .04 = .73$ steradians

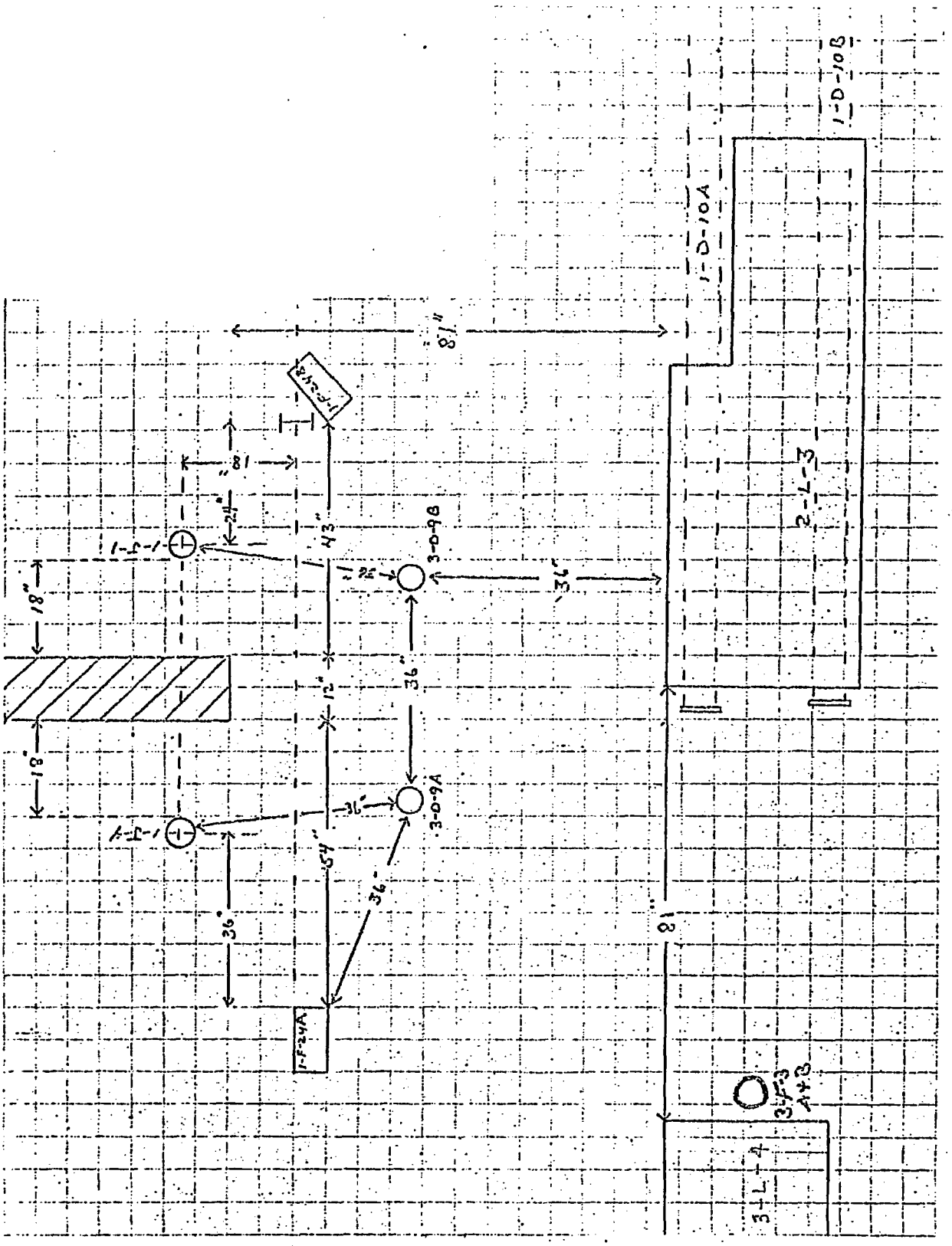
Allowable Interaction

From K-1019, 5th Rev., the allowable interaction for a 5" dia. system is 3.2 steradians.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.8
Solid Angle Calculations - Vertical Hold Tanks 3-D-9
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968



LICENSE:	SNM-777
Docket:	70-320
SECTION: 300, Subpart 320.8	
Sketch 320.8-I, 3-D-9 A & B Hold Tanks	
Page 1 of 1	
APPROVED	
ISSUED:	October 31, 1968
SUPERSEDES:	New



LICENSE:	SNM-777,
Docket:	70-020
SECTION:	900, Subpart 922.8
Sketch 922.8-11, 3-D-8 A & B Hold Tanks, Plan View	
Page 1 of 1	
APPROVED	
ISSUED:	October 31, 1983
SUPERSEDES:	New

923.9 Permanent Assay Tank 3-D-12

1. General

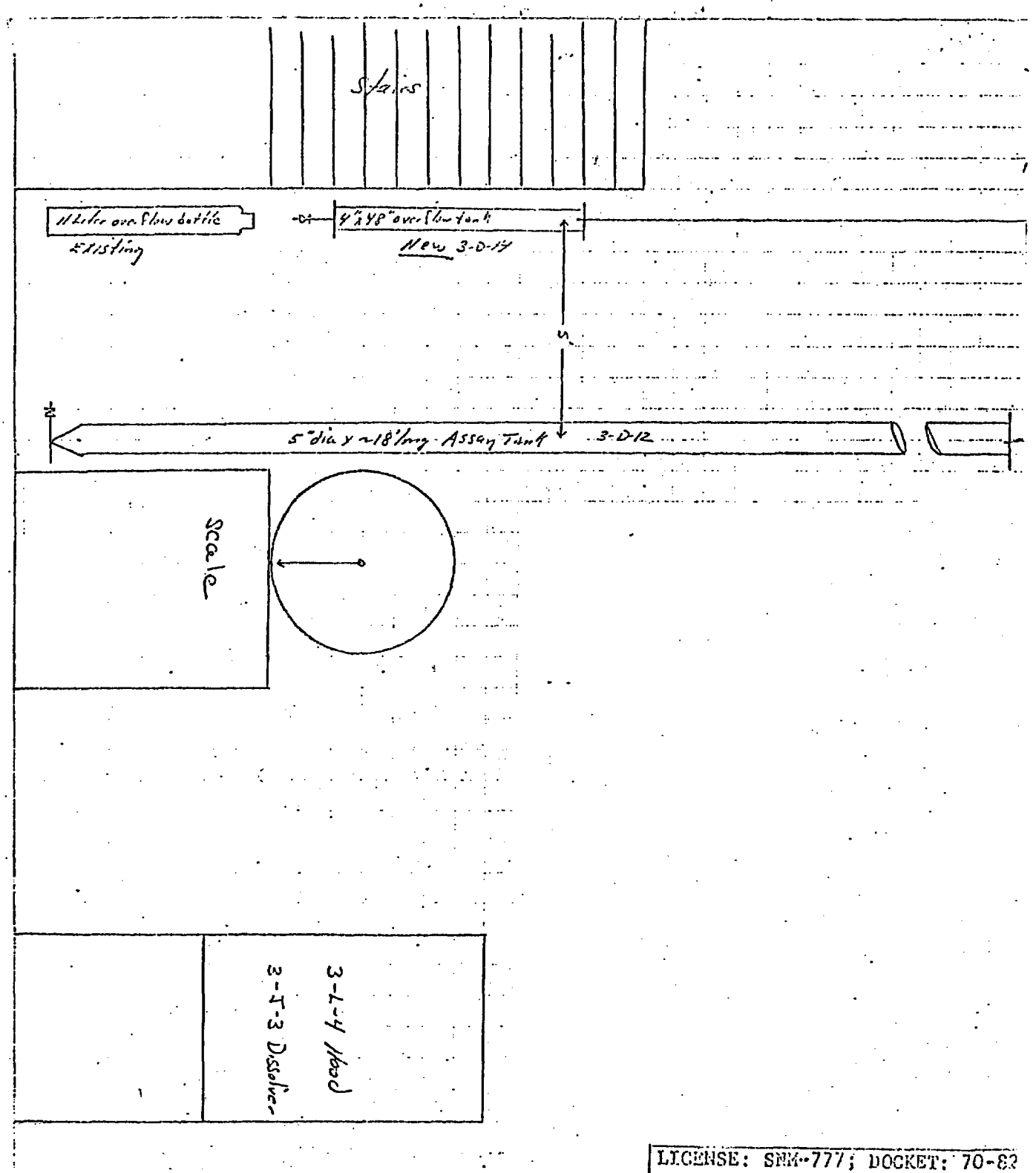
A verticle 5" diameter by a maximum of 18' long assay tank will be located in Bay XIV, 5' east of the 1-L-3C Hood, 8' north of the 3-L-4 Hood and 4' south of the dissolver mezzanine stairs. The assay tank will be vented into the 2-X-1 scrubber system and in over flow line will drain into a new 4" diameter x 48" long over flow tank 3-D-14.

The 3-D-14 Over flow Tank will be located above the OK Liquor Tank Over flow Bottle 1-D-N, 47" from the 1-J-4 Overflow Tank, and 5' from the 3-D-12 Permanent Assay Tank.

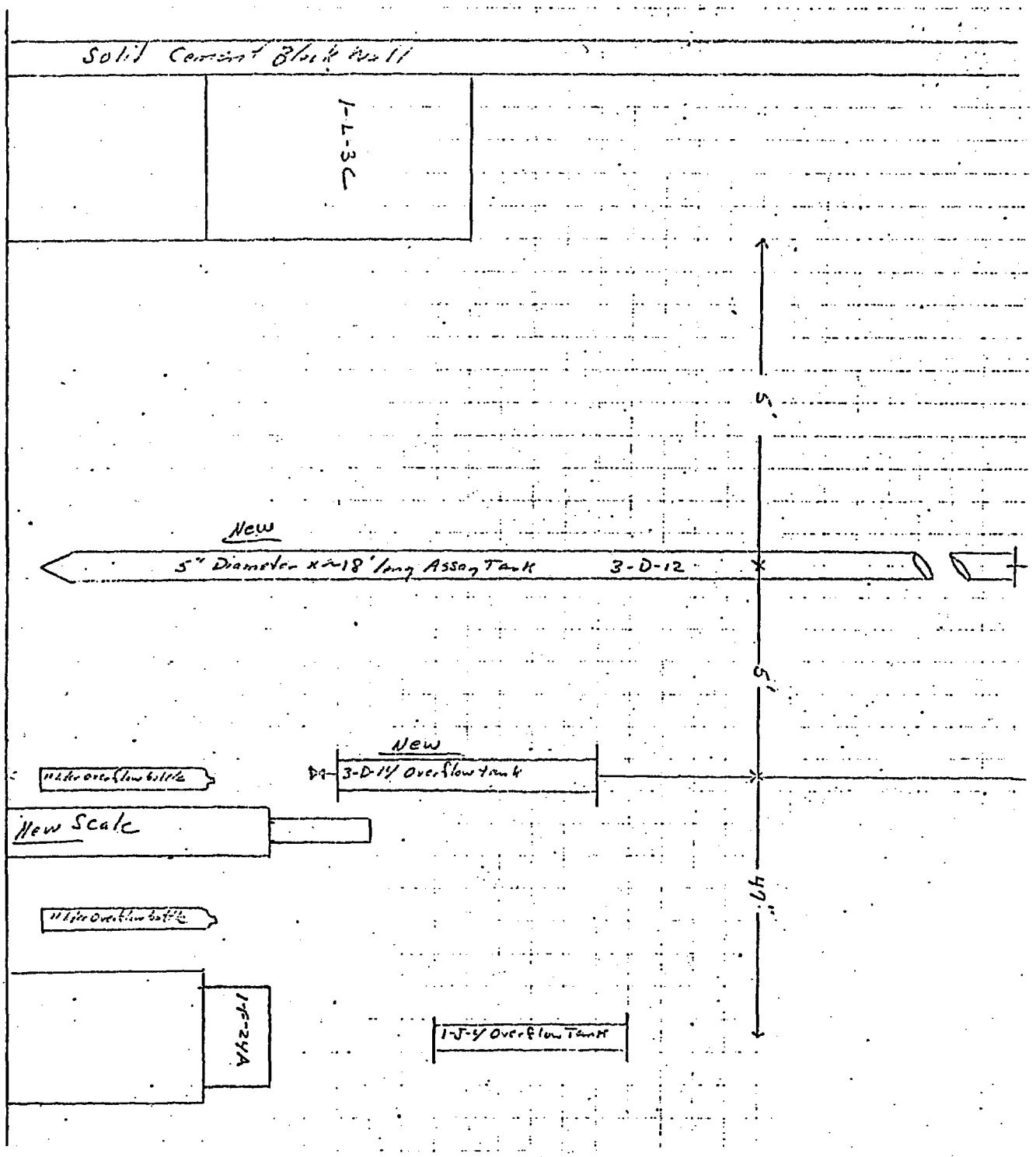
This assay tank will receive adjusted, filtered solutions from the disolver systems or the 3-D-9 Hold Tanks for assay weighing, mixing and sampling. After the weighing, mixing and sampling, the solution is transferred to the 1-D-41 Extraction Feed Tank by pressurized air. Details of the tank and its location are shown in Sketches 923.9 - I-II & - III.

2. Nuclear Safety

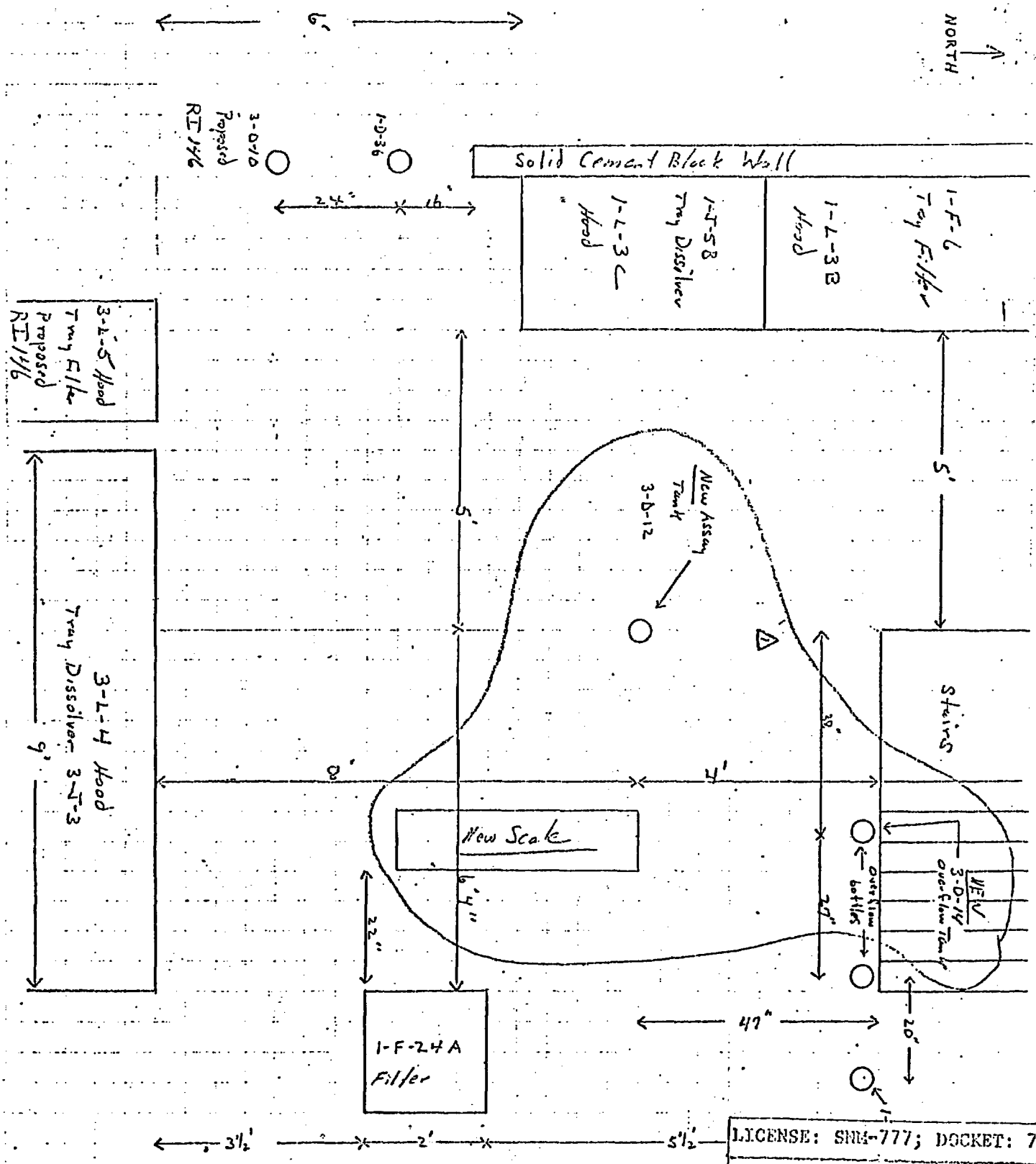
The tank has a nuclearly safe 5" diameter. The solid angle is approximately .19 steradians.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 923.9	
Sketch: 923.9-I	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	



LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 923.9
Sketch: 923.9-II
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968



Δ Modification with new assay tank, overflow tank + scale

LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 923.9	
Sketch: 923.9-III	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

1. Contribution form 3-D-14 and O.K. Liquor Tank Overflow Bottle

d=5", h=height of both tank and bottle = 48" + 48" = 96"

L/2=48", h=60" - 2.5" = 58.5"

$\Omega = \frac{2d}{h} \sin \theta$ Where $\tan \theta = \frac{L/2}{h} = \frac{48''}{58.5''} = .82$

$\sin \theta = .63$

$= \frac{10''}{58.5''} (.63) = .17 \times .63 = .11$ steradians

2. Contribution from 1-J-5B

a=24", b=4", q=h=60"

$\Omega = \frac{abh}{q^3} = \frac{ab}{q^2} = \frac{24''x4''}{(60'')^2} = \frac{96 \text{ in}^2}{3600 \text{ in}^2} = .03$ steradians

3. Contribution from Other Equipment Further Away

Assume $\Omega = .05$ steradians

4. Total Interaction

$\Omega_T = .11 + .03 + .05 = .19$ steradians

5. Allowable Interaction

From K-1019, 5th Rev., a 5" diameter system has an allowable interaction of 3.2 steradians.

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 923.9
Solid Angle Calculations Permanen Assay Tank 3-D-12
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

924.1 General (Sheet A-903)

1. Materials

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.

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, or composite of many drums for internal control purposes.

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.

924.2 Pickle Liquor System

1. 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 maximus 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 or syphoning from the drum.

The pickle liquor is treated by mixing with aluminum compounds 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.

If required ammonium hydroxide is transferred to the adjustment tank from a drum located outside the building.

The treated pickle liquor is transferred to the Extractor Feed Tank 1-D-41, (1500 gallon capacity, 1200 gallons net capacity due to Boron Pyrex Rasching Rangs) through Filter 1-F-1 which is 4" diameter by 13-1/8" long.

2. Equipment and Nuclear Safety, Pickle Liquor System

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 Treatment Tank 1-D-12 exist since the capacity of the tank is 90 gallons. The gallon pickle liquor batch plus the required neutralizing volume of chemicals 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.

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

1. SIZE: 2'6" DIAMETER X 2'6" STRAIGHT SIDE

2. CONTENTS: PICKLE LIQUOR WITH U-(ENRICHED); ALUMINUM NITRATE ($Al(NO_3)$) AQUEOUS AMMONIA (28% NH_3), ZR, FE, & OTHER CORROSION PRODUCTS

3. MATERIALS: SHELL 3/16" MIN. TYPE 304L STAINLESS
TOP HEAD 304L STAINLESS (LOOSE
BOTTOM HEAD 3/16 MIN. TYPE 304L STAINLESS (DISHED)

4. LOCATION: 1ST FLOOR BETWEEN COLS A-B & 7-8

5. URANIUM CONTENT: 1.2 gm/LITER NOMINAL
350 gm MAXIMUM TOTAL

6. NUCLEAR SAFETY

a) SAFE CONCENTRATION – CONCENTRATIONS OF 5 gm/l OR LESS ARE SAFE IN ANY QUANTITY.

b) SAFE MASS – MASS LESS THAN 350 GRAMS

c) ADMINISTRATIVE CONTROLS – TO ASSURE THAT THE CONCENTRATION OF THE OVER FEED NEVER EXCEEDS 5 gm/l. (NOTE: CONCENTRATIONS IN EXCESS OF 1.7 GM/LITER WILL EXCEED THE 350 GM ALWAYS SAFE MASS.

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 924.4
Interaction Calculations - Raw Liquor Tank, 1-D-12
PAGE 1 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968

7. INTERACTIONS WITH OTHER EQUIP

a) PUMP 1-P-6

$\Omega_a = 2\pi(1-\cos\theta)$ $\quad$ $L = 34''$ $R = 3''$

$\cos\theta = 0.9968$

$\Omega_a = 2\pi(0.0032) = 0.0201$

b. TANK 1-D-14A $\quad$ ISOLATED $\quad$ $L \geq 12'$

c. TANK 1-D-14B

$\Omega_c = \frac{2d}{L}\sin\theta$ $\quad$ $d = 4.5$ $\quad$ $L = 11$

$L = 6.5$ $\quad$ $L/2 = 3.25$

$\Omega_c = \frac{2.599}{11} = 0.2317$ $\quad$ $\sin\theta = 0.2832$

d) OVERHEAD PIPES 1-R-6, 1R11, 1-LA-2

$\Omega_d = 3\left[\frac{2d}{L}\sin\theta\right)$ $\quad$ $d = 1.375$ $\quad$ $L \geq 12'$

$\Omega_d = 0$

(e) 1-LA-2 VERT.

$\Omega_e = \frac{2d}{L}\sin\theta$ $\quad$ $d = 1.375$ $\quad$ $L = 78''$

$L = 13'$ $\quad$ $L/2 = 78''$

$\Omega_e = \frac{1.945}{78} = 0.025$ $\quad$ $\sin\theta = 0.707$

f) 1-LA2 HORIZ

$\Omega_f = \frac{d}{L_1}\sin\theta_1 + \frac{2d}{L_2}\sin\theta_2$ $\quad$ $d = 1.375$ $\quad$ $L_f = 3''$

$L = 98''$

$\Omega_f = 0.0063 + 0.0081 = 0.0144$

(where $\sin\theta_1 = .0069$, $\sin\theta_2 = .0121$)

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 924.2
Interaction Calculations - Raw Liquor Tank, 1-D-12
PAGE 2 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968

g) 1 LA 2 VERT (PUMP DISCH)

$\Omega_g = \frac{2d}{h} \sin\theta$ $\quad$ $d = 1.375$ $\quad$ $h = 24''$

$\sin\theta = 0.313$

$\Omega_g = 0.0358$

h) 1" LA 1 V

$\Omega = \frac{d}{h} \sin\theta$ $\quad$ $d = 1.375$ $\quad$ $h = 24''$

$\sin\theta = 0.6795$

$\Omega_h = 0.0390$

i) $\Omega_1 = \text{TOTAL} = \Omega_a + \cdots + \Omega_h = 0.366 < 1$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 924.2
Interaction Calculations, Raw Liquor Tank, 1-D-12
PAGE 3 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968

924.3 Other Liquors

The processing of liquors other than pickle liquor will be done the same as described in Subpart 924.2 including the specified concentration and batch control procedures.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 924 - Preperation of Liquid Scraps
924.4 - Uranium Solutions System

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

924.4 Uranium Solutions System

Uranium solutions for recovery with unknown concentrations and contained in safe volume or safe geometry containers are adjusted and mixed with air agitation in this equipment prior to assay (if required) or processing. The Residue Adjustment Tank 1-D-43 is 5 inches in diameter and spaced a minimum distance of 17" edge-to-edge which includes 12 inches of solid concrete wall forming the adjacent hoods, 1-L-17 & 1-L-18, (Ref. Subparts 922.8 and 922.9) from other U bearing containers.

The tank will be filled under vacuum and discharged under air pressure through pipe lines 1" diameter or less to existing equipment.

924.5 Low Level Liquid Waste System

1. General

Low level of contaminated liquid waste, scrap, or other residues generated or received for processing must have their volume reduced for efficient storage and later processing. The maximum U-235 content or batch of this material will be 350 grams U-235, although normally the levels would be expected to range from one-tenth to one gram. Material will be analyzed both before and after volume reduction to determine the total volume and SNM mass that may be processed plus the disposition of the reduced volume material.

2. Incineration of Contaminated Organic Liquids (Such as the TBP-AMSCO Mixture Discarded After Use in the Extraction Column)

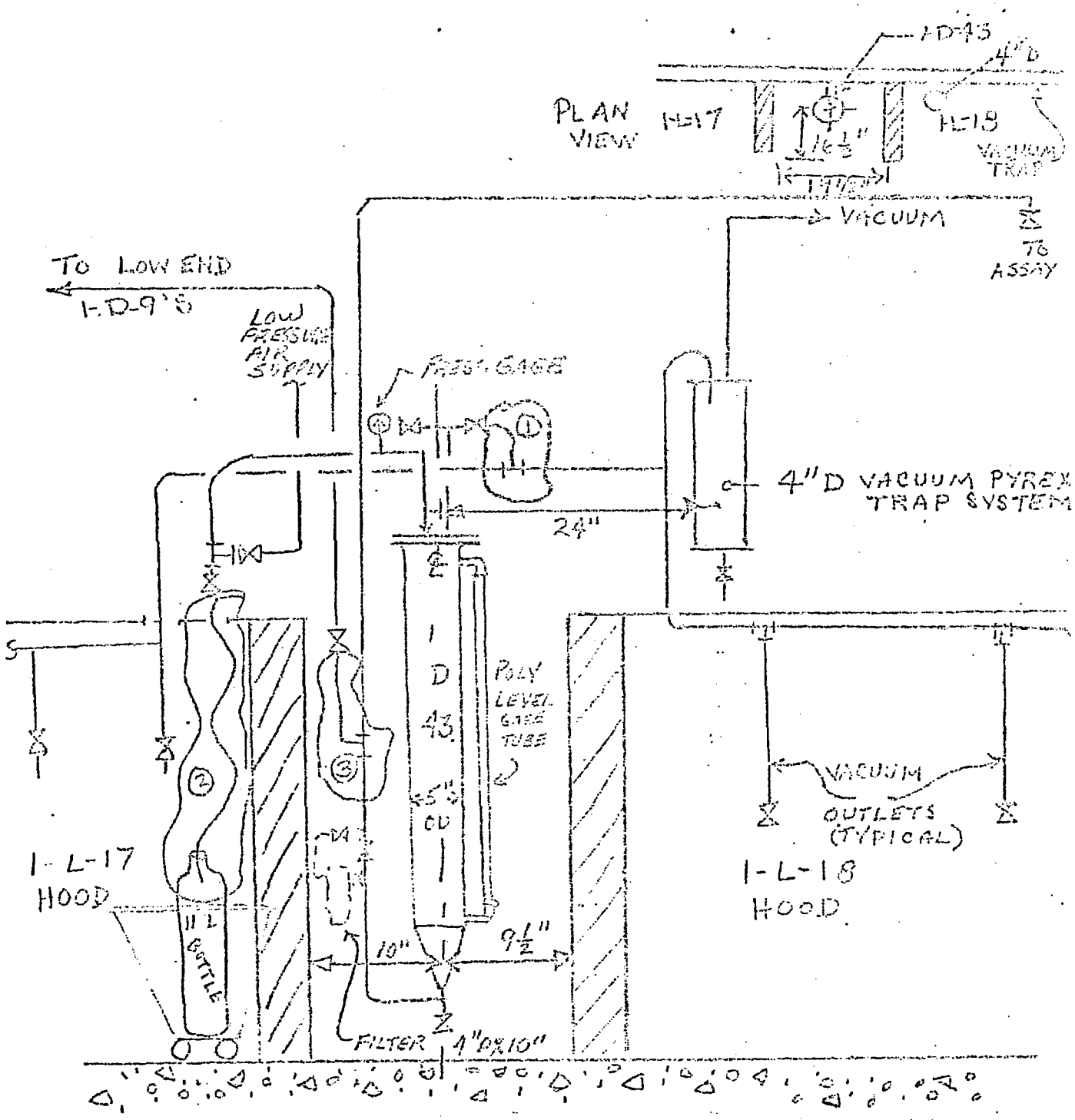
Organic liquids, such as discarded TBP-AMSCO solvent are sampled and if less than 2 gm U/liter and more than 30 ppm U, are considered contaminated and acceptable for recovery. However, these liquids need to be reduced in volume. This is accomplished by controlled burning. In all cases, a batch will not contain over 350 gm U-235 and a max. volume of 30 gallons. Ash will be cleaned up and removed to an approved safe storage container as each batch is completed.

2.1 Equipment

Equipment for burning of this material consists of a 5" diameter schedule 40 steel pipe mounted approximately 3 feet off the ground with the small 1/4" or 3/8" diameter tubing allowing gravity flow of the liquid onto a tray mounted in a drum which has been perforated. The perforated drum allows free access of air for combustion. The tray is less than 1" deep to insure against any unsafe accumulation of dry ash. Equipment will be located approximately 30 feet from the building on the west side on sandy soil inside the security fence, drums a minimum of 10 ft. apart. The feed drum will be randomly packed with boro-silicate (nominal 4%) Glass Raschig Rings filled to the top of the drum as a secondary safeguard.

2.2 Procedure

The gravity feed drum will be charged with up to 10 gallons of contaminated organic material. The valve connecting the drum to the ignition tray is opened, the material ignited and air samples will be taken downwind of the burner. In addition, smears of fence or other pieces of adjacent material will be taken to check for any radioactivity which may have become airborne. The operation will not be left unattended and the operator in charge will wear approximate respiratory equipment, not for primary protection against airborne radioactivity, but rather as a precaution in the event toxic or hazardous combustion products are generated during the burning of this material. Air sample results will be evaluated following each batch and prior



MODIFICATIONS:

(1) 1/2" Cross Connection From 1-D-43 to Vacuum Header

(2) Tygon Fill Tube From 11 L Bottle Dolly

(3) 1/2" I.D.S. Cross Tie To Discharge Tank to Either the Assay Tanks or the 1-D-9.

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 924.4
Sketch: 924.4-I, 1-D-43 Residu Adjustment Tank Modifications
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

2.2 Procedure (continued)

to burning the second batch to insure that concentrations never exceed those allowable in 10 CFR 20. If, in the opinion of the Health Physics Representative, or the supervisor in charge, burning should be discontinued due to changing wind conditions or for other reasons, the flow of organic liquid will be shut off, the fire allowed to die down and cool, and material in the storage drum returned to the bulk storage facility. No material is to be burned until approved by the shift supervisor and the Health Physics Representative, who will review the results of the analysis and who will approve in writing the burning operation.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 924 - Preperation of Liquid Scraps
924.6 - Aluminum Nitrate System

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

924.6 Aluminum Nitrate System

1. General

Aluminum nitrate is normally stored outside in the 1-D-1 Aluminum Nitrate Tank. As an alternate method, aluminum nitrate will be dissolved or generated in the 1-D-28, 500 gallon Aluminum Nitrate Make-Up Tank. No uranium bearing material will be permitted in these tanks.

The aluminum nitrate solution is transferred by Pump 1 to the 1-D-6A, 400 gallon Aluminum Nitrate Storage Tank on the third floor of Bay XX. This 1-D-6A was originally a strip acid tank.

The aluminum nitrate storage feeds by gravity from the 1-D-6A Aluminum Nitrate Storage Tank to all the aluminum nitrate headers throughout the plant. Air gaps are incorporated into the piping between all aluminum nitrate headers, and the equipment they serve to prevent any nuclear solutions from entering these headers.

925.1 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.

1.1 Process

Activities in this area include:

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

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

c) Stripping the organic solvent of the uranium present.

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

e) Clean up of organic solvent before recycling.

1.2 Equipment and Nuclear Safety

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:

a) 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.

b) 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.

