NITRAM, INC.
5321 Hartford St. • P.O. Box 2968 • Tampa, Florida 33601 • Phone (813) 626-2181

DER
JUL 23 1984
BAQM

July 20, 1984

Mr. C. H. Fancy, P. E.
State of Florida
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301 - 8241

Dear Mr. Fancy:

I am writing in response to your letter of July 2, 1984.

Application Fee: In a telephone conversation with your Mr. Bill Thomas, we concluded that the application would be submitted without the fee accompanying it to allow review by your Department to determine if the full $1,000.00 fee was applicable for a modification project such as ours. The fee has been forwarded under separate cover.

<u>DER Form 17-1.122(16) Section II:</u>

Addressing your questions in order:

1. The Nitric Acid process proceeds stepwise from (a) oxidation of ammonia (NH_3) to Nitric Oxide (NO); (b) Oxidation of NO to Nitrogen Dioxide (NO_2); (c) Reaction of NO_2 with water to form Nitric Acid (HNO_3). The equations for the above reactions are:

(a) $2NH_3 = 5/_2 O_2 \xrightarrow{P+} 2NO + 3H_2O$

(b) $2NO + O_2 \rightarrow 2NO_2$

(c) $3NO_2 + H_2O \rightarrow 2HNO_3 + NO\uparrow$

The NO liberated in (c) enters into reaction (b). A Flow Sheet, with an overall material balance, is Attachment I.

In this case, the reactions take place at 140 psig. Oxygen is supplied by air from the two process air compressors. A portion of the power to drive these compressors is supplied by a gas expander turbine, where the residual atmospheric nitrogen (tailgas) is expanded to atmospheric pressure before discharge.

Reaction (a) occurs across a platinum catalyst at a temperature of 1640°F±. As the gas flows through the heat transfer equipment, reaction (b) occurs as energy is recovered in the form of superheated steam or in reheating of the tail gas. Reaction (b) proceeds to 85% complete in the energy recovery equipment and the gas stream splits and flows to the two weak acid condensers. Heat is given up to cooling water, to reduce

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NITRAM, INC.

5321 HARTFORD STREET, P.O. BOX 2968, TAMPA, FLORIDA 33601

TO MR. C.H. FANCY, P. E.
STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION
TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FL. 32301 - 8241

CERTIFIED
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the temperature of the gas to 140°F.

The two process gas streams then enter the bottom of their respective Absorption Towers, where reaction (c) occurs, and the evolved NO re-enters into reaction (b). In each "cycle", NO_x content of the gas is reduced by two-thirds. Cooling coils on each tray of the tower remove heat of reaction. The top one-third of the towers is chilled by water at about 34°F, giving an exit temperature of 50°F. This enhances both reactions in this region, reducing NO_x in the tail gas to 2000 ppm ±. The tower bottom product is 54 - 57% w/w Nitric Acid.

The chill water is supplied by ammonia evaporated at low pressure (30 psig+) and exported to the neutralizers. Neither the Nitric Acid plant nor the neutralizers can operate without the other, so chill water is assured.

The two tail gas streams exit the towers at 50°F, are recombined and then reheated to 900°F in the heat transfer equipment. The gas is then treated in the catalytic combustor where the temperature increases to 1450°F. The gas stream splits and the temperature is reduced to the temperature limits of the gas expander turbines by heat recovery. Power is recovered in the turbines, additional heat is recovered and the tail gas is discharged.

2. The catalytic combustor is a new piece of equipment, designed for the service.

3. At this writing, I have not obtained compliance test data from another source, since other producers are also concerned about their trade secrets. However, I note that Air Products and Chemicals, Inc., in Pensacola, has two nitric acid plants with similar abatement systems. I would suggest that you would have better access to these data than I, and therefore request that the data be obtained from your files. I will assume that this is the case unless you advise me differently.

4. I know of no future modifications as a result of combining the two plants into one.

5. The combined facility is being designed to operate as a single plant, operating near design rates or shut down. However, in the event of a major failure in one compressor or absorption tower, it may be possible to devise a means of operating at half rates, though there are major problems to be resolved, primarily at the ammonia oxidation catalyst.

The absorption efficiency is primarily influenced by tower pressure and this should remain at the design rate if the plant were operated at half rate, since the other portion of the plant would be isolated.

If your question is addressed to the possibility of operating at nearly full rates through one absorption tower, the operation would be inefficient. Pressure drop through the weak acid condenser would be excessive, and the towers can only handle about 15% above design flow.

6. The catalytic combustor performs no absorption function. It is a gas phase reactor wherein the NO_x bearing tail gas is reacted with natural gas (95.76% methane, CH_4) to reduce the NO_x to elemental nitrogen (N_2). Three reactions occur sequentially: (a) Oxygen is reacted with CH_4 to form carbon dioxide; (b) NO_2 is reduced to NO; (c) NO is reduced to N_2. The equations are:

(a) $2O_2 + CH_4 \rightarrow CO_2 + 2H_2O$

(b) $4NO_2 + CH_4 \rightarrow CO_2 + 2H_20 + 4NO$

(c) $4NO + CH_4 \rightarrow CO_2 + 2H_20 + 2N_2$

Design specifications are included as Attachment II.

