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UNITED STATES
ATOMIC ENERGY COMMISSION

C11-6
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DIVISION OF INSPECTION REPORT

By ~~L. D. Low~~ Dated ~~April 2, 1956~~

Title: INSPECTION REPORT - LINDSAY CHEMICAL COMPANY, 258 ANN STREET, WEST CHICAGO, ILLINOIS

Ltr R-106

BRIEF OF FINDINGS

This was primarily an informational type visit.

The primary purpose was to determine whether or not the manufacture of thorium nitrate would require inspection under 10 CFR 20 (Standards for Protection Against Radiation). It is the conclusion of the inspectors that inspections will be required for licensees engaged in the manufacture of thorium nitrate from monazite sands.

Subject company is not currently subject to 10 CFR 20 (Standards for Protection Against Radiation) but will be required to comply when their license expires on May 1, 1956, since Part 20 is usually incorporated by reference in recent renewals of consumer licenses.

Subject company has retained the services of a consultant for radiation safety who is currently engaged in establishing operating procedures in accordance with provisions of 10 CFR 20.

Deficiencies of 10 CFR 20 were noted and furnished Hansen Blatz who is serving on the Committee that is preparing the final issuance of this regulation. They are as follows:

Thorium-232 and -233 are omitted from Appendix B

Thorium is omitted from Paragraph 20.23 (Caution Signs and Labels); Paragraph (e), (ii) and (f).

A "field test" of a tentative inspection procedure for 10 CFR 20 was accomplished and pertinent revisions are being made on the basis of this experience.

Work measurement estimates indicate that it would take an inspector three to five days to conduct an inspection of an activity having the scope of the Lindsay Company.

Distributed to: DIE

Approved _____

Period of Inquiry:
March 20 - 21, 1956

Prior to Exit Interview of Division Director

Pertinent observations concerning difficulties with current reporting procedures under 10 CFR 40 (Source Material) are being furnished the Division of Civilian Application. Radiation measurements and air sample analysis are being made available to the Lindsay Company.

No evidence of non-compliance was noted.

DETAILS

The purpose of this visit was to acquaint the writer and Paul Klevin (Health and Safety Laboratory, NYOO) with the process employed by Lindsay Chemical Company to determine if their activities under 10 CFR 20, Standards for Protection Against Radiation, were such that routine inspections should be conducted by the Inspection Division. This visit was also scheduled in order to "field test" a tentative inspection procedure for Part 20.

The following individuals were interviewed:

Mark W. Eichelberger, Vice President and Treasurer
Clifford W. Stabenau, Secretary and Production Manager
Lloyd H. Hansen, Purchasing Agent
Howard Kremers, Ph.D., Technical Advisor to the President
Robert S. Landaeur, Ph.D., Consultant to Lindsay and Company for Radiation Safety

The writer and Mr. Klevin, after discussing the purpose of the visit, spent considerable time in discussing 10 CFR 20 with officials of the company. It was noted that License R-106 expires on May 1, 1956, and that 10 CFR 20 would probably be incorporated in the license renewal as of that date so that it would be effective. The following items were noted during this discussion.

1. The AEC should properly establish standard units in all regulations for material weights, radiation measurements, exposure rates, air sampling analysis, etc., so that the same units will be used in licensee records, AEC Inspection Reports, and other related data such as inventories, radiation surveys, personnel monitoring records, reports and correspondence. In this case company officials indicated that if we had such standardization they would then maintain their records, measuring equipment, etc. in the same units.

2. It was noted that thorium-232 was omitted from Appendix B to 10 CFR 20.

3. It was noted that thorium-233 was not included in Appendix B of 10 CFR 20.

4. The question was raised as to whether or not Paragraph 20.22 (Personnel Monitoring) of 10 CFR 20 was intended to include alpha radiation.

5. Paragraph 20.23 (Caution Signs and Labels) (c) (ii) should probably include a time element perhaps in terms of "stay" time.

6. Paragraph 20.23 (Caution Signs and Labels) (e) (ii) and (f) do not include any reference to source material. It would appear that this may be an oversight.

7. Paragraph 20.32 (Waste - Burial) and 20.33 (Waste - Sewers) of 10 CFR 20 do not specifically regulate the type of waste disposal practices by Lindsay (and probably by any other companies in the same type of operation).

The Lindsay Company has generated approximately 20,000 tons (about 400,000 cubic feet) of waste during the past 15 years. This waste is comprised of about 10,000 tons of mesathorium. The waste is in the form of a solid that is dumped in sludge piles on 12 acres of ground owned by the company. In dry weather it may dry out to the point where air-borne dust would be in existence. Rain water can carry radioactive contamination off the property. Nothing is known as to the amount of contamination, if any, in the subsurface water. It was noted that the water table rises to about eight feet within the surface and that the surrounding population (homes) get their water from wells. In addition, a liquid waste is pumped into open sumps on the 12 acres where the liquid is leeched (seeps) into the subsurface. Periodically the residue of solids is collected from the sumps and added to the piles.

[redacted]

It was noted that this waste material had a significant gamma radiation count as reflected in the attachment and that the area was not fenced on one side.

It may be practical to interpret the operating control procedures in 10 CFR 20 to cover this problem by establishment of controlled area, but again, specific regulations may be more desirable.

During discussions with company officials, it was noted that they considered their process flow sheets as Company Confidential. They requested that such information not be included in the Inspection Report, unless it was absolutely necessary. In this particular instance, it was not necessary since plant lay-out served the purpose. This is recorded as an observation for future instruction of inspectors. They should be cautioned not to request process or flow information that is Company Confidential, unless it is absolutely necessary to the inspection. It appears that process temperatures, exact weights, measurements and time cycles are not usually pertinent and can be excluded.

In addition, two general observations were made during this visit regarding the demeanor that should be practiced by an inspector. They are:

[redacted]

1. Extreme caution should be exercised by an inspector when he is taking radiation measurements or air samples in the presence of employees. At least psychological fear of radiation may be inferred or implied by indiscrete words or acts. For example, it was noted during this particular visit that the company was currently negotiating with the Labor Union. It is quite likely that any observations by workmen of a radiation meter registering at the upper limits of a scale would create apprehension and misunderstanding on his part. Inspectors must be carefully instructed in this regard and should adhere to very strict ground rules.

[redacted]

2. Likewise, Inspectors should be very careful in conducting radiation measurements or air samples in unrestricted areas of the licensee property. Here again, the misunderstanding and apprehension of a person not connected with the company may create the basis for nuisance suits and damage to the company's public relations.

Although the Lindsay file from the Division of Civilian Application does not contain any copies of monthly inventory it was noted that the license did require the reporting of inventories, processing consumption, receipts, and deliveries of source material periodically. Mr. Hansen, the Purchasing Agent, advised that this required about 12 man hours per month to prepare the required reports. He stated that, if the AEC did not have this requirement, the company would normally maintain a perpetual inventory on the monazite sands and an inventory of final products. Mr. Hansen felt that a quarterly report on in and out amounts to the Commission would not be too difficult but "processing consumption" was rather meaningless.