5" DIA AREA = 19.635 IN²

COLUMN 1-C-6

	DIA-IN.	AREA-IN²
1-C-6 -	3.0	7.069
½" LA-4	0.622	0.304
½" LA-4	0.622	0.304
½" SCR-4	0.622	0.304
2" R-14	2.067	3.350
2" LEV. CONT.	2.000	3.142
1" R12	1.000	0.785
½" TBP 3	0.622	0.304

15.562 TOTAL AREA < 19.635

COLUMN 1-C-7

1-C-7	3.0	7.069
1" TBP4	1.049	0.864
½" SCR 1	0.0622	0.304
2" SCR 5	2.067	3.350
1" TBP 5	1.049	0.864
2" LEV. CONT.	2.000	3.142
1" SCR 3	1.000	0.785

16.378 TOTAL AREA < 19.635

COLUMN 1-C-8

1-C-8	3.0	7.069
½" AND 1	0.622	0.304
½" TBP 6	0.622	0.304
2" LOK 16	2.067	3.350
½" TBP 7	0.622	0.304
2" LEV. CONT.	2.000	3.142
1" LOK 3	1.049	0.864
		15.337

TOTAL < 19.635

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 925.1
Equivalent Cross Sections of Pulse Columns
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

COL. 1-C-9

	DIA.-IN.	AREA-IN²
1-C-9	3.000	7.069
½" TBP-7	0.622	0.304
½ TBP-8	0.622	0.304

7.677 TOTAL AREA < 19.635

COL 1-C-10

1-C-10	3.000	7.069
1"-LOK 3	1.049	0.864
½"-LOK-17	0.622	0.302

8.235 TOTAL AREA < 19.635

NOTE: 1-C-9 & 1-C-10 COMBINED

1-C-9	7.677
1-C-10	8.235

15.912 TOTAL COMBINED AREA < 19.635

SUMMARY OF SOLID ANGLE TOTALS.

EXTRACTION COLUMN,	TOTAL SOLID ANGLE, STERADIAN.
1 C 6	2.12
1 C 7	2.36
1 C 8	2.39
1 C 9	1.10
1 C 10	1.06

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 925.1
Equivalent Cross Sections of Pulse Columns
PAGE 2 OF 2
APPROVED :
ISSUED: OCTOBER 31, 1968

925.2 Extraction Column 1-C-6

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.

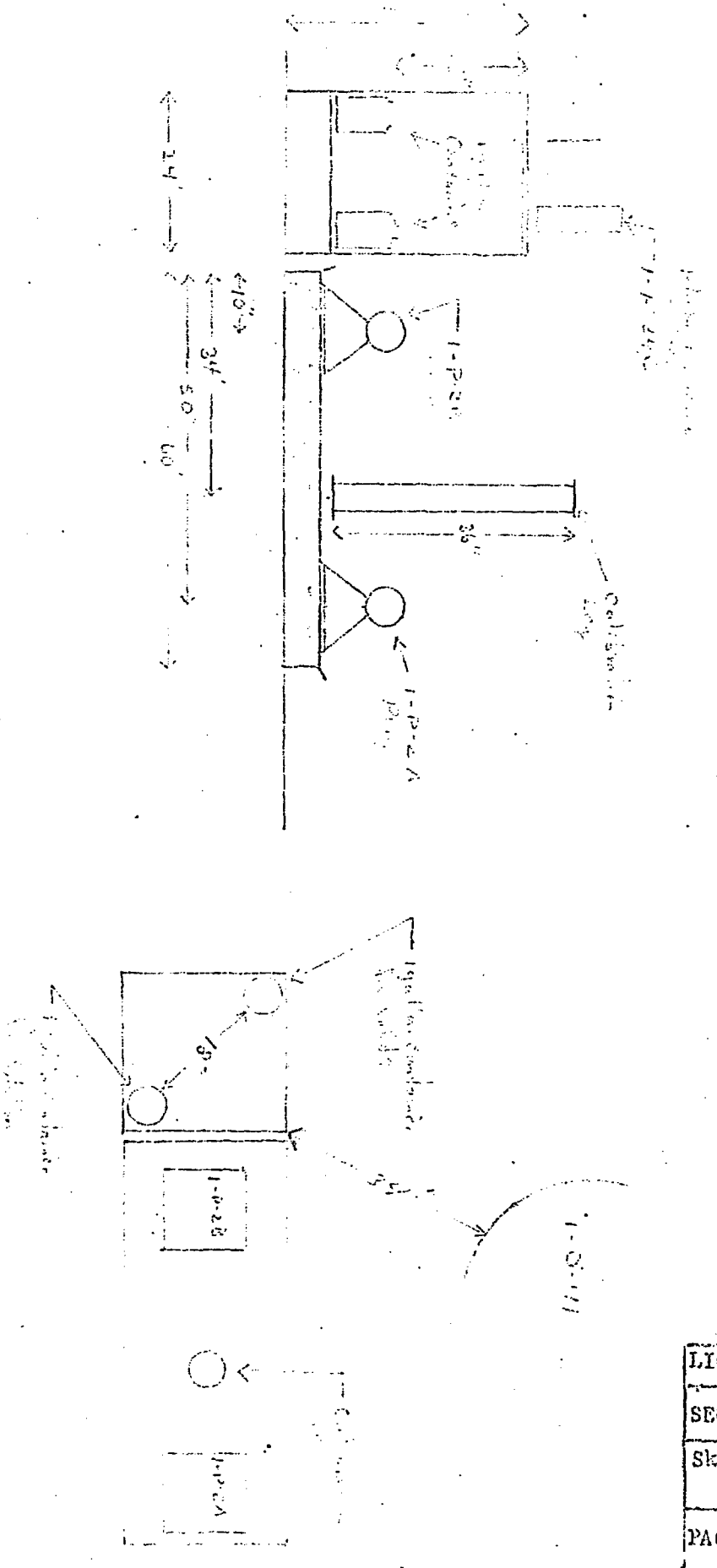
The solution may then be passed through Filter Press 1-F-24C. This filter press is identical to those described in Subparts 923.3.2.4 and 923.4.5. Two 1 gallon containers are provided, one for solution in the drip pan under the Filter Press and the other for solids removed from the Filter Press. These containers are separated from each other and surrounding equipment by 18". Details of the Filter Press and Pump locations are shown on Sketch 925.2-I.

Organic solvent is transferred to the Extraction Column from the Solvent Feed Tank 1-D-5 through a metering pump 1-P-33 and the organic head tank 1-D-44.

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.

The acid discharge from the bottom of the column extracted of uranium is transferred as raffinate to either of the Slop Tanks 1-D-21 A and B, by means of gravity 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.



LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 925.2
Sketch: 925.2-I
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

1. SIZE: 3" X 31'9".

2. CONTENTS: TBP IN KEROSINE (10-30% TBP), ADJUSTED LIQUOR CONTAINING URANIUM (AS NITRATE)

3. MATERIALS: SHELL - 1/8" STAINLESS STEEL & 13/64 PYREX

HEADS - STAINLESS STEEL

4. LOCATION: TOWER ROOM BETWEEN COL'S. 7 & 8

5. URANIUM CONCENTRATION: FEED - .75 gm/l MAX.
TBP - 0.8-11.4 gm/l MAX.

6. SAFETY AS ISOLATED UNIT

a. 3" ϕ PROVIDES SAFE GEOMETRY FOR INF. LENGTH AND ANY CONCENTRATION (SOLUTION)

b. ADJACENT PIPING ∥ TO AXIS & INTERFACE LEVEL CONTROL — TOTAL AREA OF COLUMN PLUS ADJACENT PIPE = 16.48 in² < 19.64 in². SAFE GEOMETRY IS PROVIDED EVEN WHEN INCLUDING ADJACENT PIPE (< 5" ϕ)

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 925.2
Interaction Calculations-Extractio Pulse Columns 1-C-6
PAGE 1 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

INTERACTION

7.- AS ARRAY WITH OTHER COLUMNS

a. WITH 1-C-7

$\Omega_a = \frac{2d}{h} \sin\theta$ $\quad d = 3''$, $h = 34.5''$

$L = 19'$, $L/2 = 9.5' = 114''$

$\sin\theta = 0.9577$

$\Omega_a = \frac{5.74}{34.5} = 0.166$

OR $\Omega_a = \frac{d}{h}(\sin\theta_1 + \sin\theta_2)$ $\quad \sin\theta_1 = 0.7268$, $\sin\theta_2 = 0.9825$, 1.7093

$\Omega_a = \frac{5.128}{34.5} = 0.149$

USE 0.166

b. WITH 1-C-8

NOTE 1-C-8 PARTLY SHIELDED BY 1-C-7

$\Omega_b = \frac{d}{h} \sin\theta$ $\quad d = 3''$ $\quad h = 70.5$ $\quad L = 19'$

$\sin\theta = 0.938$

$\Omega_b = \frac{2.814}{70.5} = 0.04$

c. WITH 1-C-9 & 1-C-10

$\Omega_c = 0$ (SHIELDED BY 1-C-8)

d. TOTAL INTERNAL

$\Omega_{Ti} = \Omega_a + \Omega_b + \Omega_c = 0.189$

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 925.2
Interaction Calculations-Extracti Pulse Column 1-C-6
PAGE 2 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

7.- ALTERNATE

INTERACTIONS WITH OTHER COLUMNS AS 5" ϕ

(AREA OF COL'S. + ADJACENT PIPE < AREA OF 5" ϕ THEREFORE COL. & PIPE CAN BE GROUPED AS A 5" ID PIPE)

(ALT.) (a) $\Omega_a = \frac{2d}{h} \sin\theta$ $\quad d = 5''$ $\quad h = 38.5$ $\quad \sin\theta = 0.9577$

$$\Omega_a = \frac{9.577}{38.5} = 0.2776$$

(ALT.) (b) $\Omega_b = \frac{d}{h} \sin\theta$ $\quad d = 5''$ $\quad h = 70.5''$ $\quad \sin\theta = 0.938$

$$\Omega_b = \frac{4.69}{70.5} = 0.0666$$

(ALT.) (c) $\Omega_c = 0$

ALT. (d) $\Omega_{Ti} = 0.3442$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 925.2	
Interaction Calculations- Extraction Pulse Column 1-C-6	
PAGE 3 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

8. INTERACTION WITH OWN PIPE, FEEDS, LEVEL CONTROL ETC.

a. 1/2" INCOMING AQUEOUS FEED (LA-4)

$\Omega_a = 0$ SHIELDED

b. 1/2" SCRUB SOL (SCR-4)

$\Omega_b = \frac{2d}{h} \sin\theta$ $d = \cancel{0.622}\ 0.840$ $h = \cancel{8}\ 13.5$ 1.807/2

$L = 28'$ $L/2 = 14' = 168''$

$\Omega_b = \cancel{0.125}\ 0.124$ $\sin\theta = 0.9968$

c. 2" ϕ PYREX INTERFACE LEVEL CONTROL

$\Omega_c = \frac{2d}{h} \sin\theta$ $d = 2.25$ $h = 8''$

$L = 28'$ $L/2 = 14' = 168''$

$\sin\theta = 0.9989$

$\Omega_c = \cancel{0.995}\ 0.560$

d. 1" ϕ PYREX LEVEL CONT. DRAIN 1" R12

$\Omega_d = \frac{2d}{h} \sin\theta$ $d = 1.3$ $h = \cancel{10}\ 10.2$

$L = \cancel{22}\ 20$ $L/2 = \cancel{11}\ 10 = \cancel{132}\ 120$

$\sin\theta = \cancel{0.997}\ 0.996$

$\Omega_d = \cancel{0.199}\ 0.254$

e. 1/2" TBP FEED TBP-3

$\Omega_e = \frac{2d}{h} \sin\theta$ $d = \cancel{0.622}\ 0.840$ $h = \cancel{8}''\ 7.75$

$L = \cancel{70}''\ 48''$ $L/2 = \cancel{35}\ 24''$

$\sin\theta$ [illegible]

$\Omega_e = \cancel{0.153}\ 0.206$

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 925.2
Interaction Calculations-Extraction Pulse Column 1-C-5
PAGE 4 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

8-(f) 1" TBP OUTLET (TBP-4)

$\Omega_f = \frac{2d}{h} \sin\theta$ $d = \frac{1}{2}" \; 1.3 \; h = 24"$

$\sin\theta = 0.988$

$\Omega_f = \cancel{\frac{2.776}{24}} = \cancel{0.0823} \; 0.107$

(g) TOTAL INTERACTION WITH PIPE ETC. ADJACENT TO COLUMN

$+\Omega_{f1} = 1.776$

$\Omega_8 = \Omega_a + \Omega_b + \cdots + \Omega_f = \cancel{1.0875} \; \cancel{1.5293}$

Add Pulse line

9. TOTAL INTERACTIONS W/OTHER COL'S. & WITH OWN PIPE

$\Omega_T = \Omega_{7\,all} + \Omega_8$

$\Omega_T = 0.3442 + \cancel{1.5293} \; 1.776 = \cancel{1.8735} \; 2.120$

8 (f)(1) PULSE LINE 2" R.14

$\Omega_{f1} = \frac{2d}{h} \sin\theta$ $d = 2.375 \; h = 9"$

$L/2 = 81"$ $\sin\theta = 0.993$

$\Omega_{f1} = \frac{\cancel{3.4756}}{9} = \cancel{0.4618} \; 0.525$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 925.2	
Interaction Calculations-Extraction Pulse Column, 1-C-6	
PAGE 5 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

1) APPROXIMATE VOLUME SIZE

ASSUME 12" ø × 1½" THICK (1½" DISCH)

ASSUME ▯ AS A 12" ø × 1.5" CYLINDER

$$V = 0.785(12)^2(1.5)(1.64\times10^{-2}) = 2.79 \text{ LITERS}$$

SAFETY BASED ON SAFE VOLUME

2.79 liters < 9.8 liters

2) INTERACTIONS

PER 70.52 $\Omega_{\text{TOTAL ALLOWABLE}} = .9 - 0.8(10) = 1.0$

a) WITH 1-C-9

$$\Omega_a = \frac{2d}{h}\sin\theta$$

$d = 5''$ $h = 22''$
$L = 10'6$ $L/2 = 63''$
$\sin\theta = 0.9209$

$$\Omega_a = \frac{9.209}{22} = 0.418$$

b) WITH 1-C-10

$$\Omega_b = \frac{2d}{h}\sin\theta =$$

$d = 5''$ $h = 60$
$L = 10'6$ $L/2 = 63''$
$\sin\theta = 0.7242$

$$\Omega_b = \frac{7.242}{60} = 0.1207$$

c) WITH 1-P-29

$$\Omega = \frac{2d}{h}\sin\theta$$

Assume $d = 1.5$ $h = 24''$
$L = 12''$ $L/2 = 6''$
$\sin\theta = 0.9239$

$$\Omega = \frac{0.7275}{24} = 0.0303$$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 925.2	
Interaction Calculations - Pump 1-P-4 & 1-P-29	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

2) d) WITH 1-P-30

$R = 6''$ $L = 57$

$\cos\theta = 0.9985$

$\Omega = 2\pi(1 - \cos\theta)$

$\Omega_d = 2\pi(0.0055) = 0.0345$

e) WITH 1-P-33

$R = 6$ $L = 102$

$\cos\theta = 0.9983$

$\Omega = 2\pi(1 - \cos\theta)$

$\Omega_e = 2\pi(0.0017) = 0.0107$

f) $\Omega_{2T} = 0.6143$

3) FOR ADJACENT PIPE

$\Omega_p \leq 0.015$

4) TOTAL INTERACTION

$\Omega = 0.6143 + 0.015 = 0.6293$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 925.2
Interaction Calculations- Pumps 1-P-4 & 1-P-29
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

925.3 Scrub Column 1-C-7

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.

1. SIZE 3" X 15'

2. CONTENTS: TBP IN KEROSINE (10-30% TBP) WITH URANIUM (AS NITRATE) & SCRUB SOLUTION

3. MATERIALS - SHELL 1/8" STAINLESS STEEL & 13/64" PYREX
HEADS - STAINLESS STEEL

4. LOCATION: TOWER ROOM BETWEEN COLS
&

5. URANIUM CONCENTRATION: 75 gm/L MAX

6. SAFETY AS ISOLATED UNIT

a. 3" DIA SEE 1-C-6, 6a
b. ADJACENT ETC SEE 1-C-6, 6b

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 925.3
Interaction Calculations- Scrub Pulse Column 1-C-7
PAGE 1 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

7.- INTERACTIONS AS ARRAY WITH OTHER COLUMNS

a; WITH 1-C-6

$\Omega_a = \frac{2d}{h} \sin\theta$ $\quad$ $d = 3''$ $\quad$ $h = 38.5''$ (38.5)

$L = 31.75'$ $\quad$ $L/2 = 190.5''$

$\Omega_a = \frac{5.904}{38.5} = 0.171$ ✓ $\quad$ $\sin\theta = 0.984$ ✓

b. WITH 1-C-8.

$\Omega_b = \Omega_a = 0.171$ ✓

c. WITH 1-C-9

$\Omega_c = 0$ (SHIELDED BY 1-C-8)

d. $\Omega_{Ti} = 0.342$ ✓

ALTERNATE: INTERACTIONS WITH COLS AS 5" ϕ

e; $\Omega_e = \frac{2d}{h} \sin\theta$ $\quad$ $d = 5''$ ✓ $\quad$ $h = 38.5$ ✓

$\sin\theta = 0.984$ ✓

$\Omega_e = \frac{9.84}{38.5} = 0.285$ ✓

f. $\Omega_f = \Omega_e = 0.285$ ✓

g. $\Omega_{Ti} = \underline{0.57}$ ✓ TOTAL ALTERNATE

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 925.3
Interaction Calculations - Seri Pulse Column 1-C-7
PAGE 2 OF 4
APPROVED
ISSUED: OCTOBER 21, 1969

8. INTERACTIONS WITH OWN PIPE, FEEDS, LEVEL CONT. ETC.

(a) ½" SCR-1

$\Omega_a = \frac{2d}{h} \sin\theta$ $\quad d = \cancel{0.622}\ 0.540$, $h = \cancel{10}\ 9.6"$

$L = 13'$ $\quad L/2 = \cancel{78}\ 66"$

$\sin\theta = 0.992\ 0.9899$

$\Omega_a = \frac{1.234}{\cancel{10}\ 9.6} = \cancel{0.123}\ 0.173$

(b) 1" TBP-4

$\Omega_b = \frac{2d}{h} \sin\theta$ $\quad d = 1.3$ $\quad h = \cancel{12}\ 12.76$

$L = 24'$ $\quad L/2 = 12' = 144"$

$\Omega_b = \frac{2.589}{\cancel{12.93}\ 12.76} = \cancel{0.1665}\ 0.203$ $\quad \sin\theta = 0.9965$

(c) 2" PULSER LINE 2" SCR 5

$\Omega_c = \frac{2d}{h} \sin\theta$ $\quad d = 2.375$ $\quad h = \cancel{12}\ 9"$

$L = \cancel{16}\ 162$ $\quad L/2 = \cancel{8'} = \cancel{96}\ 81"$

$\Omega_c = \frac{3.969}{\cancel{12}\ 9} = \cancel{0.331}\ 0.525$ $\quad \sin\theta = \cancel{0.9923}\ .9939$

(d) 2" PYREX INTERFACE LEVEL CONTROL

$\Omega_d = \frac{2d}{h} \sin\theta$ $\quad d = 2.25$ $\quad h = 8"$

$L = 16'$ $\quad L/2 = 8' = 96"$

$\Omega_d = \frac{3.985}{8} = \cancel{0.4980}\ 0.560$ $\quad \sin\theta = 0.9965$

(e) 1" PYREX LEVEL CONT. DRAIN 1" SCR-3

$\Omega_e = \frac{2d}{h} \sin\theta$ $\quad d = \cancel{1}\ 1.3"$ $\quad h = \cancel{10}"\ 10.2$

$L = \cancel{18}\ 12$ $\quad L/2 = \cancel{7}\ = \cancel{84}\ 72"$

$\Omega_e = \frac{\cancel{1.96}\ 2.57}{\cancel{10}\ 10.2} = \cancel{0.1966}\ 0.252$ $\quad \sin\theta$

$\sin\theta = .9901$

LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 925.3	
Interaction Calculations - Scru Pulse Column 1-C-7	
PAGE 3 OF 4	
APPROVED	
ISSUED: OCTOBER 31, 1968	

8. (f) 1" TBP-5

$$\Omega_f = \frac{2d}{h} \sin\theta$$

$d = \cancel{1}\ 1.3$ $h = \cancel{10}\ 33''$

$L = 18'$: $L/2 = 9' = \cancel{105}\ 95'$

$\sin\theta = 0.9959\ 0.9947$

$$\Omega_f = \frac{2.576}{\cancel{1.0944}\ 1033} = \cancel{0.0943}\ 0.0808$$

(g) $\Omega_{TOTAL} = \Omega_a + \Omega_b + \cdots + \Omega_f = \cancel{1.5508}\ 1.7938$

9. TOTAL INTERACTIONS W/OTHER COLS & OWN PIPE

$$\Omega_T = \overset{\Omega_{7ga}}{0.57} + \overset{1.7938}{\cancel{1.508}} = \cancel{2.078}\ 2.3638$$

$$\Omega_T = \Omega_{7g} + \Omega_{8g} = 0.312 + 1.7938 = 2.1358$$

$$\Omega_T = \Omega_{7g\,(ALT)} + \Omega_{8g}$$

$$= .57 + 1.7938 = 2.3638$$

LICENSE: SNM-777; DOCKET: 70-82(	
SECTION: 900, SUBPART: 925.3	
Interaction Calculations - Scrul Pulse Column 1-C-7	
PAGE 4 OF	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.4 - Stripper Column 1-C-8

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925.4 Stripper Column 1-C-8

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 the 20 gallon hot water tank 1-D-45 (Ref. Subpart 925.9).

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

The organic solvent minus the uranium flows by gravity through the Solvent Cleanup Column 1-C-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.

1. SIZE:- 3" X 31'7"

2. CONTENTS: TBP IN KEROSINE (10-30%) WITH URANIUM (AS NITRATE) & STRIP SOLUTION (NITRIC ACID)

3. MATERIALS:- SHELL: 1/8" STAINLESS STEEL
13/6X PYREX
HEADS: STAINLESS STEEL

4. LOCATION: TOWER ROOM, BETWEEN COL'S. & 7

5. URANIUM CONCENTRATION: 150 gm/l MAX.

6. SAFETY AS ISOLATED UNIT

(a) SEE 1-C-6

(b) SEE 1-C-6

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 925.4
Interaction Calculations - Str Pulse Column 1-C-8
PAGE 1 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

7. INTERACTION AS ARRAY WITH OTHER COLUMNS

(a) WITH 1-C-6

NOTE-(1) 1-C-6 PARTIALLY SHIELDED BY 1-C-7
(2) BASE ON 5" ϕ COL. - SEE 1-C-6, 1-C-7

$\Omega_a = \frac{d}{h} \sin\theta$ $\quad d = 5''$ $\quad h = 70.5''$
$L = 190.5$
$\sin\theta = 0.938$

$\Omega_a = \frac{4.69}{70.5} = 0.0666$

(b) WITH 1-C-7

$\Omega_b = \frac{2d}{h} \sin\theta$ $\quad d = 5''$ $\quad h = 34.5''$
$L = \cancel{16}\ 19'$ $\quad L/2 = 9.5' = 114''$
$\sin\theta = \cancel{0.977}\ 0.9577$

$\Omega_b = \frac{\cancel{9.77}\ 9.577}{34.5} = \cancel{0.273}\ 0.2776$

(c) Ω WITH 1-C-9

$\Omega_c = 0$ (SHIELDED BY OK LIQUOR CLEAN UP TANK 1-C-10)

(d) O.K. LIQUOR CLEAN UP TANK 1-C-10

$\Omega_d = \frac{2d}{h} \sin\theta$ $\quad d = 5''$ $\quad h = \cancel{24.5}\ 25.5$
$L = \cancel{8}\ 10'$ $\quad L/2 = 4' = \cancel{48}\ 60''$
$\sin\theta = \cancel{0.8077}\ 0.9205$

$\Omega = \frac{\cancel{8.807}\ 9.205}{\cancel{24.5}\ 25.5} = \cancel{0.360}\ 0.36$

(e) TOTAL $\Omega = \Omega_a + \Omega_b + \Omega_c + \Omega_d = 0.704$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 925.4
Interaction Calculations - Str Pulse Column 1-C-8
PAGE 2 OF 4
APPROVED
ISSUED: OCTOBER 31, 1968

8. INTERACTIONS WITH OWN PIPE, FEEDS, LEVEL CONTROLS ETC.

(a). ½" AND-1

$\Omega_a = \frac{2d}{h} \sin\theta$

$d = 0.84$ $h = 13"$

$L = 24.0$ $L/2 = 144$

$\sin\theta = 0.9959$

$\Omega_a = \frac{1.673}{13} = 0.129$

(b) ½" TBP-6

$\Omega_b = \frac{2d}{h} \sin\theta$

$d = 0.84$ $h = 9"$

$L = 57$ $L/2 = 28.5$

$\sin\theta = 0.9537$

$\Omega_b = \frac{1.602}{9} = 0.178$

(c) 2" PULSER LINE

$\Omega_c = \frac{2d}{h} \sin\theta$

$d = 2.375$ $h = 9"$

$L = 162"$ $L/2 = 81"$

$\sin\theta = 0.9939$

$\Omega_c = \frac{4.750}{9} = 0.525$

(d) 2" PYREX LEVEL CONTROL

$\Omega_d = \frac{2d}{h} \sin\theta$

$d = 2.25$ $h = 8$

$L = 264"$ $L/2 = 132"$

$\sin\theta = 0.998$

$\Omega_d = \frac{4.491}{8} = 0.561$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 925.4	
Interaction Calculations - Stri Pulse Column 1-C-8	
PAGE 3 OF 4	
APPROVED	
ISSUED: OCTOBER 31, 1968	

8. (e) 1" LEVEL CONTROL DRAIN 1" LOK 3

$\Omega_e = 0$ SHIELDED BY 2" PYREX (8d)

(f) ½" TBP-7

$\Omega_f = \frac{2d}{L} \sin\theta$ $d = 0.84$ $L = 30"$

$L = 2'/4'' \; 4/2 = 16'' \; 111$

$\Omega_f = \frac{1.6218}{30} = 0.054$ $\sin\theta = 0.9653$

(g) 3" PYREX 1-C-10 (OK LIQUOR WASH W/TCE)

$\Omega = \frac{2d}{L} \sin\theta$ $d = 3.25$ $L = 25.5$

$L = 8'10'' \; 4/2 = 53 = 1'63$

$\Omega = \frac{6.02F}{25.5} = 0.236$ $\sin\theta = 0.9269$

(h) $\Omega_{TS} = \Omega_a + \Omega_b + \cdots + \Omega_g = 1.683$

9. TOTAL INTERACTION W/OTHER COLS. & OWN PIPE

$\Omega_T = 0.704 + 1.683 = 2.387$

LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 925.4	
Interaction Calculations - Str Pulse Column 1-C-8	
PAGE 4 OF 4	
APPROVED	
ISSUED: OCTOBER 31, 1968	

925.5 Organic Feed Tank 1-D-5

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.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.6 Scrub Solution Tank 1-D-3

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925.6 Scrub Solution Tank 1-D-3

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. There is no uranium in this tank.

925.7 Aluminum Nitrate Head Tank 1-D-6A and Nitric Acid Head Tank 1-D-6B

1. Aluminum Nitrate Head Tank 1-D-6A

Aluminum Nitrate solution is pumped up to this tank from the Aluminum Nitrate make-up tank 1-D-23. The Aluminum Nitrate is then fed to the plant by gravity through the Aluminum Nitrate Distribution system. There is no uranium in these tanks.

2. Nitric Acid Head Tank 1-D-6B

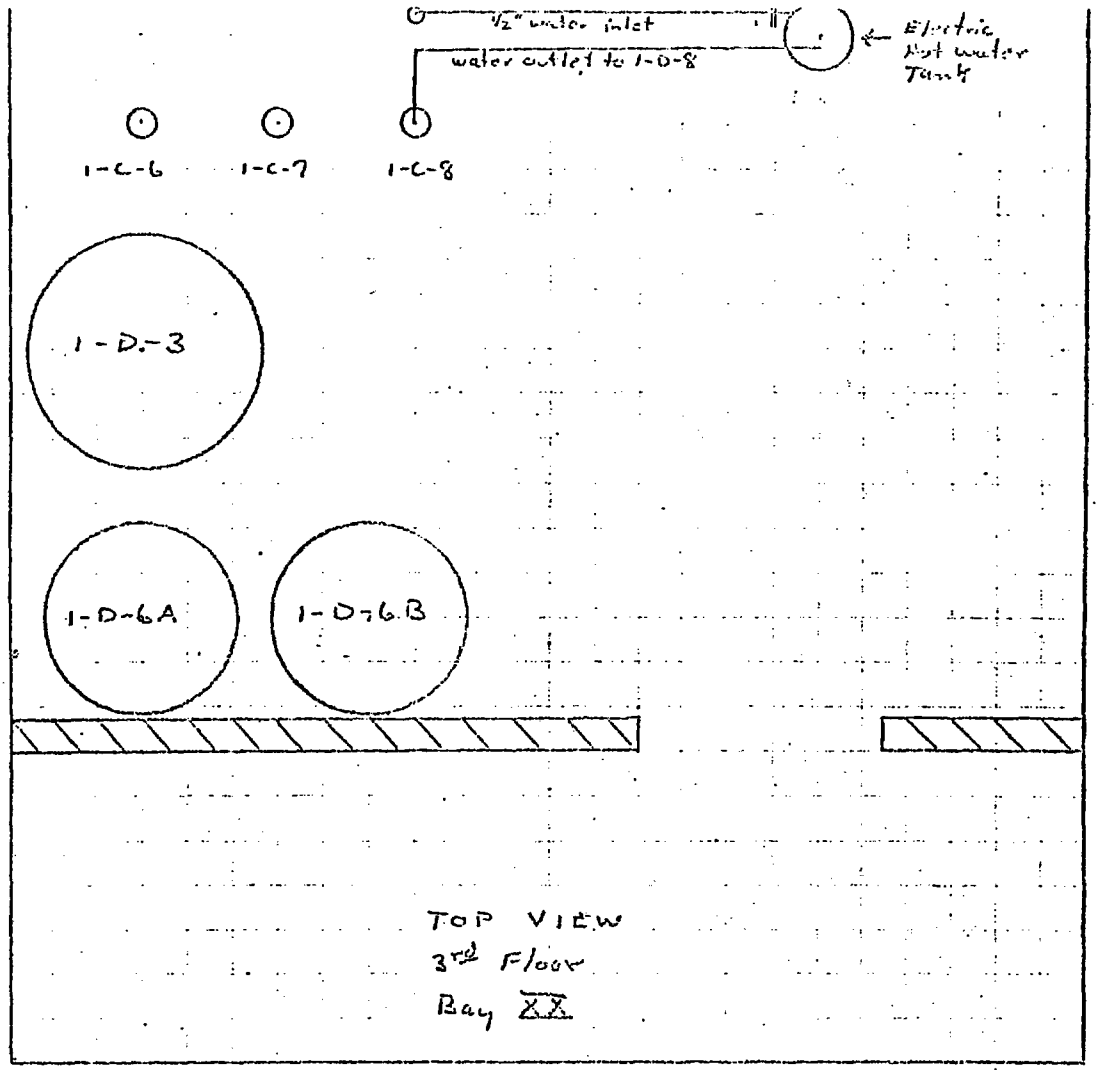
Concentrated Nitric Acid is pumped up to this tank from the outside HNO_3 Storage Tank 1-D-29. HNO_3 is then fed to the plant by gravity through the Nitric Acid distribution system. There is no uranium in these tanks.