Section V: Supplemental Requirements

1. The most recent years' data is not representative of typical operation since Nitram's production parallels the activity of the Florida Agricultural industry (vegetable and citrus freeze). I,therefore, have selected the two year period ending June 30, 1983. These data are as follows:

Year Ending	No. 1 Plant Tons Acid Produced (100% Basis)	NO_x Discharged (T, as NO_2)	Allowable Discharge (T as NO_2) /Yr.
6/30/82	98,595	143.0	197
6/30/83	113,606	175.0	
	No. 2 Plant		
6/30/82	118,787	146	191
6/30/83	105,272	133	
Totals	436,260 T	597 T	388
Yearly Average	218,130 T	299 T	

A sample calculation is attached as Attachment II.

2. The derivation of the production rate is simply the Barnard and Burk Process Flow Sheet Drawing No. 31.0 - PF - 10 issue A_2, already forwarded to you. Streams 16 and 17 are the product acid streams, they are equal and each shows 51,170 lbs/hr. of 57% acid. Therefore:

$$\frac{2 \times 51{,}170 \times .57}{2000} = 29.17 \text{ Tons/hr.}$$

Control efficiency is the ratio of the molar flows of the NO_x entering the catalytic combustor in stream 11 (or 13), to the molar flow of NO_x leaving the catalytic combustor in streams 14 and 15 combined. Therefore, NO_x entering is 14.2 lb. moles/hr. NO_x leaving is (0.83 + 0.83)=1.66 lb. moles/hr. Efficiency is calculated as:

$$\text{Eff. } (\%) = \left(1 - \left(\frac{1.66}{14.2}\right)\right) \times 100$$

$$= 88.3\%$$

3. The design of the new plant is to produce 700 TPD of 100% Nitric Acid, replacing two plants rated at 350 TPD each. The current permitted discharges are 45 lbs/hr. for the No. 1 plant, and 43.74 lbs./hr. for the No. 2 plant. Since there is no restriction on operating hours, total permitted discharge is now (45 + 43.74)(8760)/2000 = 388.7 TPY.

The design point on the flow sheet, when converted to NO_2 is 2.52 lbs./T. This gives an expected discharge of 334 TPY, a decrease of 54.7 TPY. At 3 lbs/T, the maximum allowable discharge would be 87.5 lbs/hr, which is still less than the sum of the presently permitted discharge.

We are asking that the permit be issued on the basis of 3 lbs/T, for a plant to produce an average of 700 TPD, resulting in no increase in allowable emissions. Because there is no increase in allowable emissions, PSD does not apply.

4. The design of the facility is to maintain the present production rate, therefore, there is no additional nitric acid. The only possible changes downstream would be those caused by market pressures. Since we are permitted for 100% on stream all cases, there need be no permit ammendments for downstream operating units.

5. The present continuous emissions monitor alternately samples each stack of the two separate plants. The existing monitor will be re-used in the same manner for both "modified" stacks.

6. I have created some confusion by my response to question B on Page 4 of the application, and I must apologize.

Capacity of a Nitric Acid plant is typically set by the capacity of the air compression equipment, and this air capacity is governed by available power and ambient air conditions. An air compressor in winter will handle more air than on a hot day. The reported answers are for maximum production in ideal contitions; the average production will be 700 TPD. If you wish, for the sake of clarity, to ammend the answers, they should read:

B. (1) Total Process Input Rate (lbs/hr): 17,500 max; 16,847 Avg.
(2) Product Weight (lbs/hr): 67,000 max, 58,334 Avg. as 100% HNO_3.

On page 4 of 12, Maximum hourly rate may reach the 33.5 TPH, but daily production will be 700 TPD.

Please consider this entire reply as CONFIDENTIAL, since it does contain proprietary design information.

I trust this response satisfactorily answers your questions and concerns. However, if questions remain or new questions arise, do not hesitate to contact me. I will re-state my offer originally made to your Mr. Bill Thomas to come to Tallahassee to meet with your Department to assist in your review of this application.