Mr. Klevin, after reviewing the process, selected 16 locations where air samples and radiation measurements were taken. This information will be set out in Appendix to this report.

GENERAL OBSERVATIONS

The Lindsay Company has not established Health and Safety procedures from the radiation standpoint. Dr. Landaeur was recently retained by the company as a consultant to establish procedures. Dr. Landaeur or company officials had not seen Part 20 and they appeared very grateful for the opportunity to discuss it with representatives of the Commission. They were equally grateful for the opportunity to observe the techniques of air sampling. Dr. Kremers was told that the Commission would make available to him the laboratory analysis of the air samples.

The Lindsay Company is engaged almost exclusively in the manufacture of thorium oxide and thorium nitrate and rare earths. The company does not have any contractual relationship with the AEC except a unit price contract for thorium nitrate.

A draft inspection procedure was "field tested" and will require substantial revision in the light of this experience. Primarily the procedure did not require the specific factual data that will obviously be required to evaluate compliance with Part 20.

It is the opinion of the writer and Mr. Klevin that it would take one man at least three to five full days to inspect a licensee activity of this scope and type. It will take at least one-half day for the inspector to comprehend the process and to review the company procedures. At least one-half day will be required to review the records that must be kept in accordance with 10 CFR 20 and at least two to three full days to obtain air samples and

and radiation measurements. In this regard, it is believed that at least three 15-minute air samples should be taken at each location. The number of locations, of course, will depend upon the discretion of the inspector.

NOTE: All observations concerning Part 20 have been made available to Hannen Blatz for consideration in the preparation of the final issuance in the CFR.

Attachment:
Appendix

COPY

APPENDIX

LINDSAY CHEMICAL COMPANY, WEST CHICAGO, ILLINOIS

A. Description of Process

1. Monozite sand received in 100 pound bags are dumped into a rotary drying furnace. The dried sand is loaded into buggies and transferred to a sand storage hopper on the fourth floor by bucket elevator. Five hundred pound batches of sand, mixed with barium carbonate are reacted with sulfuric acid yielding a "pot cake" ($Th(SO_4)_2$, rare earth $(SO_4)_3$, $H_3P_2O_4$, gangue). Unreacted sand is dried, recrushed and treated as virgin sand.

2. The pot cake is leached with water and separated centrifugally yielding Th as PO_4 - complex, rare earth $(SO_4)_3$ and gangue (first rare earth (RE) sulfate).

3. First RE sulfate is leeched with water filtered yielding a RE solution containing some thorium and gangue cake containing mesothorium and calcium sulfate. The cake is sent to an open 12 acre storage area about 1/8 miles from the plant. The RE solution is treated with P_2O_7 yielding a Th PO_3 precipitate which is treated as in # 2 above. The remaining RE solution containing approximately 0.2 #Th per 100# RE is treated with Na_2SO_4. The resulting RE $(SO_4)_3$ $NaSO_4$ H_2O solid is conveyed into the RE plant or stored on the 12 acre property. The waste is sent to the company's sewer or outside sump area.

4. The thorium solution from centrifuge is treated with HF yielding Th F_4 and spent acids which consist of 0.05 gms/l ThO_2, 10% H_3PO_4 and 30% H_2SO_4. These acids are sold. The ThF_4 is leached with a soda ash solution, the residue precipitated with caustic, dissolved in HCl and precipitated with H_2SO_4 yielding a Th $(OH)_2$ which is leached with nitric acid to produce a thorium nitrate solution. The Th NO_3 (TNT) solution is crystallized, centrifuged and recrystallized to produce a purified TNT which is packaged and shipped.

5. TNT precipitated with oxalic acid yields thorium oxalate which upon calcining is decomposed to thorium oxide which is packaged and shipped.

B. Measurements

1. Results of Air Dust Samples - If it is assumed that the radioactive toxicity of thorium is the same as that for uranium three of the 15 samples collected inside the operating area were found to exceed the permissible airborne levels (5×10^{-11} uc/ml or 110 d/m/M^3 A

description of these samples and the results follow:

Sample Description	Type Sample	Concentration d/m/M3	Concentration uc/ml
In front of Monozite loading hopper prior to operation	general air	177	8 x 10-11
Charging pot buggy with monozite sand	breathing zone - general air	403	19 x 10-11
At charging site in monozite roasting area	general air	753	34 x 10-11

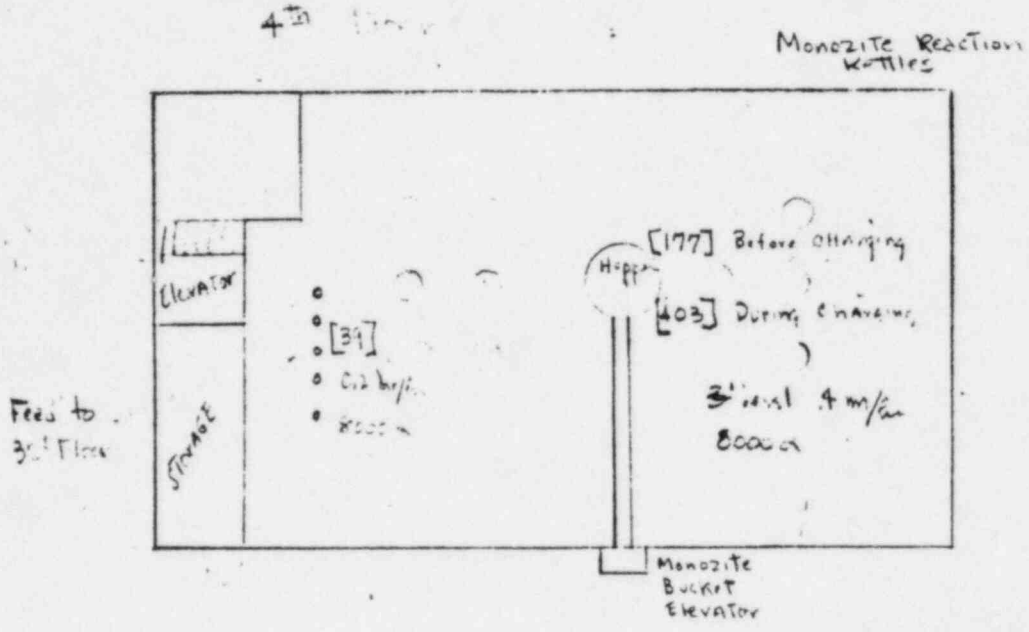
2. Results of direct radiation measurements made with a Juno and Detectron are included on the diagrammatic layout of the plant operations areas. The highest reading implant were found on the second area adjacent to TNT Evaporation Kettle and thorium sulfate filtration areas. A gamma reading of 30 mr/hr was found in contact with wood tank. Average three foot level readings in this area ranged between 3-5 mr/hr. Thorium sulfate tanks on the third floor revealed 10-15 mr/hr γ at contact with the tanks. Three foot level readings in this area were 2 mr/hr γ.