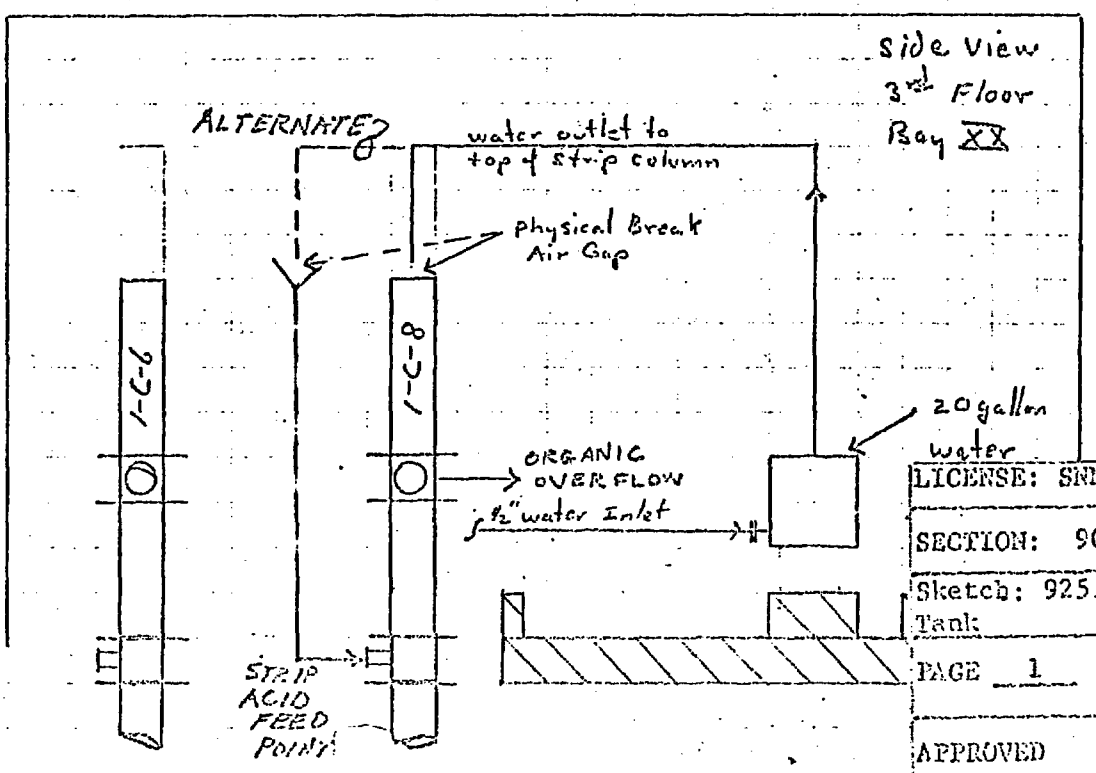
925.8 Distilled Water Tank A-9

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

925.9 20 Gallon Hot Water Heater

Metered water will be fed into the bottom of the hot water heater and discharged through the top of the heater into the top of the Strip Pulse Column, 1-C-8. An air gap will be incorporated into the discharge line from the heater so that no uranium bearing solutions can back up through the discharge line into the hot water system. Details of the equipment arrangement are shown on Sketch 925.9-I.





LICENSE: SNM-777; DOCKET: 70-[illegible]

SECTION: 900, SUBPART: 925.

Sketch: 925.9-I, Strip Hot Wat Tank

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

925.10 Waste Treatment Tanks 1-D-14 A and B

1. Equipment

The waste treatment tanks receive raffinates from the Filtrate Tanks 1-D-24 A and B, and the Slop Tanks 1-D-21 A 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 and 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.

2. 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-24 A and B, Tanks 1-D-21 A and B, and the miscellaneous Solution Discard Station and shift supervisor approval prior to transfer to the Waste Treatment Tank 1-D-14 A and B.

925.11 Waste Lagoon

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.

The lagoon is lined with suitable waterproofing material equivalent in integrity, corrosive resistance, etc., to overlapping polyethylene sheets which are sealed by mechanical, chemical, or thermal means at the seams to preclude seepage. When the lagoon has filled sufficiently to require removal of solids, a new liner will be laid down. Samples of lagoon effluent will be taken during discharge to the river, at least once a month, and will include analyses for alpha and beta activity, Ph, and other trace elements as determined by process conditions to assure against pollution of the stream. 10 CFR 20 requirements will be the guide for compliance in this respect. To check contamination of subterranean waters, samples of the plant drinking water obtained from a driven well, will be taken once a month and, again checked for alpha and beta activity, Ph, fluoride, nitrate, or other elements. This check should give further indication of movement of material from the lagoon subterranean waters. Samples are periodically transmitted to the State Department of Health for confirmation that contamination has not spread to the drinking water.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.12 - Miscellaneous Solution Discard Station

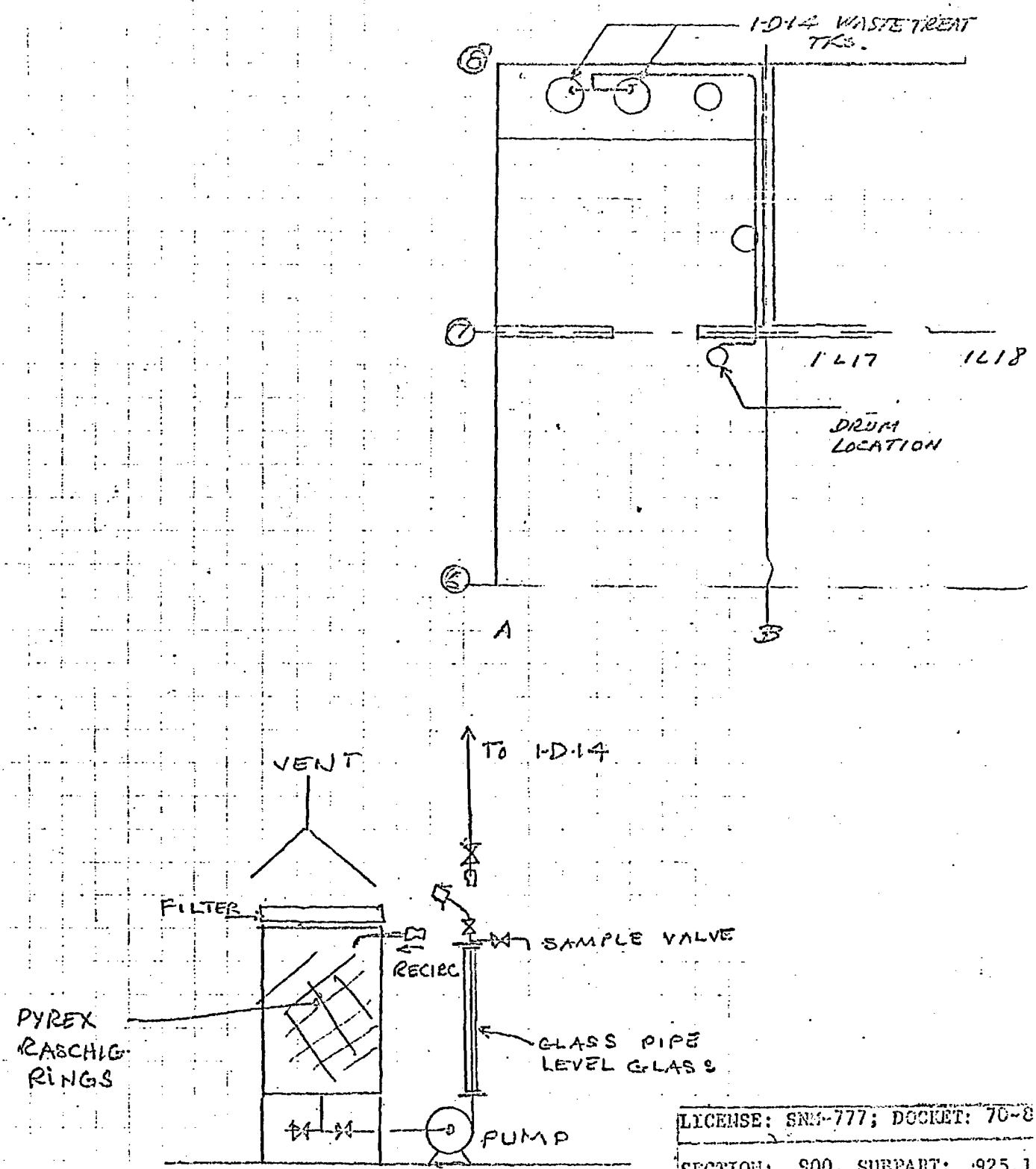
Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925.12 Miscellaneous Solution Discard Station

This station is used for the disposal of miscellaneous solutions such as those from the DDU Scrubber 2-F-4 , the Calciner Scrubber 1-X-23 , the Filtrate Tanks 1-D-24 A & B , etc. A 55-gallon drum filled to the top with bero-silicate (nominally 4%) glass Raschig Rings will be used to filter and mix these various solutions for sampling prior to discharge. If the U-235 content is less than 0.1 grams per liter, discharge will be to the Waste Treatment Tanks 1-D-14 . If the U-235 content exceeds this value, discharge will be to the Filtrate Tanks 1-D-24 A & B for further processing. Solution transfers will be made through a positive disconnect. This station will be separated from other SNM by at least two (2) feet edge-to-edge. Therefore, the interaction effects will be negligible. The equipment location and details are shown on Sketch 925.12-1. The drum will be marked and checked as stated in Subpart 925.10.2.



LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 925.1	
Sketch: 925.12-1, Misc. Waste Solution Discard Station	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.13 - Slop Tanks 1-D-21 A & B

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925.13 Slop Tanks 1-D-21 A & B (Dwg. Y-601)

1. General

These are stainless steel tanks filled with Raschig Rings and are located in the yard outside Bay XIX. Each tank has a 6'-6" diameter and a 5' height. They have 1200 gallon capacities which are reached to effective volumes of 800 gallons due to the Raschig Rings.

These tanks are used primarily for the storage of Ruffinates.

2. Nuclear Safety

Nuclear safety is provided by maintaing a safe concentration of 5 grams U-235 or less per liter of solution. Secondary or backup protection is afforded by the Raschig Rings.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.14 - Extractor Feed Tank 1-D-41

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925.14 Extractor Feed Tank 1-D-41

1. General

This is a stainless steel tank filled with Raschig Rings and is located in Bay XVI. The tank has a 6'-6" diameter and a 7' height. It has a 1500 gallon capacity which is reduced to an effective volume of 1000 gallons due to the Raschig Rings.

This tank is used primarily for pickle liquor but may be used as an alternate raffinate storage tank.

2. Nuclear Safety

Nuclear Safety is provided by maintaining a safe concentration of 5 grams U-235 or less per liter of solution. Secondary or back up protection is provided by the Raschig Rings.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 925 - Purification
925.15 - Other Waste Streams

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

925 .15 Other Waste Streams

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

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.1 - General

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.1 General (Dwg. A-602, Bays XXI, XVIII, XVII, XV, XIV)

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.

926.2 OK Liquor Evaporation System

1. Process and Equipment

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 1-E-2. 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. Condenser 1-E-1 cools the vapors and the condensate flows to the Filtrate Tanks 1-D-24A and 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 Treatment Tanks 1-D-14 A 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 or 1-D-16 Tank for further processing or to the Extractor Feed Tanks 1-D-9A to F, each of which is 5" diameter by 45' long for reprocessing.

2. Nuclear Safety

2.1 Evaporator 1-E-2

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 (1/2" VC) from top of 2 inch pyrex pipe leg prevents an inadvertent pressure build up.

2.2 Cyclone

The cyclone separator is 6" diameter with a straight side length of 12 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 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 (Pg. 13, TID-7016, Rev. 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

2.2 Cyclone (continued)

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 Subpart 923.4 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.

2.3 Entrainment Separator

The entrainment separator is a 5" I.D. de-entrainment separator (Anderson Hi F) used to remove any mists that may pass through the cyclone.

2.4 Flash Tank

The dimensions of the flash tank 3" diameter x 8" long.

2.5 Condenser 1-E-1

Condenser 1-E-1 is 4.987 inch inside diameter and thus geometrically safe.

2.6 Interaction

The maximum solid angle calculated for the evaporator system is less than 1 steradian.

3. Operating Controls

The following operating controls will be applied to the Evaporator:

3.1 In operation pressure on shell side exceeds tube side preventing any leak of uranium into shell side.

3.2 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 tubes in 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.

1. SIZE:- 5" ID x 45' STRAIGHT SIDE

2. CONTENTS:- ADJUSTED LIQUOR - URANIUM (AS NITRATE) AND DISSOLVED METALS AS IMPURITIES.

3. MATERIAL: SHELL 1/8" - TYPE 304L STAINLESS STEEL
HEADS 3/16" MIN. (FLAT) 304L STAINLESS STEEL

4. LOCATION: MTD. HORIZONTALLY 14'9" (MEAN) ABOVE BLDG. FLOOR - BETWEEN COL'S A-B & 4-7 SLOPE 6"

5. URANIUM CONCENTRATION: ANY gm/L.

6. NUCLEAR SAFETY:

a. AS INDIVIDUAL UNITS -

5" I.D. PROVIDES SAFE GEOMETRY FOR INFINITE LENGTH AT ANY CONCENTRATION AND FULLY REFLECTED.

WALL THICKNESS (1/8") AND LOCATION ABOVE ANY FLOOD CONDITION MEET CRITERIA FOR MINIMUM REFLECTOR

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.2
Interaction Calculations - Extract Feed Tanks 1-D-9
PAGE 1 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

6.-b. AS ISOLATED ARRAY

THESE TANKS DO NOT MEET THE REQUIREMENT OF PROPOSED 10CFR70 70.53 THROUGH 70.55. SO INTERACTION MUST BE BASED ON 70.52 (SOLID ANGLE CRITERIA)

PER 70.52 (b)(2) $\Omega_{MAX.TOTAL} = 9 - 10\ k$

" 70.52 (c)(2)(iii) $k = 0.58$ 5" ϕ CYL. ETC.

THEN $\Omega_{MAX} = 9 - 10(0.58) = 3.2$

PER 70.52 (d)(2)(vi) $\Omega = \frac{2d}{h} \sin\theta$

AND FOR CENTRAL UNITS $\Omega = 2\left(\frac{2d}{h}\sin\theta\right)$

$d = 5"$, $h = 30" - 2.5" = 27.5"$ $\sin\theta = 0.99486$

$$\Omega = 2\left(\frac{9.9486}{27.5}\right) = 0.7235$$

NOTE - THIS DOES NOT INCLUDE PIPE ASSOCIATED WITH THESE TANKS

FOR ½" OD GAUGE TUBE

$$\Omega = \frac{2d}{h_1}\sin\theta_1 + \frac{2d}{h_2}\sin\theta_2$$

$h_1 = 5.75"$
$\sin\theta_1 = .9998$
$h_2 = 23.75$

$$\Omega = \frac{.9998}{5.75} + \frac{.996}{23.75} = .174 + .216 = 0.39$$

$$\Omega_{TOTAL} = .7235 + .216 = 0.0395$$

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.2
Interaction Calculations - Extract Feed Tanks 1-D-9
PAGE 2 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

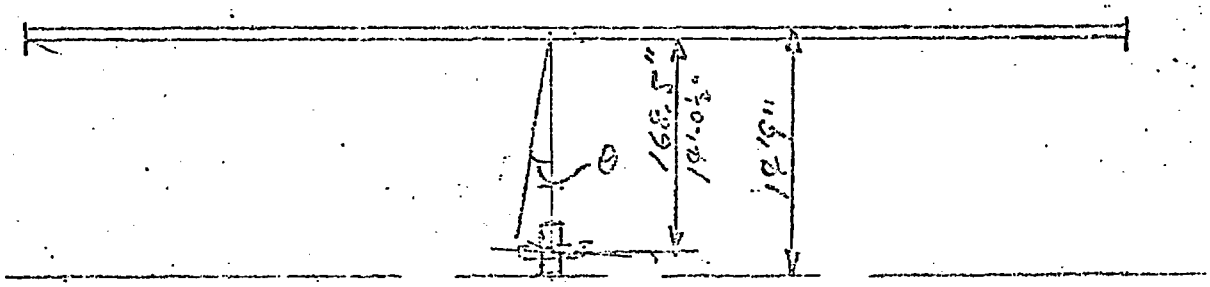
6.-C. INTERACTIONS WITH ADJACENT EQUIPMENT

PER 6-B $\Omega_{MAX\ TOTAL} = 3.2$

$\Omega_{AS\ ISOLATED\ ARRAY} = 0.9395$

THEN $\Omega_{EXTERNAL} = 3.2 - 0.9395 = 2.2605$

(1) WITH 5" DIA. x 14'5" STORAGE ON FLOOR BELOW.



AS CYL. $\Omega = \frac{2d}{h} \sin\theta$ $d = 5"$ $h = 168.5"$

$\sin\theta = \cancel{0.00834}\ 0.1409$

$\Omega_a = \frac{\cancel{1.409}\ 0.0053}{168.5} = \cancel{0.0052276}$

FOR 50 BOTTLES $\Omega_a = 50(\cancel{0.0052276}\ 0.0053) = \cancel{0.2638}\ 0.915$

OR AS DISC. $\Omega = 2\pi(1 - \cos\theta)$ $h = 153.5$

$d = 5"$ $R = 2.5"$

$\Omega_b = 2\pi(0.00013) = 0.00082$ $\cos\theta = 0.99987$

FOR 50 $50(0.0082) = 0.041 = \Omega_b$

$\Omega_a > \Omega_b$ USE Ω_a

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.2	
Interaction Calculations - Extract Feed Tanks 1-D-9	
PAGE 3 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

6-C-

(2) WITH BALL MILL 1-K-1

5 - SS JARS 5" ϕ x ~6" INSIDE = TOTAL 5"x36

$\Omega_2 = \frac{2d}{h} \sin\theta$, d=5" L=30, h=145

$\sin\theta = 0.10395$

$\Omega_2 = \frac{1.0395}{145} = 0.0072$

(3) WITH PULVERIZER 1-K-3

Assume $\Omega_3 = \Omega_2 = 0.0072$

(4) WITH SCALE 1-W-1 & CONTENTS OF HOOD 1-L-1 -

ASSUME - 3 - 5" ϕ X 12" CONTAINERS

$\Omega_4 = \frac{2d}{h} \sin\theta$ d=5", L=36" h=145

$\Omega_4 = \frac{1.24}{145} = \underline{0.0086}$ $\sin\theta = 0.124$

(5) WITH DEGREASER 1-D-22

$\Omega_5 = \frac{a\,b\cos\theta}{g^2}$ a=7", b=18" g=145"

$\cos\theta = 0.9688$

$\Omega_5 = \frac{7(18)\,0.9688)}{145^2} = 0.0058$

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.2	
Interaction Calculations - Extract Feed Tanks 1-D-3	
PAGE 4 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

6-C-

(6) WITH LIQUOR FEED TANK 1-D-21

$\Omega_6 = 2\pi(1-\cos\theta)$ $R = 39"$, $h = 118"$

$\cos\theta = 0.9995$

$\Omega = 2\pi(0.0505) = 0.317$

(7) WITH 1-K-4 (SAME AS 1-K-1

9/25/63 $\Omega_7 = \Omega_2 = 0.0072$

(8) WITH 1-H-8

$\Omega_8 = \frac{ab\cos\theta}{g^2}$ $a = 13$, $b = 13$

$g = 145"$

$\cos\theta = 0.9688$

9/20/ $\Omega_8 = \frac{13(13)(.9688)}{(145)^2} = \frac{162}{21025} = 0.0077$

9) TOTAL INTERACTION

9/20 $\Omega_9 = \Omega_1 + \Omega_2 + \ldots + \Omega_8 = 0.4587$

TOTAL INTERACTION INTERNAL & EXTERNAL FROM FIXED EQUIPMENT

9/20 $\Omega_T = 0.9395 + 0.4587 = 1.3982 < 3.2$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 926.2
Interaction Calculations-Extract Feed Tanks 1-D-9
PAGE 5 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

1. SIZE: 5" X 60'0" ST. SIDE

2. CONTENTS: - OK LIQUOR (URANIUM AS NITRATE)

3. MATERIALS: SHELL 1/8" STAINLESS
HEADS 3/16" MIN (FLAT) STAINLESS

4. LOCATION: MTD HORIZONTALLY 14'9" (MEAN)
ABOVE BLDG FLOOR - BETWEEN
COL'S. C-D & 5-8

5. URANIUM CONTENT: 25.8 gm/l

6. NUCLEAR SAFETY:

a. AS INDIVIDUAL UNITS -

5" Ø PROVIDES SAFE GEOMETRY INF. LENGTH
NO REFLECTOR PROVIDES SECONDARY
SAFEGUARD SEE 1-D-9

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liquor Storage Tanks, 1-D-10's
PAGE 1 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

6-b. AS ISOLATED ARRAY:

THESE TANKS DO NOT MEET THE REQUIREMENTS OF 70.53 → 70.55. INTERACTION MUST BE BASED ON 70.52 (SOLID ANGLE CRITERIA)

PER 70.52

$$\Omega_{MAX.\,TOTAL} = 9 - 10(0.58) = 3.2$$

FOR CENTRAL UNIT,

$$\Omega_i = 2\left(\frac{2d}{h}\sin\theta\right)$$

$d = 5''$, $h = 30'' - 2.5 = 27.5''$ $\sin\theta = .9998$

$$\Omega_i = 2\left(\frac{9.998}{27.5}\right) = 0.7254$$

NOTE:- Ω_i DOES NOT INCLUDE PIPE ASSOCIATED WITH THESE TANKS.

WITH ½" OD GAUGE TUBE

$$\Omega = \frac{2d}{h_1}\sin\theta_1 + \frac{2d}{h_2}\sin\theta_2$$

$d = .5$ $h_1 = 5.75$
$h_2 = 23.75$
$\sin\theta_1 = .99987$
$\sin\theta_2 = .9998$

$\Omega = 0.2165$

$$\Omega_{TOTAL} = 0.7254 + 0.216 = 0.9414$$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Li[illegible] uor Storage Tanks 1-D-40's
PAGE 2 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

6-C. INTERACTIONS WITH ADJACENT EQUIP.

PER 6 B $\Omega_{MAX\ TOTAL} = 3.2$

$\Omega_{EXTERNAL} = 3.2 - 0.7254 = 2.4746$

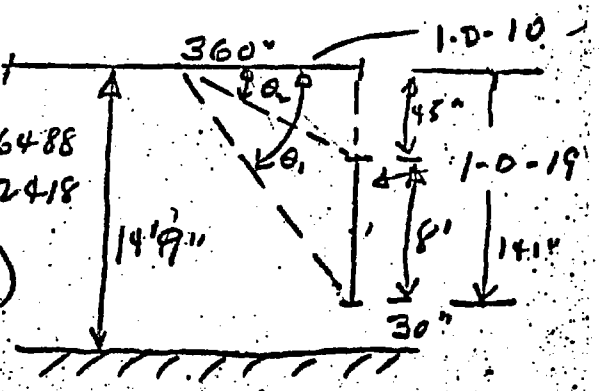
(1) WITH TANKS 1-D-24 A & B

$\Omega_1 = 2\pi(1 - \cos\theta)$ $\cos\theta = 0.97845$

$= 2\pi(0.02155) = 0.135$ EA. TANK

FOR 2 TANKS $\Omega_1 = 2(0.135) = 0.270$

(2) WITH 1-D-19 A, B, C,



$d = 4.25$ $\sin\theta_1 = 0.36488$

$h = 360$ $\sin\theta_2 = 0.12418$

$\Omega = \frac{d}{h}(\sin\theta_1 - \sin\theta_2)$

$\Omega = \frac{4.25}{360}(0.241)$

$= 0.00285$

FOR 3 TANKS $\Omega_2 = 0.0086$

OR SAY $h = 141$

THEN $\sin\theta_1 = 0.707$ $\sin\theta_2 = 0.304$

$\Omega = \frac{4.25}{141}(.403) = 0.0122$

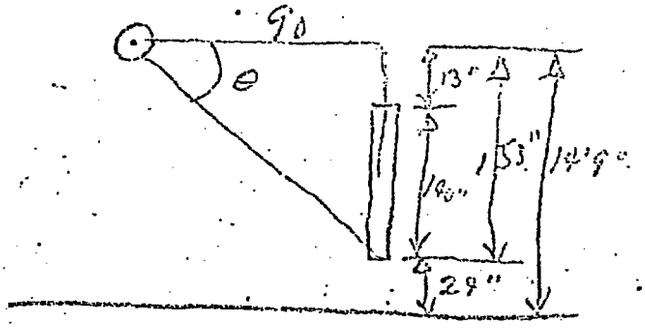
$\Omega_2 = 3(\Omega) = 0.0366$

USE THIS

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liquor Storage Tanks, 1-D-20's
PAGE 3 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

6-C

(3) WITH DISSOLVER 1-J-1



$d = 4"$ $L = 90"$

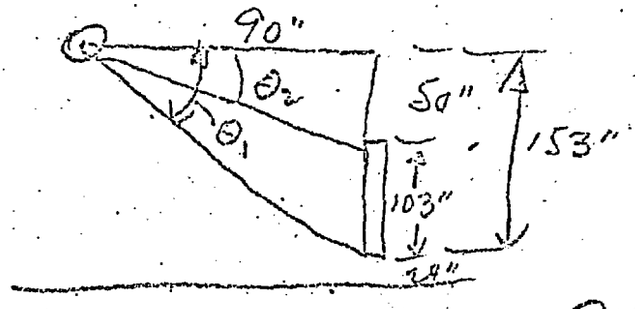
$\sin\theta = 0.862$

$\Omega = \frac{d}{L}\sin\theta$

$\Omega_3 = \frac{5}{90}(0.862)$

$= 0.0478$

(4) WITH DISSOLVER 1-J-4



$d = 5"$ $L = 90"$

$\sin\theta_1 = 0.862$

$\sin\theta_2 = 0.485$

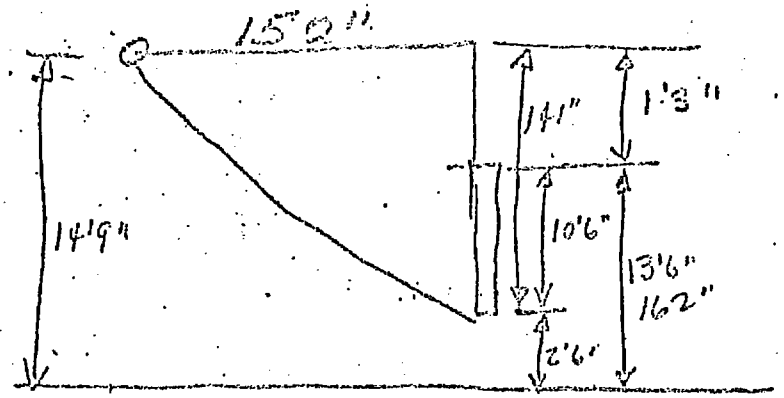
$\Omega_4 = \frac{d}{L}(\sin\theta_1 - \sin\theta_2)$

$\Omega_4 = \frac{5}{90}(0.377) = 0.0209$

LICENSE: SNM-777; DOCKET: 70-82(
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liqu Storage Tanks, 1-D-10's
PAGE 4 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

6-C

(5) WITH ASSAY TANK 1-D-34



$$\Omega_5 = \frac{d}{h} \sin\theta \qquad d = 5'' \quad h = 150''$$

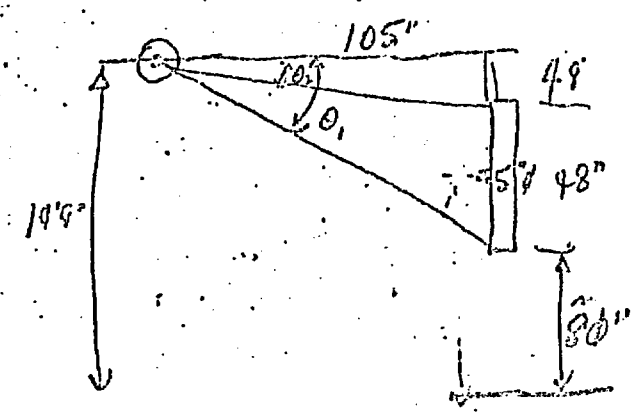
$$\sin\theta = 0.685$$

$$\Omega_5 = \frac{3.425}{150} = 0.0283$$

(6) WITH 1-E-2

$$\Omega_6 \cong \tfrac{2}{3}\,\Omega_2 = 0.0244$$

(7) WITH 1-R-2 AT 1-H-3,



$$\Omega = \frac{d}{h}(\sin\theta_1 - \sin\theta_2)$$

$d = 5''$, $h = 105''$

$\sin\theta_1 = 0.61516$

$\sin\theta_2 = 0.41575$

$$\Omega_7 = \frac{5}{105}(.20001)$$

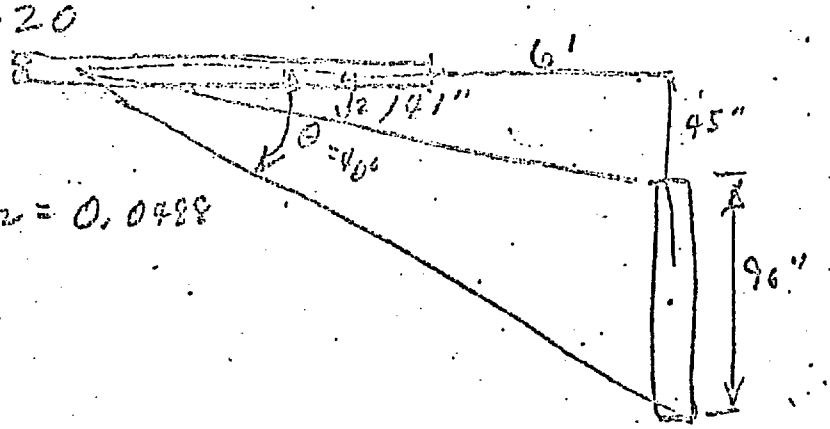
$\Omega_7 = 0.0095$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liquor Storage Tanks, 1-D-10's
PAGE 5 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

(8) WITH 1-R-2 AT 1-D-42

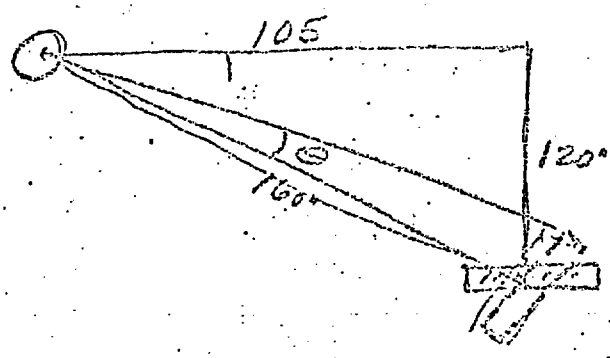
$\Omega_8 = \Omega_9 = 0.00954$

(9) WITH 1-D-20



$\Omega_9 = \frac{4}{3}\,\Omega_8 = 0.0488$

(10) WITH 1-F-4



$\Omega = 2\pi(1-\cos\theta)$

$d = 12'$ $h = 160''$

$\cos\theta = 0.9993$

$\Omega_{10} = 2\pi(0.0007)$

$\Omega_{10} = 0.0044$

(11) WITH 1-H-1

$\Omega_{11} = \Omega_{10} = 0.0044$

LICENSE: SNM-777; DOCKET: 70-[illegible]
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liq Storage Tanks, 1-D-20's
PAGE 6 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

(12) TOTAL INTERACTION WITH ADJ. EQUIP.

$\Omega_{d12} = \Omega_1 + \Omega_2 + \cdots + \Omega_n = 0.50968$

6-d TOTAL INTERACTION

$\Omega = \Omega_b + \Omega_{d12} = 0.9418 + 0.5087 = 1.4461$

$3.2 - 1.4461 = 1.7539$ AVAILABLE FOR INTERACTION WITH 1-L-18 & WITH TRANSIENT CHARGES.