Sincerely yours,

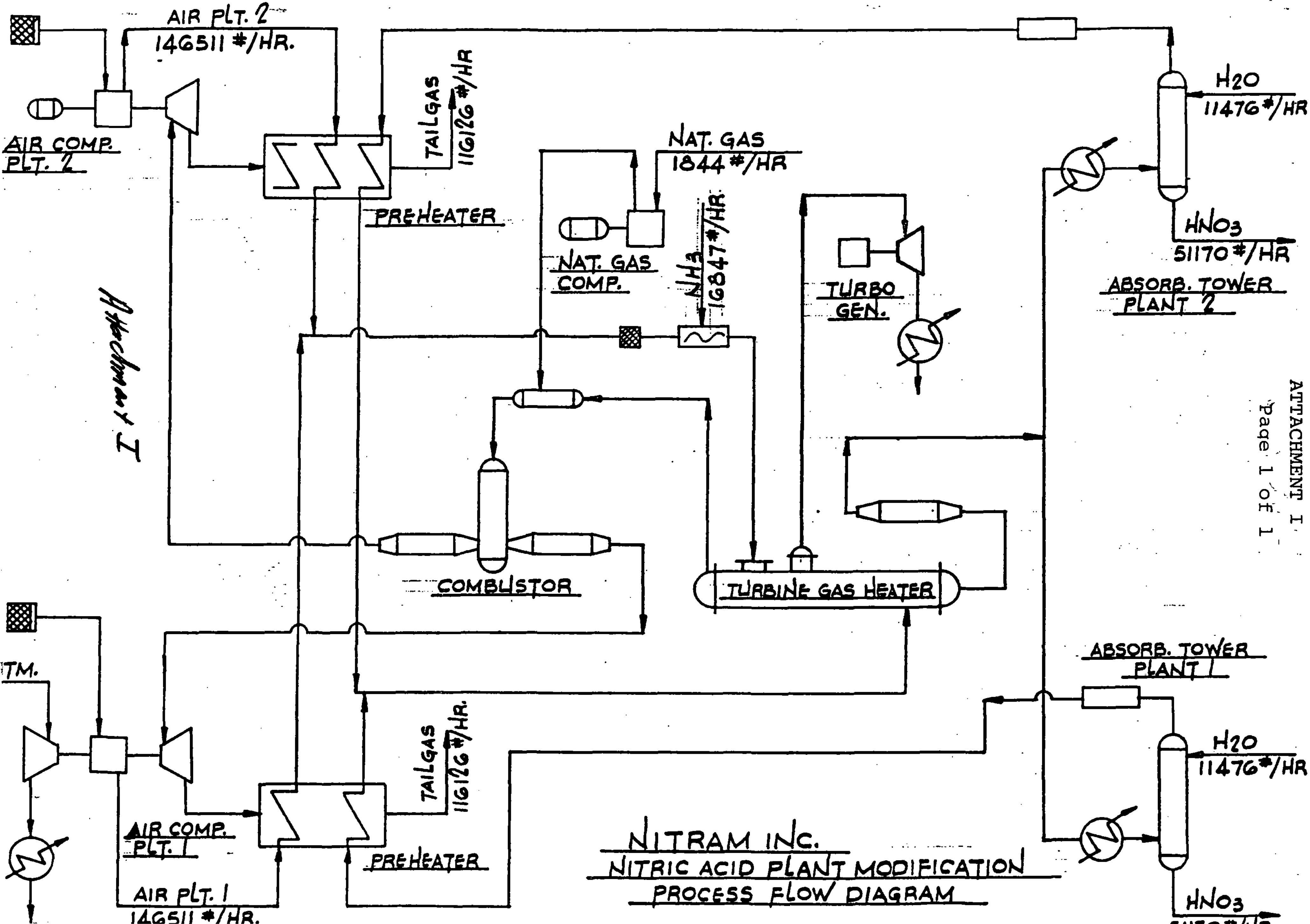
NITRAM, INC.

Daniel E. Ross, P. E.
Technical Manager

DER:la

CC: A. C. Perry

Mr.Victor San Agustin, HCEPC
Mr. W. Thomas, DER, Tampa


AIR PLT. 2
146511 #/HR.
AIR COMP. PLT. 2
TAILGAS 116126 #/HR
PREHEATER
NAT. GAS 1844 #/HR
NAT. GAS COMP.
NH_3 16847 #/HR
TURBO GEN.
H_2O 11476 #/HR
HNO_3 51170 #/HR
ABSORB. TOWER PLANT 2
Attachment I
COMBUSTOR
TURBINE GAS HEATER
ABSORB. TOWER PLANT 1
TM.
AIR COMP. PLT. 1
TAILGAS 116126 #/HR.
PREHEATER
AIR PLT. 1
146511 #/HR.
H_2O 11476 #/HR
HNO_3
NITRAM INC.
NITRIC ACID PLANT MODIFICATION
PROCESS FLOW DIAGRAM

NO.	BY	DATE	DESCRIPTION	NO.	BY	DATE	DESCRIPTION

PROJECT NO. 4139-02
CLIENT Nitram Inc.
PROJECT Nitric Acid Plant
SPECIFICATION NO.
SH. 1 OF 2

SPECIFICATIONS FOR COMBUSTOR CATALYST

ITEM NO. 03W-101

A. SCOPE: The function of the catalyst is to reduce the nitrogen oxides (NO_x) content of the tail gases from a nitric acid plant from a level of 1000-3000ppm to 200 ppm (NO_x) (volume basis) at the operating conditions specified below. The catalyst will be installed in a brick lined vessel 10'-0" ID for continuous plug flow operation. Natural gas is added to the tail gas and uniformly mixed in a static type mixer prior to contacting the catalyst. The fuel gas reacts with the tail gas as it passes through the catalyst bed and the heat generated in the combustor is recovered downstream as (1) high pressure steam in a boiler and (ii) as power for driving an air compressor.

B. DESIGN BASIS

Operating Pressure	114 psia
Temperature at Inlet	900° F *
Temperature at outlet	1450°F
Pressure Drop (max.)	2.0 psi

* The catalyst must be suitable for a tail gas inlet temperature range of 850°-1000°F, a minimum continuous operating temperature of 1500°F and be able to withstand instantaneous temperature swings of up to 1600°F for five minute intervals.

