6204 G-000-104 .119

SUBMITTAL OF FMPC PROJECT 6-053, SCRAP PICKLING FACILITY FOR A DETERMINATION UNDER 40 CFR 61.06 AS TO WHETHER EPA ADMINISTRATOR APPROVAL IS REQUIRED FOR PROJECTED WORK

12/15/88

DOE-303-89
DOE-FN USEPA
22
LETTER

6204

Department of Energy
Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831—

December 15, 1988
DOE-303-89

Mr. David Kee, Director
Air and Radiation Division
U.S. Environmental Protection Agency
Region V, Mail Code 5AC-26
230 South Dearborn Street, 13th Floor
Chicago, IL 60604

Dear Mr. Kee:

SUBMITTAL OF FMPC PROJECT 6-053, SCRAP PICKLING FACILITY FOR A DETERMINATION UNDER 40 CFR 61.06 AS TO WHETHER EPA ADMINISTRATOR APPROVAL IS REQUIRED FOR PROJECTED WORK

Reference is made to a letter dated January 11, 1988, from J. A. Reafsnyder to Bill Franz, subject: "Demonstration of Compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPS) - Feed Materials Production Center (FMPC)."

Enclosed is an application for a determination by the administrator under 40 CFR 41.06 as to whether the equipment to be installed is a modification of the source (the entire FMPC site) as defined by 40 CFR 61.15. If so, please consider the submittal as an application to modify under the requirements of 40 CFR 61.07. This is a very minor source of the same magnitude as the fourteen (14) submitted on August 9, 1988, and the two submitted on November 8, 1988, for a similar determination.

The application format followed is that required by the Ohio EPA for permits to install (PTIs). Calculation of dose equivalents follows the same methodology as that in the previous submittals and is based on the 1986 computations provided in the computer printouts enclosed with the reference letter.

We would appreciate a timely review of this application under 40 CFR 61.06 and 61.07 if the latter is applicable. If you have any questions or require additional information, please contact Weldon Dillow of our Environmental Protection Division at FTS 626-1354.

Sincerely,

Ray Hansen for

James A. Reafsnyder
Site Manager

SE-311:Dillow

See Page 2 for Enclosure and ccs.

Enclosure:
FMPC No. 6-053, Scrap Pickling Facility--
Application for a Determination if Installation
of FMPC No. 6-053 is a modification pursuant to
40 CFR 61.15.

cc w/o enclosure:
L. C. Goidell, SRO
M. L. Galper, WMCO
R. F. Hodanbosi, OEPA
J. C. Tseng, EH-23, FORSTL
M. Neal, DP-84

ENCLOSURE

FMPC Source 6-053

SCRAP PICKLING FACILITY

ENCLOSURE

METHODOLOGY FOR CALCULATING THE DOSE TO MAXIMALLY EXPOSED MEMBERS OF THE PUBLIC FROM PLANT 6 SCRAP PICKLING FACILITY (6-053)

No separate calculations for Plant 6 were made for the 1986 emissions, therefore, the emissions and committed dose equivalents for the entire FMPC site for 1986 are used in calculating the committed dose equivalents for Plant 6 equipment. The uranium site emissions for 1986 were as follows:

Uranium Emissions

U-234 - 9.10×10^{-3} Ci or 1.47 g
U-235 - 4.53×10^{-4} Ci or 212 g
U-238 - 9.72×10^{-3} Ci or 29200 g

Total U emissions - 1.93×10^{-2} Ci or 29412 g

Committed dose equivalents from the FMPC 1986 emissions which include uranium, fission products, radium, thorium, neptunium, and plutonium are:

Effective committed dose equivalent -- 1.18 mrem
Lung committed dose equivalent -- 7.38 mrem
Endosteal bone committed dose equivalent -- 7.14 mrem

Then the committed dose equivalents from the Plan 6 Scrap Pickling Facility which are estimated to result in a net increase of 0.3 pounds or 136 grams of uranium plus accompanying radionuclides per year, are:

Effective Committed Dose Equivalent:

$$\frac{1.36 \times 10^{2}\ g \times 1.18\ mrem}{2.941 \times 10^{4}\ g} = 5.5 \times 10^{-3}\ mrem/yr$$

