70-820

For Div of Compliance

UNITED NUCLEAR
CORPORATION

In Reply Refer to: NLS:REK-977

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January 5, 1967

Mr. Donald A. Nussbaumer, Chief
Source & Special Nuclear Materials Branch
Division of Materials Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

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SUBJECT: Boat Calciner and Associated Equipment

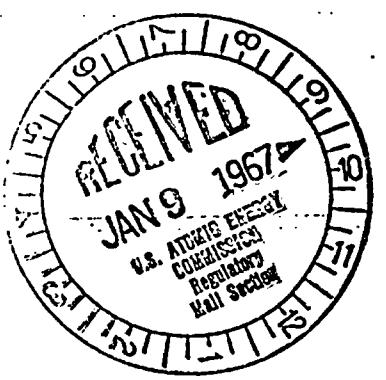
Reference: (1) SNM-777, Section 300, Subsection 302.15
(2) SNM-33, Section 300, Subsection 302.15

Dear Mr. Nussbaumer:

UNC proposes to install equipment at the Fuels Recovery Plant to be used primarily for the calcining of residues. These operations were previously performed in this equipment at our Hematite Plant.

Attached are pages for a new subsection, reference (1), which cover this equipment and its use. The content of these pages is essentially the same as that contained in approved reference (2).

Your early consideration is requested.



Very truly yours,

D. F. Cronin

REK/DFC/tc

D. F. Cronin
Director of Licensing

attachment

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302.15 Boat Calciner and Associated Equipment

15.1 Facilities

The drying and/or calcining of liquid and solid residues containing uranium will be done in the equipment shown on Figure 302.15-1. No known material with explosive or pyrophoric characteristics will be processed in this facility. This facility is located in Bays X, XIII and XVI as shown on Figure 302.15-2; 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.

15.2 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 of 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.

15.2 Process (continued)

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 3-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 Section 302.10.2.3.

15.3 Nuclear Safety

15.3.1 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 loadin into furnace boats. Due to the method of operation, no mor 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.

15.3.2 Furnace System (2-H-2, 2-H-3)

Dimensions of the furnace tube, boat return tube and boats are set forth in Table 302.15-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 as dry.

15.3.3 Slide Valves Between Glove Boxes and Furnace

The slide valves are geometrically safe per Table XV of K-1019, Fifth Revision. The discussion of Section 302.15.3.1 above, is also applicable here.

15.3.4 Exit Glove Box (2-L-5)

The discussion of Section 302.15.3.1 above, is applicable here.

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

15.3.5 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 Figure 302.15-2. Therefore, these are safe individual units.

15.3.6 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. 302.15-II shows that the maximum solid angle any subcrit will see is 1.9 steradians.

This angle permits multiplication factors of 0.72 for the subcrits (TID-7016, Revision I, Figure 26, Page 36). Table XVII, Page 29, K-1019, Fifth Revision indicates that an interaction angle of 1.9 steradians is permissible for five inch diameter cylinders, for 8.24 inch spheres and configurations having volumes of 4.8 liters, for 1.5 inch thick slabs, and for 11.4 inch diameter spheres containing safe masses of 350 grams of U-235.

TABLE 302.15-I

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			

TABLE 302.15-II

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		Bottle	Total
Furnace Tube	--	.52*	.05	.05	.05	--		.126	<1.64*
Return Tube	.52	--	.05	.05	.05	<.05*		<.126*	<1.69*
Filter on Inlet Box	<.234*	.234	--	small*	small*	small*		≪.126*	<1.44*
Filter on Outlet Box	<.234*	.234	small*	--	small*	small*		≪.126*	<1.44*
Filter on Furnace Tube	.234	<.234*	small*	small*	--	.178		≪.126*	<1.61*
High Temp. Filter on Furnace	≪.234*	≪.234*	small*	small*	.178	--		≪.126*	<1.61*
Residue Bottle	<.52*	<.52*	small*	small*	small*	small*		--	<1.88*

*Conservative estimates based on the actual calculations.