FLOW RATES

Tail Gas

Component	Mols/hr.
O_2	205.0
N_2	7966.4
$NO + NO_2$	14.2
H_2O	13.4
	8199.0

NO.	BY	DATE	DESCRIPTION	NO.	BY	DATE	DESCRIPTION

PROJECT NO.
CLIENT
PROJECT
SPECIFICATION NO.
SH. 2 OF 2

Natural Gas

Component	Mole%
CH_4	95.76
C_2H_6	2.66
C_3 and Higher	0.34
O_2	0.01
N_2	0.51
CO_2	0.72
	100.00

Mol Wt. 16.77

C. PROPOSAL

Vendor shall provide the following data with his proposal:

1. Quantity of Natural Gas required
2. Quantity of catalyst required
3. Size, form and composition of catalyst.
4. Life of catalyst.
5. List of catalyst poisons
6. Minimum ignition temperature
7. Maximum continuous operating temperature.
8. Maximum instantaneous operating temperature (shut down point)

D. GUARANTEES

The following guarantees are to be included as part of the proposal:

1. Reduction of NO_x to a concentration of 200 ppm by volume maximum
2. Minimum tail gas temperature for ignition.
3. Fuel efficiency
4. Pressure drop
5. Catalyst life

CLIENT	NITRAM INC.
LOCATION	TAMPA FLA
CODE NUMBER	03H-102
AUTHORIZATION NO.	4139-02
NAME OF UNIT	CATALYTIC COMBUSTOR
NUMBER OF UNITS REQ'D.	ONE (1)
PREPARED BY	[signature]
SPEC. NO'S	4139-02-EQ8, 4139-02-ER18
PLANT SECTION NAME AND SECTION NUMBER	NITRIC ACID
CHECKED BY	

VESSEL SHALL BE FURNISHED WITH :

MANHOLE DAVIT	EF-2
SKIRT ACCESS OPENING	EF-7
SKIRT BASE (DETAIL)	EF-8
TOWER LIFTING LUG	EF-9
SKIRT BASE RING	EF-10
SKIRT VENT	EF-11

DESIGN DATA

		CODE	ASME SECT VIII DIV. I
SP. GR. PRODUCT		CODE STAMP	YES [X] NO [ ]
DESIGN PRESS.	135 PSIG	STRESS RELIEVED	PER CODE
WORKING PRESS.	110 PSIG	RADIOGRAPHED	SPOT
DESIGN TEMP.	600 F	EARTHQUAKE FACTOR	ZONE
WORKING TEMP.	400 F	WIND PRESS.	40 PSF
JOINT EFFICIENCY	85 %	ORIENTATION BY	
HYDROSTATIC TEST	PER CODE	CORROSION ALLOWANCE	
NATIONAL BOARD STAMP		HEAD	0
		SHELL	0
ERECTION WEIGHT	LB	INTERNAL PARTS	0
OPERATING WEIGHT	LB		
WEIGHT OF TOWER FILLED WITH	LB		
CONSTRUCTION	DOUBLE WELDED BUTT JOINT		
INSPECTION BY BUYER, UNDERWRITER, CLIENT			

TYPE OF PARTS AND MATERIAL SPECIFICATION

SHELL	SA-240 -304L
HEAD (BOTTOM)	SA-240 -304L
HEAD (TOP)	SA-240 -304L
NOZZLE NECKS	SA-312-304L OR SA-240-304L
NOZZLE FLANGE	N-1&N-5 SA182-304L, N-1 C.S W/308 SS OVERLAY
NOZZLE REINFORCEMENT	SA-240-304L
COUPLINGS	
GASKETS	1/8" THK. 304SS JACKETED ASBESTOS
BOLTS AND/OR STUDS	SA-193 B7
NUTS	SA-194 2H
MANHOLE NOZZLE	SA-312 GR.304L OR SA-240-304L
MANHOLE FLANGES	C.S W 1/8" 308SS OVERLAY
MANHOLE COVERS	C.S. W 1/8" 308SS OVERLAY
INTERNAL PIPING	
DISTRIBUTOR	
BAFFLES & SHROUD	SA-240 GR.310
STRUCT. CLIPS AND ATTACHMENTS	SA-240-304L
INSULATION SUPPORTS	SA-240-304L
INSULATION	
WEATHERPROOFING	
PAINT	NONE
CATALYST SUPPORT SCREEN	A580 GR310 (2 REQ'D)