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-OK Liquor Storage Tanks, 1-D-20's
PAGE 7 OF 7
APPROVED
ISSUED: OCTOBER 31, 1968

A. HEAT EXCHANGER SECTION - SHELL & TUBE EXCHANGER WITH EXPANSION JOINT IN THE SHELL, STEAM ON SHELL SIDE - OK LIQUOR ON TUBE SIDE. 5" DIAM. SHELL PROVIDES SAFE GEOMETRY EXCEPT AT THE EXPANSION JOINT

B. VERTICAL LEG (STAND PIPE - OPPOSITE HEAT EXCH). 3" DIAMETER - PROVIDES SAFE GEOMETRY

C. BOTTOM HORIZONTAL CROSS OVER PIPE 3" DIAMETER PIPE - PROVIDES SAFE GEOMETRY

D. TOP (VAPOR) HORIZONTAL CROSSOVER - 3" DIAMETER PIPE - PROVIDES SAFE GEOMETRY

E. CYCLONE -
6" DIAMETER - SAFE GEOMETRY FOR VAPOR & LIQUID CONTAINING <60 g/l ENTRAINED URANIUM

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-Liquor Evaporator 1-E-2
PAGE 1 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

F. VAPOR LINE TO ENTRAINMENT SEPARATOR. 3" PIPE - PROVIDES SAFE GEOMETRY

G. SEPARATOR

10" DIAMETER - SAFE GEOMETRY FOR CONCENTRATIONS TO < 60 g/l URANIUM.

H. SEPARATOR DRAIN LINE

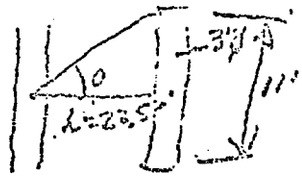
1½" DIAMETER - SAFE GEOMETRY

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 926.2
Interaction Calculations-Liquor Evaporator 1-E-2
PAGE 2 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

EVAPORATOR AS AN ISOLATED ARRAY

HEAT EXCHANGER $\Omega_A = 9-10(.58) = 3.2$

1. TO VERTICAL STAND PIPE



$$\Omega_1 = \frac{2d}{L} \sin\theta$$

$$\Omega_1 = \frac{2(3)}{22.5}(0.946) = 0.251$$

2. TO SEPARATOR DRAIN LINE

$$\Omega_2 = \frac{2d}{L} \sin\theta \qquad \sin\theta = \frac{66}{34}$$

$$\Omega_2 = \frac{2(1.5)}{34}(0.889) = 0.0785$$

3. TO BOTTOM CROSSOVER

$$\Omega_3 = \frac{d}{L} \sin\theta$$

$$\Omega = \frac{3}{66}(0.342) = 0.0156$$

4. $\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 = 0.2510 + 0.0785 + 0.0156$

$$\Omega_T = 0.3451 < 3.2$$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-Liquor Evaporator 1-E-2
PAGE 3 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

SEPARATOR DRAIN LINE

1. TO HEAT EXCH.

$$\Omega_1 = \frac{2d}{L} \sin\theta$$

$$\Omega_1 = \frac{2(5)}{34}(0.889) = 0.266$$

2. TO STAND PIPE

$$\Omega_2 = \frac{2d}{L} \sin\theta \qquad \tan\theta = 0.603$$

$$\Omega_2 = \frac{2(3)}{10.5}(0.988) = 0.571$$

3. TO BOTTOM CROSSOVER

$$\Omega_3 = \frac{d}{L} \sin\theta$$

$$\Omega_3 = \frac{3}{66}(0.342) = .0156$$

4. $\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 = 0.266 + 0.571 + 0.0156 = 0.7$

$$\Omega_T = 0.753 < 1$$

STAND PIPE

1. TO HEAT EXCHANGE

$$\Omega_1 = \frac{2d}{L} \sin\theta$$

$$\Omega_1 = \frac{2(5)}{34}(0.889) = 0.261$$

LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 926.2	
Interaction Calculations-Liquo Evaporator 1-E-2	
PAGE 4 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

2. STAND PIPE TO SEPARATOR DRAIN

$$\Omega_2 = \frac{2(3)}{10.5}(.988) = 0.565$$

3. TO BOTTOM CROSS OVER

$$\Omega_3 = \frac{1(d)}{h} \sin\theta$$

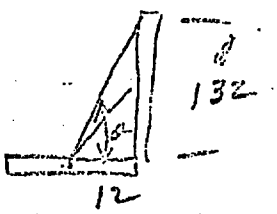
$$\Omega_3 = \frac{3}{66}(0.342) = 0.0156$$

4. $\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 = 0.261 + 0.565 + 0.0156 = 0.8$

$\Omega_T = 0.842 < 1$ $\quad$ [illegible] $= 1.03$ OK

CROSS-OVER (BOTTOM)

1. TO HEAT EXCHANGER



$$\Omega_1 = \frac{d}{h} \sin\theta$$

$$\Omega_1 = \frac{5}{12}(0.996) = 0.416$$

2. TO VERTICAL STAND PIPE

$$\Omega_2 = \frac{d}{h} \sin\theta$$

$$\Omega_2 = \frac{3}{12}(0.996) = 0.249$$

3. TO SEPARATOR DRAIN

$$\Omega_2 = \frac{d}{h} \sin\theta$$

$$\Omega_2 = \frac{1.5}{17}(0.992) = 0.0875$$

4. $\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 = 0.916$

[illegible] < 1

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.2
Interaction Calculations-Liquo Evaporator 1-E-2
PAGE 5 OF 5
APPROVED
ISSUED: OCTOBER 31, 1968

926.3 Filtrate Tanks 1-D-24 A 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 Subpart 926 .4. 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 Tanks 1-D-14:

3.1 Equipment Elevation (Reference Dwg. A-905)

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-24 A and B and 1-D-14A and B are vented. Therefore, transfer by siphon action from 1-D-24 A and B to 1-D-14 A and B is impossible.

Also, maximum elevation of lines feeding Tanks 1-D-10 A, B, and C is 86'-3". Elevation of Tanks 1-D-10 A, B, and C and vent from 1-D-10 A, 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.

3.2 Operating Controls (Reference Dwg. A-905)

a) 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.

b) Transfer out of 1-D-24A and B requires supervisory approval which is based on uranium analysis of their content.

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

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.4 - ADU Precipitators 1-D-19 A,B & C and 1-D-20 A,B,C & D

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.4 ADU Precipitators 1-D-19 A,B & C and 1-D-20 A,B,C & D

Feed for the precipitators is transferred from the OK Liquor Storage Tanks 1-D-10 A, B, and C, and the 1-D-16 as concentrated solution. A predetermined amount of solution is fed to the precipitators, three 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 filtered through a Buchner Filter. The filter cake is washed with distilled water which has been added to the precipitator and treated with anhydrous ammonia.

These precipitators have 5" diameters and the 1-D-19's are 5' long and the 1-D-20's are 8' long.

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

PRECIPITATOR TANKS : 5" DIA. x 96" LONG

SAFE GEOMETRY FOR ANY CONCENTRATION

TANKS ON 2'-6" CENTERS.
ALLOWABLE SOLID ANGLE = 3.2 STERADIANS.

SOLID ANGLE SUBTENDED AT 1D20 BY :

1. 1D20A

$h = 27\frac{1}{2}''$ $\quad \frac{h}{a} = \frac{h}{d} = 5.5 \quad \frac{h}{b} = \frac{27.5}{96} = .286$
$d = 5''$

$\Omega_1 = .32$ STERADIANS.

2. 1B20C

$\Omega_2 = \Omega_1 = .32$ STERADIANS.

3. PUMP 1P5

$h = 3' = 36''$
$a = b = 12''$ ASSUMES A 12" DIA. PUMP CAVITY.
$\frac{h}{a} = 3 = \frac{h}{b}$

$\Omega_3 = .11$

4. FILTER 1F4 11" DIA. x $3\frac{1}{4}$"

$h = 10' = 120''$
$h/a = \frac{120}{11} = 10.9$

$\frac{h}{b} = \frac{120}{3.25} = 37$

$\Omega = \ll .005$

5. TOTAL $\Omega = .75$ STERADIANS

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.4	
Solid Angle Calculations - ADU Precipitator, 1-D-20's	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.5 - ADU Filtration and Drying Hood 1-L-11

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.5 ADU Filtration and Drying Hood 1-L-11

The Hood 1-L-11 contains the 1-K-1 Ball Mill. It maybe attached to a Drying Oven like the 1-H-1 which in turn maybe 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 drying oven is limited to one Buchner Filter at a time. The solid angle calculated at the Drying Oven 1-H-1 is less than .5 steradians.

When this hood is not being used for ADU filtration and drying, that equipment will be removed and the following operations may be performed:

a) Blending and packaging

b) Unloading as received containers.

c) Wet or dry ball milling and drying.

d) Loading and unloading muffle boxes.

Only one of these operations will be performed at a time.

The nuclear safety and equipment description for Hood 1-L-14 (Ref. Subpart 922.3) is applicable.

1. ADU FILTER 1-F-4

2. SIZE: 2-11" DIA x 1½ TRAYS
C: 11" DIA x 3.3" CAVITY

3. CONTENTS: ADU SLURRY FEED
ADU CAKE BUILDS UP ON FILTER

4. NUCLEAR SAFETY:

a) AS INDIVIDUAL UNIT: (FILTER)

1) FROM K-1019 (5TH EDIT) TABLE XV

11" ϕ (27.9 cm) CYL - SAFE HEIGHT = 3.7" (9.4 cm)
S.G. - 3.3" < 3.7"

2) FROM 10 CFR-70 TP 70.42(a) FIG 2
FROM FIG. 2
S.V. = 4.8 AT H/U ≅ 50
THEN FROM TP 70.43(a)(2)(ii), 70.43(d) & FIG. 16
~~FROM FIG.~~
AT H/D = .3 & THICK REFLECTOR ALL. FACT ≅ 1.25

THEN S.V. = 4.8 (1.25) = 6.0 liters

ACTUAL VOL = 5.14 l < 6.0 liters

b) FILTER CAKE AS INDIVIDUAL UNITS

1) SIZE = 11" ϕ x 1½" < 1½" SAFE SLAB.

2) FROM 4(a)(1) ABOVE SAFE GEOM. 1½" < 3.7"

3) FROM 4(a)(2) ABOVE SAFE VOL. < 6 liters.

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 926.5
Interaction Calculations - ADU Filter, 1-F-4 & 1-L-11
Page 1 of 3 pages
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

4. b. (4) FOR 2 CAKES SAME AS 4(a)
IE S.G., & S.V.

C. INTERACTIONS WITH ADJACENT EQUIPMENT

1. WITH 2 TRAYS IN 1-H-1
2 TOGETHER
TAKE AS 12"ϕ (ASSUMED) X 8" HIGH CYL.

$\Omega = \frac{2d}{h} \sin\theta$ $\quad d = 12 \quad h = 33"$

$\sin\theta = 0.1203$

$\Omega_1 = \frac{2.6872}{33} = 0.0815$

2. WITH 1-R-2 IN LOADING POSITION

$\Omega = \frac{d}{h} \sin\theta$ $\quad d = 5" \quad h = 51"$

$\sin\theta = 0.68539$

$\Omega_2 = \frac{3.4270}{51} = 0.0671$

3. WITH 1-D-16

$\Omega = \frac{2d}{h} \sin\theta$ $\quad d = 5" \quad h = 167"$

$\sin\theta = 0.8499$

$\Omega = \frac{8.495}{167} = 0.050$

4. WITH 1-D-10-C

$\Omega = \frac{2d}{h} \sin\theta$ $\quad d = 5" \quad h = 190"$

$\sin\theta = 0.8845$

$\Omega = \frac{8.845}{190} = 0.0465$

5) WITH 1-C-10 B

$\Omega_5 = \frac{2d}{h} \sin\theta$ $\quad d = 5 \quad h = 214$

$\sin\theta = 0.8597$

$\Omega_5 = \frac{8.597}{214} = 0.040$

6) WITH 1-C-10 A

$\Omega_6 = \frac{2d}{L} \sin\theta$ $\quad d = 5 \quad h = 240$

$\sin\theta = .8321$

$\Omega = \frac{8.321}{240} = 0.0397$

7.) WITH 1-D-20 D

$\Omega = \frac{2d}{h} \sin\theta$ $\quad d = 5'' \quad h = 117.5$

$\sin\theta = 0.3795$

$\Omega_7 = \frac{3.795}{117.5} = 0.0323$

8) WITH 1-D-20 C $\quad d = 5'' \quad h = 122.5$

$\sin\theta = 0.365$

$\Omega_8 = \frac{3.65}{122.5} = 0.0298$

9) WITH 1-D-20 B

$\Omega_9 = \frac{3.42}{132} = 0.0259$

10) WITH 1-D-20 A

$\Omega_{10} = \frac{3.082}{148} = 0.0208$

TOTAL INTERACTION

$\Omega_T = \Omega_1 + \Omega_2 + \ldots + \Omega_{10} = 0.4286 < 1$

ALLOWABLE $\Omega \leq 1$

LICENSE: SNM-777; DOCKET: 70-8
SECTION: 900, SUBPART: 926.5
Interaction Calculations - ADH Eilhar, 1-F-4 & 1-L-11
PAGE 3 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

1. DRYING OVEN 1-H-1

2. SIZE: 13 X 13 X 12" HIGH INSIDE

3. CONTENTS: 2 - FILTER CAKES 12" Ø (OD) X 1½" HIGH (WET ADU)

4. NUCLEAR SAFETY:

a) AS INDIVIDUAL UNIT:
LIMIT TO 2 CAKES IN FURNACE AT ONE TIME

1) SAFE GEOMETRY - 11" Ø X 3" (2 CAKES)

2) SAFE VOLUME — V < 6 liters

b) INTERACTIONS WITH ADJACENT EQUIPMENT

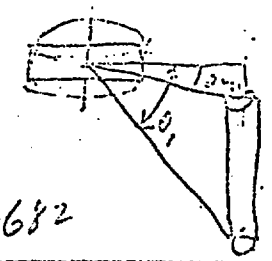
(1) ALLOWABLE $\Omega = 9 - .8(10) = 1.0$

2) WITH FILTER 1-F-4

SAME AS 1-F-4 - (4)(C)(1) $\Omega_2 = 0.0815$

3) WITH 1-R-2 IN GLOVE BOX 1-L-20

$\therefore \Omega = \frac{d}{h}(\sin\theta_1 - \sin\theta_2)$



$d = 5''$ $h = 12.5''$

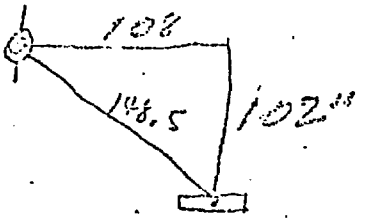
$\sin\theta_1 = .979$, $\sin\theta_2 = 0.682$

$\therefore \Omega = \frac{1.485}{12.5} = 0.119$

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.5
Interaction Calculations - Drying Oven 1-H-1
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968

4) WITH 1-D-16

$$\Omega = \frac{2d}{L} \sin\theta$$



$d = 5''$ $L = 146''$

$\sin\theta = 0.8798$

$$\Omega_4 = \frac{8.798}{146} = 0.0603$$

5) WITH 1-D-10-C

$$\Omega_5 = \frac{9.029}{169} = 0.0535$$

6) WITH 1-D 10.B

$$\Omega_6 = \frac{8.803}{194} = 0.0455$$

7) WITH 1-D 10 A

$$\Omega_7 = \frac{8.538}{220} = 0.0388$$

TOTAL $\Omega = \Omega_2 + \Omega_3 + \ldots + \Omega_7 = 0.3986$

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 926.5	
Interaction Calculations - Drying Oven 1-H-1	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

926.6 Reactor Loading Glove Box 1-L-20

After the ADU has been dried, a Buchner Filter or 1 gallon bottle of ADU maybe transferred one at a time to the Reactor Loading Glove Box 1-L-20. The dry ADU is placed into a funnel in the bottom of the glove box 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 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 try 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 three Filter loads. The solid angle subtended at the Reactor 1-R-2 is less than 3 steradians.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.7 - Reactor Furnace 1-H-3

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.7 Reactor Furnace 1-H-3

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. The nuclear safety of this equipment is based on the uranium being confined to the safe geometry (5" diameter reactor).

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOFERY OPERATION
Subsection: 920 - Processing
926 - End Product
926.8 - Reactor Cooler 1-D-42

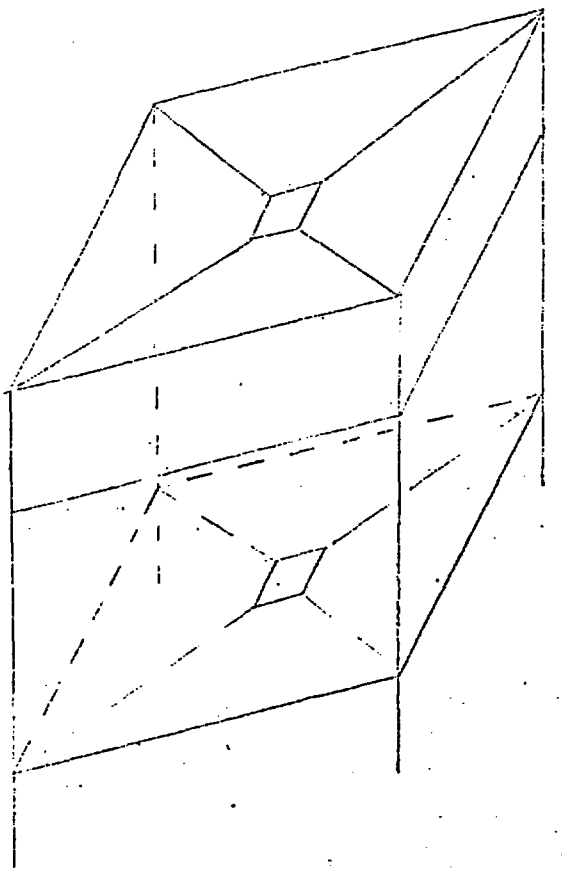
Approved

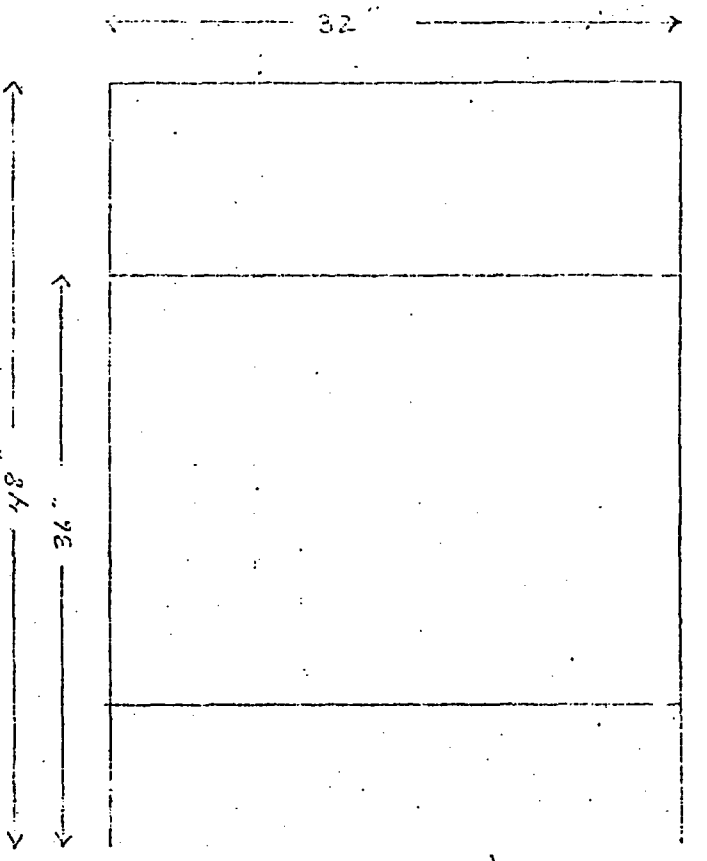
ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

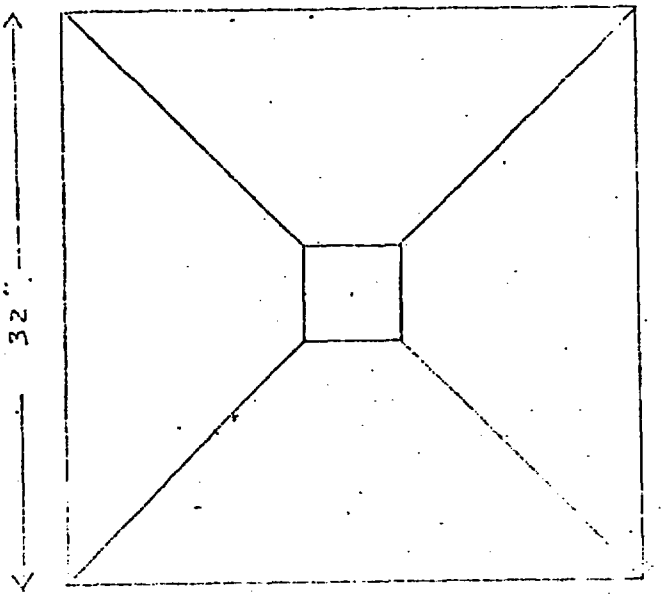
926.8 Reactor Cooler 1-D-42

Upon completion of the conversion cycle in the furnace, the reactor is removed and placed in the reactor cooler. This cooler is an angle iron frame rack 4 ' high x 32" square with bumpers located 36" and 12" off the floor to prevent the possibility of movable carts coming into contact with the Pyro Tube. Details of this equipment and its location are shown on Sketch 926.8-II. The nuclear safety of this equipment is based on the SNM being confined to the sage 5" diameter of the reactor.





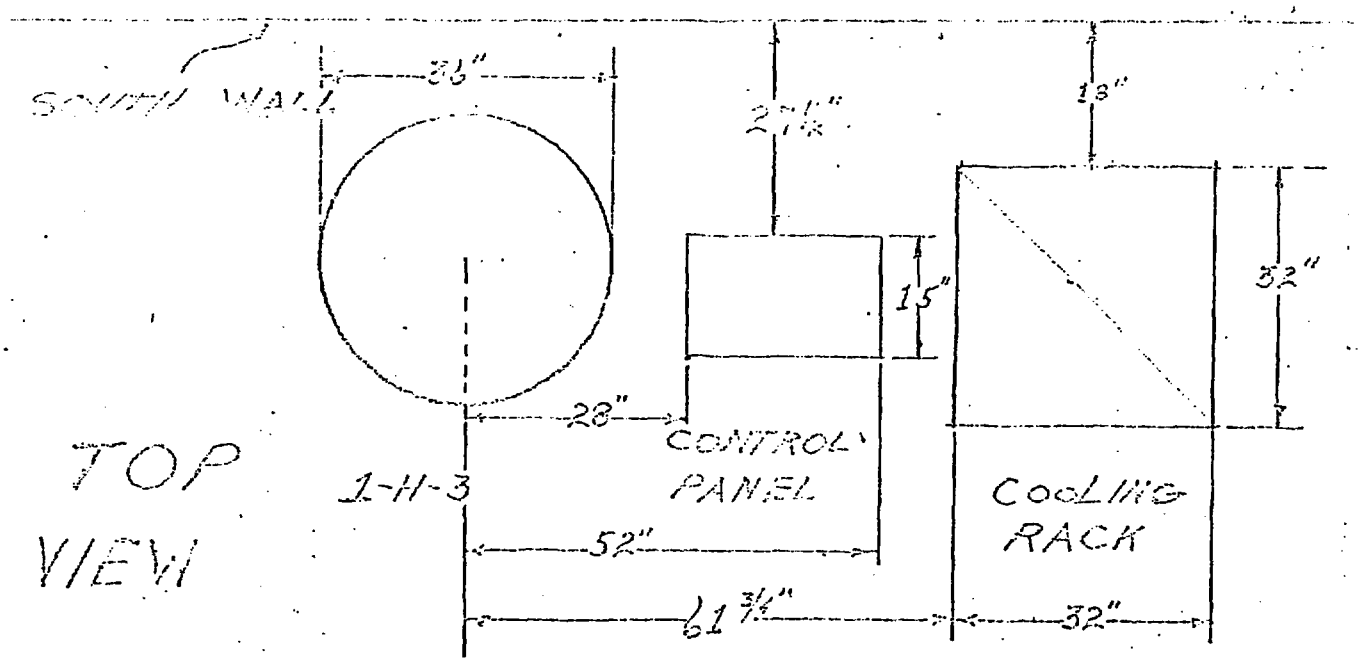
Front + Side view

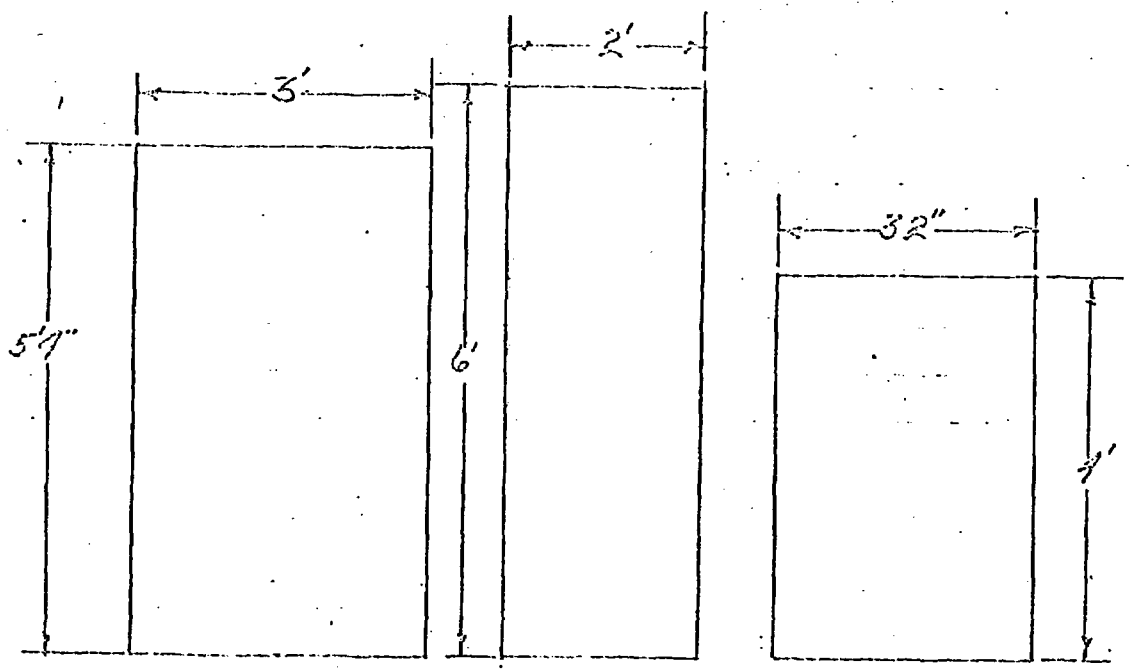


Top + bottom views

New angle iron frame to replace 1-D-42 Reactor Water Spray Cooler

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 926.8	
Sketch 926.8-I, New Cooling Rac for Pyro Tube	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	





FRONT VIEW 1-H-3 CONTROL PANEL COOLING RACK

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.8
Sketch 926.8-II, Replacement Rack for 1-D-42 Tank
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.9 - Reactor Unloading Hood 1-L-8

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.9 Reactor Unloading Hood 1-L-8

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 1-L-8, 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 1-K-2. 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.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.10 - Interim Product Weighing

Approved

ISSUED October 31, 1968

SUPERSEDES New

926.10 Interim Product Weighing

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.

926.11 Product Blending and Packaging

1. Blender Loading Hood 1-L-6

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 and 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.

2. Product Packaging and Blending Hood 1-L-14

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 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.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 920 - End Product
926.12 - ADU Precipitation and Filtration Tanks 1-D-19 A,B, & C

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.12 ADU Precipitation and Filtration Tanks 1-D-19 A, B, & C

These tanks are 4" in diameter by 8' long. They are located on 2' centers. Fuel for these precipitators is transferred from the OK Liquor Storage Tank 1-D-16 which is 5" diameter by 45' long or the OK Liquor Storage Tanks 1-D-10 A,B, and C, which are 5" diameter by 60' long.

A predetermined volume of solution is fed to the precipitators 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 may be 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.

An alternate method of disposing of the filtrate is to transfer the solution from the 1-D-19A,B, & C Filtrate Tanks to the 1-D-20 A, B, C, and D Precipitators. When the 1-D-20 A,B,C and Precipitators are full, the filtrate solution is disposed of through the waste treatment system (Subpart 925.10). If the filtrate solution is greater than 0.01 grams U-235 per liter, the solution is pumped up to the 1-D-16 on 1-D-10 A, B and C OK Liquor Storage Tanks and reprocessed through the 1-E-2 Evaporator.

THESE SOLID ANGLE CALCULATIONS WERE MADE ON THE OAK RIDGE GASEOUS DIFFUSION PLANT SOLID ANGLE SLIDE RULE.

A. SOLID ANGLE SUBTENDED AT THE MIDDLE 4"Ø X 10 BUECHNER FILTER FUNNEL BY:

1. THE OTHER TWO FILTER FUNNELS

$H = 19$ $H/A = 4.75$

$A = 4$ $H/B = 1.90$ $2\Omega = .216$

$B = 10$ $\Omega = .108$

2. ADU PRECIPITATION TANK, DIRECTLY ABOVE

$H = 19$ $H/A = 4.75$

$A = 4$ $H/B = 4.75$ $\Omega = .044$

$B = 4$ $\Omega = .044$

3. THE OTHER TWO ADU PRECIPITATION TANKS

$H = 70.5$ $H/A = 17.6$

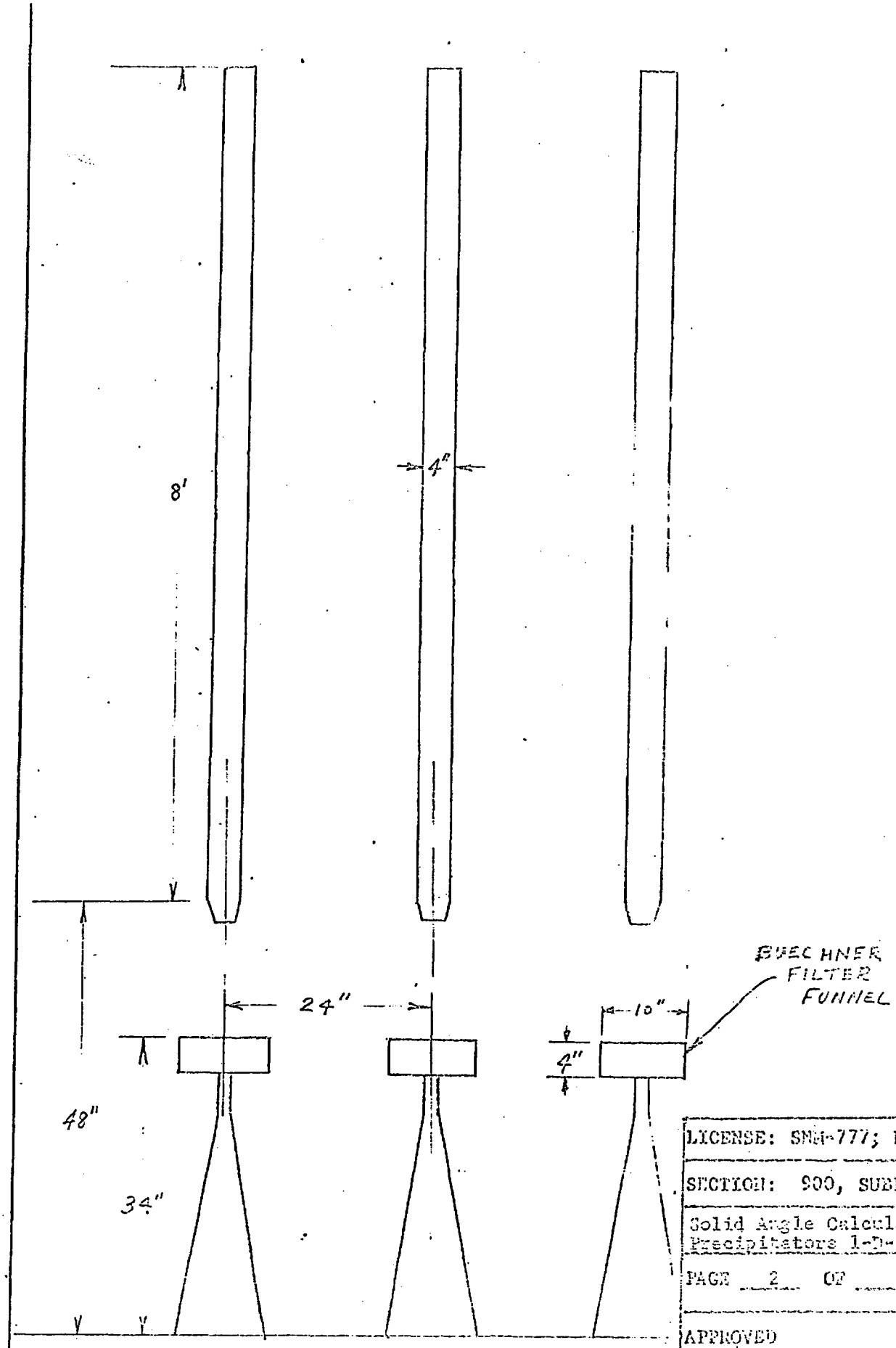
$A = 4$ $H/B = .734$ $2\Omega = .128$

$B = 96$ $\Omega = .064$

4. TOTAL SOLID ANGLE SUBTENDED AT THE MIDDLE BUECHNER FILTER.

$\Sigma\Omega = .388$

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.12	
Solid Angle Calculations - Precipitators 1-D-19 A, B, C	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	



LICENSE: SNM-777; DOCKET: 70-[illegible]	
SECTION: 900, SUBPART: 926.1[illegible]	
Solid Angle Calculations - Precipitators 1-D-19 A, B, C	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

PRECIPITATORS 1-D-19 A, B & C

1. SIZE 4" ~~3~~" ID X 8'0" LONG

2. CONTENTS: O.K. LIQUOR CHARGE - PRECIPITATED W/NH_3 TO ADU.

3. URANIUM CONTENT: MAX 120 gm/L.

4. NUCLEAR SAFETY:

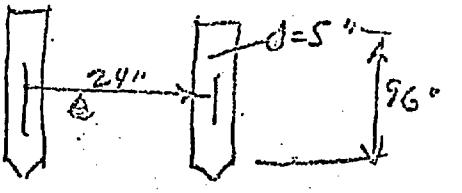
a) AS INDIVIDUAL UNITS

4" ~~3~~" ϕ PROVIDES SAFE GEOMETRY FOR INF. LENGTH.