SECTION 302.- 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 tube to the furnace tube).

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

Ω = .52 steradians

NOTE: In Table 306-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 tube:

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 furnace tube:

The formula used in this calculation was:

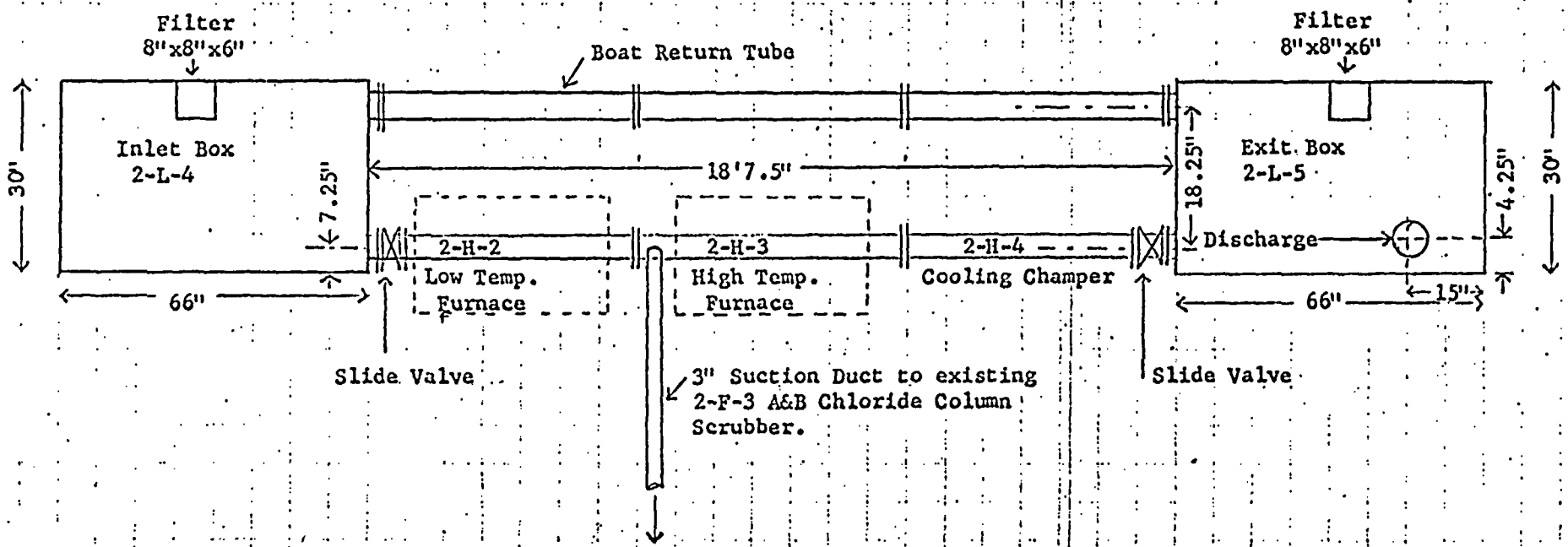
$\Omega = 2\pi (1-\cos\theta)$:

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

PLAN VIEW OF BOAT CALCINER



Elevations:

Bottom of Hoods, Furnace Tubes & Return = 38"