Lung Committed Dose Equivalent:

$$\frac{1.36 \times 10^{2}\ g \times 7.38\ mrem}{2.941 \times 10^{4}\ g} = 3.41 \times 10^{-2}\ mrem/yr$$

Endosteal Bone Committed Dose Equivalent:

$$\frac{1.36 \times 10^{2}\ g \times 7.14\ mrem}{2.941 \times 10^{4}\ g} = 3.30 \times 10^{-2}\ mrem/yr$$

Although these are not rigorous calculations, they are accurate enough to indicate that this facility will have a very minor effect on site emissions and will not affect compliance with the site dose equivalent standards. The numbers calculated above compare favorably with those using 1987 data. For example, in 1987 35.4 Kg of uranium plus accompanying radionuclides were emitted with a calculated effective committed dose equivalent of 1.2 mrem. Then the effective committed dose equivalent for the Plant 6 Scrap Pickling Facility is

$$\frac{1.36 \times 10^{2} \text{ g from Plant 6} \times 1.2 \text{ mrem}}{3.54 \times 10^{4} \text{ g from entire plant}} = 4.6 \times 10^{-3} \text{ mrem}$$

which is comparable to the 5.5×10^{-3} mrem using 1986 data.

For Office Use Only

Check Appropriate Box(es)

___ Air Discharge

___ Water Discharge to New Source Treatment Works

___ Solid Waste Disposal Facility

___ Hazardous Waste Disposal Facility

PTI Application No. _____

Date Received _____

Premise No. _____

OHIO ENVIRONMENTAL PROTECTION AGENCY
Application for Permit to Install

US Department of Energy — Feed Materials Production Center
Applicant's Name

PO Box 398705
Mailing Address

Cincinnati, — Hamilton — Ohio — 45239
City — County — State — Zip Code — Telephone Number

Mary Stone, DOE/FMPC — (513) 738-6656
Person to contact (Name and Title and Telephone Number)

FMPC is located near Fernald, Ohio at 7400 Willey Road
Location of Proposed Facility (State the location as completely and precisely as possible)*

FMPC Plant 6

Crosby Township — Hamilton County — 45030
City or Township — County — Zip Code

Directions: A Permit to Install is required for new or modified sources of pollution under the provisions of OAC Rule 3745-31. An application cannot be considered complete unless all applicable questions are answered and the required information has been submitted. This application must be signed in accordance with OAC Rule 3745-31-04(B) or it cannot be accepted.

Applicants for permits involving air emissions or wastewater treatment facilities will be required to pay a permit to install fee as shown in Section 3745.11(B) and (C) of the Ohio Revised Code. This fee is payable fifteen days after the date of final issuance of the permit.

Name of new or modified source or facility: Ingot and Scrap Pickling Facility Plant (6-053)

Product of new or modified source/facility: Surface cleaned Uranium Ingots and Scrap

Will the proposed source/facility involve any of the following: Check all that apply.

A. X ___ Air Discharge

B. ___ Wastewater Treatment Works

C. ___ Solid Waste Disposal Facility

D. ___ Hazardous Waste Disposal Facility

000006

*Example: "The source will be constructed on a 20 Acre plot to be located on Franklin Township Road No. 17, approximately 1 1/4 miles north of the intersection of State Route 99 and Franklin Township Road No. 17."

6204

Under OAC 3745-31-04, These signatures shall constitute personal affirmation that all statements or assertions of fact made in the application are true and complete, comply fully with applicable state requirements, and shall subject the signatory to liability under applicable state laws forbidding false or misleading statements.

Ray Warren 12/15/88

Authorized Signature (for facility) Date

James A. Reafsnyder
Site Manager

Title

U. S. Department of Energy
P.O. Box 398705
Cincinnati, OH 45239-8705

Address

For Wastewater Treatment Plants:

Signature of General Contractor or Agent Performing installation, if selected. Date

Company

Address

EPA 3150
6/8/82

The following information must be submitted on a separate piece of paper and attached to this application.