ABSENCE OF REFLECTOR PROVIDES SECONDARY SAFEGUARD.

INTERACTION CALCULATED ON BASIS OF 5" DIAMETER

b) AS ISOLATED ARRAY



$$\Omega = \frac{2d}{h} \sin\theta$$

$d = 5"$ $h = 24 - 2\frac{1}{2} = 21.5"$

$\sin\theta = 0.9127$

$$\Omega = \frac{9.127}{21.5} = 0.9245$$

$$\Omega_b = 2(0.9245) = 0.849$$ (MOST CENTRAL UNIT 1-D-19B)

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.12	
Interaction Calculations - Precipitators 1-D-19 A, B, C	
PAGE 1 OF 3	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NIL	

4-C INTERACTIONS WITH ADJACENT EQUIPMENT

(1) 1-E-2

$$\Omega = \frac{2d_1}{h}(\sin\theta) + \frac{2d_2}{h}\sin\theta = (2d_1 + 2d_2)(\sin\theta/h)$$

$d_1 = 5"$, $d_2 = 3"$ $h = 69"$

$\sin\theta = .70711$

$$\Omega_{D1} = (10+6)\frac{.70711}{69} = 0.164$$

(2) WITH FILTERS 1-F-2

ASSUME 10"Ø x 4" FILTER DIRECTLY UNDER PRECIPITATOR — (REF. UNC "GEN. INFO. & PROCED. APPLICABLE TO ETC." EFFECTIVE JULY 15-1963" PAGE 20 OF 42)

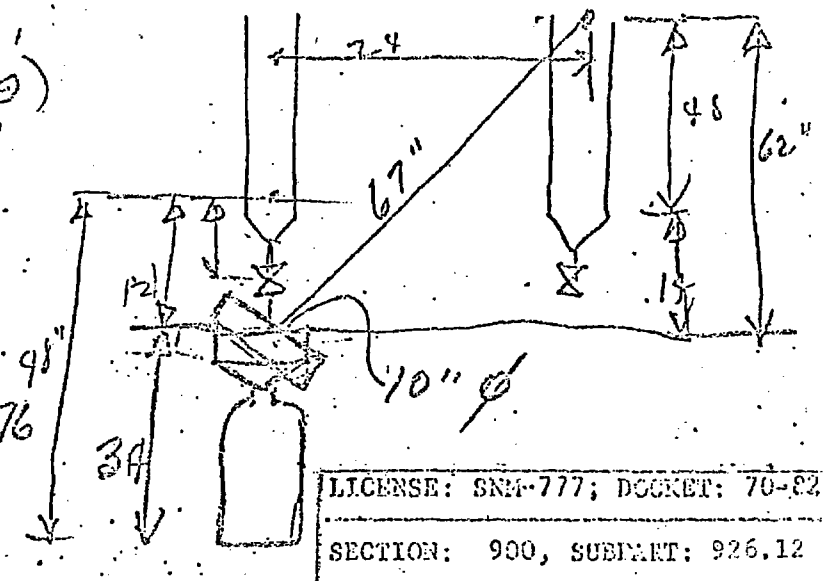
$$\Omega = 2\pi(1-\cos\theta)$$

$\cos\theta = 0.997$

$\Omega = 0.0188$

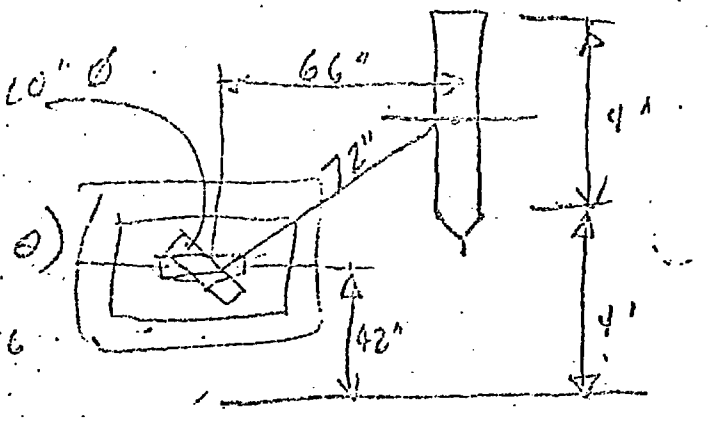
FOR 2 FILTERS

$\Omega = 2(0.018) = 0.0376$



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 926.12	
Interaction Calculations - Precipitators 1-D-19 A, B, C	
PAGE 2 OF 3	
APPROVED	
ISSUED: OCTOBER 31, 1968	

(3) WITH FILTER 1-F-2 IN 1-H-2!



$\Omega = 2\pi(1 - \cos\theta)$

$\cos\theta = 0.9976$

$\Omega_{c3} = 0.0151$

(4) TOTAL INTERACTION W/ADJ. EQUIP -

$\Omega_{c3} = 0.164 + 0.0376 + 0.0151 = 0.2167$

TOTAL INTERACTION —

$\Omega = 0.849 + 0.2167 \cong 1.066$

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.12	
Interaction Calculations - Precipitators 1-D-19 A, B, C	
PAGE 5 OF 5	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.13 ADN Drying and Unloading (Hoods 1-L-16 A,B&C & Drying Ovens 1-H-1,2 & 8)

Approved

ISSUED October 31, 1968

SUPERSEDES New

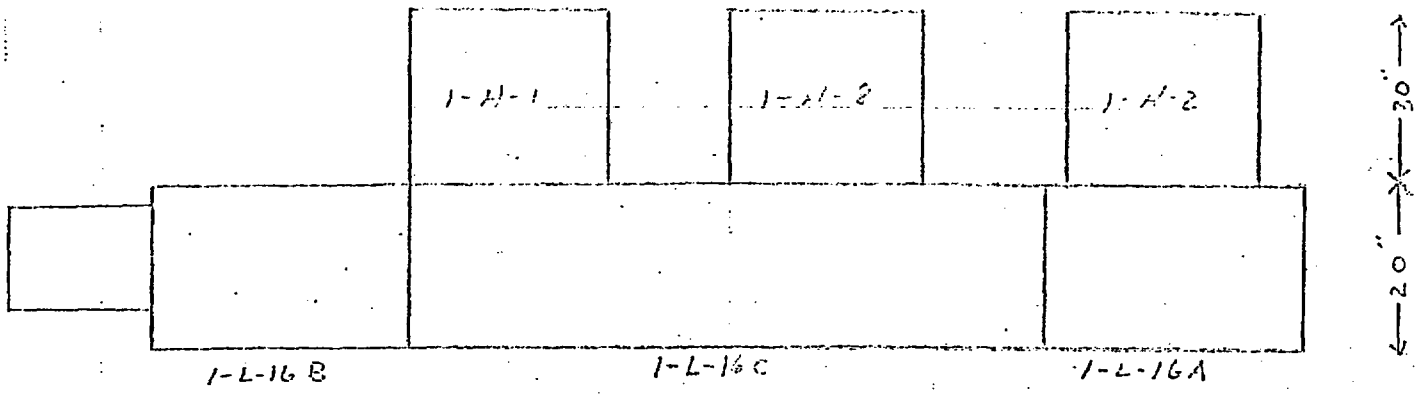
926.13 ADU Drying and Unloading (Hoods 1-L-16 A,B&C & Drying Ovens 1-H-1,2&8)

1. General

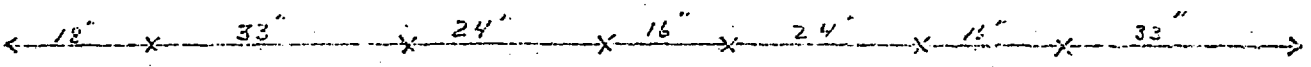
After filtration, the ADU cake (still on the Buchner Filter Funnel) is dried. This drying, and the subsequent unloading of the filter funnels, is performed in a work station formed by the 1-L-16 A,B & C Hoods with the 1-H-1, 1-H-2 and 1-H-8 Drying Ovens attached to the backs of these hoods. The Buchner Filter Funnels are introduced into the drying ovens through the open face front of the 1-L-16 A or C hoods. Dried ADU is scraped or placed in a funnel at the bottom of the glove box. This funnel directs the dried ADU into a 1 gallon bottle attached to the bottom of the glove box. Filled bottles of ADU are transferred to the Reactor Loading Glove Box 1-L-20 or to storage. Sketch 926.13-I shows the arrangement of the work station.

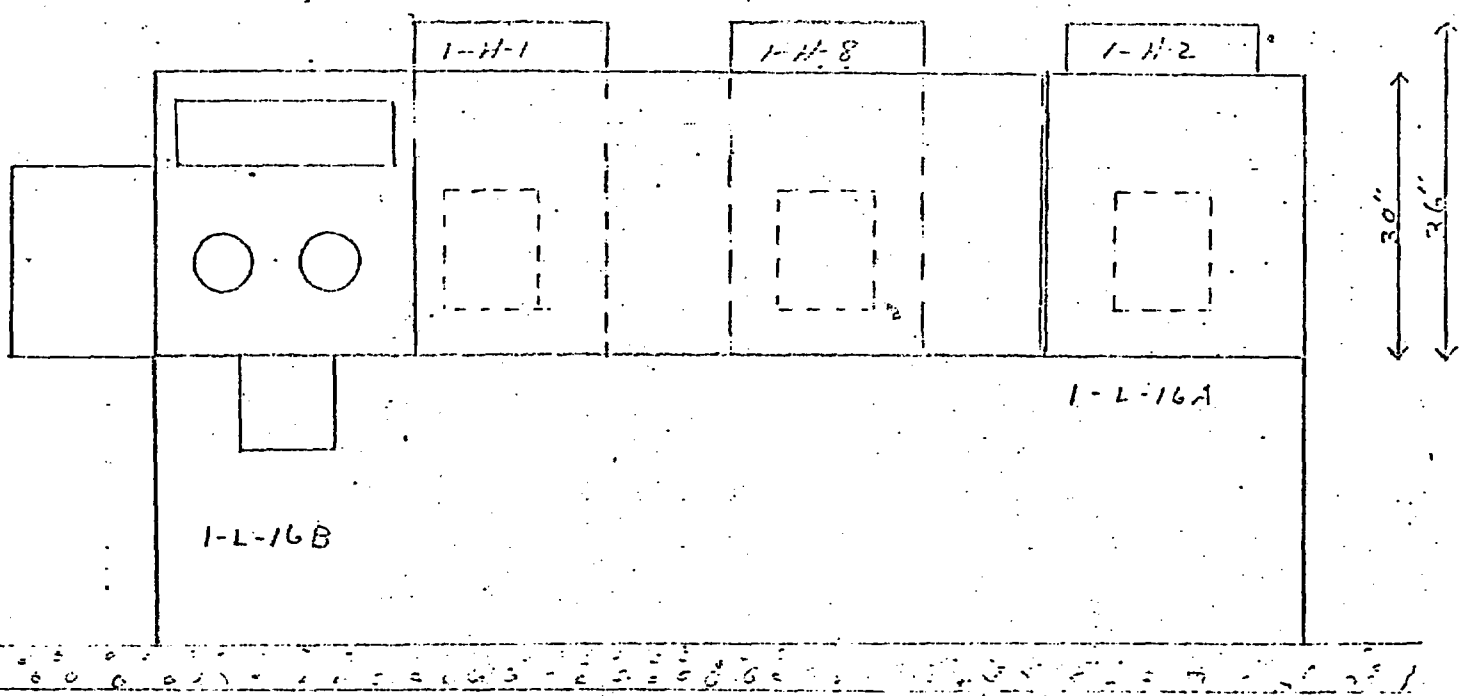
2. Nuclear Safety

Nuclear safety is provided by having the SNM in a bottle or funnel with a volume not exceeding 3.6 liters and limiting each bottle or funnel to 3.6 Kgs U-235 which is nuclearly safe as shown on modified Table IV, TID-7016, Rev. 1. Only one funnel may be in transit at any one time. Therefore there will be a maximum of 1 funnel in each of the drying ovens, 1 funnel in transit and one funnel and 1 bottle in the unloading hood. Individual funnels will be on 16" centers and the funnel and bottle in the 1-L-16B unloading hood are on 10" centers. Six funnels or bottles with this separation are nuclearly safe as shown on curve A, Fig. 22, TID-7016, Rev. 1.



Top View





FRONT VIEW

LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 926.13

Sketch: 926.13-I

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

calculated on Oak Ridge gaseous diffusion plant solid angle slide rule.

Solid Angle subtended from:

A. Center Buechner Filter Funnel by

1. Right Buechner Filter Funnel

$h_1 = 1.12$ $\quad h/a = \frac{1.12}{0.33} = 3.4$

$a = 0.33$ $\quad h/b = \frac{1.12}{0.835} = 1.3$ $\quad \Omega_1 = 0.21$

$b = 0.835$

2. Left Buechner Filter Funnel

$h_2 = 1.12$ $\quad h/a = \frac{1.12}{0.33} = 5.4$

$a = 0.33$ $\quad \Omega_2 = 0.21$

$b = 0.835$ $\quad h/b = \frac{1.12}{0.835} = 1.3$

3. Bottle Compartment

$h_3 = 2.19$ $\quad h/a = \frac{2.19}{0.50} = 4.4$

$a = 0.50$ $\quad h/b = \frac{2.19}{0.835} = 2.6$ $\quad \Omega_3 = .086$

$b = 0.835$

4. Muffle Box

$h_4 = 2.63$ $\quad h/a = \frac{2.63}{.75} = 3.5$

$a = 0.75$ $\quad h/b = \frac{2.63}{1.5} = 1.75$ $\quad \Omega_4 = 0.16$

$b = 1.50$

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 926.13
Solid Angle Calculations - Dryi & Loading Hood 1-L-16 A, B & C
PAGE 1 OF 3
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

5. Total Solid Angle Subtended

$\Omega_1 + \Omega_2 + \Omega_3 + \Omega_4 = 0.67$

ADDITIONAL SOLID ANGLE CONTRIBUTED BY 1-D-10 A, B, C & 1-D-16 = .13 STERADIANS. (REF. 1 H 2)

TOTAL = .80 STERADIANS.

B. Bottle Compartment by

1. Left Buechner Filter Funnel

$h_1 = 0.8$ $\quad h/a = \frac{0.8}{0.835} = 0.96$

$a = 0.835$ $\quad h/b = \frac{0.8}{.33} = 2.4$ $\quad \Omega_1 = 0.36$

$b = 0.33$

2. Center Buechner Filter Funnel

$h_2 = 2.25$ $\quad h/a = \frac{2.25}{.835} = 2.70$ $\quad \Omega_2 = 0.058$

$a = 0.835$

$b = 0.33$ $\quad h/b = \frac{2.25}{.33} = 6.82$

3. Right Buechner Filter Funnel

$h_3 = 3.6$ $\quad h/a = \frac{3.6}{0.835} = 4.3$ $\quad \Omega_3 = 0.021$

$a = 0.835$

$b = 0.33$ $\quad h/b = \frac{3.6}{0.33} = 10.9$

4. Muffle Box

$h_4 = 2.5$ $\quad h/a = \frac{2.5}{1.5} = 1.68$ $\quad \Omega_4 = 0.15$

$a = 1.50$

$b = 0.75$ $\quad h/b = \frac{2.5}{.75} = 3.34$

5. TOTAL SOLID ANGLE SUBTENDED

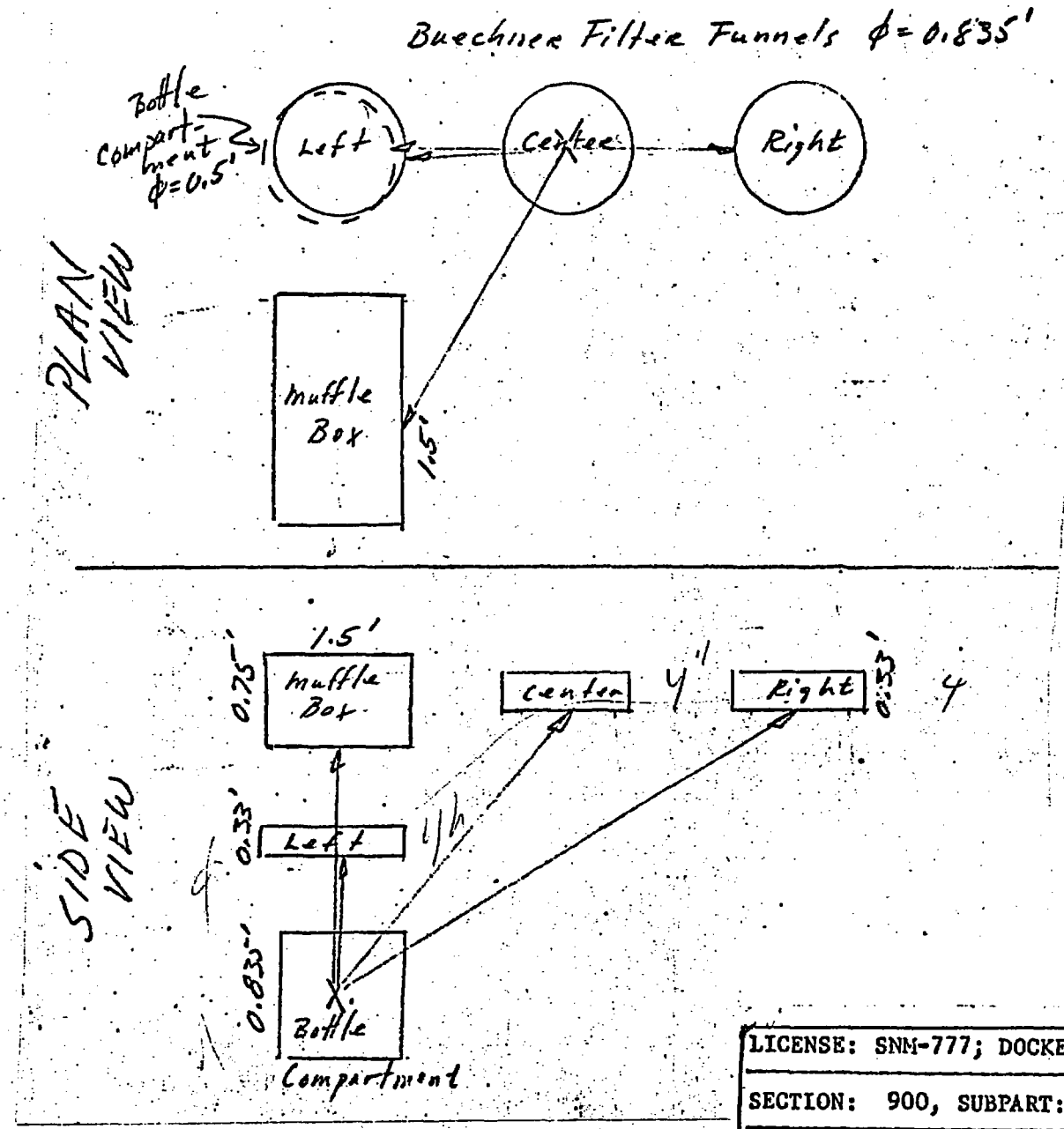
$\Omega_1 + \Omega_2 + \Omega_3 + \Omega_4 = 0.606$

ADDITIONAL SOLID ANGLE CONTRIBUTED BY 1-D-10 A, B, C & 1-D-16 = .13 STERADIANS (REF 1-H-2)

TOTAL = .74 STERADIANS

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 926.13	
Solid Angle Calculations - Dryi & Loading Hood 1-L-16 A, B & C	
PAGE 2 OF 3	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

Not to Scale



LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 926.13	
Solid Angle Calculations - Dry & Loading Hood 1-L-16 A, B & C	
PAGE 3 OF 3	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.14 - Muffle Boxes

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

926.14 Muffle Boxes.

The maximum dimensions of the muffle boxes are 9" x 9" x 20" long or 9" diameter x 20" long. No more than two trays, each no larger than 8 1/4" by 15 5/8" by 1 1/4", will be allowed in the boxes, 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" diamter circle.

b) A 6: diameter cylinder 19.6" long is "limited safe" (Page 23, Table XV, K-1019, Fifth Revision). The multiplication factor , K, for this cylinder is o.68 (Figure 4, K-1317).

926.15 Muffle Box Furnace 1-H-4, A & B

The muffle box furnaces are high temperature furnaces used for pyrohydrolysis of uranium bearing materials to a compound compatible with the solutions used in processing uranium. Also, the furnaces can be used to reduce the density of materials that have densities greater than 3.2 grams U-235/cc. A furnace will hold only one muffle box. The furnace arrangement is shown on Sketch 926.15-I.

The solid angle subtended at the muffle box in furnace 1-H-4 B is 0.82 steradians.

2) To 1-D-34 A, B & C

$\Omega = \frac{2d}{L} \sin\theta$ $\quad d = 5''$ $L = 37.5''$

$\Omega = \frac{8.695}{37.5} = 0.232$ $\quad \sin\theta = 0.695$

For 3 Tanks

$\Omega = 3(0.232) = 0.696$

3) Total $\Omega = 0.0544 + 0.696 = 0.755$

Plus .061 for Muffle Box in 1-H-4

∴ Total = .816

LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 926.15	
Interaction Calculations Muffle Furnace 1-H-4	
PAGE 2 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	

A INTERACTIONS 1-H-9A

1) TO 1-J-1 (6" LEG)

$\Omega = \frac{2d}{h} \sin\theta$ $d = 6''$, $h = 58''$, $\sin\theta = 0.707$

$\Omega = \frac{8.48}{58} = 0.146$

2) TO 1-H-6 ~~No Interaction – Limits No Use Since Decomposition~~ TIME

$\Omega = .061$

3) TO ASSAY TANKS 1-D-34 A, B, C

$\Omega = \frac{2d}{h} \sin\theta$ $d = 5''$, $h = 71.5''$, $\sin\theta = 0.6784$

$\Omega = \frac{6.784}{71.5} = 0.0946$

IF ALL THREE TANKS ARE FILLED AND AT THEIR CLOSEST POSITION

$\Omega \cong 3(0.0946) = 0.2838$

4) THEN TOTAL $\Omega = 0.146 + 0.2838 + .061 = .491$ ~~0.492~~

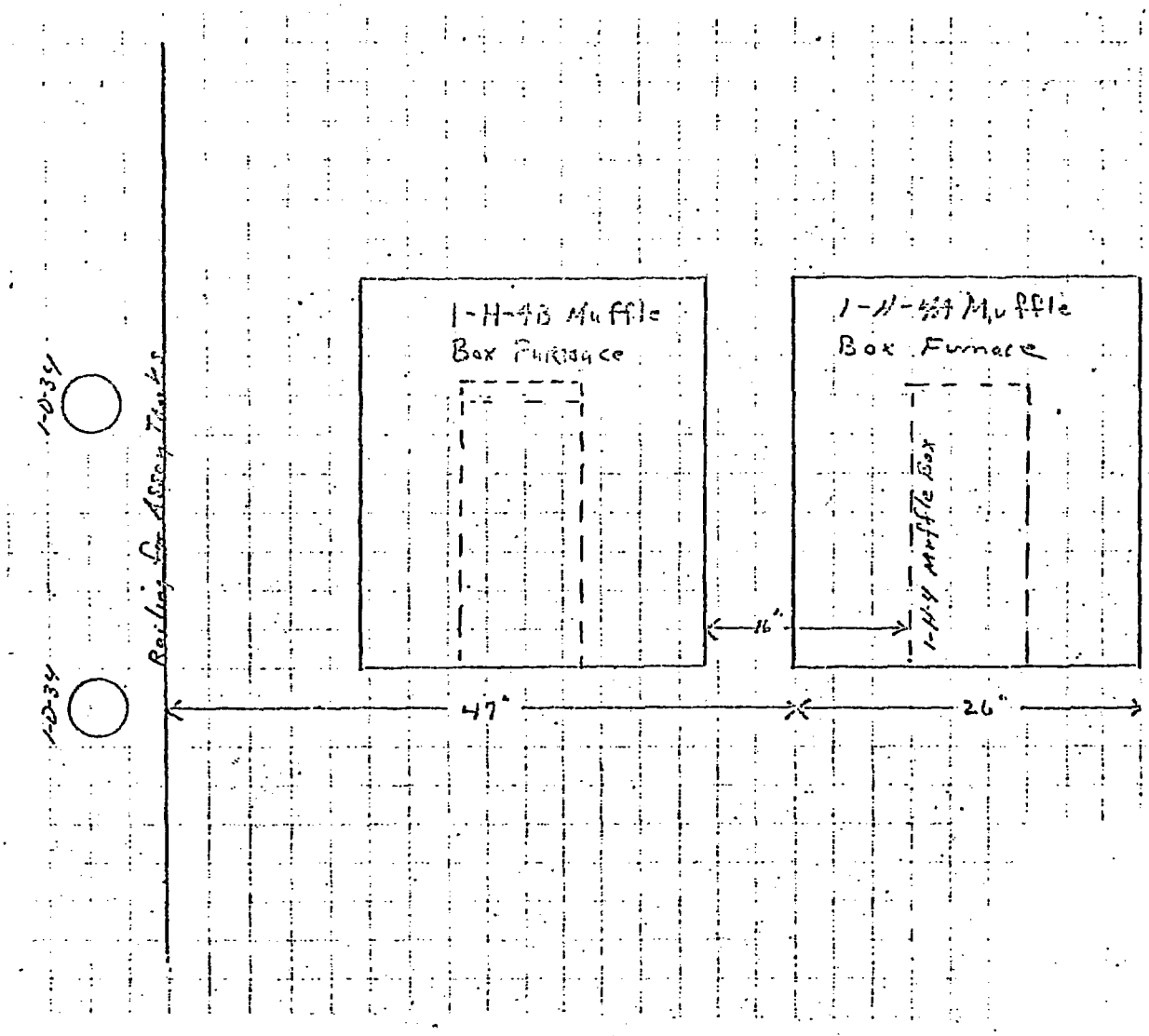
B INTERACTIONS 1-H-9B

1) TO 1-J-1 (6" LEG)

$\Omega = \frac{2d}{h} \sin\theta$ $d = 6''$ $h = 100''$, $\sin\theta = 0.995$

$\Omega = \frac{5.94}{100} = 0.0594$

LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.15	
Interaction Calculations Muffle Furnace 1-H-4	
PAGE 1 OF 2	
APPROVED	
ISSUED: OCTOBER 31, 1968	



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 926.15	
Sketch 926.15 - I, New 1-H-4 Muff Box Furnace	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 920 - Processing
Subpart: 926 - End Product
926.16 - Muffle Box Storage Rack

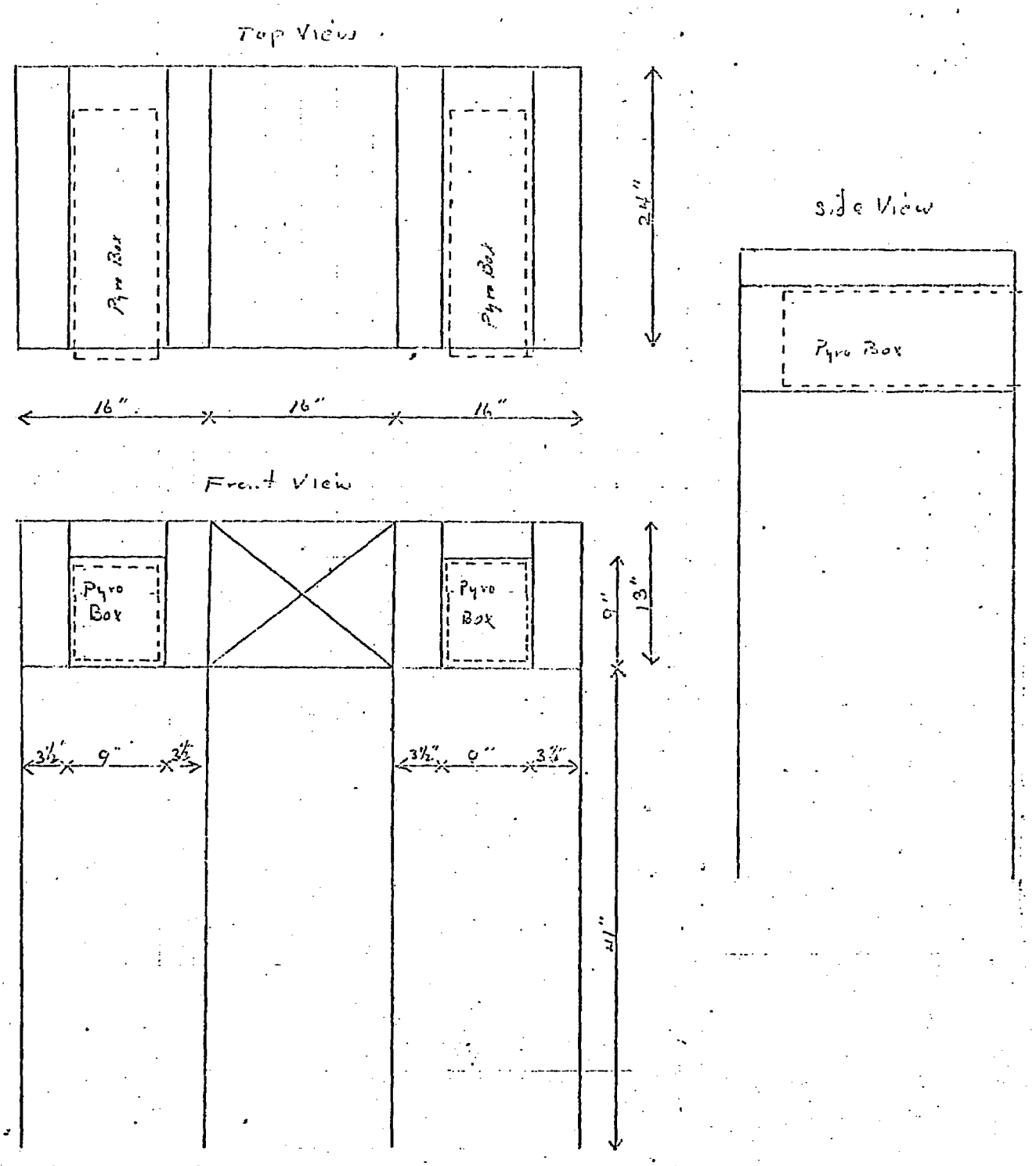
Approved

ISSUED OCTOBER 31, 1968

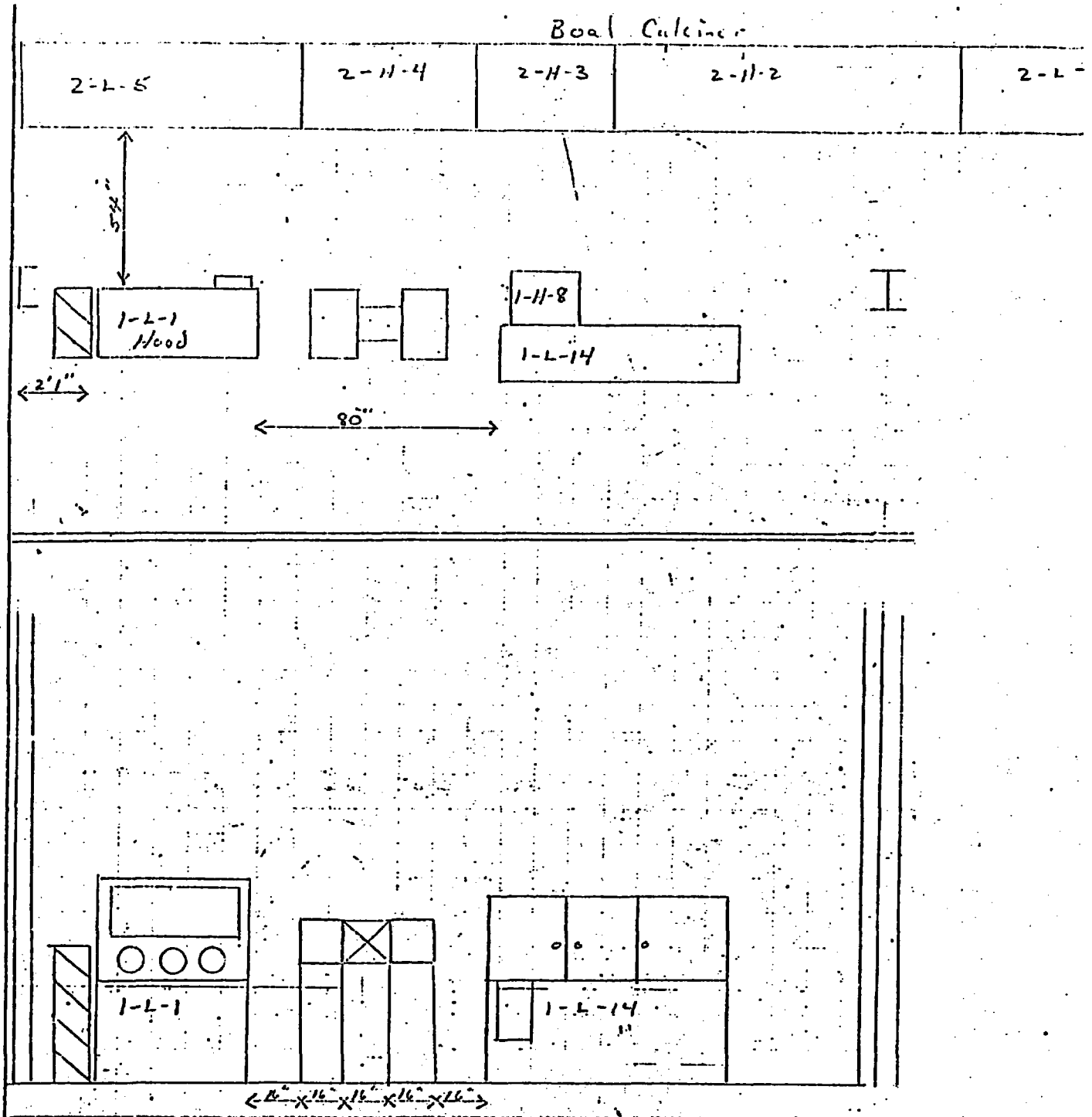
SUPERSEDES New

926.16 Muffle Box Storage Rack

Storage and cooling rack for the Muffle Box Furnace 1-H-4 Muffle Boxes are located between the Counting Glove Box 1-L-1 and the Milling and Drying Hood 1-L-19. The rack is located a minimum of 16" away from these hoods and 54" away from the Boat Calciner System. Details of this rack and its location are shown on Sketches 926.16-I and II.



LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 926.16
Sketch 926.16 - I, 1-H-4 Pyro B Cooling Rack
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NONE



LICENSE:	SNM-777
Docket:	70-820
SECTION: 900, Subpart: 926.15	
Sketch 926.16-II, 1-H-4 Pyro Box Cooling Stations	
Page 1 of 1	
APPROVED	
ISSUED: October 31, 1968	
SUPERSEDES: New	

SECTION 900 - RECOVERY OPERATION

Subection 930 - Support Activities

TABLE OF CONTENTS

Subpart 931 GENERAL CONSIDERATIONS

Subpart 932 LABORATORIES (Formerly 600)

932.1 General
932.2 Description
932.3 Equipment and Nuclear Safety

Subpart 933 CLEAN-UP EQUIPMENT

933.1 Vacuum Cleaner (Formerly 1201)
933.2 Mop Buckets (Formerly 1203)
933.3 Dry Solids Vacuum Collection System (Formerly 1204)
933.4 Decon Hood (New)
933.5 Vapor Demister Trap & Acid Vapor Neutralizer Tanks (New)

Subpart 934 NON-URANIUM BEARING EQUIPMENT

934.1 Remote Liquid Chemical Pumping Station (Formerly 1202)

Subpart 935 URANIUM BEARING EQUIPMENT

935.1 Charge Make-up Scale 1-W-1 (New)
935.2 Assay Tank Scale 2-W-1 (New)
935.3 Vacuum Removal System (New)

Subpart 936 LOW LEVEL COMBUSTIBLE WASTE INCINERATOR (Formerly 1205)

931. General Considerations

Certain equipment or processes are designed to support the process operations and their associated equipment. These support operations include, but are not limited to:

a) Laboratories

b) Clean-up equipment.

c) Non-uranium bearing support equipment.

These operations or pieces of equipment normally have little uranium associated with them, however, nuclear criticality safety and radiation protection are considered in their design and use.

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 930 - Support Activities
Subpart: 932 - Laboratories
932.1 - General

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

932.1 General

Only control laboratory operations will be performed in this lab. These consist of routine quality control tests. As such, the laboratory may handle materials up to fully enriched. In addition, final product weighing may be performed on the laboratory scale.

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.

932.2 Description

Criticality control will be based on 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 and figures in Section 300.

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

LICENSE: SNM-777, Docket: 70-820
SECTION 900 - RECOVERY OPERATION
Subsection: 930 - Support Activities
Subpart: 932 - Laboratories
932.3 - Equipment and Nuclear Safety

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

932.3 Equipment and Nuclear Safety

Samples will be received in four ounce size containers and placed in the safe geometry storage rack. One gallon bottles are used to consolidate discard solutions.

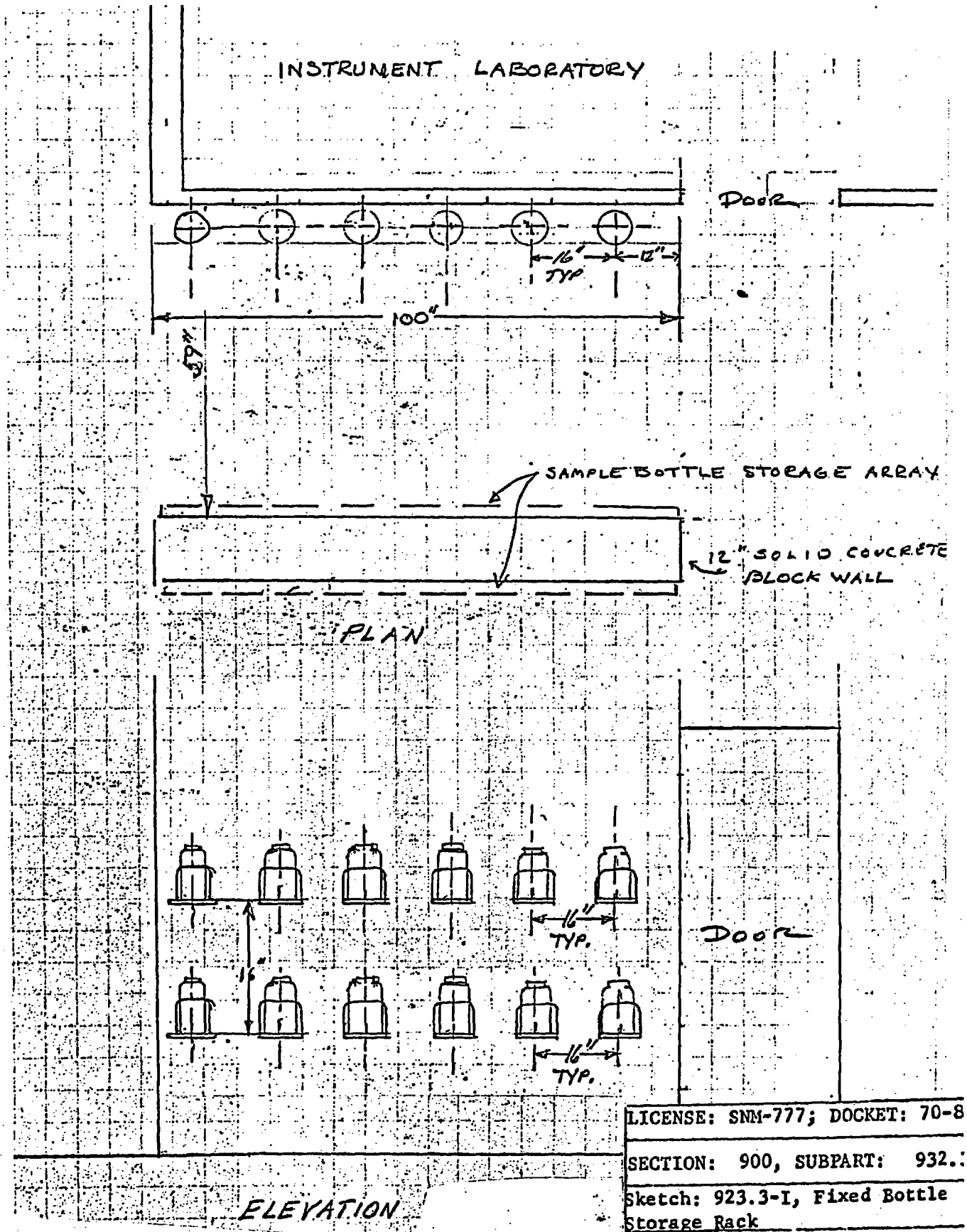
Criticality control away from the rack will be achieved by limiting (through logging control) the amount being worked on in the lab facilities to one limited safe mass amount (350 grams U-235) which is distributed throughout the laboratory.

The laboratory scale may be used for final product weighing. During this product weighing, one gallon bottles will be brought to the laboratory, weighed and returned to the process area or the receiving area one at a time.

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.

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.

Fixed bottle storage racks to accomodate up to 12 containers of 1 gallon size or less as shown on the attached Sketch 432.3-I Bottles will be in metal holders on 16 inch centers, 48 inches apart.



LICENSE: SNM-777; DOCKET: 70-8

SECTION: 900, SUBPART: 932.

Sketch: 923.3-I, Fixed Bottle Storage Rack

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

933.1 Vacuum Cleaner

1. Equipment Description

Dry materials such as residual ash in the DDU retort will be vacuumed from the source point to a safe volume container fastened under a 5" diameter cyclone mounted in a portable vacuum cleaner unit. Particulate fines which pass through the cyclone are collected on an 8" x 8" x 5" absolute type air filter. A manometer is provided to monitor the pressure drop across the filter and the cyclone. The vacuum producer is a commercial tank-type vacuum cleaner, approximately 7" wide at the widest point which is in the motor housing. The 3 ply filter bag which is used only in case of a rupture or leak in the absolute filter has a 2.7 ℓ volume. The vacuum cleaner and one gallon container are each separately housed on the portable frame. A steel outrigger bumper is fastened from the dolly at a 32" level above the floor and extends 10" from the outer perimeter of the dolly. The vacuum cleaner, mounted vertically, is spaced 30" on centers from the 1 gallon container and the cyclone. The 8" square filter is mounted between and 15" on centers from the cyclone.

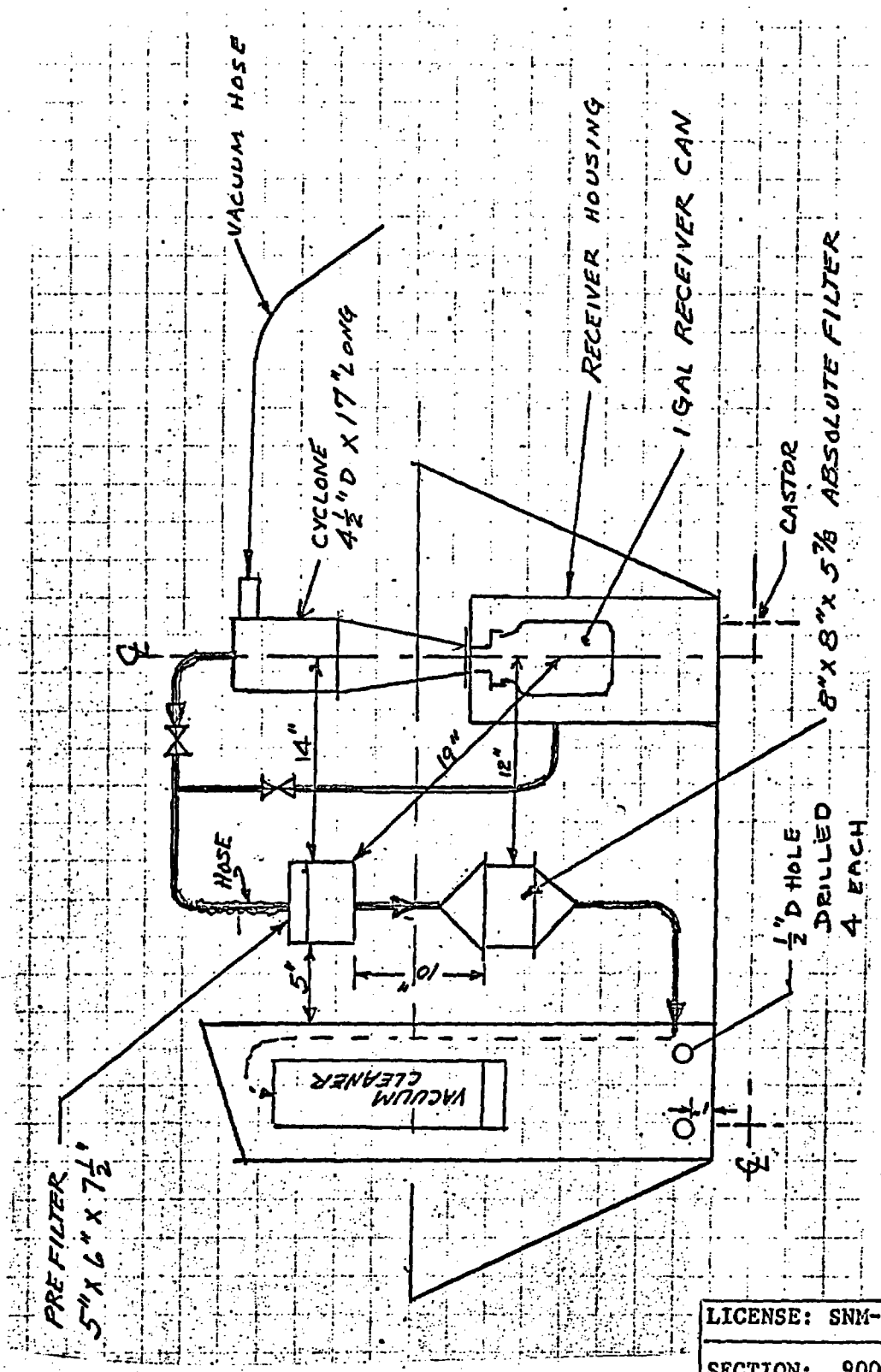
2. Nuclear Safety Considerations

Each unit in the portable vacuum cleaner is dimensionally safe.

Interaction between units on the cart, considering the cyclone and receiver as the most reactive unit and for interaction calculations as a 6" diameter cylinder the total solid angle is:

due to filter	0.895
due to vacuum cleaner=	0.1922
	1.087 steradians

The outrigger framework on the cart assures a 19" minimum center-to-center spacing from adjacent equipment. The computed solid angle between the cyclone and receiver on the cart and an adjacent 5" diameter 42" long cylinder of uranium solution is 0.571 steradians.



LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900, SUBPART: 933.1
Sketch: 923.1-I, Portable Vacuum Cleaner
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

933.2 Mop Buckets

1. Equipment

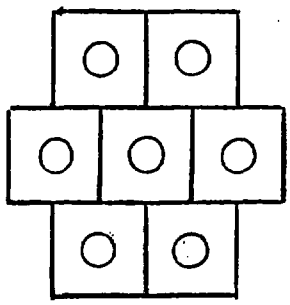
Modified standard commercial polyethylene or stainless steel mop buckets will be used in conjunction with commercial mop ringer dollies, for general floor cleaning in the process areas. These clean-up solutions will normally contain less than 1 gm uranium per liter. These mop buckets will be modified by drilling four 1/2" holes in them at the 7 liter (approximately 2.5 gallon) level. Physical barriers will be added to the dollies to maintain at least two (2) foot center-to-center separation from other uranium bearing equipment.

These buckets will be used for clean-up operations only. No process solutions will be allowed in them. Mop buckets will be stored outside the process areas when not in use.

2. Nuclear Safety

From Figure 2, TID-7016, Rev. 1, a 7 liter solution system is nuclearly safe if nominally reflected. The solid angle subtended by a mop bucket will be less than 1.0 steradians. However, only two (2) mop buckets may be in the process area at any one time.

CASE 1 - SEVEN MOP BUCKETS



A. Assumptions

1. For ease of analysis, assume all 6 buckets on 24" centers

2. Assume volume is cylindrical with height = diameter

$$V = 7000 \text{ cc} = \pi \frac{d^2}{4} h = \pi \frac{d^3}{4} = 0.785\, d^3$$

$$d = \sqrt[3]{\frac{7000}{0.785}} = \sqrt[3]{8{,}917} = 20.8 \text{ cm} = 8.15 \text{ in}$$

B. Calculations

$$d = 8.15 \text{ in},\ h = 24'' - \frac{8.15''}{2} = 24'' - 4.08'' = 19.92'',\ L = d = 8.15'',\ L/2 = 4.08''$$

$$\Omega_1 = \frac{2d}{h} \sin\theta \qquad \text{where} \quad \tan\theta = \frac{1/2\ L}{h} = \frac{4.08}{19.92} = 0.205 \qquad \sin\theta = 0.197$$

$$= \frac{16.3}{19.92}(0.197) = 0.818 \times 0.197 = 0.161$$

$$\Omega \text{ (Total)} = 6 \times \Omega_1 = 0.966 \text{ steradians}$$

C. Allowable Interaction

For a bare mop bucket with H/D = 1, From Fig. 3, TID-7028,

$$\lambda = 2.25 \text{ cm}$$

From A.2 above

$$r = 10.4 \text{ cm},\ h = 20.8 \text{ cm}$$

$$B_g^2 = \frac{J_o^2}{(r+\lambda)^2} + \frac{\pi^2}{(h+2\lambda)^2} = \frac{5.8}{(10.4+2.25)^2} + \frac{9.8}{(20.8+4.5)^2} = \frac{5.8}{(12.65)^2} +$$

$$\frac{9.8}{(25.3)^2} = \frac{5.8}{160} + \frac{9.8}{640} = 0.0363 + 0.0153 = 0.0516 \text{ cm}^{-2}$$

Assume $M^2 = 32 \text{ cm}^2$ and $k\infty = 2.06$

$$K_{eff} = \frac{k\infty}{1 + M^2 B^2} = \frac{2.06}{1 + (32 \times 0.0516)} = \frac{2.06}{1 + 1.651} = \frac{2.06}{2.651} = 0.784$$

$$\Omega \text{ (allowable)} = 9 - 10\,K = 1.16 \text{ steradians}$$

D. Conclusions

Seven (7) mop buckets are nuclearly safe. However, only two (2) mop buckets will be allowed in the process area.

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 933.2
Interaction Calculations - Mop Buckets
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

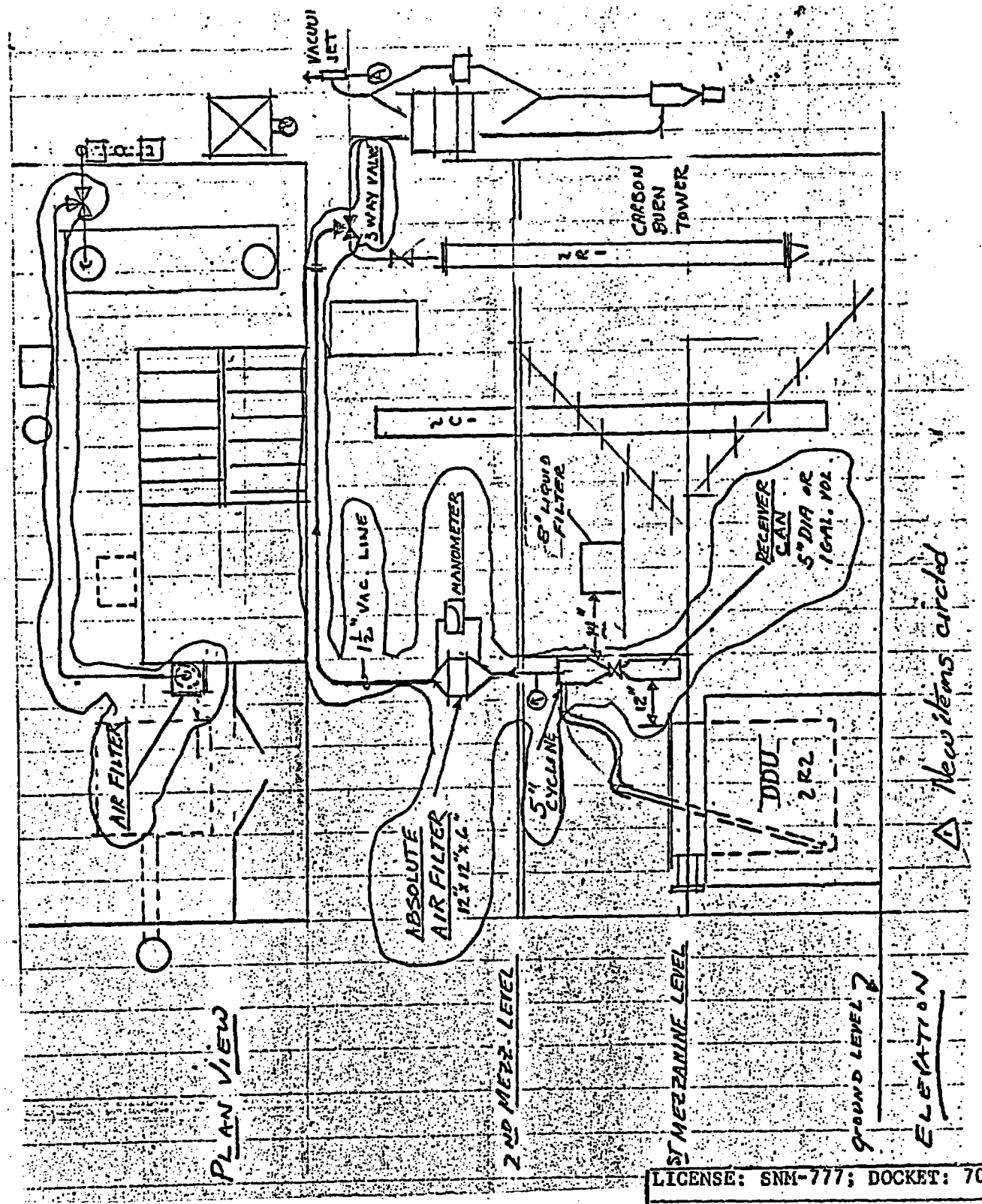
933.3 Dry Solids Vacuum Collection System

1. Equipment

This equipment consists of a 2" ID (max) hose connected to a 5" ID cyclone with a 5" ID or 1-gallon process container mounted underneath as a receiver for the solid. The exhaust will be through a 4" dia. line with a porous metal filter in it, then through an absolute filter to a 1-1/2" vacuum line to the 2-R-1 Oxygen Tower exhaust system. Details of the equipment are shown on Sketch 933 .3-I. The Oxygen Tower will not be operating when using this equipment.

2. Nuclear Safety

All equipment is equal to or less than 5" in diameter or 1-gallon in volume. It is separated from other uranium bearing equipment by at least 12" and the interaction is considered negligible.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 933.3	
Sketch: 933.3-I, Dry Vacuum System - DDU	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
Subsection: 930 - Support Activities
Subpart: 933 - Clean-up Equipment
933.4 - Decon Hood

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES New

933.4 Decon Hood

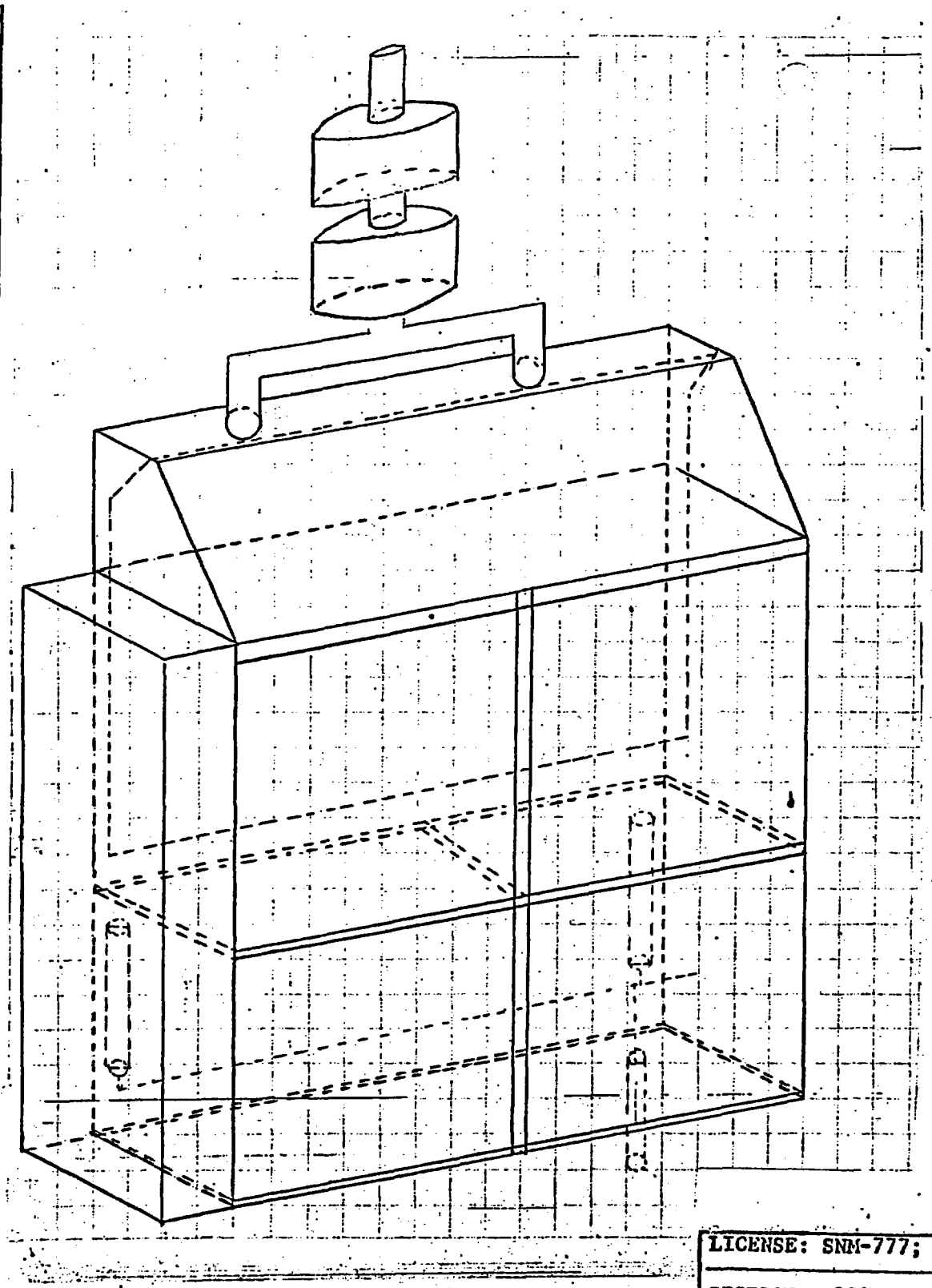
1. Description

A special hood is provided for the clean-up of equipment contaminated with SNM. This hood is approximately 8' wide X 8' high (10' overall) x 32" deep and is located in Bay XIX between the 1-D-12 Liquor Adjustment Tank and the solid concrete block wall. The sides and rear of the hood will be installed against solid concrete block walls. The hood will be constructed of stainless steel and plastic. The floor will be a 48" x 39" x 1" deep tray with a 5" diameter sump. The removable center trays will both be 24" x 30" x 1 1/2" deep with individual drains into 5" diameter pipes. These 5" diameter drains are connected to a pump that transfers the solution to the Waste Solution Discard Station (ref. Subpart 925.13). There are water and steam connections inside the hood which will be used for cleaning. The hood is vented through a duct into a 24" diameter Raschig ring chamber, a 24" diameter section, to an exhaust stack in the roof. A removable bottle is located at the rear of the hood for complete cleanout of the hood. The hood doors are constructed of stainless steel and/or plastic which are sectioned to maintain proper hood face velocity while cleaning. Details of this hood and its arrangement are shown on Sketches 933.4-I, II and III.

2. Nuclear Safety

The objects to be decontaminated in this hood will normally have insignificant amounts of SNM in or on them. If large, visuable amounts of SNM are on an object, it will be "dry" cleaned in another hood, such as the Dry Solids All Purpose Hood 2-L-3, prior to wet cleaning in this hood.

Nuclear safety is provided by the safe geometry of the clean-up equipment in the hood. The trays have a safe slab thickness of 1 1/2", the cleaning liquid drains to pipes with safe diameters of 5", and the sump is a safe 5" diameter. This hood is effectively isolated from surrounding equipment by 12" thich high density concrete block walls.