* WALL TEMP. = 400°F.
INTERNAL TEMP. = 1500°F

SKIRT — CARBON STEEL WITH A240-304L BAND

BASERING — CARBON STEEL

NOZZLE DATA

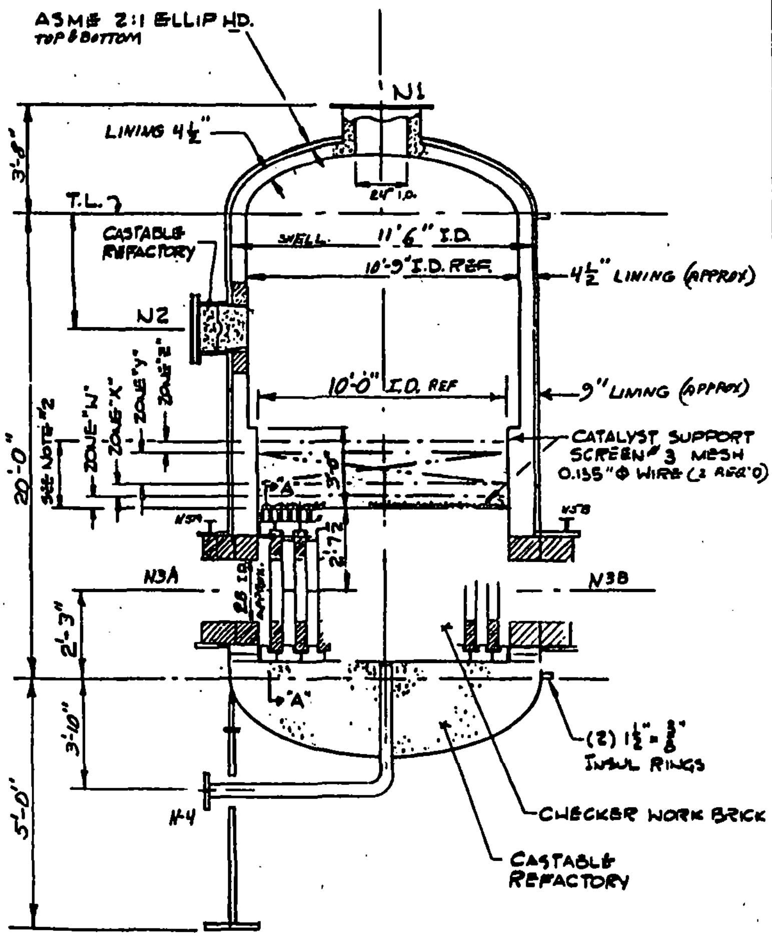
NOZZLE	SIZE	ASA RATING	NOZZLE SCH'D.	FLANGE TYPE	FLANGE FACE	DIM. "A" (1)	REMARKS
N 1	33	300#	STD	SO	RF	℄	INLET
N 2	18	300#	STD	SO	RF	6'-6"	MANWAY W/COVER
N 3A/3B	45" ID PIPE STUB-BEVEL FOR WELD						OUTLET (TWO)
N 4	1½	300#	STD	SO	RF	6'-6"	DRAIN
N 5A/5B	1	3000#	STD				THERM. WELL (TWO)
N 6							
N 7							
N 8							
N 9							
N 10							
N 11							
N 12							
N 13							
N 14							
N 15							
N 16							
N 17							
N 18							
N 19							

(1) MEASURED FROM ℄ OF VESSEL

NOTES:

1- BRICKWORK – HARBISON WALKER DURO BRICK (OR EQUAL)
CASTABLE REFACTORY – PENNWALT TUFCHEM SILICATE CONCRETE (OR EQUAL)
MORTAR – PENNWALT CORLOK "B" (OR EQUAL)

2- CATALYST BED "BY OTHERS"
ZONE "W" = 2" OF 1" DIA. ALUMINA BALLS
ZONE "X" = 2" OF ½" DIA. ALUMINA BALLS
ZONE "Y" = 24" OF CATALYST
ZONE "Z" = 2" OF ½" DIA. ALUMINA BALLS



ISSUE RECORD						
ISSUE	APPROVED BY	DATE	ISSUE	APPROVED BY	DATE	
2	[signature]	4-6-81				
1	[signature]	3-23-81				

DRAWING NO. DD-03H-102

BARNARD AND BURK ENGINEERS & CONSTRUCTORS, INC.
200 SHEFFIELD STREET
MOUNTAINSIDE, NEW JERSEY 07092

DRAWING AND DATA REQUIREMENTS

PROJECT NO. 4139-02
CLIENT NITRAM INC
PROJECT NITRIC ACID PLANT
SPECIFICATION NO. 4139-02-EQB
SH. 2 OF 2

NAME: CATALYTIC COMBUSTOR
ITEM NO: 03H-102

VENDOR SHALL FURNISH SEPIA OR OTHER REPRODUCIBLE AND/OR COPIES OF ALL DOCUMENTS CHECKED BELOW AS PART OF THIS SPECIFICATION. DOCUMENTS SHOULD BE CHECKED FOR ACCURACY PRIOR TO SUBMITTAL FOR REVIEW. ALL DOCUMENTS SHALL BE SENT VIA FIRST CLASS MAIL TO PRINT SERVICE AT ABOVE ADDRESS, AND SHALL INCLUDE OUR PURCHASE ORDER NUMBER, PROJECT NUMBER, AND EQUIPMENT IDENTIFICATION.