FOR ALL PERMITS TO INSTALL

1. **Describe the product or service to be produced by the applicant along with a description of the proposed source/facility.**

2. **List the name and quantity of all materials and chemicals (solid, liquid, or gaseous) that will be used or produced by the source/facility.**

3. **State the reason for the application. Is this a new installation, modification to an existing source/facility, reconstruction of an existing source/facility, or startup of a source/facility that has been permanently shutdown for _____ year** (State number of years)

4. **Has a previous Ohio EPA application or plan submission been filed for this source facility? If so, state the date and type of the application previously submitted**

5. **Will the proposed source/facility comply with all rules, laws, and regulations of Ohio EPA and U.S. EPA?**

FOR AIR POLLUTION SOURCES

6. State the amount of each air contaminant (actual emissions) from each source in pounds per hour and tons per year at maximum and average conditions.

7. Are the proposed sources required to comply with the following federal requirements
   i. New Source Performance Standards (NSPS)
   ii. National Emission Standards for Hazardous Air Pollutants (NESHAPS)
   iii. Prevention of Significant Deterioration (PSD)
   iv. Appendix "S" - Emission Offset Policy

8. Will the proposed sources employ best available technology?

9. Will the proposed sources cause the significant degradation of air quality?

10. Will the proposed sources interfere with the attainment and maintenance of the ambient air quality standards?

11. Describe any source monitoring, emission monitoring, or control equipment monitoring devices to be installed by the applicant.

12. Will the proposed sources involve the use of asbestos, benzene, beryllium, mercury, or vinyl chloride?

13. Complete and attach an anticipated construction schedule for each proposed source (See attached).

14. Please include the estimated cost of any air pollution control equipment to be installed on the proposed sources.

15. An appendix for each air contaminant source must accompany this application. See the following description of the appendices, determine which should accompany your application.

FOR ALL PERMITS TO INSTALL

6204

1. **Describe the product or service to be produced by the applicant along with a description of the proposed source/facility.**

   The Feed Materials Production Center (FMPC) is a government owned facility which produces highly pure uranium metal. The proposed air emission source to be installed at the FMPC Plant 6 is an ingot and scrap pickling process. Plant 6 is a production facility used for heat treating, acid pickling, and finish machining of uranium metal.

   The new Plant 6 ingot and scrap pickling process utilizes 8 normal (N) nitric acid to surface clean cast ingots or scrap uranium metal. The pickling process removes decay deposits and oxidation from the ingots and scrap metal. The cleaned ingots are machined while the scrap metal is used for recasting.

2. **List the name and quantity of all materials and chemicals (solid, liquid, or gaseous) that will be used or produced by the source/facility.**

   The ingot and scrap pickling process utilizes a 8 N nitric acid solution to surface clean the uranium metal. The facility uses a 500 gallon nitric acid tank and 2 water rinse tanks which are replenished on an as needed basis.

3. **State the reason for the application. Is this a new installation, modification to an existing source/facility, reconstruction of an existing source/facility, or startup of a source/facility that has been permanently shutdown for _____ years?**

   The ingot and scrap pickling process is a new installation at the FMPC.

4. **Has a previous Ohio EPA application or plan submission been filed for this source, facility? If so, state the date and type of the application previously submitted.**

   An OEPA permit to install (PTI) application for this air emission source was submitted to SWOAPCA on October 1, 1987. On January 5, 1988, SWOAPCA was provided with a revised Appendix A-2 for the ingot and scrap pickling process. The January 1988 submittal reflected the final design specifications on the NOx Destructor which vented the scrap pickling process. On July 20, 1988, SWOAPCA requested potential radionuclide emissions for this source. Additional production, emission, and engineering information was obtained in an effort to respond to this request. This revised application reflects the most current system design and includes an Appendix A which lists uranium as a pollutant controlled by the Destructor.

5. **Will the proposed source/facility comply with all rules, laws, and regulations of Ohio EPA and U.S. EPA?**

Yes.

FOR AIR POLLUTION SOURCES

6. **State the amount of each air contaminant (actual emissions) from each source in pounds per hour and tons per year at maximum and average conditions.**

See attachment for emission calculations. A summary table is shown below.