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 933.4

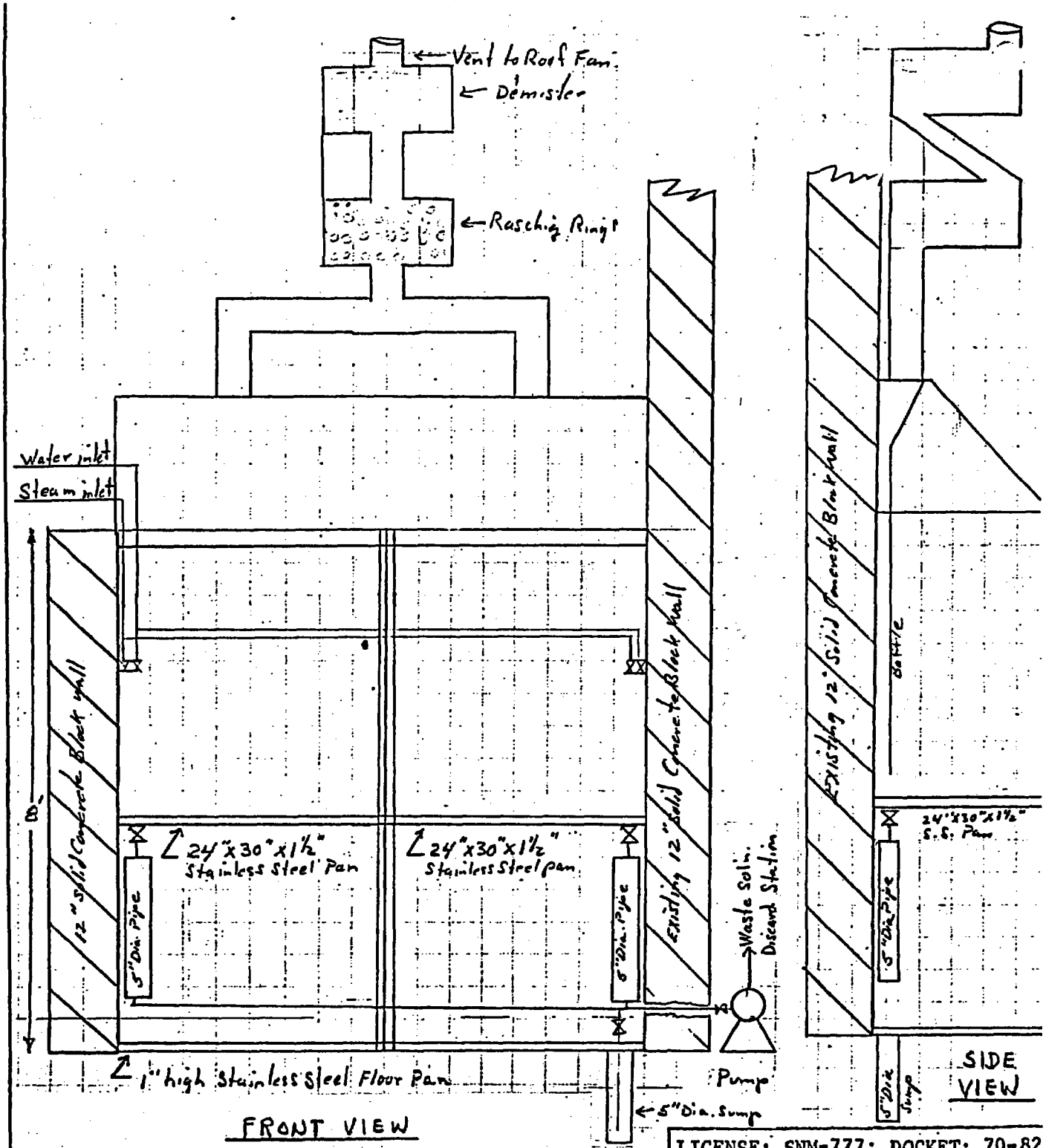
Sketch: 933.4-I, Decon Hood

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 933.4

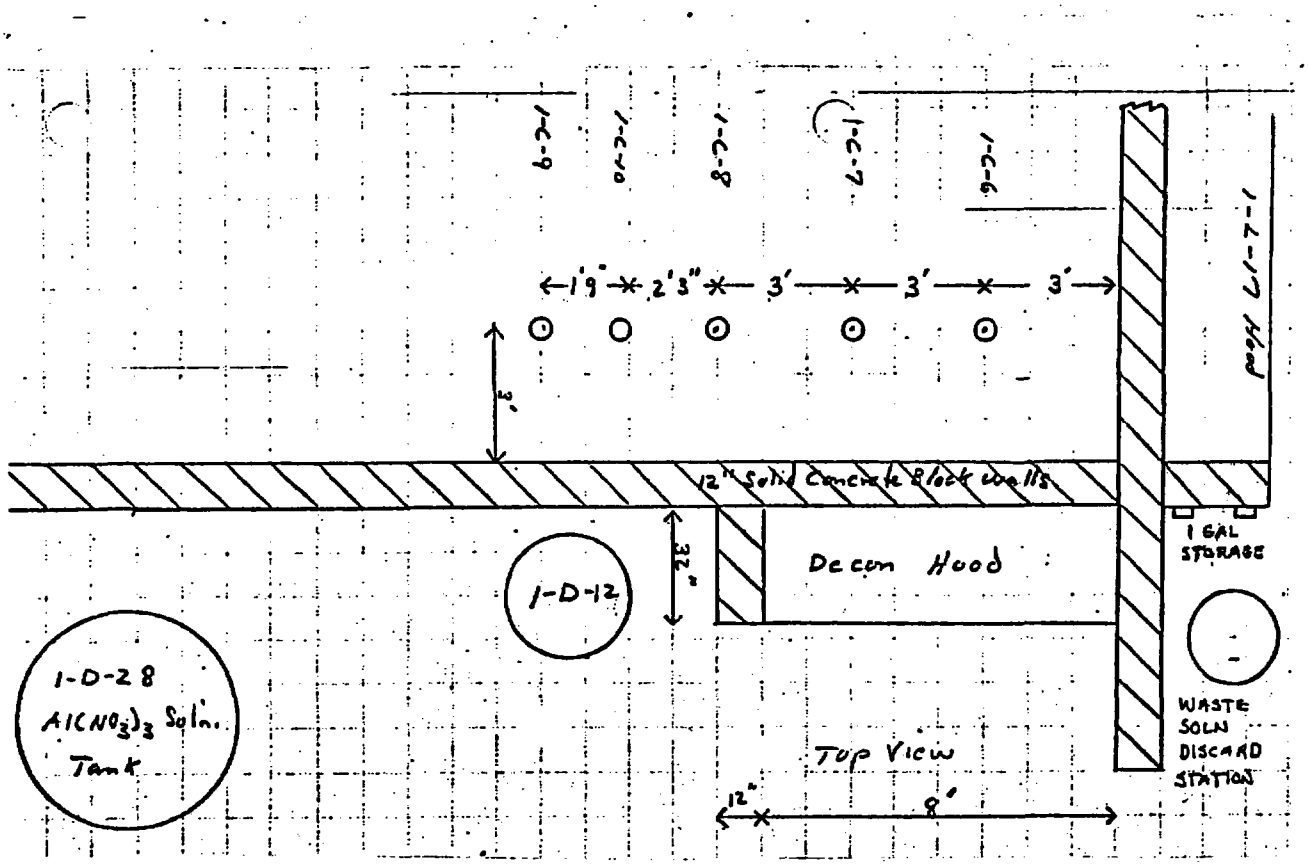
Sketch: 933.4-II, Decon Hood

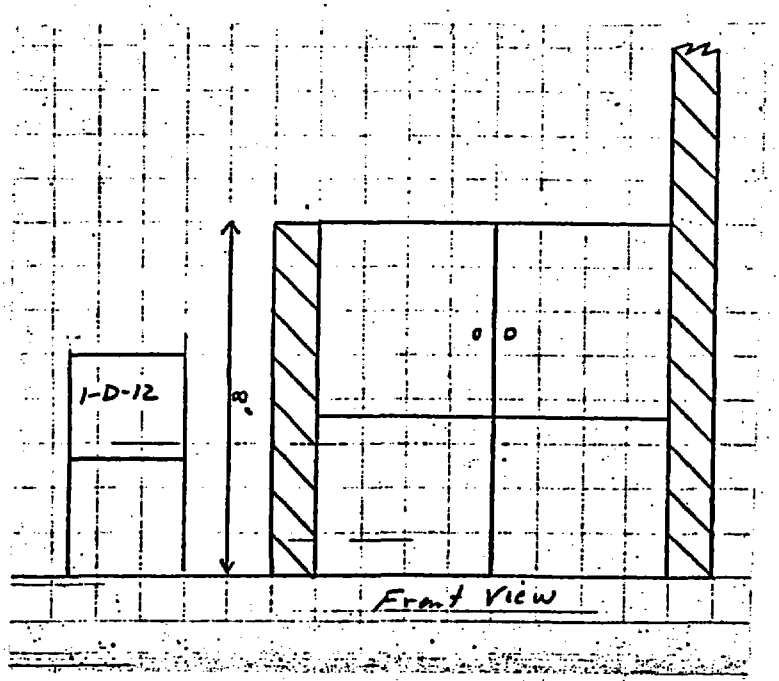
PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW





LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 933.4	
Sketch: 933.4-III-Decon Hood-Location Bay XIX	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

LICENSE:	SNM-777; DOCKET: 70-820	Approved
SECTION:	900 - RECOVERY OPERATIONS	
SUBSECTION:	930 - Support Activities	ISSUED October 31, 1968
SUBPART:	933 - Clean-up Equipment 933.5 - Vapor Demister Tray and Acid Vapor Neutralizer Tanks	SUPERSEDES New

933.5 Vapor Demister Trap and Acid Vapor Nentralizer Tanks

1. General

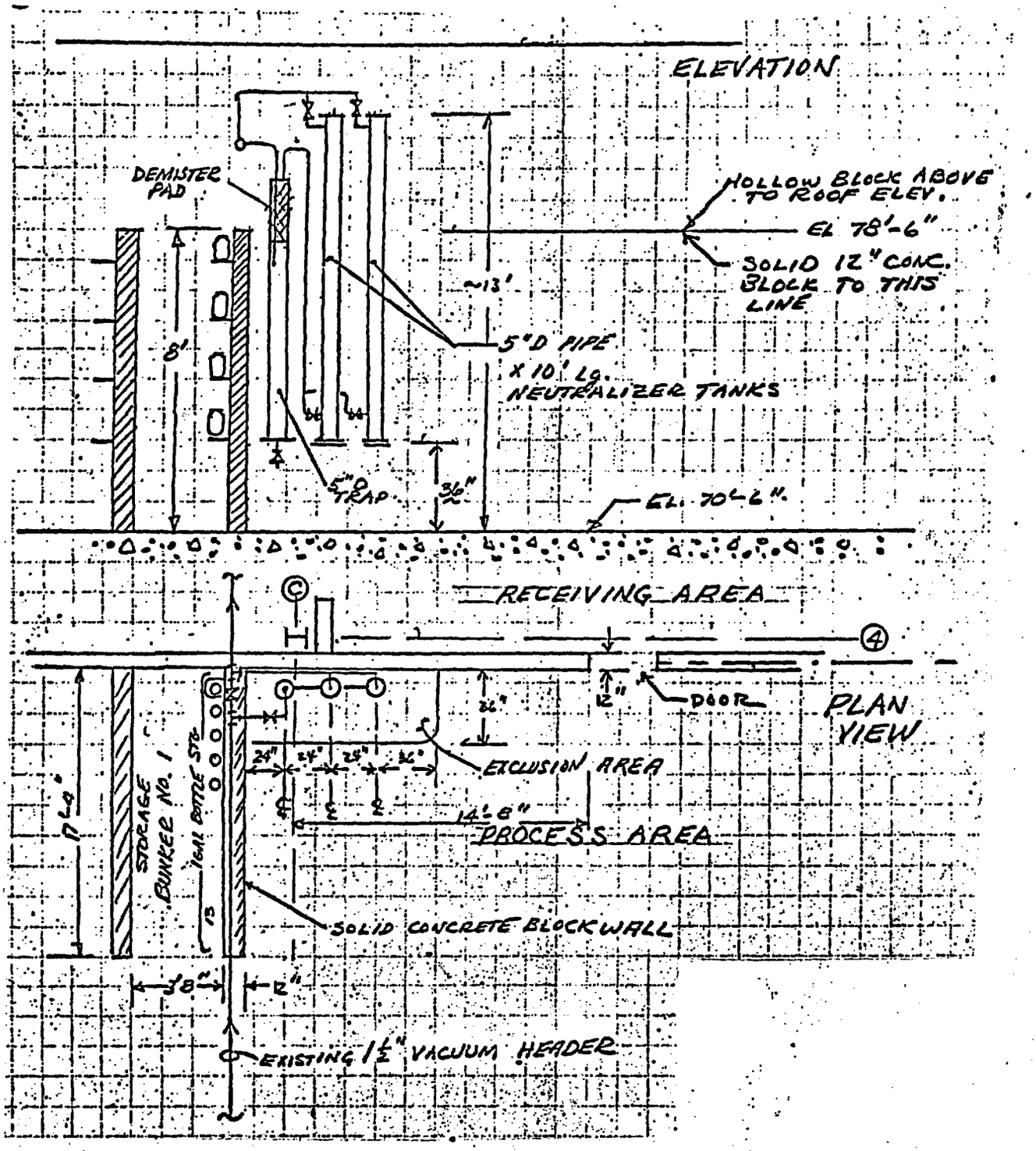
A vapor demister system will be provided absorbing and/or nentralizing acid vapors generated in the process area. The vapor demister trap is 5" in diameter and approximately 10' long, and are packed with limestone rock or other material of this type.

These columns will be mounted on an interior wall inside the process, area with 24" center to center spacing. An exclusive area 9' x 3' will be provided by a guard rail or other similar barrier to assure that SNM bearing material is separated from this system.

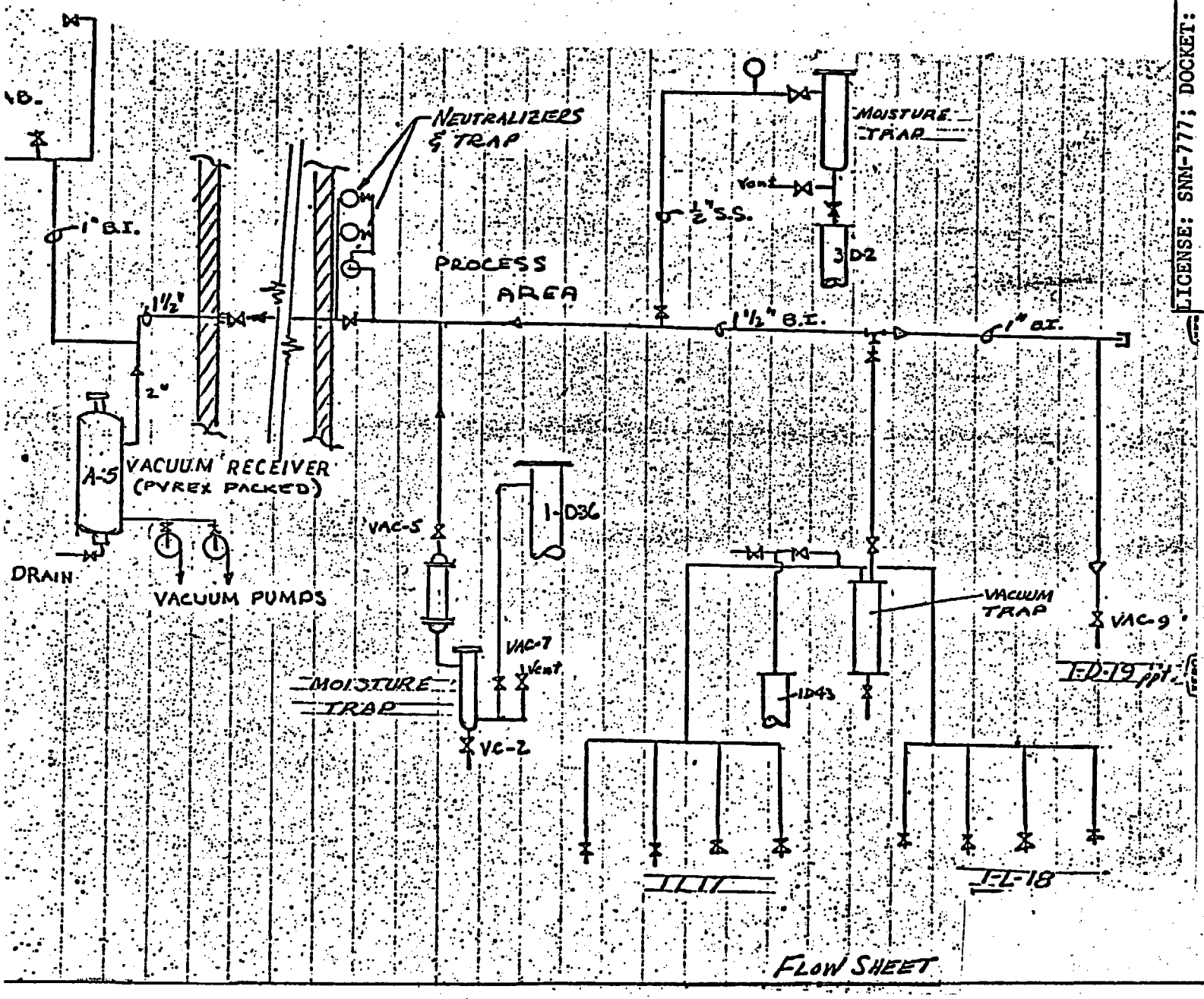
Details of this system are shown on Sketches 933.5-I and -II.

2. Nuclear Safety

Each column has a nuclearly safe 5" diameter. The solid angle subtended by the central column (first neutralizer tank) is approximately 1.6 steradians.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 933.5-1	
Vacuum Trap & Neutralizer Tanks	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	



LICENSE: SNM-777; DOCKET: 70-82(

SECTION: 900, SUBPART: 933.5

Sketch: 933.5-II - Vacuum Trap Neutralizer Tanks

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

1. Contribution from Vapor Demister Trap

$d=5''$, $L=8'=96''$, $L/2=48''$, $L=24'' - 2.5'' = 21.5''$

$\Omega = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{48''}{21.5''} = 2.23$, $\sin \theta = .91$

$= \frac{10''}{21.5} (.91) = .488 \times .91 = .44$ steradians

2. Contribution from Other Neutralizer Tank

$d= 5''$, $L=10'=120''$, $L/2=60''$, $h=24'' - 2.5'' = 21.5''$

$\Omega = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{60''}{21.5''} = 2.8$, $\sin \theta = .94$

$= \frac{10''}{21.5''} (.94) = .488 \times .94 = .46$ steradians

3. Contribution from 11ℓ Bottle in Cart, Directly in Front of Exclusion Area.

$d=5''$, $L=48''$, $L/2=24''$, $h= (36''-6'') + (16'' - 2.5'') = 30''+13.5+ = 43.5''$

$\Omega = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{24''}{43.5''} = .552$, $\sin \theta = .48$

$= \frac{10''}{43.5''} (.48) = .23 \times .48 = .11$ steradians

4. Contribution from 11ℓ Bottle in Cart Next to Closest Cart

$d=5''$, $L=48''$, $L/2=24''$, $h = \sqrt{(43.5'')^2 + (32'')^2} = 54''$

$\Omega = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{24''}{54''} = .445$, $\sin \theta = .43$

$= \frac{10}{54''} (.43) = .185 \times .43 = .08$ steradians

5. Contribution from Other Equipment on Carts

Assume total contribution will not exceed .5 steradians

6. Total Interaction

$\Omega_T = .44 + .46 + .11 + .08 + .50 = 1.6$ steradians

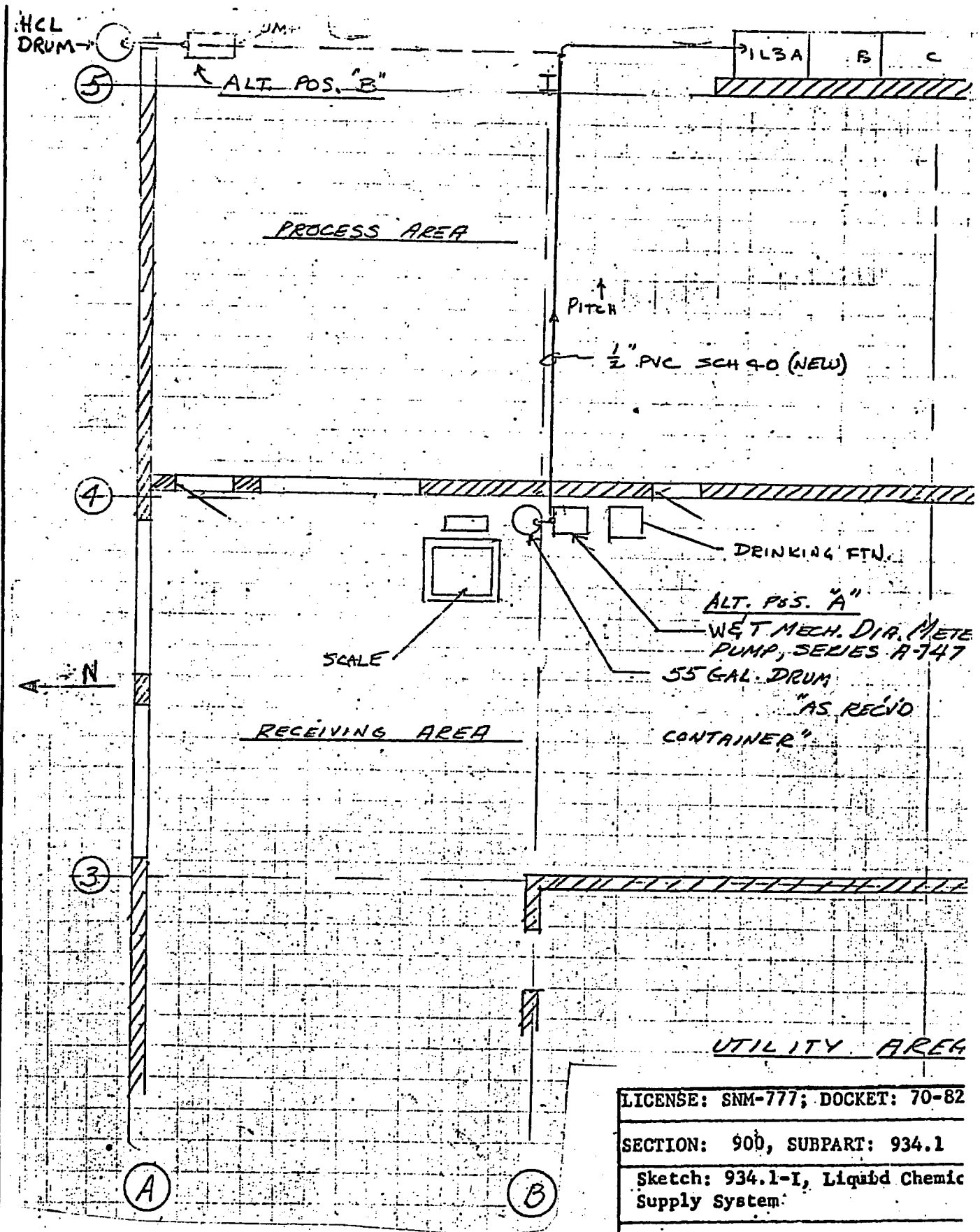
7. Allowable Interaction

From , K-1019, 5th Rev. the allowable interaction is 3.2 steradians.

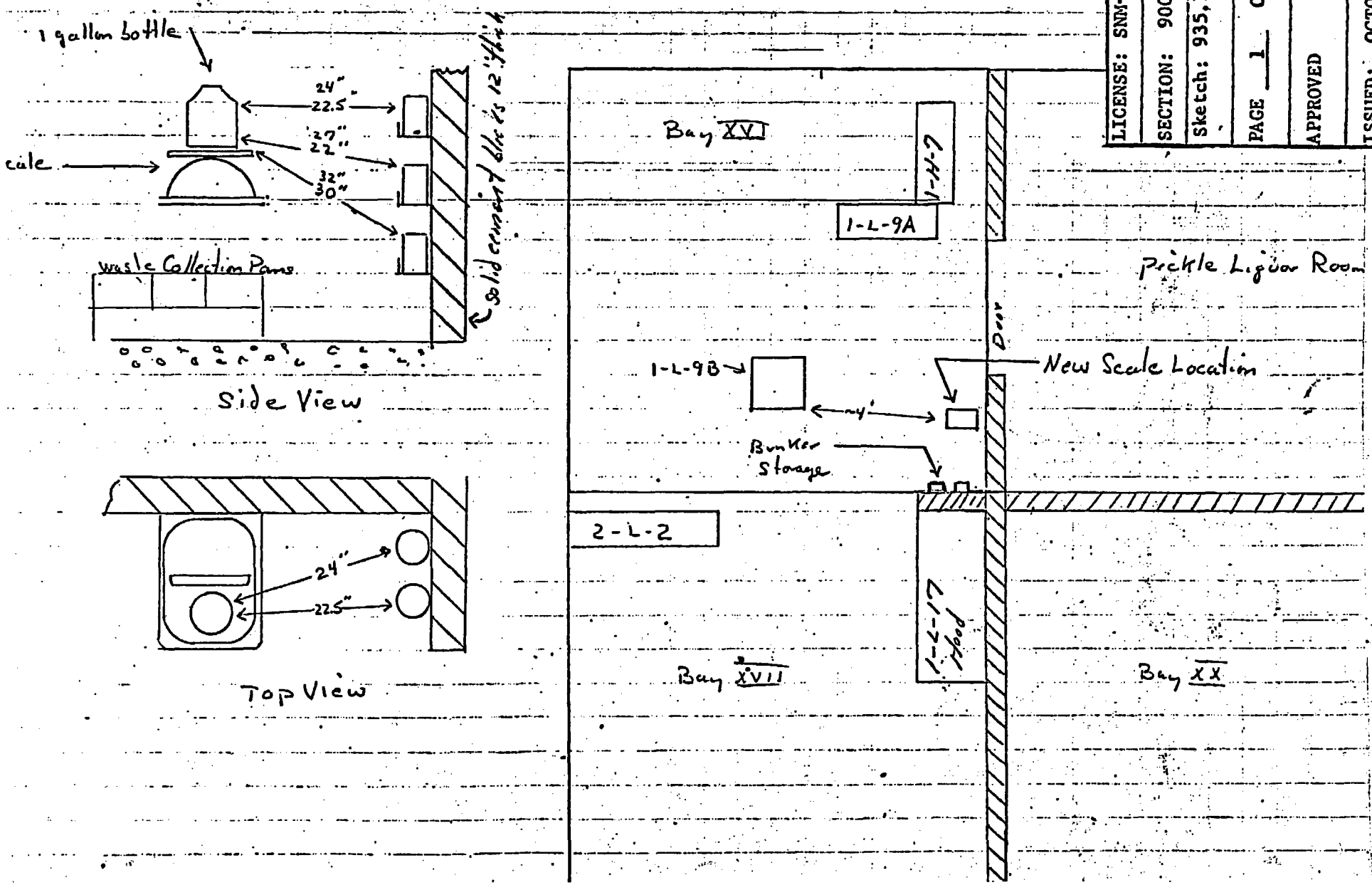
LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 933.5
Solid Angle Calculations-Vapor Demister System
PAGE 1 OF 1
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

934.1 Remote Liquid Chemical Pumping Station

A volumetric time-controlled positive meter pump with a capacity of approximately 20 GPH will be located in the Receiving Area. It will be used to pump liquid chemical from the shipper's drum directly to the process through a 1/2" plastic pipe line. An alternate drum position may be used with the drum located outside the building and the pump in the Receiving Area. The drum will be roped off and marked "No Uranium Allowed." The proposed location is shown on Sketch 934.1-I. A physical air break is located in the 1/2" line approximately 9" above the tray.



LICENSE: SNM-777; DOCKET: 70-82	
SECTION: 900, SUBPART: 934.1	
Sketch: 934.1-I, Liquid Chemic Supply System	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	



LICENSE: SNM-777; DOCKET: 70-8	
SECTION: 900, SUBPART: 935.1	
Sketch: 935,1-I	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	

1. <u>Contribution from Bottle 1L</u>

d=6", L=10", L/2=5", h=24"

$\Omega_{1L} = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{5''}{24''} = .208$

$\sin \theta = .204$

$= \frac{12''}{24''} (.204) = .5 \times .204 = .10$ steradians

2. <u>Contribution from Bottle 1R</u>

d=6", L=10", L/2=5", h= 22.5"

$\Omega_{1R} = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{5''}{22.5''} = .222,$

$\sin \theta = .216$

$= \frac{12''}{22.5''} (.216) = .532 \times .216 = .11$ steradians

3. <u>Contribution from Bottle 2L</u>

d=6", L=10", L/2=5", h=27"

$\Omega_{2L} = \frac{2d}{h} \sin \theta$ where $\tan \theta \frac{L/2}{h} = \frac{5''}{27''} = .185.$

$\sin \theta = .182$

$= \frac{12''}{27''} (.182) = .444 \times .182 = .08$ steradians

4. <u>Contribution from Bottle 2R</u>

d=6", L=10", L/2=5", h =22"

$\Omega_{2R} = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{5''}{22''} = .22$

$\sin \theta \approx .216$

$= \frac{12''}{22''} (.216) \approx .11$ steradians

5. <u>Contribution from Bottle 3L</u>

d=6", L=10", L/2 =5", h=32"

$\Omega_{3L} = \frac{2d}{h} \sin \theta$ where $\tan \theta = \frac{L/2}{h} = \frac{5''}{32''} = .156,$

$\sin \theta = .154$

$= \frac{12''}{32''} (.154)$

$= .376 \times .154$

$= .06$ steradians

LICENSE: SNM-777; DOCKET: 70-82(
SECTION: 900, SUBPART: 935.1
Solid Angle Calculations - Sca 1-4-1
PAGE 1 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

5. <u>Contribution from Bottle 3R</u>

d=6", L=10", L/2=5", h=30"

$\Omega_{3R} = \frac{2d}{h} \sin e$ where $\tan e = \frac{L/2}{h} = \frac{5''}{30''} = .167$

$\sin e = .165$

$= \frac{12''}{30''} (.165) = .4 \times .165 = .07$ steradians

6. <u>Contribution from 11ℓ Bottle in Cart</u>

d=5", L=48", L/2=24", h=16" - 2.5" = 13.5"

$\Omega_{BC} = \frac{2d}{h} \sin e$ where $\tan e = \frac{L/2}{h} = \frac{24''}{13.5''} = 1.78$

$\sin e = .87$

$= \frac{10''}{13.5} (.87) = .74 \times .87 = .65$ steradians

7. <u>Total Interaction</u>

$\Omega_T = .10 + .11 + .08 + .11 + .06 + .07 + .65 = 1.18$ steradians

LICENSE: SNM-777; DOCKET: 70-82
SECTION: 900, SUBPART: 935.1
Solid Angle Calculations - Scal 1-W-1
PAGE 2 OF 2
APPROVED
ISSUED: OCTOBER 31, 1968
SUPERSEDES: NEW

LICENSE: SNM-777, Docket: 70-820
SECTION: 900 - RECOVERY OPERATION
SUBSECTION: 930 - Support Activities
SUBPART: 935 - Uranium Bearing Equipment
935.2 - Assay Tank Scale 2-W-1

Approved

ISSUED OCTOBER 31, 1968

SUPERSEDES NEW

935.2 Assay Tank Scale 2-W-1

1. General

This scale is a Print-weigh or similar type used to weigh assay tanks. It is located 22" from the 1-F-24A Filter, 3'-6" from the 3-D-14 Overflow Tank, approximately 48" from the 3-D-12 Permanent Assay Tank and approximately 48" from the 3-J-3 Tray Dissolver in the 3-L-4 Hood. Details of the scale location are shown on Sketchs 923.9 - I, - II and - III.