   A direct radiation survey of the 12 acre storage area showed the piles of mesothorium inside the area to measure 50 mr/hr γ at contact; sump material storage measured 10 mr/hr at contact; rare earth material measured 3 mr/hr γ. Other contact measurements taken on material between the mesothorium storage area and the end of the storage area ranged from 20-50 mr/hr γ. Access to the general storage area is available to the general public, although not obviously so.

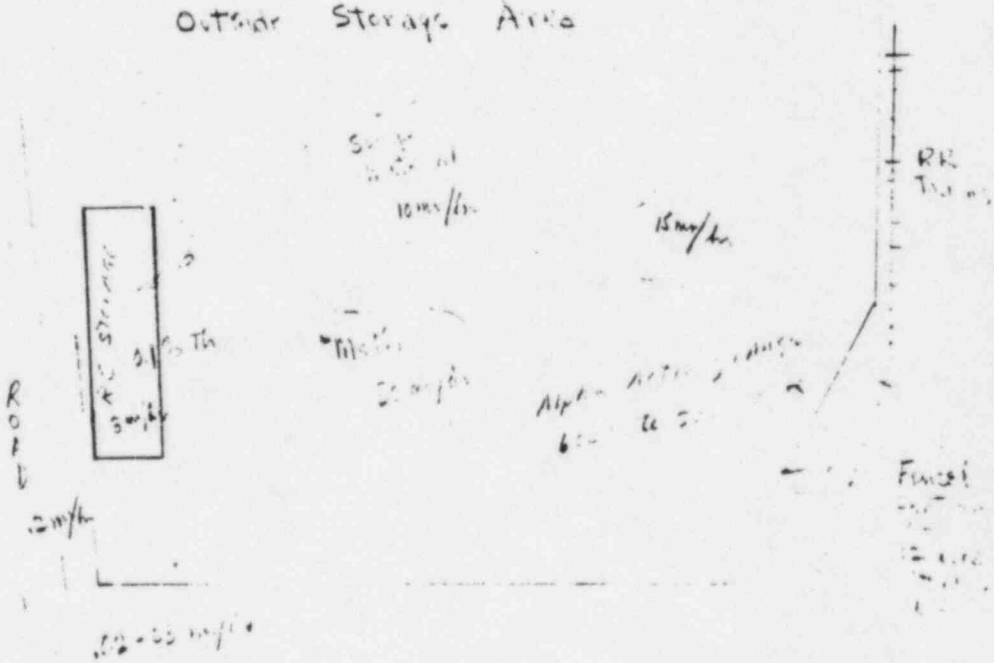
   On the road outside of the fence which partially encloses the storage area, readings from .02 to .2 mr/hr γ were obtained.

Layout Lindsay [illegible]

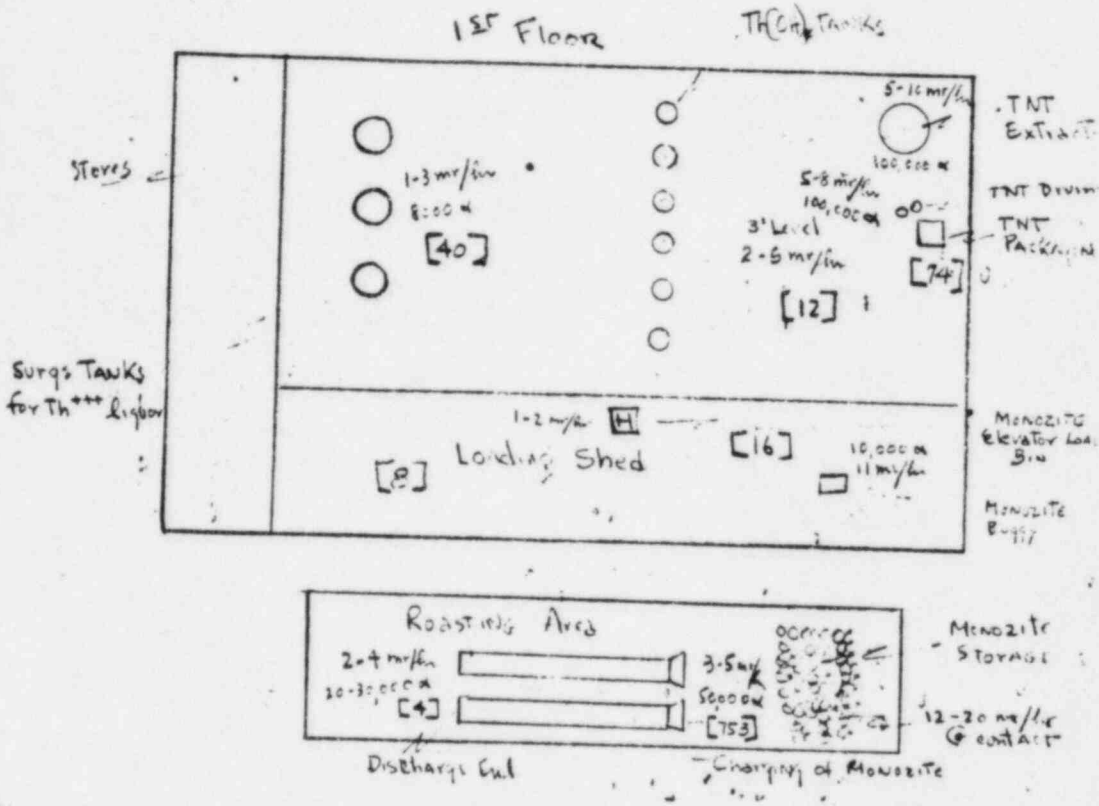
4th [illegible]



Outdoor Storage Area



Layout of Operating Area - Lindsay Chemical Co.
Showing Results of Air Samples and Radiation Measurements