Summary Table

	NO_x Emissions	Uranium Emissions
A. Average Controlled	18.2 (NO_2)	2.14 X 10-5
(lbs/hr)	2.0 (NO)	
B. Maximum Controlled	18.2 (NO_2)	3.23 X 10-5
(lbs/hr)	2.0 (NO)	
C. Average Controlled	18.2 (NO_2)	9.00 X 10-5
(tons/yr)	2.0 (NO)	
D. Maximum Controlled	54.6 (NO_2)	1.36 X 10-4
(tons/year)	6.0 (NO)	

FOR AIR POLLUTION SOURCES (CONT.)

7. Are the proposed sources required to comply with the following federal requirements?

   i. - No

   ii. - Yes. Based on updated production, emissions, and engineering information, the new scrap pickling process is estimated to release at maximum operating conditions approximately 0.3 pound of uranium per year.

   iii. - No
   iv. - No

8. Will the proposed sources employ best available technology?

   The proposed source will employ best available technology for NO_x and uranium removal. The pickling system will be enclosed, hooded, and vented to a NO_x Destructor (packed tower design). The design efficiency for uranium and NO_x removal is estimated to be 95%. In addition, the metal is vacuumed to remove loose surface contamination prior to pickling. The vacuum exhaust is vented to a HEPA filter.

9. Will the proposed sources cause the significant degradation of air quality.

   The source does not cause a significant degradation of air quality.

10. Will the proposed sources interfere with the attainment and maintenance of the ambient air quality standards?

    The source does not interfere with the attainment and maintenance of the ambient air quality standard.

11. Describe any source monitoring, emission monitoring, or control equipment monitoring devices to be installed by the applicant.

    The ingot and scrap pickling process will be ducted to a NO_x Destructor (packed tower design). A FUJI infrared monitor (model 1155) will be used to measure NO_x emissions from the Destructor.

12. Will the proposed sources involve the use of asbestos, benzene, beryllium, mercury, or vinyl chloride?

    No.

13. Complete and attach an anticipated construction schedule for each proposed source (See Attached).

Attached.

14. Please include the estimated cost of any air pollution control equipment to be installed on the proposed sources.

Estimated cost of the NO_x Destructor is $400000.

15. An appendix for each air contaminant source must accompany this application. From the following description of the appendices, determine which shoud accompany your application.

Attached.

OHIO ENVIRONMENTAL PROTECTION AGENCY

INSTALLATION SCHEDULE

TO ACCOMPANY APPLICATION FOR PERMIT TO INSTALL

THIS FORM CONSTITUTES PART OF THE APPLICATION OF:

FACILITY NAME: Feed Materials Production Center

ADDRESS: 7400 Willey Road, Fernald, OH 45030

FOR A PERMIT TO INSTALL THE FOLLOWING AIR CONTAMINANT SOURCE:

IDENTIFICATION: Plant 6 INGOT AND SCRAP PICKLING FACILITY (6-053)

DESCRIPTION: Surface cleaning of cast Ingots and scrap utilizing nitric acid

THE INSTALLATION OF THE ABOVE AIR CONTAMINANT SOURCE IS PLANNED TO FOLLOW THE TIME SCHEDULE DESCRIBED BELOW:

		DATE
1.	EQUIPMENT ORDERED	4/88
2.	COMMENCE CONSTRUCTION	1/89
3.	STARTUP	6/89
4.	PERFORMANCE TESTING	6/89

Premise No. __/__/__/____
Source No. __/____
Application No. __/____

APPENDIX A, PROCESS A-1

PROCESS DATA

1. Name of process Ingot and Scrap Pickling Facility - 6 (6-053)
2. End product of this process Pickled (Surface Cleaned) Uranium Ingot & Scrap
3. Primary process equipment Acid Pickling Tanks and Rinse Tanks

   Your identification Ingot and Scrap Pickling Facility - Plt. 6 Year Installed 1988
4. Manufacturer Custom Design Make or model NA
5. Capacity of equipment (lbs./hr): Rated 8730 Max. 13,200
6. Method of exhaust ventilation: [X] Stack [ ] Window fan [ ] Roof vent
   [ ] Other, describe
   Are there multiple exhausts? [ ] Yes [X] No