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FRP
Wood River Jct., R.I.
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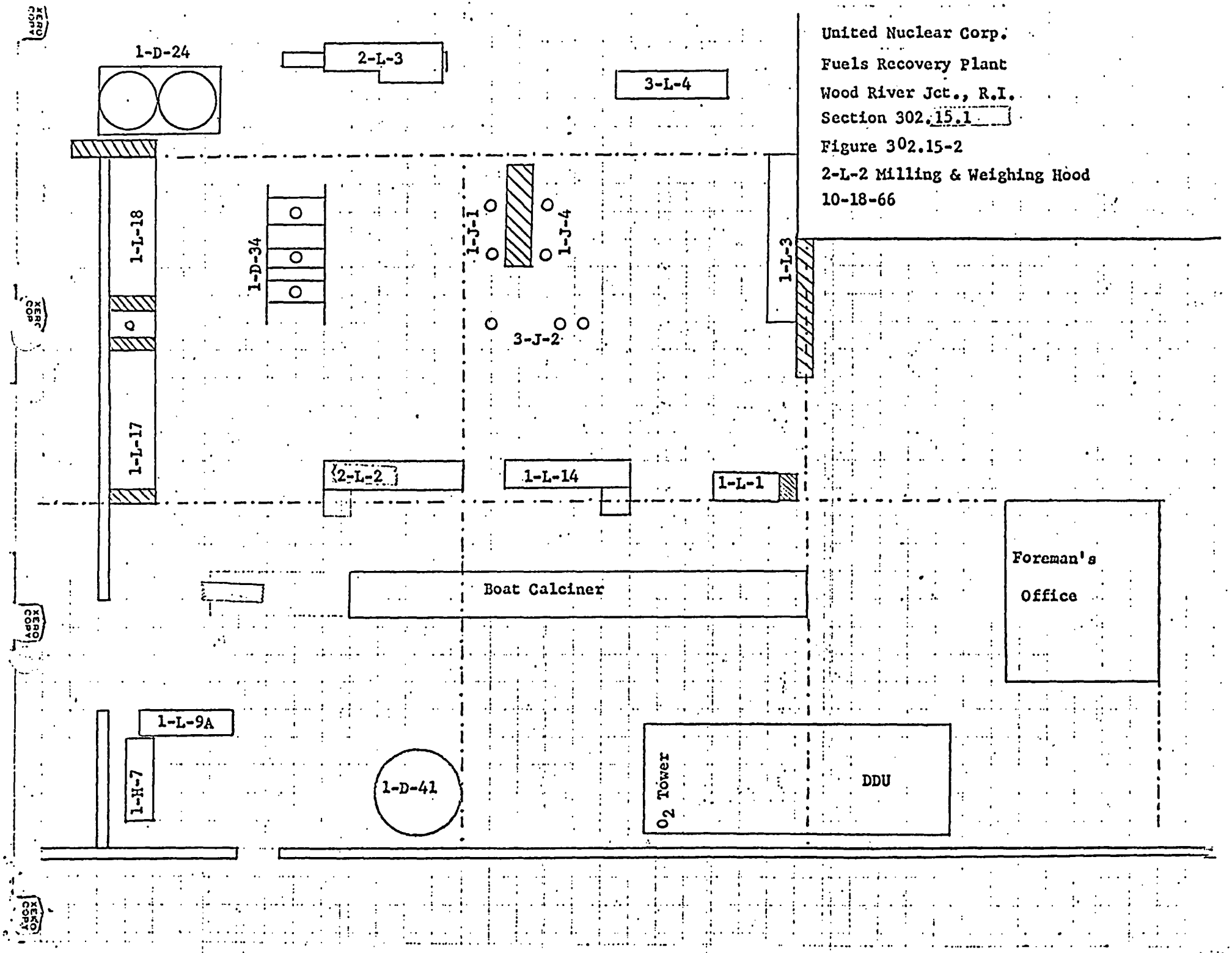
Section 302.15
Figure 302.15-1


United Nuclear Corp.
Fuels Recovery Plant
Wood River Jct., R.I.
Section 302.15.1
Figure 302.15-2
2-L-2 Milling & Weighing Hood
10-18-66
1-D-24
2-L-3
3-L-4
1-L-18
1-L-17
1-D-34
1-J-1
1-J-4
3-J-2
1-L-3
2-L-2
1-L-14
1-L-1
Boat Calciner
Foreman's Office
1-L-9A
1-H-7
1-D-41
O_2 Tower
DDU