2. Nuclear Safety

The assay tanks all have a nuclearly safe 5" diameter. The solid angle subtended by an Assay Tank on the scale is approximately 1.0 steradians.

a=4", b=24", q=h=22"

$$\Omega = \frac{abh}{q^3} = \frac{ab}{q^2} = \frac{4''x24''}{(22'')^2} = \frac{96\ in^2}{484\ in^2} = .20 \text{ steradians}$$

2. Contribution from 3-D-14

d=5", L=48", L/2=24", h=42" + 2.5" = 44.5"

$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{24''}{44.5''} = .54, \quad \sin \theta = .48$$

$$= \frac{10''}{44.5''} (.48) = .225x.48 = .11 \text{ steradians}$$

3. Contribution from 3-D-12

d=5", L=18'=216", L/2=108", h=48" +2.5"= 50.5"

$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{108''}{50.5''} = 2.14, \quad \sin \theta = .91$$

$$= \frac{10''}{50.5''} (.91) = .198x.91 = .18 \text{ steradians}$$

4. Contribution from 3-J-3

a=4", b=24", q=h=48"

$$\Omega = \frac{abh}{q^3} = \frac{ab}{q^2} = \frac{4''x24''}{(48'')^2} = \frac{96in^2}{2304in^2} = .04 \text{ steradians}$$

5. Contribution for 11½ Bottle in Cart

d=5", L=48", L/2=24", h=16" + 2.5" = 18.5"

$$\Omega = \frac{2d}{h} \sin \theta \qquad \text{where } \tan \theta = \frac{L/2}{h} = \frac{24''}{18.5''} = 1.3, \quad \sin \theta = .79$$

$$= \frac{10''}{18.5''} (.79) = .54 \times .79 = .43 \text{ steradians}$$

6. Total Interaction

$$\Omega_T = .20 + .11 + .18 + .04 + .43 = .96 \text{ steradians}$$

7. Allowable Interaction

From , K-1019, Rev. 5, the allowable solid angle for a 5" diameter system is 3.2 steradians

LICENSE:	SNM-777
Docket:	70-820
SECTION: 900, Subpart: 935.2	
SOLID ANGLE CALCULATIONS SCALE 2-W-1	
Page 1 of 1	
APPROVED	
ISSUED:	October 31, 1968
SUPERSEDES:	New

LICENSE: SNM-777; DOCKET: 70-820
SECTION: 900 - RECOVERY OPERATION
SUBSECTION: 930 - Support Activities
SUBPART: 935 - Uranium Bearing Equipment
935.3 - Vacuum Removal System

Approved

ISSUED Oct. 31, 1968

SUPERSEDES New

935.3 Vacuum Removal System

A one liter vacuum flask with a plastic hose extension will be used for vacuum removal of undissolved uranium bearing material from the bottom of the 1-J-5 and 3-J-3 tray dissolvers. Most of the dissolver solution will be decanted from the tray dissolvers before using the vacuum system. After all the solids have been "sucked" out of the tray, the hose will be rinsed clean.

The volume of solution in the flask will be visually checked to prevent carry-over of solution to the vacuum. However, should any droplets be entrained in the line, a secondary trap equipped with an audible alarm will detect solution carry-over. Any dissolver solution in the flask will be decanted back to the tray dissolvers. The solids may be transferred to another 1 liter container for further processing.

During the vacuum transfer, the vacuum flask will be placed in the floor and spaced a minimum of 2 feet away from the tray dissolver being vacuumed.

A 1 liter volume is nuclearly safe for all metal-water mixtures as shown on Fig. 2, TID-7016, Rev. 1. Since this flask will be located a minimum of 2 feet away from any equipment containing SNM, its interaction affects are considered negligible.

936. Low Level Combustible Waste Incinerator

1. General

The incineration of combustible low level uranium containing material will be done in the equipment shown on Fig. 936.1. No known material with explosive or pyrophoric characteristics will be processed in this system. The system is located approximately 65 ft. north-east of the plant.

The equipment consists of a 100 lb./hr. waste incinerator, Model 57-P, Class 1A, as designed and manufactured by Joseph Goder, Inc. The unit consists of a primary firing chamber and detachable secondary cyclonic ash collector chamber, steraman breeching, stack and gas burner. A wet scrubber will be installed between the cyclone separator and the fan, if required. A sketch of the incinerator is shown on Fig. 936-II.

2. Process

2.1 Selection of Material

Administrative controls are used in the collection of waste to insure that contaminated waste for incineration does not contain significant quantities of special nuclear material. Experience in this regard involving the recovery of uranium from 50 - 55 gallon drums of ash representing 1750 drums of waste was; a total of 226 grams of U-235 recovered, equivalent to 0.13 grams of U-235 per drum of waste, or 4.5 grams U-235 per drum of ash.

This experience was obtained on the same type of material at our Montville facility (described in SNM-368) which will be used less as this incinerator becomes operable.

As an additional precaution, and to minimize the possibility of placing any significant quantity of U-235 in the incinerator, the contents of individual drums will be searched and unburnable or highly contaminated material removed, prior to incineration. During this sorting, an alpha survey meter is on hand for the operator to check any suspicious item.

2.2 Personnel Protection

The operator will wear protective equipment, i.e., coveralls, cap, gloves, overshoes, and as a precautionary measure; a respirator while sorting, charging the incinerator, and while removing ashes.

2.2 Personnel Protection (continued).

Experience in the similar operation at our Montville facility, have shown that this is adequate control.

As stated in the Health Physics Manual, should a urine sample exceed cur action level (100 alpha dpm/liter), the operator will be restricted to work away from exposed uranium until two succesive urine samples are below 50 dpm/l.

2.3 Charging The Incinerator

Waste to be incinerated is manually charged into the fire box at the leading end. The incinerator draft blower will be on to pull air away from the operator.

2.4 Removal of Ash

Ashes fall through a grate in the primary section and are removed manually, as required, and at the completion of a run. The ash pit is completely accessible upon removal of the ash pan into the containment hood.

Fly ash is removed in the cyclo-vane and accumulated in a secondary ash pan which is inspected and emptied at the same time the primary is cleaned. Further inspection of the various sections of the incinerator will be performed during each cleanout to insure against any buildup.

Ashes are removed from the ash pit to the Containment Hood attached to the front of the incinerator by pulling the ash pan into the hood. Ashes are then sampled and gamma counted prior to removal from the hood. Ash is removed from the hood by means of a drum type vacuum cleaner (a power unit on a 55 gallon drum). Exhust from the vacuum cleaner is directed into the incinerator exhaust system.

Samples of the ash will be analyzed and, provided a value of 40 gms U-235 per cu. ft. is not exceeded, the bulk of the ash will be placed in 55 gallon drums (maximum of 350 gms U-235 per drum). Should it be necessary to remove ash before an analysis is completed, or, if the value of 40 gms U-235 per cu. ft. is exceeded, ash shall be placed in 1-gallon containers or 5 inch diameter cylinders and stored in accordance with approved techniques.

Only closed drums will be moved or stored. Drums may be stored in arrays provided a prejected surface density of 175 gms U-235 per square foot is not exceeded. Arays will be separated by at least 12 ft. All storage areas will be covered by a radiation monitor as required by 10 CFR 70.24.

3. Nuclear Safety

The incinerator will be limited to a maximum of 350 grams U-235. Experience with this type of material over several years of operation yields an average of 4.5 gms U-235 per 55 gallons of ash with a maximum value of 31 gms of U-235 per drum.

3. Nuclear Safety (continued)

Pre-sorting of the waste material; sampling and analysis of the ash, provide control of amounts processed. Storage will be based on 350 gms U-235 max. per 55-gallon drum for planar arrays, or a projected surface density* of 175 gms U-235 per square foot for cubic arrays of 55 gallon drums.

Should it become necessary to add a scrubber to the exhaust system, this will be considered separately and authorized in accordance with approved techniques or submitted as a proposed amendment.

*The value of 175 gms U-235 per square foot was obtained by replotting the date of Fig. 11, TID-7028, in terms of U-235 content per square foot of planar area versus U-235 density. This curve has a minimum at about 350 gms U-235 per square foot. A safety factor of two is thereby incorporated.

4. Radiation Safety

4.1 The operation is considered to be contaminated and Health Physics rules for protective clothing, methods of handling, etc., as established in the Health Physics Manual, will be followed.

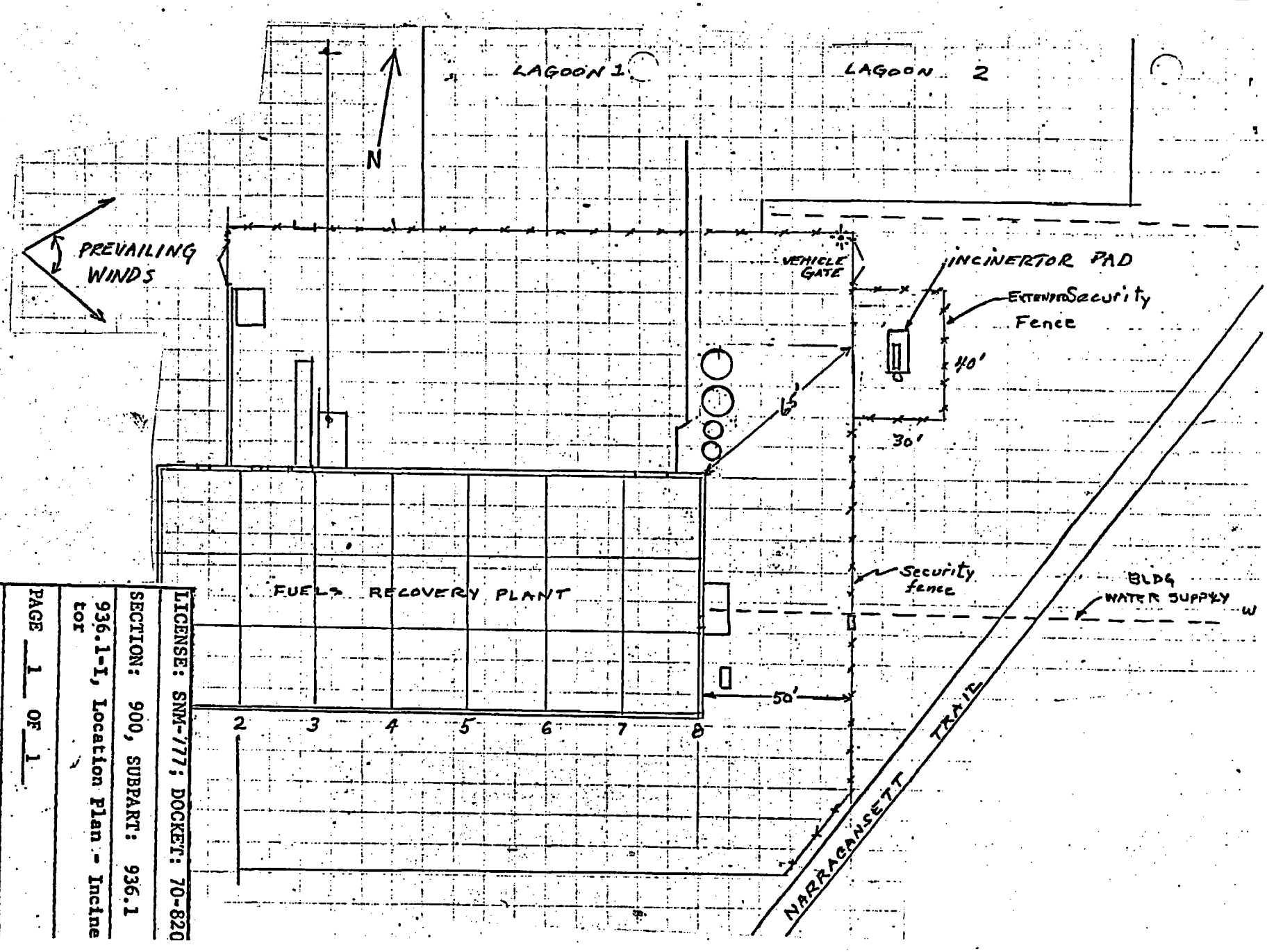
4.2 Incinerator will be under surveillance of a NMC GA-2 Monitor.

4.3 Air samples will be taken while the incinerator is operating, as follows:

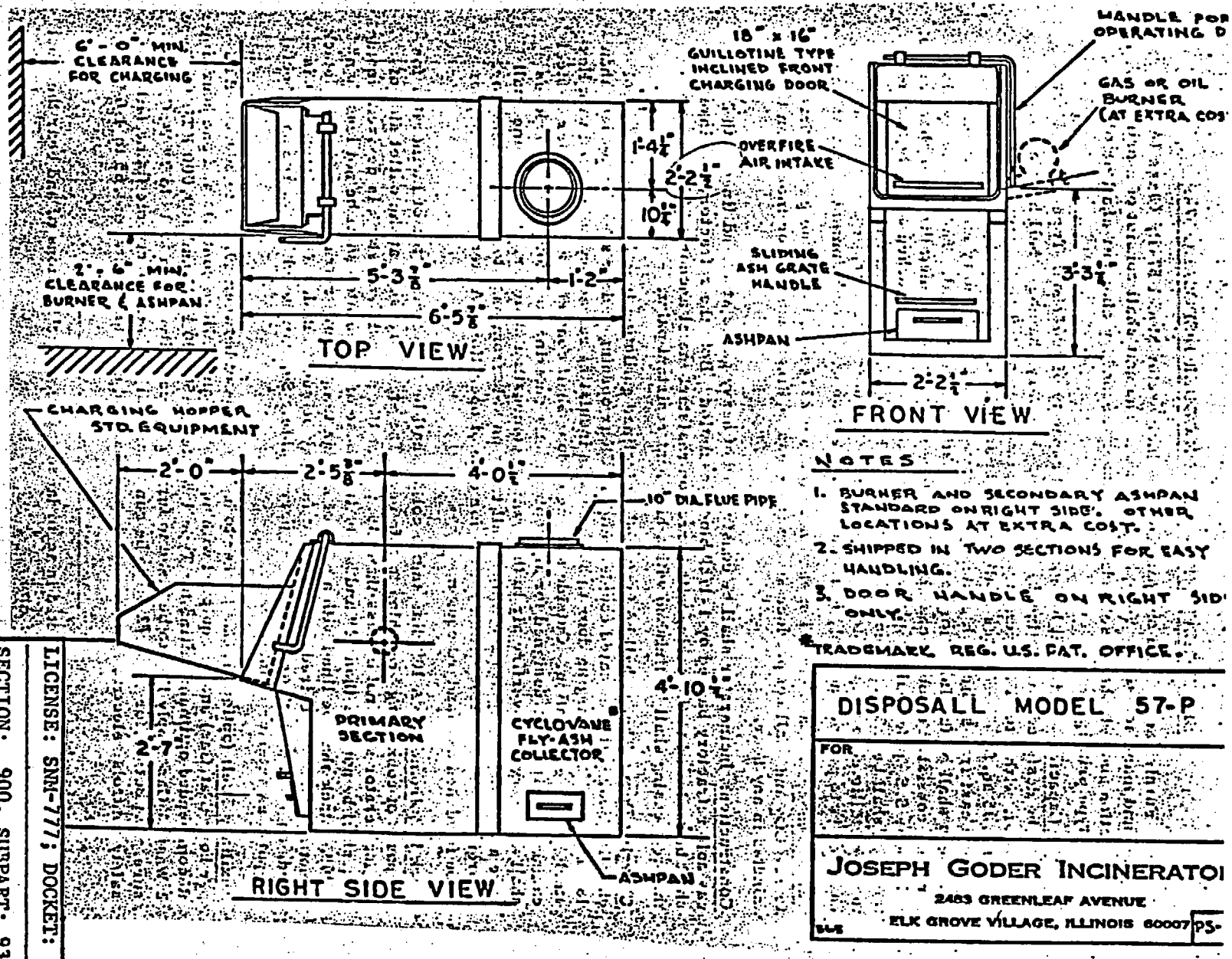
4.3.1 Exhaust (in stack)

4.3.2 Adjacent Environment (downwind)

4.3.3 Breathing Zone



LICENSE: SNM-777; DOCKET: 70-820	
SECTION: 900, SUBPART: 936.1	
936.1-I, Location Plan - Incinerator	
PAGE 1 OF 1	
APPROVED	
ISSUED: OCTOBER 31, 1968	
SUPERSEDES: NEW	



LICENSE: SNM-777; DOCKET: 70-82

SECTION: 900, SUBPART: 936.1

936.1-II, - Incin
erator

PAGE 1 OF 1

APPROVED

ISSUED: OCTOBER 31, 1968

SUPERSEDES: NEW

LICENSE: SNM-777, Docket: 70-820

SECTION: 900 - Recovery Operation
Subsection: 940 - Nuclear Criticality Alarm

Approved

ISSUED 10/31/68

SUPERSEDES New

940. Nuclear Criticality Alarm System

A nuclear criticality alarm system complying with the criteria of subsection 405.1 is in operation. The monitor locations and respective areas covered are shown on figures:

940-RM 2
940-RM 3
940-RM 4
940-RM 5
940-RM 6
940-RM-Yard

Technical Note

Nuclear Alarm Coverage Calculations

Subsection 405.1 establishes the calculational technique for determining coverage of nuclear alarm monitors. In this subsection, the formula for calculations is:

$$I = \frac{I_o\ (e^{-\mu t})}{d^2}$$

Calculations performed for the nuclear alarm coverage defined in Subsection 940 were stated in different terms but based on the same formula, i.e.:

$$D = \frac{S\ (e^{-z/\lambda})}{d^2}$$

The similar terms are:

$I = D$ = gamma intensity (or radiation level) at the detector.

$I_o = S$ = unattenuated gamma intensity 1 ft. from the flux source.

$t = z$ = thickness of shield in centimeters

d^2 = distance from source in feet.

Since $\lambda = \frac{1}{\mu}$ and μ = mass absorption cross section of the shielding material x the density of the shield, then the following statement is an equality.

$$e^{-\mu t} = e^{-z/\lambda}$$

LOCATIONS BASED ON 10-CFR-70 & 70.39 WITH ALARM LEVEL SET 5<D<20 mrem SOURCE LEVEL ≤ 300 R/HR AT 1 FOOT AND MAXIMUM DISTANCE FROM SPECIAL NUCLEAR MATERIALS = 120 FEET UNSHIELDED OR LESS IF SHIELDED.

CONCRETE AT THE SITE TAKEN AS 135 LB/FT³ OR ~2.2 gm/cm³.

CONCRETE BLOCK TAKEN AS AVERAGE WALL THICKNESSES AT AN AVERAGE OF 103 LB/FT³ OR 1.65 gm/cm³

SHIELDING EFFECTIVENESS BASED ON

(1) $D = S e^{-z/\lambda}$

WHERE D = RADIATION LEVEL AT THE DETECTOR
S = SOURCE STRENGTH AT 1 FT.
z = SHIELD THICKNESS IN cm.
$\lambda = 1/\mu$ FOR THE SHIELD MAT.

FOR CONCRETE AT 2.33 gm/cm³ AND 4 MEV GAMMA. μ = 0.0743 FROM NUCLEONICS AUG. 1962

FOR CONCRETE USED $\mu = 0.0743\left(\frac{2.2}{2.33}\right) \cong 0.0$

THEN $\lambda = \frac{1}{\mu} \cong 14$ cm

FOR CONCRETE BLOCK $\mu = 0.0743\left(\frac{1.65}{2.33}\right) = 0.0$

THEN $\lambda = \frac{1}{\mu} \cong 18.9$ cm.

EFFECT OF DISTANCE BASED ON

(2) $D = S/d^2$

MODIFIED EQUATION 9.95.1 PRINCIPLES OF NUCLEAR REACTO ENGINEERING - GLASSTONE

WHERE d = DISTANCE - FT

COMBINING (1) & (2)

(3) $D = \frac{S\, e^{-z/\lambda}}{d^2}$

(4) OR $d = \left(\frac{S\, e^{-z/\lambda}}{D}\right)^{1/2}$

WHERE TWO SHIELD MATERIALS ARE USED SHIELDING EFFECT OF EACH MUST BE ACCOUNTED FOR - THEN (3) BECOMES

$$D = \frac{S\left(e^{-z_1/\lambda_1}\right)\left(e^{-z_2/\lambda_2}\right)}{d^2}$$

MONITOR NO. RM-1

LOCATION — OUTSIDE ON ~~NORTH WALL BETWEEN~~ NORTHEAST CORNER ~~COL'S 5 & 6~~ — MTG. HEIGHT 10'0" ABOVE GRAD.

$S = 300 R = 3.0 \times 10^5$ mr.

PURPOSE TO MONITOR OUTSIDE STORAGE AREA

SINCE NO SHIELDING IS INVOLVED THE EFFECTIVE RADIUS IS 120 FT.

MONITOR NO RM-2

PURPOSE: MONITOR PROCESS AREA

LOCATION: MOUNT ON COL. A-5 ~ 6'0" ABOVE FLOOR LEVEL

EFFECTIVE RADIUS: THE EFFECTIVE RADIUS VARIES DUE TO SHIELDING EFFECTS OF WALLS - SKETCH RM-2 SHOWS THE EFFECTIVE AREA COVERED BY THIS MONITOR.

EFFECTIVE VALUES ARE:

1) $d = 54'$ NO SHIELDING $e^{-\gamma} = 1$

$$D = \frac{3.0 \times 10^5}{54^2} = 103. \text{ mr/Hr.}$$

2) $d = 75'$

$$D = \frac{3.0 \times 10^5}{(75)^2} \cong 53. \text{ mr/Hr.}$$

3) A) $d = 48'$

$$D = \frac{3.0 \times 10^5}{(48)^2} = 130 \text{ mr/Hr.}$$

B) $d = 82'$

$$D = \frac{3.0 \times 10^5}{(82)^2} = 44.6 \text{ mr./Hr.}$$

RM-2 (CONT)

RM-2 CONT.

4) $d = 100'$ $D = \frac{3.0 \times 10^5}{100^2} = 30$ mr/Hr.

5) $d = 55'$ CONCRETE = 13" = 33 cm

$$D = \frac{3.0 \times 10^5 \, e^{-33/14}}{(55)^2} = 9.3 \text{ mr/Hr.}$$

6) $d = 72'$ NO SHIELDING

$$D = \frac{3.0 \times 10^5}{(72)^2} = 57.8 \text{ mr.}$$

7) $d = 76$

$$D = \frac{3.0 \times 10^5}{(76)^2} = 52 \text{ mr.}$$

MONITOR NO. RM-3

PURPOSE: MONITOR LABORATORY & RECEIVING & STORAGE

LOCATION: MOUNT FROM LABORATORY CEILING AT 8 FEET ABOVE LAB. FLOOR — 13'0" WEST OF COL. LINE 3 AND 5 FEET NORTH OF COL. LINE B

EFFECTIVE RADIUS - THE EFFECTIVE RADIUS VARIES DUE TO THE SHIELDING EFFECTS OF THE WALLS. SKETCH RM-3 SHOWS THE EFFECTIVE AREA COVERED BY THIS MONITOR.

EFFECTIVE VALUES ARE: (THICKNESS VALUES ARE BASED ON TRUE PROJECTIONS)

1) 2 CONCRETE BLOCK WALLS ACTUAL $t = 7'' = 17.8$ cm.
D = 20

$$d = \left(\frac{3.0 \times 10^5 \, e^{-17.8/8.9}}{.20}\right)^{1/2} = (5859)^{1/2} = 76.3'$$

RM 3 (CONT)

2) A) $d = 30'$ 1 - CONC. FLOOR - $t = 10'' = 25.4$ Cm.
1 - CONC BLOCK $t = 4'' = 10.2$ Cm.

$$D = \frac{3.0 \times 10^5 (e^{-10.2/18.9})(e^{-25.4/14})}{30^2}$$

$D = 31.6$ mr/HR.

B) - SAME AS 1) ABOVE

$d = 76'$

3) 2 - CONC. BLOCK WALLS $t = 8'' = 20.3$ Cm

$D = 20$

$$d = \left(\frac{3.0 \times 10^5 \, e^{-20.3/18.9}}{20}\right)^{\frac{1}{2}} = (5145)^{\frac{1}{2}}$$

$d = 71.7' \sim 72'$

4) SAME AS 1) ABOVE

$d = 76'$

5) A) 2 BLOCK WALLS $t = 8'' = 20.3$ Cm.
1 CONC. FLOOR $t = 7'' = 17.8$ Cm.
$d = 25.5$ FT

$$D = \frac{3.0 \times 10^5 (e^{-20.3/18.9})(e^{-17.8/14})}{(25.5)^2}$$

$D = 46.2$ mr.

5) B) 2 BLOCK WALLS $t = 7'' = 17.8$ cm.
1 CONC. FLOOR $t = 10'' = 25.4$ cm.
$d = 39.5'$

$$D = \frac{3.0 \times 10^5 \left(e^{-17.8/18.9}\right)\left(e^{-25.4/14}\right)}{(39.5)^2}$$

$D = 19.8$ mr/Hr.

C) 2-BLOCK WALLS $t = 8'' = 20.3$ cm.
$d = 51.5$ FT.

$$D = \frac{3.0 \times 10^5 \left(e^{-20.3/18.9}\right)}{(51.5)^2} = 39 \text{ mr/Hr.}$$

6) A) 2-BLOCK WALLS $t = 9'' = 22.9$ cm.
1-CONC. FLOOR $t = 7'' = 17.8$ cm.
$d = 2.8$ FT

$$D = \frac{3.0 \times 10^5 \left(e^{-22.9/18.9}\right)\left(e^{-17.8/14}\right)}{(28)^2} = 37 \text{ mr/Hr}$$

B) 2 BLOCK WALLS $t = 8'' = 20.3$ cm.
1 CONC. FLOOR $t = 10'' = 25.4$ cm.
$d = 43'$

$$D = \frac{3.0 \times 10^5 \left(e^{-20.3/18.9}\right)\left(e^{-25.4/14}\right)}{(43)^2} = 9 \text{ mr/Hr}$$

RM-3 CONT.

7) 2 BLOCK WALLS $t = 12'' = 30.5$ cm.

1 CONC. FLOOR $t = 9.5'' = 24.1$ cm.

$d = 37'$

$$D = \frac{3.0 \times 10^5 \left(e^{-30.5/18.9}\right)\left(e^{-24.1/10}\right)}{(37)^2} = 7.9 \text{ mr.}$$

MONITOR NO. RM-4

PURPOSE: MONITOR FINISHED PRODUCT STORAGE AREA & PART OF THE PROCESS AREA.

LOCATION: ELEVATION 12'6" ABOVE FLOOR LEVEL - MOUNT ON WEST SIDE OF SHIELD WALL ON COL. LINE 5 (APPROX. 1'6" WEST) AND 3'6" NORTH OF COL. LINE D.

EFFECTIVE VALUES ARE: SHOWN ON SKETCH RM 4

1) d = 74 FT NO SHIELDING

$$D = \frac{3.0 \times 10^5}{(74)^2} = 55 \text{ mr/HR}$$

2) d = 78 FT NO SHIELDING

$$D = \frac{3.0 \times 10^5}{(78)^2} = 49.4$$

3) 1- CONCRETE WALL t = 16" = 40.6 cm.
d = 35'

$$D = \frac{3.0 \times 10^5 e^{-40.6/12}}{(35)^2} = 13.5 \text{ mr/HR}$$

OR - D = 20

d = 28.7'

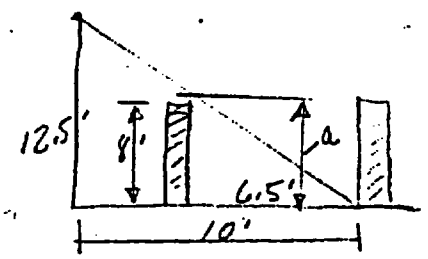
RM 4 (CONT)

4) 1- CONCRETE WALL $t = 12' = 30.5$ Cm.

$D = 20$ mr/hr.

$$d = \left(\frac{3.0 \times 10^5 \, e^{-30.5/10}}{20}\right)^{1/2} = 41.'$$

5)



AT CLOSEST POINT

$a = 12.5(6.5)/10$

$= 8.1'$

$d = 16.'$

$$D = \frac{3.0 \times 10^5}{(16)^2} = 1170 \text{ mr/hr.}$$

MONITOR No. RM-5

PURPOSE: MONITOR EXTRACTION PROCESS & RAW LIQUOR AREA.

LOCATION: ELEVATION 6'0" ABOVE FLOOR — MOUNT ON SOUTH SIDE OF WALL ON COL. LINE B & ~7'3" EAST OF COL. LINE 7

EFFECTIVE RADIUS: VARIES — SHOWN ON SKETCH RM-5

EFFECTIVE VALUES ARE:

1) 1- CONCRETE WALL $t = 12'' = 30.5$ cm.
$d = 25$ FT.

$$D = \frac{3.0 \times 10^5 e^{-30.5/14}}{(25)^2} = 54.2 \text{ mr/Hr.}$$

2) 1- CONCRETE WALL $t = 13.5'' = 34.3$ cm.
$D = 20$ mr/Hr.

$$d = \left(\frac{3.0 \times 10^5 e^{-34.3/14}}{20}\right)^{1/2} = 36.2 \text{ FT.}$$

3) 1- CONCRETE WALL $t = 18'' = 45.7$ Cm
$d = 8$ FT.

$$D = \frac{3.0 \times 10^5 e^{-45.7/14}}{8^2} = 180 \text{ mr/Hr.}$$

RM-5 (CONT)

4) 1- CONCRETE WALL $t = 16'' = 40.6$ cm.
$d = 18'6''$

$$D = \frac{3.0 \times 10^5 \, e^{-40.6/14}}{(18.5)^2} = 48.3 \text{ mr/HR.}$$

5) 1- CONCRETE WALL $t = 16'' = 40.6$ cm.
$d = 23'6''$

$$D = \frac{3.0 \times 10^5 \, e^{-40.6/14}}{(23.5)^2} = 30 \text{ mr/HR.}$$

6) 1- CONCRETE WALL $t = 14'' = 35.6$ cm.
$d = 32$ FT.

$$D = \frac{3.0 \times 10^5 \, e^{-35.6/14}}{(32)^2} = 23 \text{ mr/HR.}$$

7) 1- CONCRETE WALL $t = 13'' = 33.0$ cm.
$d = 26$ FT

$$D = \frac{3.0 \times 10^5 \, e^{-33/14}}{(26)^2} = 42 \text{ mr/HR.}$$

8) 1- CONCRETE WALL $t = 16'' = 40.6$ cm.
$D = 20$

$$d = \left(\frac{3.0 \times 10^5 \, e^{-40.6/14}}{20}\right)^{\frac{1}{2}} = 28.7 \text{ FT}$$

JOB TITLE UNITED NUCLEAR CORP.

DESCRIPTION RADIATION MONITORS

MADE BY CMC CHECKED BY

RM-5 (CONT)

9) 1- CONCRETE WALL 12" THICK = 30.5 cm.
D = 20

$$d = \left(\frac{3.0 \times 10^5 e^{-30.5/14}}{20}\right)^{1/2} = 41 \text{ FT.}$$

10) 1- CONCRETE WALL $t = 14'' = 35.6$ cm.
D = 20

$$d = \left(\frac{3.0 \times 10^5 e^{-35.6/14}}{20}\right)^{1/2} = 34.9 \text{ FT}$$

11) 1- CONCRETE WALL $t = 24'' = 61$ cm.
d = 19 FT

$$D = \frac{3.0 \times 10^5 e^{-61/14}}{(19)^2} = 19.5 \text{ mr/HR.}$$

MONITOR RM-6

PURPOSE: MONITOR PROCESS AREA

LOCATION: ELEVATION ~9'6" ABOVE FLOOR — MOUNT ON WEST SIDE OF PLATFORM STEEL ~8 FT WEST OF COL. LINE 8 & 10'0" NORTH OF COL. LINE D

EFFECTIVE RADIUS: VARIES — SHOWN ON SKETCH RM-6

EFFECTIVE VALUES ARE:

1) 1- CONCRETE WALL $t = 12" = 30.5$ cm.
$d = 14$ FT

$$D = \frac{3.0 \times 10^5 e^{-30.5/14}}{(14)^2} = 173 \text{ mr/Hr.}$$

2) $d = 120$ FT NO SHIELDING

$$D = 20 \text{ mr/Hr.}$$

3) $d = 74'$ NO SHIELDING

$$D = 3.0 \times 10^5 / (74)^2 = 55 \text{ mr/Hr.}$$

4) $d = 91$ FT NO SHIELDING

$D = 3.0 \times 10^5 / 91^2 = 36.2$ mr/HR.

MONITOR RM 7

LOCATION: OUTSIDE ON ROOF AT SOUTH WALL

MONITOR RM 8

LOCATION: OUTSIDE ON POWER POLE IN NORTH YARD.

PURPOSE: TO MONITOR OUTSIDE STORAGE AREAS.

NO SHIELDING INVOLVED - EFFECTIVE RADIUS ~ 120 FT.

6 pgs w/h
oversized drawings