OPERATING DATA

7. Normal operating schedule: 24 hrs./day, 7 days/wk., 50 wks./year.
8. Percent annual production (finished units) by season:
   Winter 25 Spring 25 Summer 25 Fall 25
9. Hourly production rates (lbs.): Average 8730 Maximum 13,200
10. Annual production (indicate units) 55,440 tons
    Projected percent annual increase in production 10%
11. Type of operation: [ ] Continuous [XX] Batch
12. If batch, indicate Minutes per cycle 15 Minutes between cycles 5
13. Materials used in process:

List of Raw Materials	Principal Use	Amount (lbs./hr.)
8N Nitric Acid	Pickling (Surface Cleaned)	14.7 lbs/hr
	Uranium Ingots and Scrap	

14. A PROCESS FLOW DIAGRAM MUST BE INCLUDED WITH THIS APPENDIX. Show entry and exit points of all raw materials, intermediate products, by-products and finished products, Label all materials including airborne contaminants and other waste materials. Label the process equipment and control equipment.

CONTROL EQUIPMENT

6204 - ◄

Control Equipment Code:

(A)	Settling chamber	(G)	Cyclonic scrubber	(M)	Adsorber
(B)	Cyclone	(H)	Impingement scrubber	(N)	Condenser
(C)	Multiple cyclone	(I)	Orifice scrubber	(O)	Afterburner - catal
(D)	Electrostatic precipitator	(J)	Venturi scrubber	(P)	Afterburner - therm
(E)	Fabric filter	(K)	Plate or tray tower	(Q)	Other, describe___
(F)	Spray chamber	(L)	Packed tower		

15. Control Equipment data:

Item	Primary Collector	Secondary Collector
(a) Type (See above code)	L1 & L2 (2 in series)	
(b) Manufacturer	Tri-Mer Corp.	
(c) Model No.	N/A	
(d) Year installed	1988	
(e) Your identification	N-06H-3000, 4000	
(f) Pollutant Controlled	NOx, Uranium	
(g) Controlled pollutant emission rate (if known)	NOx, Uranium See Attached Calculations	
(h) Pressure drop	N/A	
(i) Design efficiency	NO_2-97% NO1-95% Uranium-95%	
(j) Operating efficiency	NOx-95% Uranium-95%	

STACK DATA

16. Your stack identification EP6-11

17. Are other sources vented to this stack? [X] Yes [ ] No
    If yes, identify sources Scrap Pickling, Chip Pickling, and Ingot Pickling

18. Type: [X] Round, top inside diameter dimension 36"
    [ ] Rectangular, top inside dimensions (L)_____ x (W)_____

19. Height: Above roof 15 ft., above ground 60 ft.

20. Exit gas: Temp. 68 °F, Volume 25,000 ACFM, Velocity 4,000 ft./min.

21. Continuous monitoring equipment: [X] Yes [ ] No
    If yes, indicate: Type NDIR Mass Flow Detector, Manufacturer Whittaker
    Make or Model FUJI 760, Pollutant(s) monitored NO, NO_2

22. Emission data: Emissions from this source have been determined and such data is included with this appendix: [X] Yes [ ] No
    If yes, check method: [ ] Stack Test [X] Emission factor [ ] Material balan

Completed by J. S. Straub, Date 8/28/87
1st Revision by T. J. Walsh 11/12/87
2nd Revision by R. Cauley/T.J. Walsh/D.A. Nixon 10/14/88

EMISSION DATA FOR APPENDIX A-2

QUESTION #22

Emissions Calculations for Plant 6 Scrap Pickling **6204**

1. The new scrap pickling facility will be operated in a similar manner as the existing operation.

2. The emissions tests conducted on the existing operation are applicable to the new installation. The calculations for the new Plant 6 Scrap Pickling process use an average loading factor of 4.61 X 10-4 mg/dscf for 3740 lbs/hr of uranium processed.