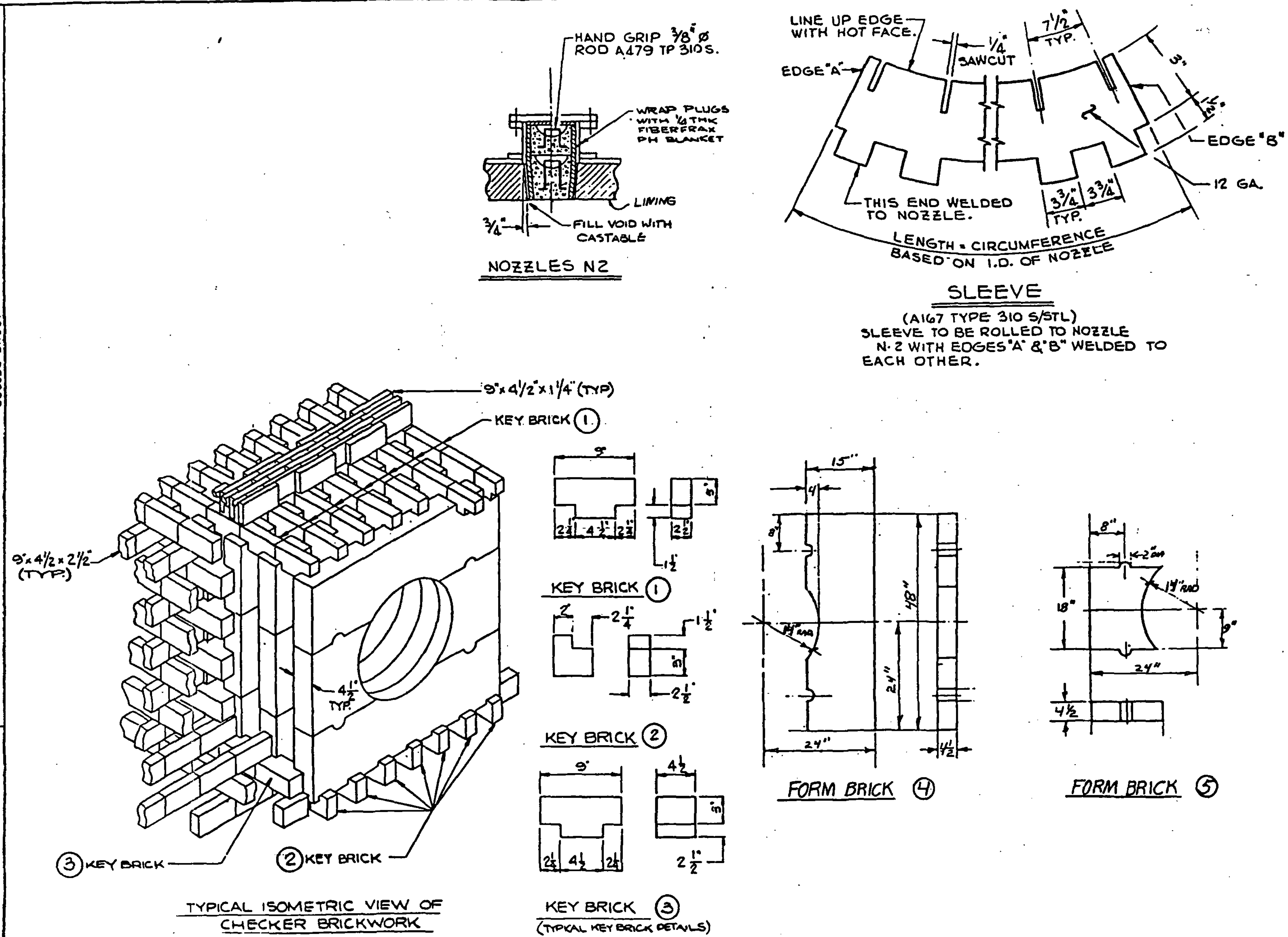
R/P = Reproducible/Print

EQUIPMENT TYPE: Pressure Vessels

DRAWINGS AND DOCUMENTS		PRELIMINARY PRINTS		REVIEW PRINTS		CERTIFIED PRINTS	
		QTY	WEEKS AFTER ORDER	QTY	WEEKS AFTER ORDER	QTY	WEEKS AFTER ORDER
Vessel Outline and Seam Location	(Approval Req'd)			2/	6	2/	
Nozzle Orientation and Elevation	(Approval Req'd)			2/	6	2/	
Foundation/Support Details	(Approval Req'd)			2/	6	2/	
Detail Drawings	(Approval Req'd)			2/	6	2/	
Design Calculations	(Approval Req'd)			/3	6		
Manufacturers Data Report						/6	
Test Reports						/6	
Welding Procedures & Welder Qualification Certificates						/6	
Material Certifications						/6	
Heat Treat Records							
Installation-Erection Procedure Instructions							
Spare Parts List							

REMARKS:

Note: Foundation drawings should include outline foundation plan and elevations; clearance for maintenance anchor bolt size and location; weight, erection, operating, and test; center of gravity unbalanced forces if any; and all other forces imposed by the unit on its supporting system. More than one of the above items may be combined in one document.