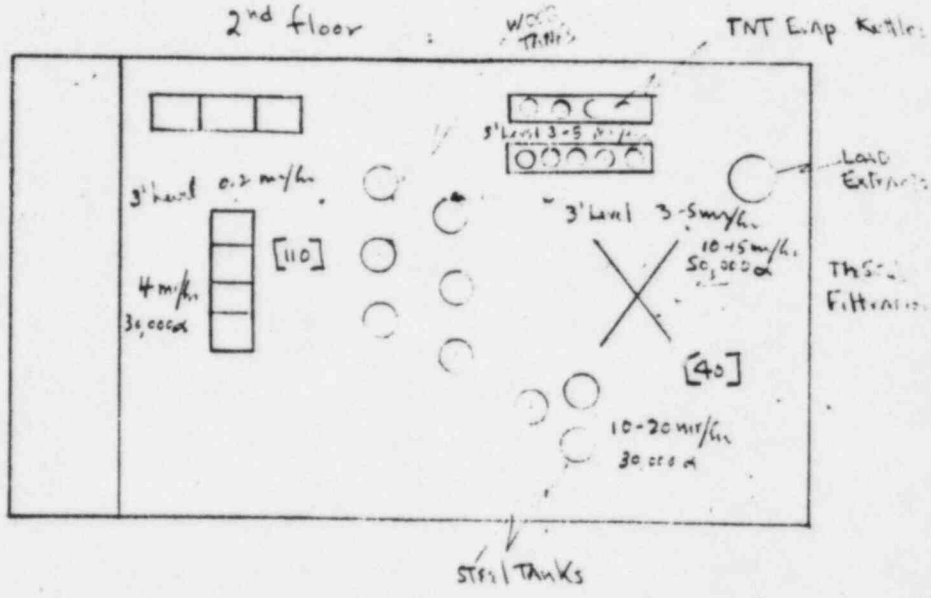


Legend

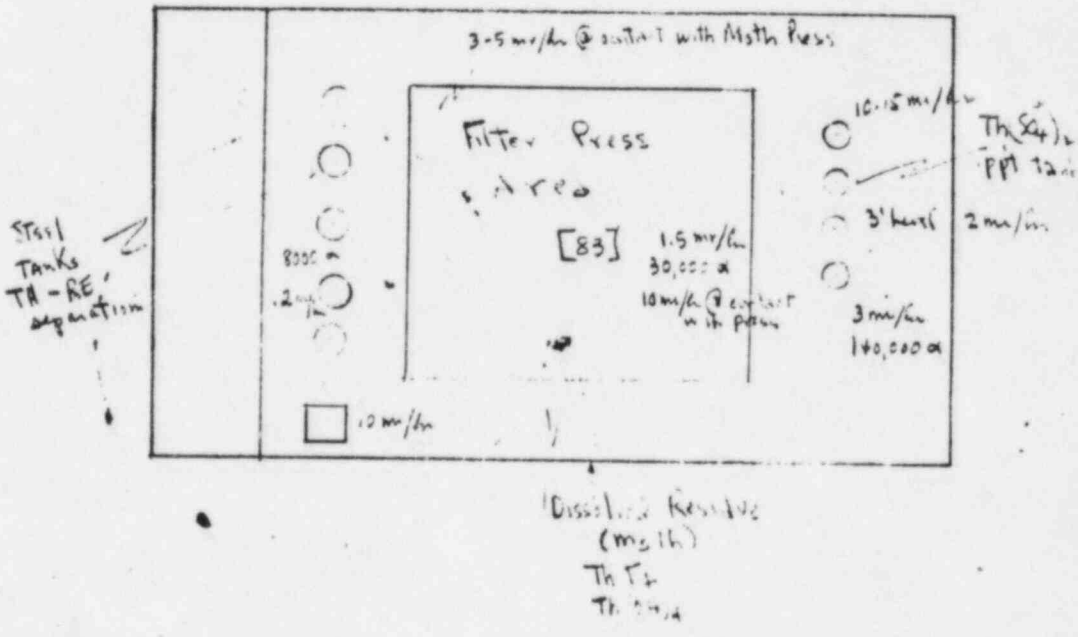
All radiation measurements are contact measurements unless specified
gamma readings expressed in mr/hr
Direct Alpha measurements expressed in α d/m/100 cm²
Air sample results expressed in d/m/M³ and are inside [ ]

LAYOUT (Lindsay Chem ... (...)