3. Engineering estimate of uranium removal efficiency for the source's control equipment is 95%.

4. Flow rate from the scrap pickling process to control equipment is 3000 dscf/min.

Calculations

1. Average loading factor (mg/dscf)

   4.61 x 10-4 mg/dscf X 8730 lbs of material /hr (new process) =

   3740 lbs of material /hr during testing (existing)

   1.08 X 10-3 mg/dscf expected from new process

2. Average hourly uncontrolled uranium emissions (lbs/hr)

   1.08 X 10-3 mg/dscf X 3000 dscf/min X 60 min/hr X .001 g/mg X 1 lb/454g =
   4.28 X 10-4 lbs/hr

3. Maximum loading factor (mg/dscf)

   4.61 X 10-4 mg/dscf X 13200 lbs of material processed/hr =

   3740 lbs of material processed/hr during testing

   1.63 X 10-3 mg/dscf

4. Maximum hourly uncontrolled uranium emissions (lbs/hr)

   1.63 X 10-3 mg/dscf X 3000 dscf/min X 60 min/hr X .001 g/mg X 1 lb/454g =
   6.46 X 10-4 lbs/hr

5. Average yearly uncontrolled uranium emissions (tons/yr)

   4.28 X 10-4 lbs/hr X 24 hrs/day X 7 days/wk X 50 wks/yr X 1 ton/2000lbs =
   1.80 X 10-3 tons/yr

6. Maximum yearly uncontrolled uranium emissions (tons/yr)

   6.46 X 10-4 lbs/hr X 24 hrs/day X 7 days/wk X 50 wks/yr X 1 ton/2000lbs =
   2.71 X 10-3 tons/yr

7. Average hourly controlled uranium emissions (lbs/hr)

   4.28 X 10-4 lbs/hr X (1-.95) removal efficiency = 2.14 X 10-5 lbs/hr

8. Maximium hourly controlled uranium emissions (lbs/hr)

   6.46 X 10-4 lbs/hr X (1-.95) removal efficiency = 3.23 X 10-5 lbs/hr

9. Average yearly controlled uranium emissions (tons/yr)

   1.80 X 10-3 tons/yr X (1-.95) removal efficiency = 9.00 X 10-5 tons/yr

10. Maximimum yearly controlled uranium emissions (tons/yr)

    2.71 X 10-3 tons/yr X (1-.95) removal efficiency = 1.36 X 10-4 tons/yr

A. Hourly NO_x Emission

Estimate of hourly NO_x emission was based on input data provided by the FMPC's Operating Contractor (NO_x-rich air stream Input rate is 25,000 SCFM at 3,960 ppm NO_x). It is further assumed that the maximum hourly emission rate equals the average hourly emission rate.

Calculate NO_2 Emission Rate

Based on vendor's performance limit of 100 ppm NO_2 in the clean exhaust air and use of the ideal gas law, the hourly NO_2 emission rate is calculated as follows: (SCFM measured at 1.0 atm and 60°F).

(1) $\rho = \frac{P}{RT}$ where ρ = density, P = pressure, R = specific gas constant and T = temperature (K)

(2) $R = \frac{Ru}{M}$ where Ru = universal gas constant and M = molar mass

From equation (2): $R = \frac{Ru}{M} = \frac{8314 \text{ J/kg-mol}\cdot\text{K}}{46 \text{ g/g-mol}} = 181 \text{J/kg}\cdot\text{K}$

Calculate density of NO_2 from equation (1):
Assume cubic feet measured at 1.0 atm and 60°F

$$\rho = \frac{P}{RT} = \frac{1.0 \text{ atm}}{(181 \text{J/kg}\cdot\text{K})(60^{\circ}\text{F})}$$

where P = 1.0 atm = 1.0133×10^5 N/m^2

R = 181 N·m / kg·K

T = °K where, T = 273°K + t (°C)
Convert 60°F to °C from t(°C) = (60°F-32°F)/1.8°F/°C

$$\rho = \frac{(1.0133 \times 10^5 \text{ N/m}^2)}{(181 \text{ N}\cdot\text{m/kg}\cdot\text{K})(289\text{K})} \approx 1.94 \text{ kg/m}^3$$