ISSUE RECORD

ISSUE	APPROVED BY	DATE	ISSUE	APPROVED BY	DATE	ISSUE	APPROVED BY	DATE
						1		
						2		

DRAWING NO. DD-03H-102
SHT. NO. 3 OF 3

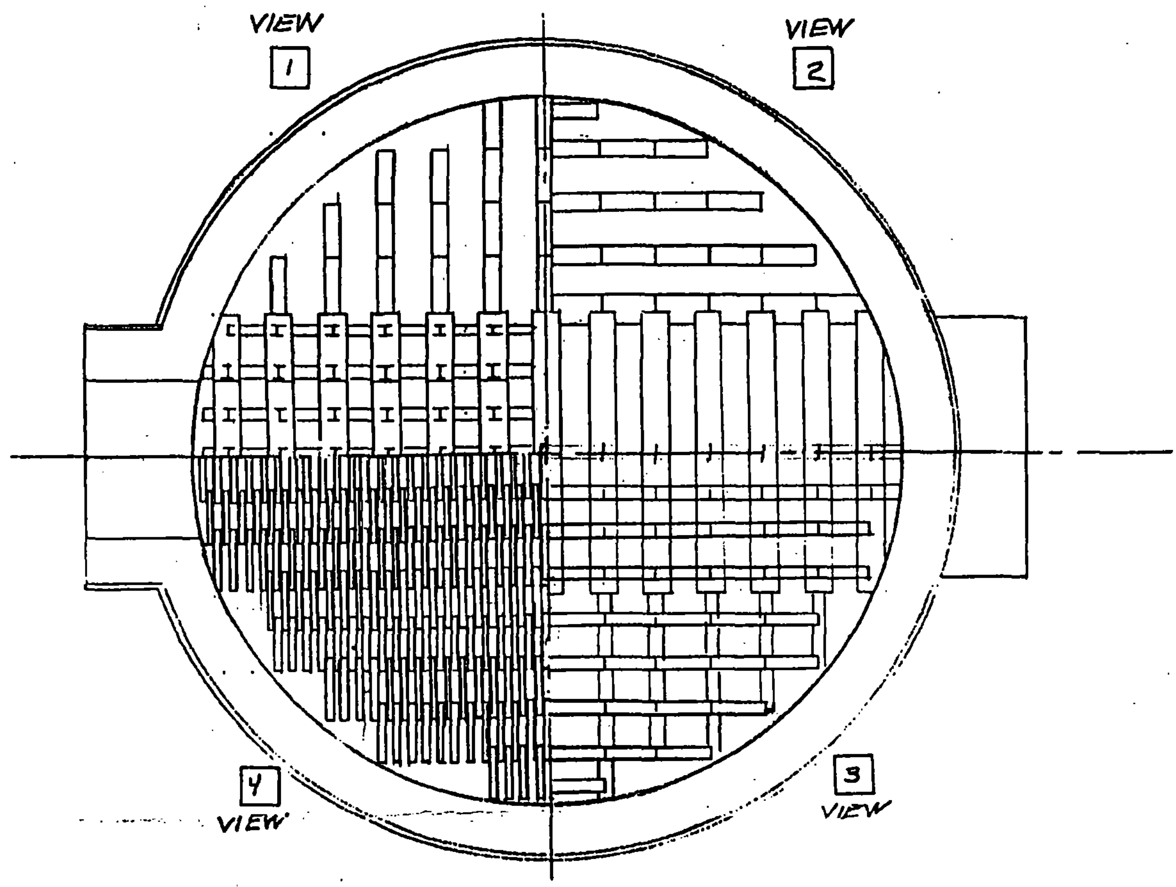
BARNARD AND BURK ENGINEERS & CONSTRUCTORS, INC.