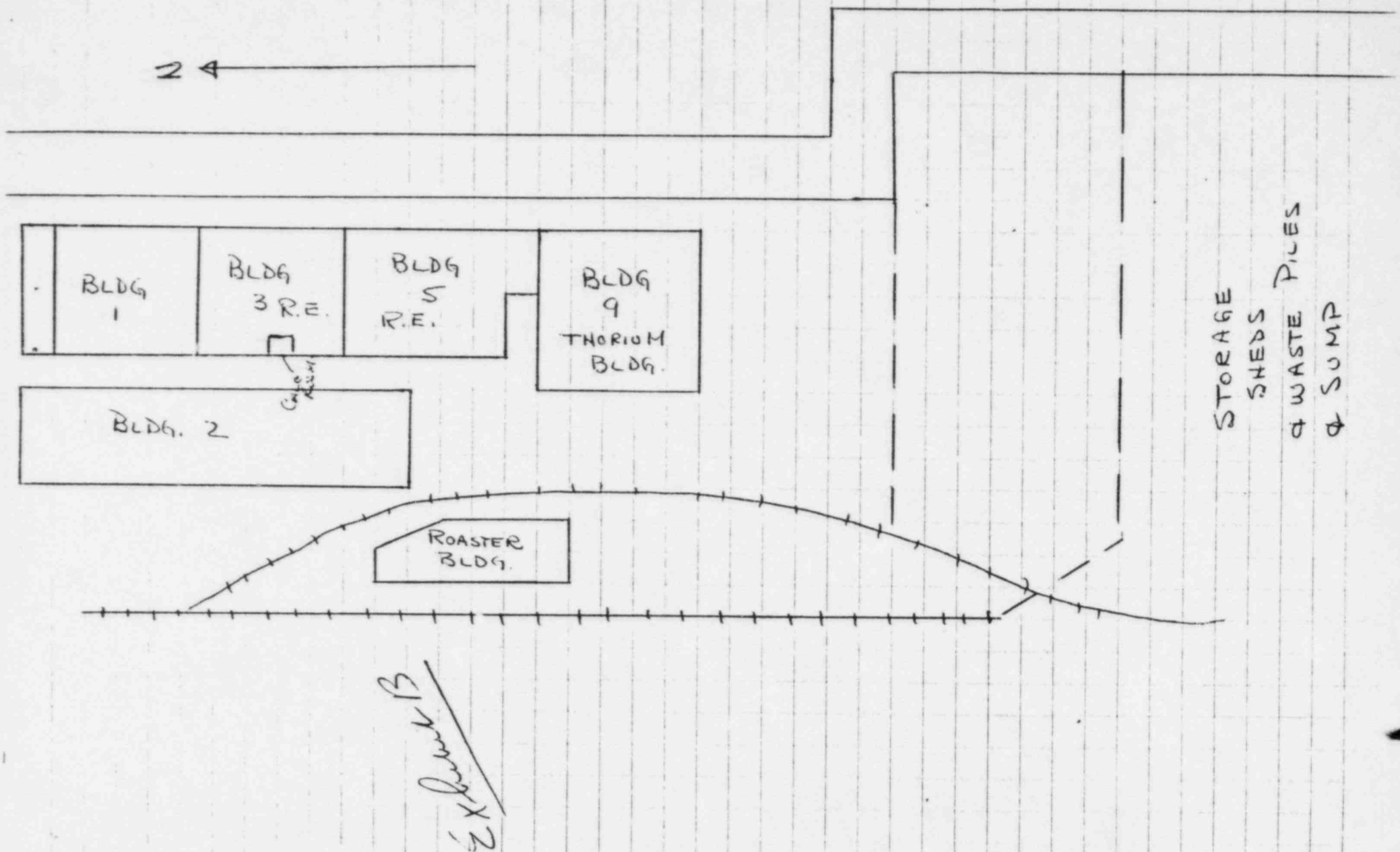
2nd floor

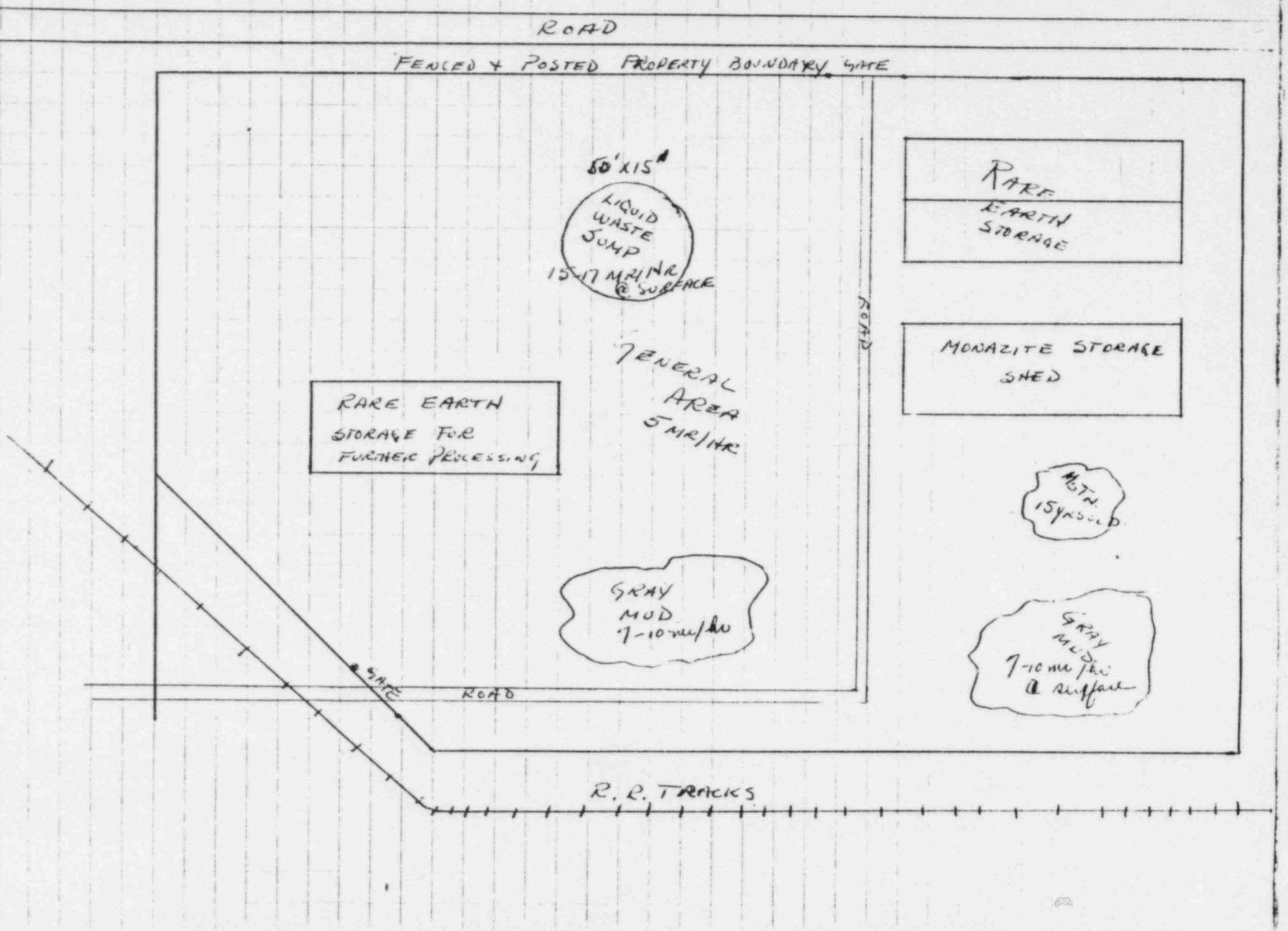


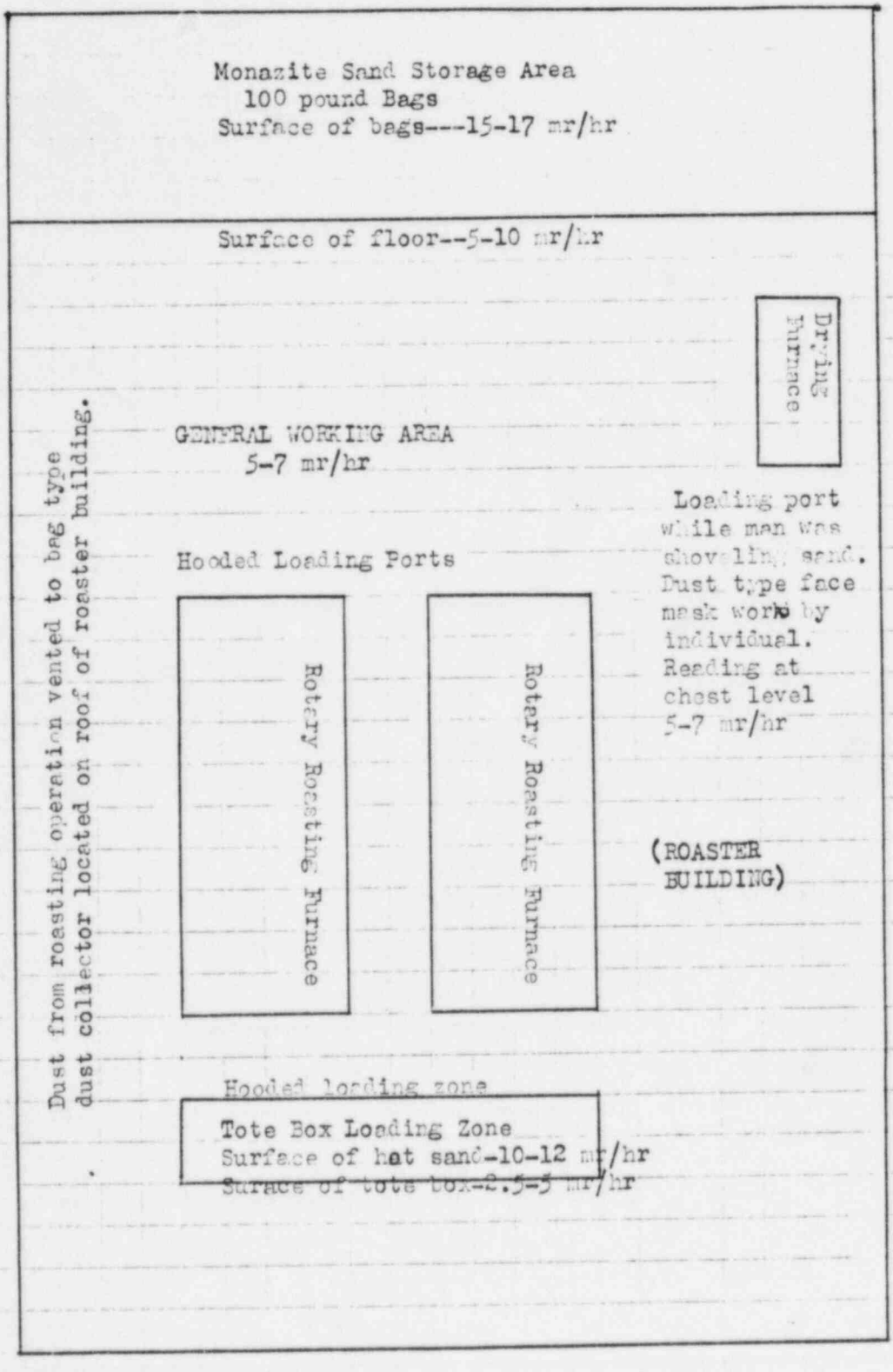
3rd Floor

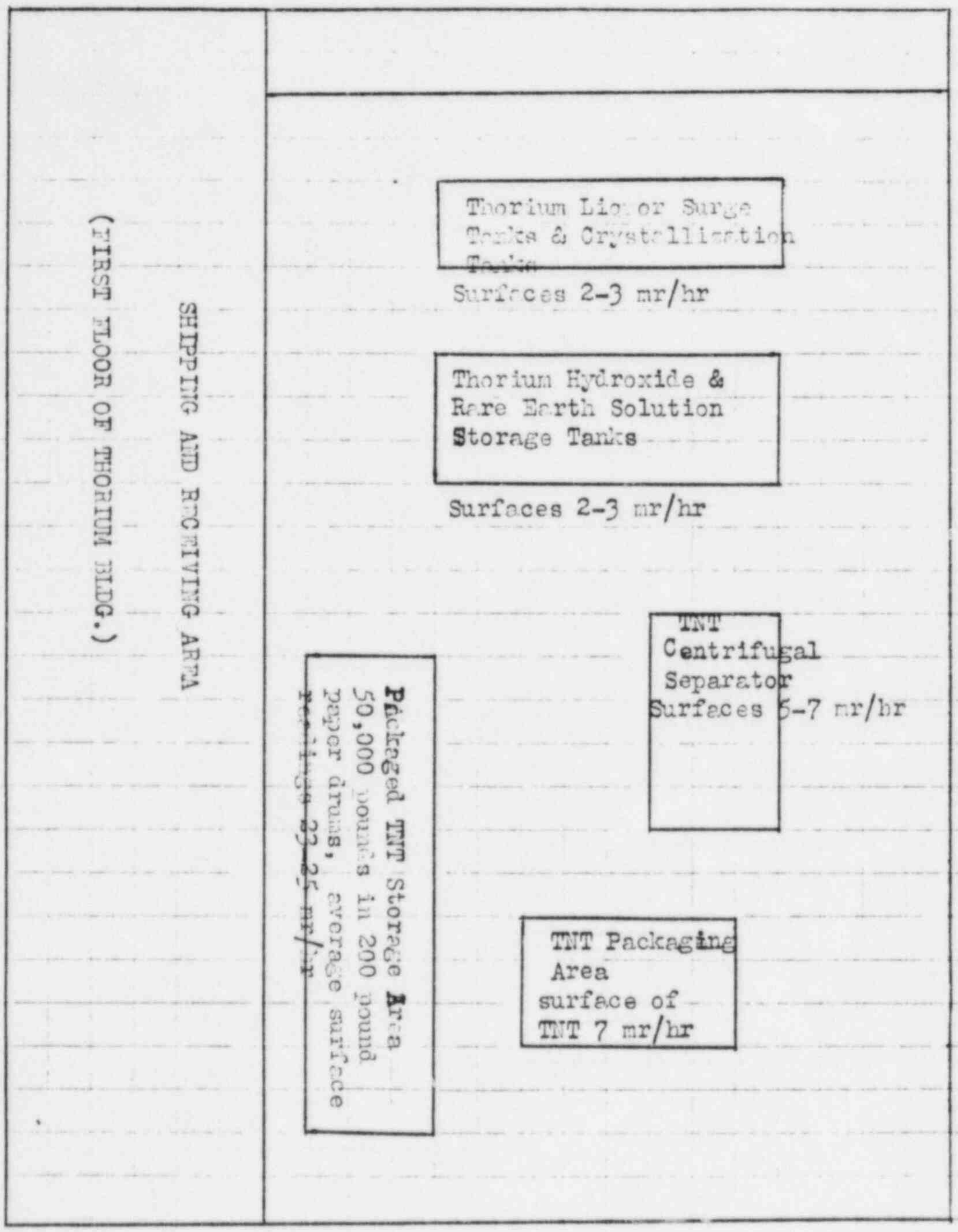


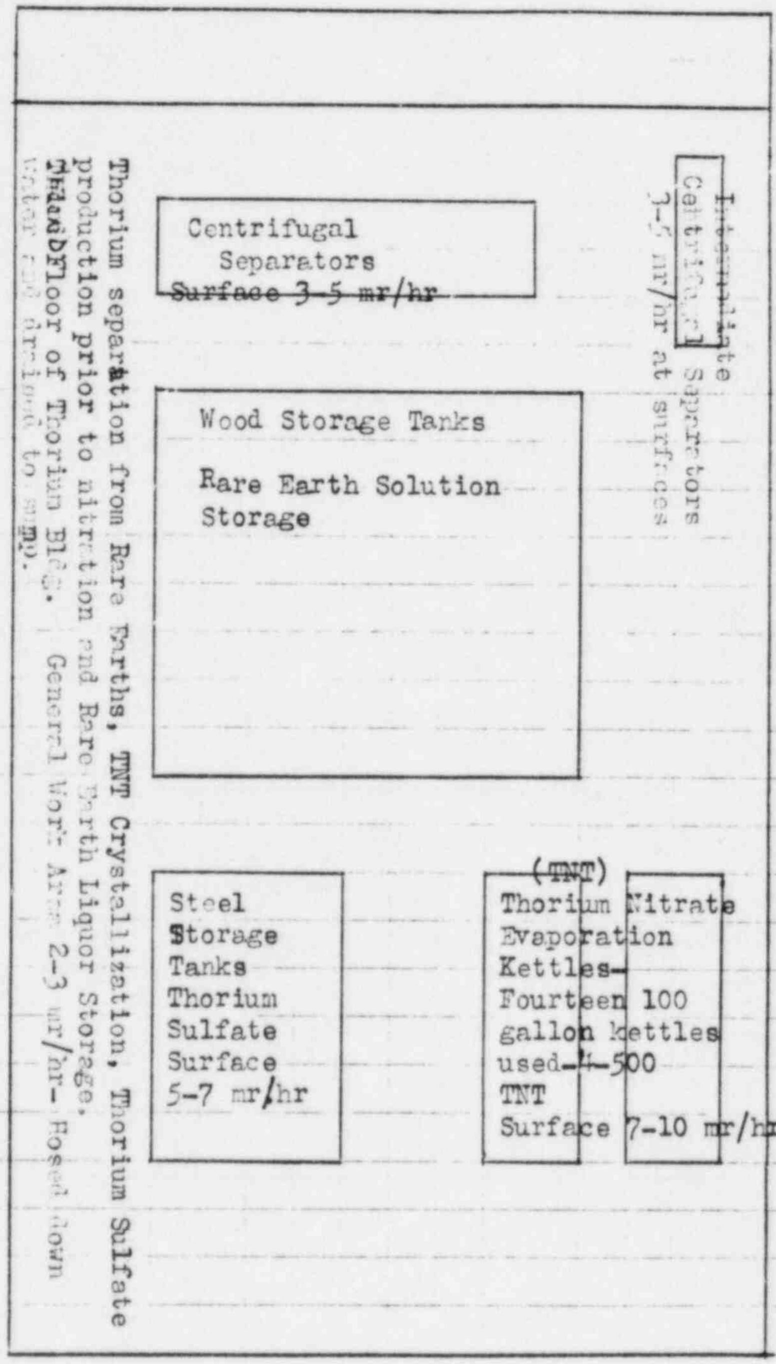
LINDSAY CHEMICAL CO.
PLANT SITE

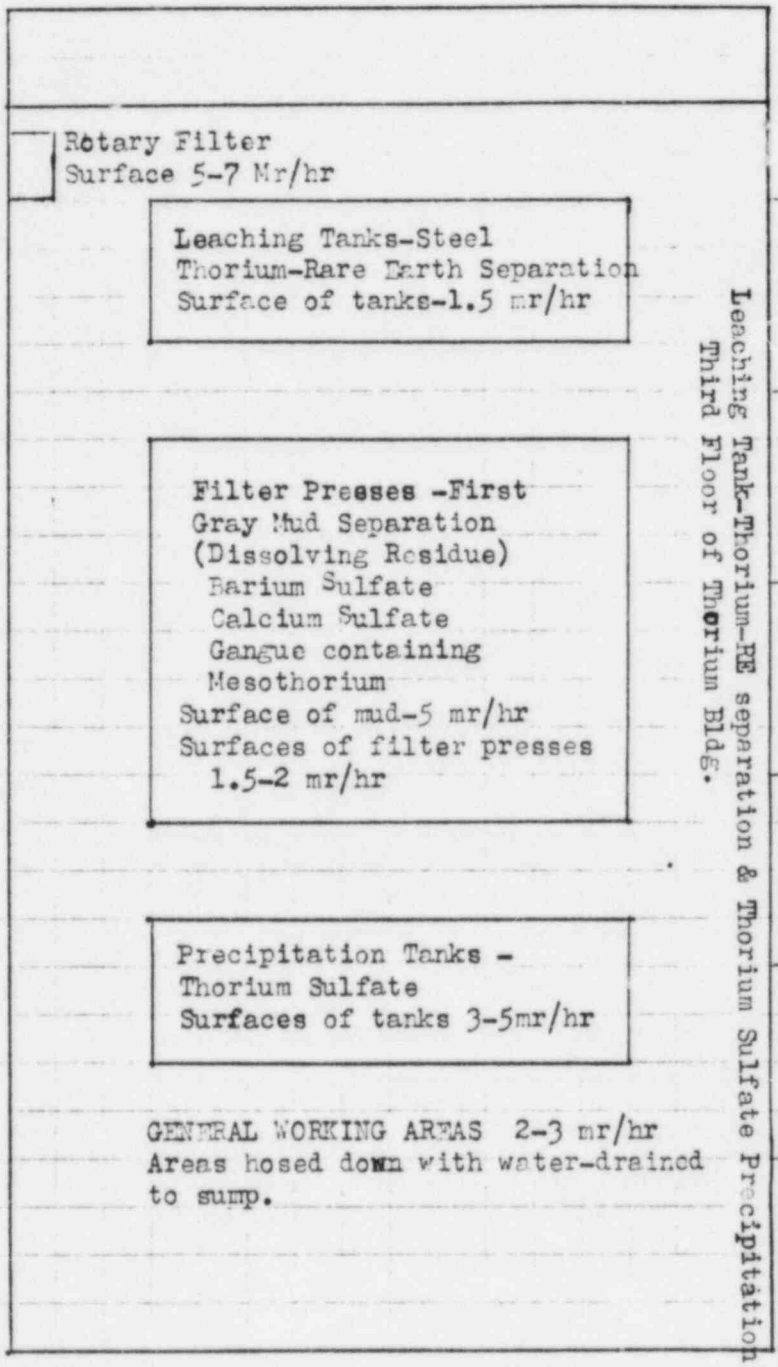


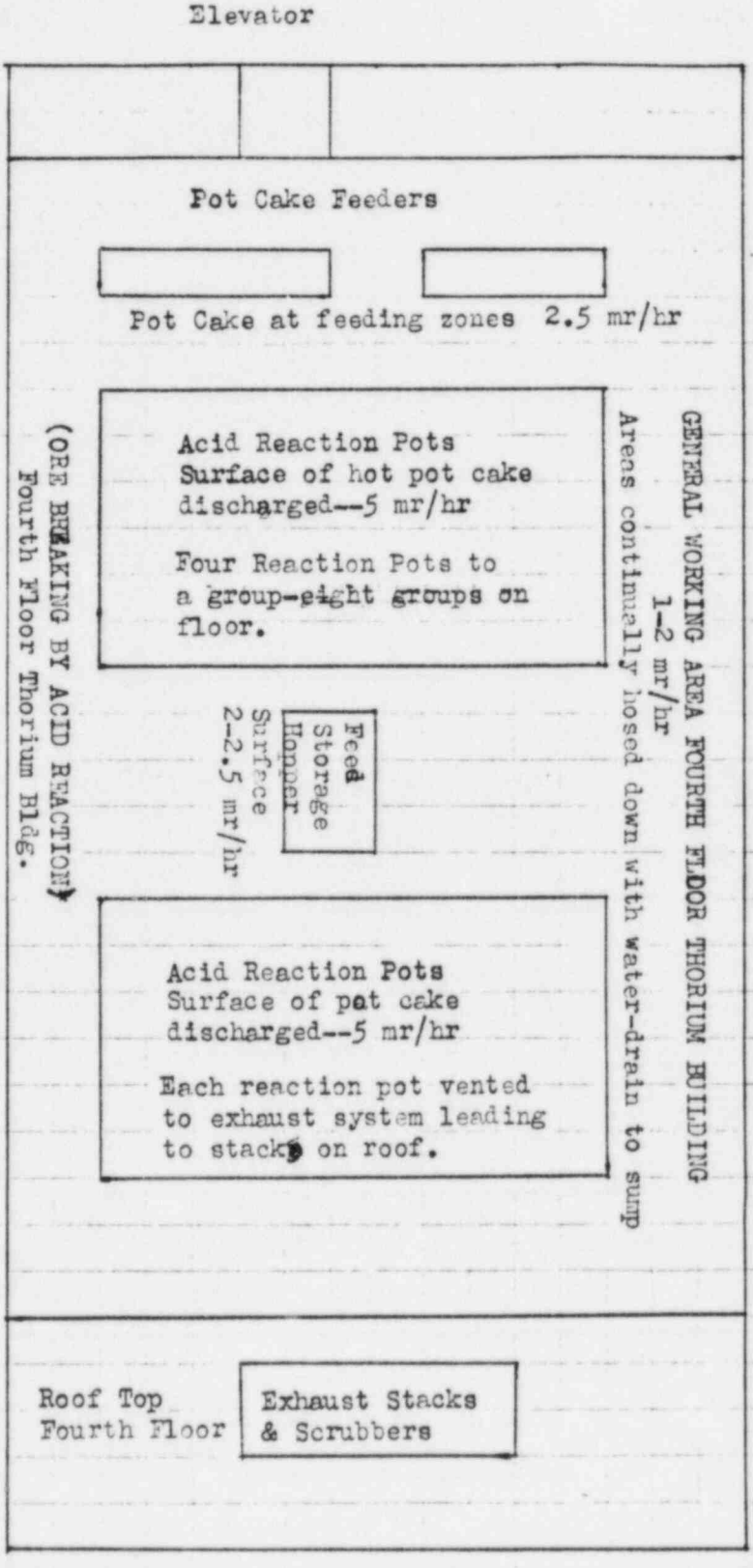

ROAD
FENCED + POSTED PROPERTY BOUNDARY GATE
50'x15'
LIQUID WASTE SUMP
15-17 MR/HR @ SURFACE
RARE EARTH STORAGE
ROAD
MONAZITE STORAGE SHED
GENERAL AREA 5 MR/HR
RARE EARTH STORAGE FOR FURTHER PROCESSING
MTN. 15 y
GRAY MUD 7-10 mr/hr
GRAY MUD 7-10 mr/hr @ surface
GATE
ROAD
R. R. TRACKS


Monazite Sand Storage Area
100 pound Bags
Surface of bags---15-17 mr/hr
Surface of floor--5-10 mr/hr
Drying Furnace
GENERAL WORKING AREA
5-7 mr/hr