To calculate hourly emission rate:

$$\left(\frac{100 \text{ ft}^3 \text{ NO}_2}{10^6 \text{ ft}^3 \text{ of air}}\right) \times \left(\frac{25000 \text{ ft}^3 \text{ of air}}{\text{min}}\right) \times \left(\frac{60 \text{ min}}{\text{hr}}\right) \times \left(\frac{1.94 \text{ kg}}{\text{m}^3}\right) \times \left(0.06243 \frac{\text{m}^3}{\text{kg}} \Big/ \frac{\text{ft}^3}{\text{lb m}}\right) \approx 18.2 \text{ lb/hr of } NO_2$$

Calculate NO emission rate:

NO_x Conversion Equation =

$$14U + 100\ HNO_3 \longrightarrow 66\ NO_2 + 6\ NO + 14\ (UO_2)(NO_3)_2 + 50\ H_2O$$

3960 ppm_v NO_x (6 moles NO/72 mole NO_x) = 330 ppm_v NO

From equation (2):

$$R = \frac{Ru}{M} = \frac{8314 \text{ J/kg - mol·K}}{30 \text{ g/g - mol}} = 277 \text{ J/kg·K}$$

Calculate density of NO from equation (1):
Assume cubic feet measured at 1.0 atm and 60°F

$$\rho = \frac{P}{RT} = \frac{1.0 \text{ atm}}{(277 \text{ J/kg·K})(60^{o}F)}$$

where

$P = 1.0 \text{ atm} = 1.0133 \times 10^5 \text{ N/m}^2$

$R = 277 \text{ N·m/kg·K}$

$T = {}^{o}K$ where, $T = 273^{o}K + t\ ({}^{o}C)$

Convert 60°F to °C from $t({}^{o}C) = (60^{o}F - 32^{o}F)/1.8\frac{^{o}F}{^{o}C}$

$$\rho = \frac{(1.0133 \times 10^5 \text{ N/m}^2}{(277 \text{ N·m/kg·K})(289K)} \approx 1.27 \text{ kg/m}^3$$

To calculate hourly emission rate: (assume 95% removal efficiency)

$$\left(\frac{330 \text{ ft}^3\text{NO}}{10^6 \text{ ft}^3 \text{ of air}}\right) \times (1.00-0.95) \times \left(\frac{25000 \text{ ft}^3 \text{ of air}}{\text{min}}\right) \times \left(\frac{60 \text{ min}}{\text{hr}}\right) \times$$

$$\left(1.27 \frac{\text{kg}}{\text{m}^3}\right) \times \left(0.06243 \frac{\text{m}^3}{\text{kg}} \Big/ \frac{\text{ft}^3}{\text{lb}_m}\right) \approx 2 \text{ lb/hr of NO}$$

B. Annual NO_x Emission from Scrubber

Average annual emission rate is calculated based on the assumption that the system will be operated 1 shift per day. Maximum annual emission occurs under the operating condition of 3 shifts per day.

Average annual NO_2 emission rate:

NO_2 = (18.2 lb/hr)(8 hr/shift)(1 shift/day)(5 days/wk))(50 wk/yr) =

$$\frac{36400 \text{ lb/yr}}{2000 \text{ lbs/ton}} = 18.2 \text{ ton/yr}$$

Average annual NO emission rate:

NO = (2 lb/hr)(8 hr/shift)(1 shift/day)(5 days/wk)(50 wk/yr) =

$$\frac{4000 \text{ lbs/yr}}{2000 \text{ lbs/ton}} = 2 \text{ tons/yr}$$

Maximum annual NO_2 emission rate:

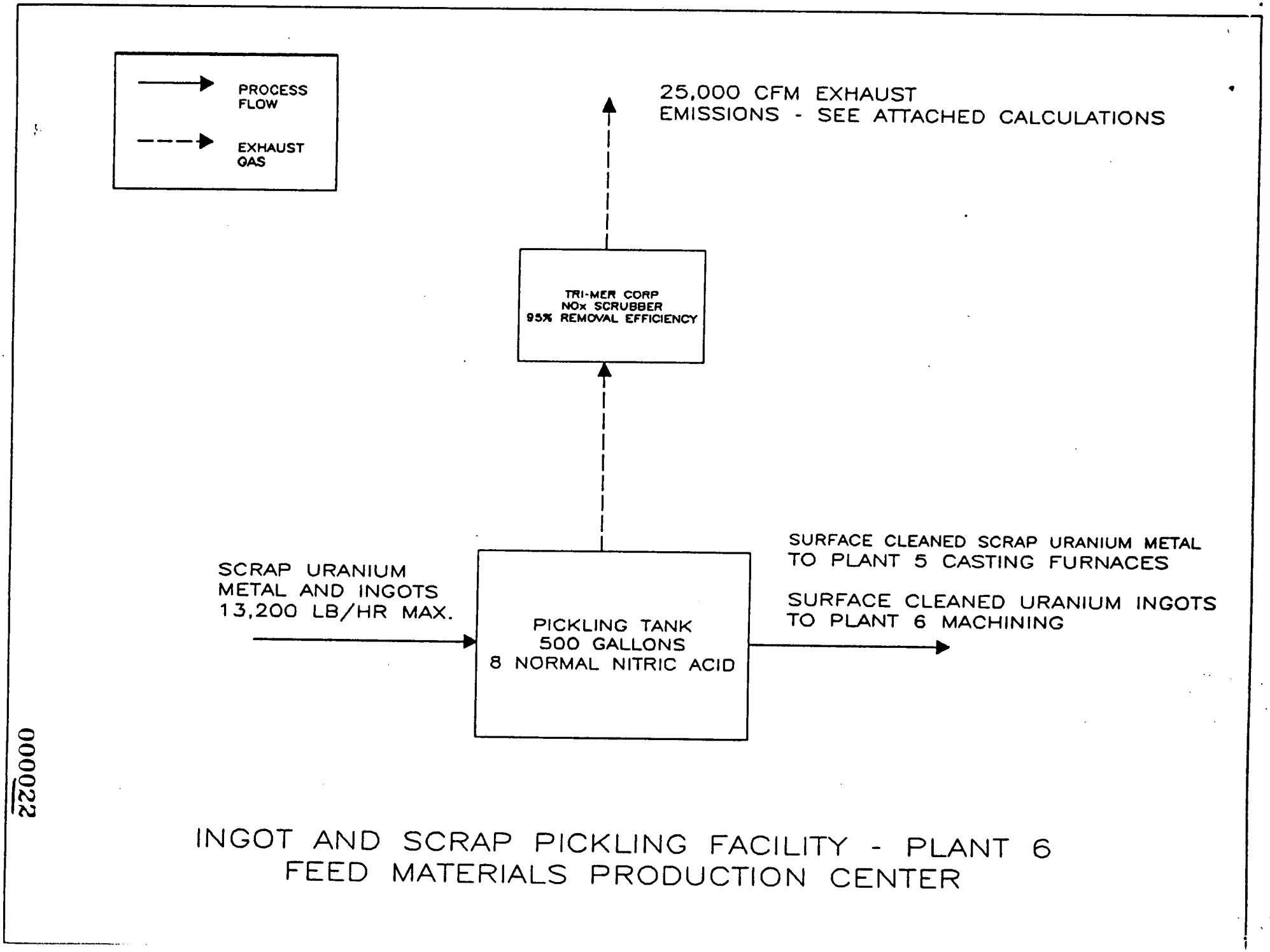
NO_2 = (18.2 lb/hr)(8 hr/shift)(3 shifts/day)(5 days/wk)(50 wk/yr) =

$$\frac{109200 \text{ lbs/yr}}{2000 \text{ lbs/ton}} = 54.6 \text{ tons/yr}$$

Maximum annual NO emission rate:

NO = (2 lb/hr)(8 hr/shift)(3 shifts/day)(5 days/wk)(50 wk/yr) =

$$\frac{12000 \text{ lbs/yr}}{2000 \text{ lbs/ton}} = 6 \text{ tons/yr}$$



220000

INGOT AND SCRAP PICKLING FACILITY - PLANT 6
FEED MATERIALS PRODUCTION CENTER