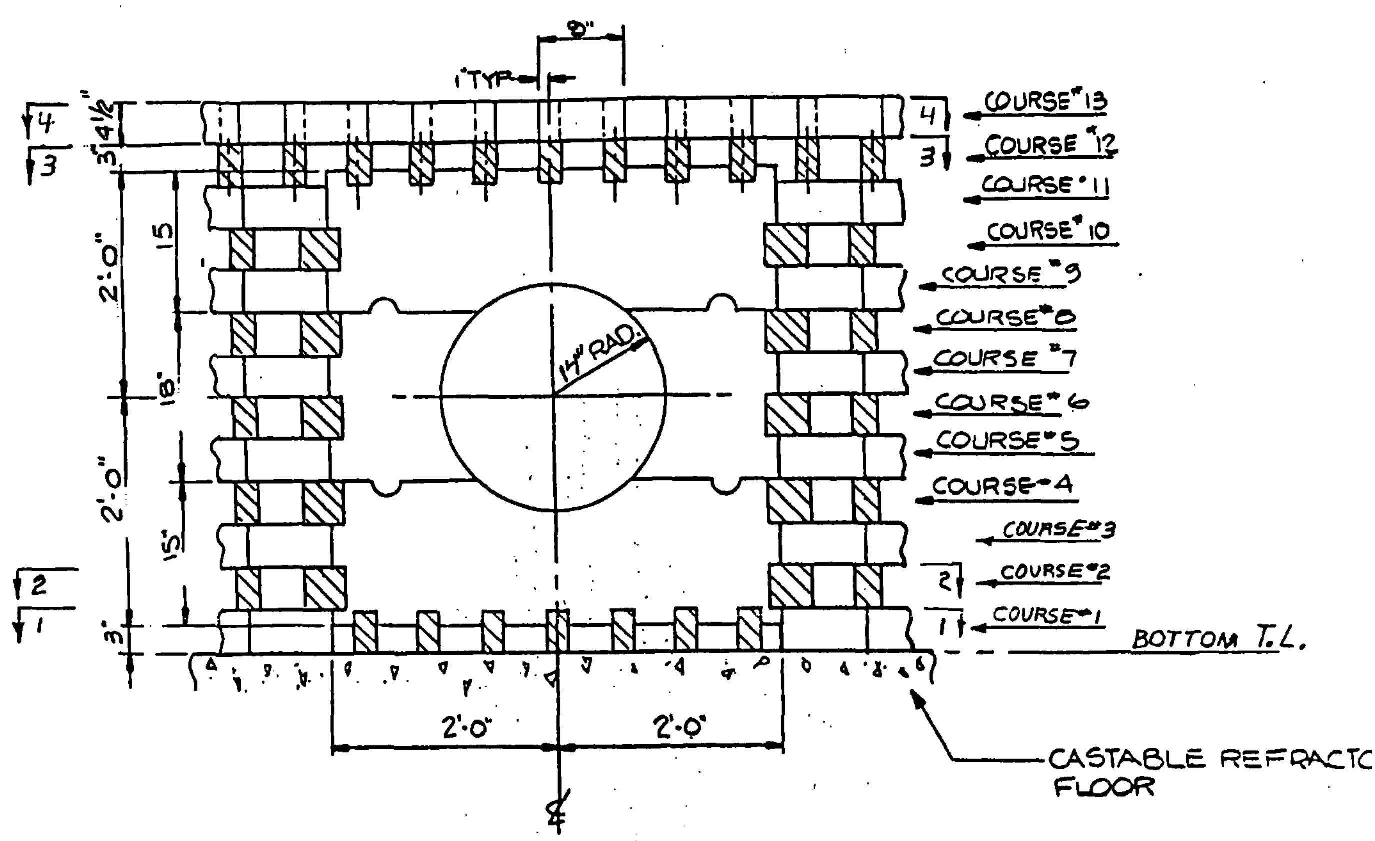
DESIGN DATA

CLIENT: NITRAM INC.
LOCATION: TAMPA FLA
NAME OF UNIT: CATALYTIC COMBUSTOR
NUMBER OF UNITS REQ'D.: 1
PLANT SECTION NAME AND: NITRIC ACI
SECTION NUMBER
CODE NUMBER: 03H-102
AUTHORIZATION NO.: 413902
PREPARED BY:
SPEC NO'S: 4139-02-E88
CHECKED BY: 4139-03-E818

BARNARD AND BURK
ENGINEERS & CONSTRUCTORS, INC.

DESIGN DATA	CLIENT: NITRAM INC. LOCATION: TAMPA FLA	CODE NUMBER: 03H-102	AUTHORIZATION N: 4139-02
	NAME OF UNIT: CATALYTIC COMBUSTOR NUMBER OF UNITS REQ'D: 1	PREPARED BY: JB	SPEC NO'S: 4139-02-EQ
	PLANT SECTION NAME AND SECTION NUMBER	CHECKED BY	4139-02-EQ





SECTION A-A

ISSUE RECORD									DRAWING NO.
						2	JB	4/6/84	DD-03H-102
						1		7-23-84	
ISSUE	APPROVED BY	DATE	ISSUE	APPROVED BY	DATE	ISSUE	APPROVED BY	DATE	SHT. NO. 2 of 3

SAMPLE CALCULATION

Overall Reaction: $NH_3 + 2O_2 \quad HNO_3 + H_2O$

Side Reaction (5%): $4NH_3 + 3O_2 \quad 6H_2O + 2N_2$

Since, in overall reaction 1 mole of NH_3/mole HNO_3

$$(.05) \quad (\frac{1}{1}) \quad x \quad \frac{3}{4} = .0375 \text{ \# moles } O_2/\text{\#mole } HNO_3$$

Overall O_2 balance is then 2 + .0375 = 2.0375# moles O_2/# mole HNO_3

$$(2.0375) \frac{(.79)}{.21} = 7.66 \text{ \# moles } N_2/\text{\# mole } HNO_3$$

@ 2.0% excess O_2:

$$\frac{x}{7.66+x + \frac{.79}{.21}} = 0.02$$

$$\frac{x}{7.66 + 4.76\ x} = 0.02$$

$$x = .0952x + .1532$$

$$x = .169 \text{ \# moles } O_2$$

$$\frac{.79}{.21} x = .637 \text{ \# moles } N_2$$

Tail gas composition is 8.29 # moles N_2

.17 # moles O_2

8.46 # moles T/G # mole HNO_3
(dry basis)

Emissions equal:

$(8.46)(NO_x)$ (Acid produced in lbs.)/ 63#/#mole HNO_3 = Moles NO_x

In a month in which 8203T Nitric Acid was produced and the average NO_x concentration was 22 ppm

$$(8.46)\frac{(222)}{1,000,000}(8203 \times 2000)/\ 63 = 490\text{\# moles}$$

as NO_2 490 x 46#/#mole/2000 = 11.3 Tons NO_2