Loading port while man was shoveling sand. Dust type face mask worn by individual. Reading at chest level 5-7 mr/hr
Hooded Loading Ports
Rotary Roasting Furnace
Rotary Roasting Furnace
(ROASTER BUILDING)
Dust from roasting operation vented to bag type dust collector located on roof of roaster building.
Hooded loading zone
Tote Box Loading Zone
Surface of hot sand-10-12 mr/hr
Surface of tote box-2.5-5 mr/hr


SHIPPING AND RECEIVING AREA
(FIRST FLOOR OF THORIUM BLDG.)
Thorium Liquor Surge Tanks & Crystallization Tanks
Surfaces 2-3 mr/hr
Thorium Hydroxide & Rare Earth Solution Storage Tanks
Surfaces 2-3 mr/hr
TNT Centrifugal Separator
Surfaces 5-7 mr/hr
Packaged TNT Storage Area
50,000 pounds in 200 pound paper drums, average surface
TNT Packaging Area
surface of TNT 7 mr/hr


Intermediate Centrifugal Separators
3-5 mr/hr at surfaces
Centrifugal Separators
Surface 3-5 mr/hr
Wood Storage Tanks
Rare Earth Solution Storage
Steel Storage Tanks Thorium Sulfate
Surface 5-7 mr/hr
(TNT)
Thorium Nitrate Evaporation Kettles-
Fourteen 100 gallon kettles used 4-500 TNT
Surface 7-10 mr/hr
Thorium separation from Rare Earths, TNT Crystallization, Thorium Sulfate production prior to nitration and Rare Earth Liquor Storage.
Third Floor of Thorium Bldg. General Work Area 2-3 mr/hr- Hosed down water and drained to sump.


Rotary Filter
Surface 5-7 Mr/hr
Leaching Tanks-Steel
Thorium-Rare Earth Separation
Surface of tanks-1.5 mr/hr
Filter Presses -First
Gray Mud Separation
(Dissolving Residue)
Barium Sulfate
Calcium Sulfate
Gangue containing
Mesothorium
Surface of mud-5 mr/hr
Surfaces of filter presses
1.5-2 mr/hr
Precipitation Tanks -
Thorium Sulfate
Surfaces of tanks 3-5mr/hr
GENERAL WORKING AREAS 2-3 mr/hr
Areas hosed down with water-drained
to sump.
Leaching Tank-Thorium-RE separation & Thorium Sulfate Precipitation
Third Floor of Thorium Bldg.


Elevator
Pot Cake Feeders
Pot Cake at feeding zones 2.5 mr/hr
Acid Reaction Pots
Surface of hot pot cake discharged--5 mr/hr
Four Reaction Pots to a group-eight groups on floor.
Feed Storage Hopper
Surface 2-2.5 mr/hr
Acid Reaction Pots
Surface of pot cake discharged--5 mr/hr
Each reaction pot vented to exhaust system leading to stacks on roof.
GENERAL WORKING AREA FOURTH FLOOR THORIUM BUILDING
1-2 mr/hr
Areas continually hosed down with water-drain to sump
(ORE BREAKING BY ACID REACTION)
Fourth Floor Thorium Bldg.
Roof Top
Fourth Floor
Exhaust Stacks & Scrubbers