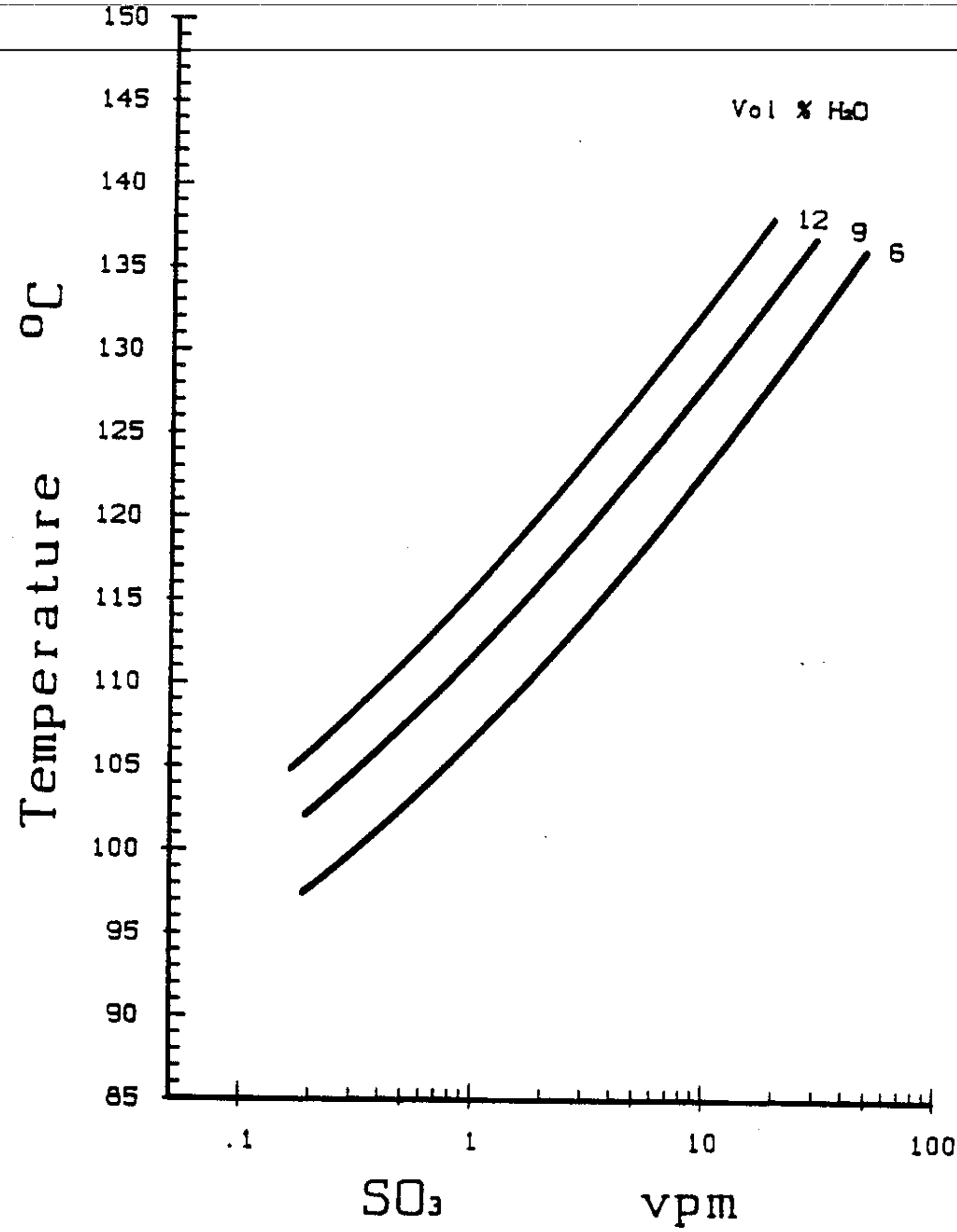
EXHIBIT 7.2-C

AMMONIA FROM FLUE GAS SIDE TO THE AIR SIDE OF THE APH

3.3 Side Effects

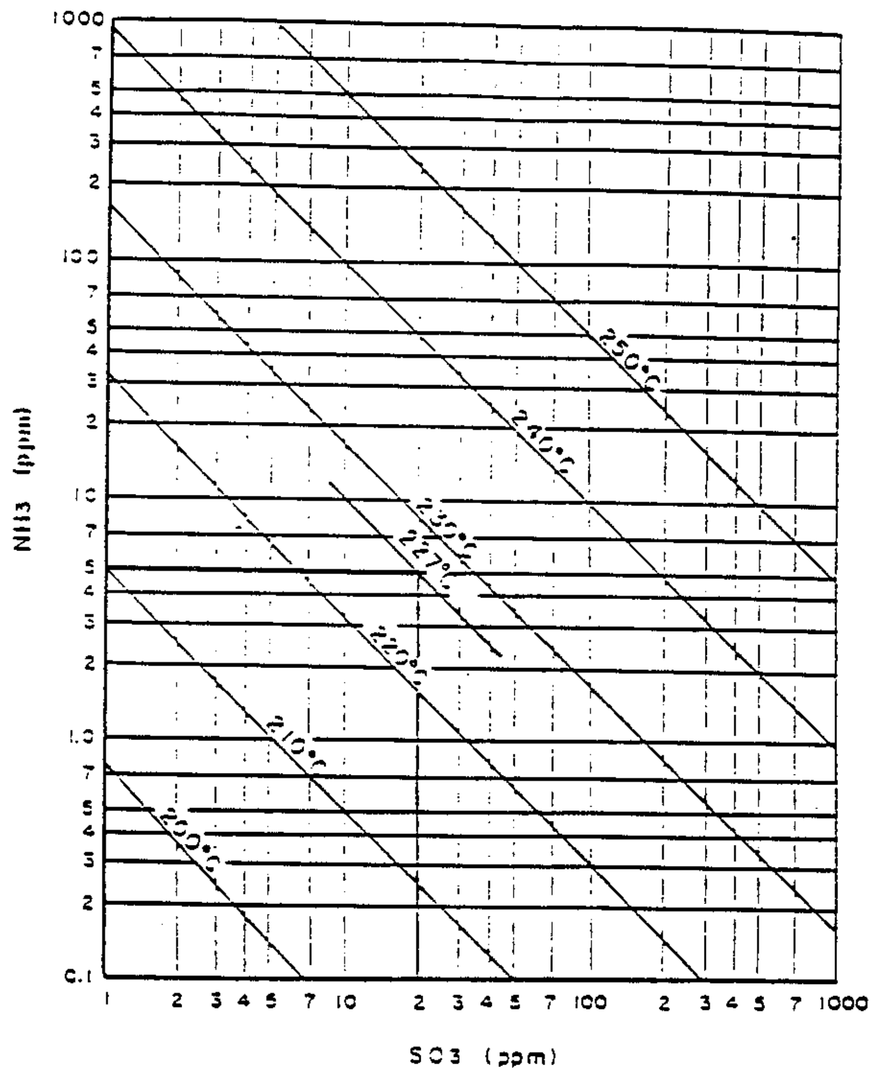
A further critical aspect of plant dimensioning is allowance for secondary reactions on dust and other effects such as condensation of ammonium sulfate compounds on the surface of cold plant items such as heat exchangers. In principle the following plant items are also affected by DeNOx plant operation:

- As shown in Fig. 3.3.1, the unavoidable oxidation of SO_2 to SO_3 the dew point of sulfuric acid is significantly raised and may cause corrosion in the heat exchangers located downstream, e.g. air preheater and gas heater. At very high SO_3 concentrations, a large fraction of this sulfuric acid can then leave through the stack in the form of iron sulfate and aerosol sulfuric acid. Such particulate and aerosol plume emissions were detected in several German plants. Basically this effect can be influenced by the selection of operating temperature, flue gas temperature, heat exchanger system and the catalyst system.
- Excess ammonia can react with SO_3 at temperatures below the dew point as shown in Fig. 3.3.2 to form sticky deposits on heat exchanger plates. These deposits are chiefly aluminous iron compounds as shown in Fig. 3.3.3. Depending on the material selected, severe corrosion can occur in addition to contamination, plugging and increased pressure drop, consequently these deposits are flushed off periodically with a special flushing device. These phenomena can be minimized by using corrosion resistant materials and profiles which facilitate cleaning.
- A certain fraction of the ammonia salts which condense

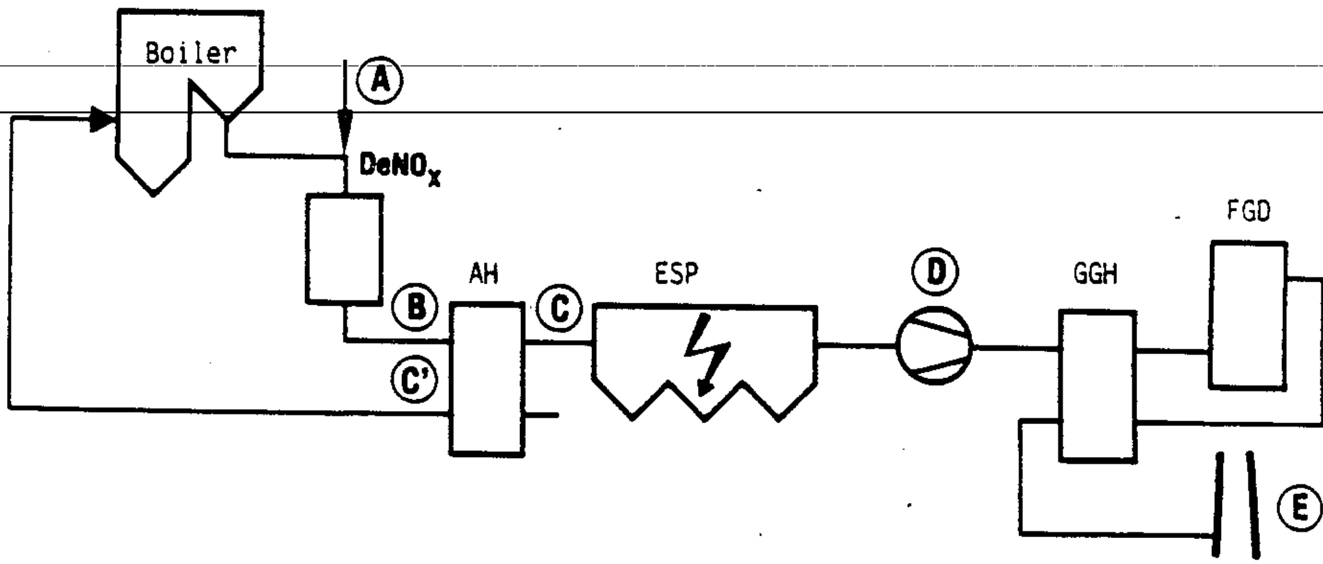


H_2SO_4 dew point as a function of water and SO_3 content

Fig. 3.3.1



Deposition temperature of ammonium sulfate



		A	B	C	C'	D	E
NH_3 gas	vpm	200	5	2	1,5	0,5	–
SO_3 gas	vpm	5	25	5	2	4	<1

Compounds from air preheater plates:

$NH_4Al(SO_4)_2 \times 12\ H_2O$	Alumens
$(NH_4)_3Fe(SO_4)_3$	Alumens
$(NH_4)_3Al(SO_4)_3$	Alumens
$Fe_2(SO_4)_3$	Ferrous sulfate
$Al_2(SO_4)_3$	Aluminium sulfate

Example of NH_3 and SO_3 balance in a high dust arrangement

Fig. 3.3.3

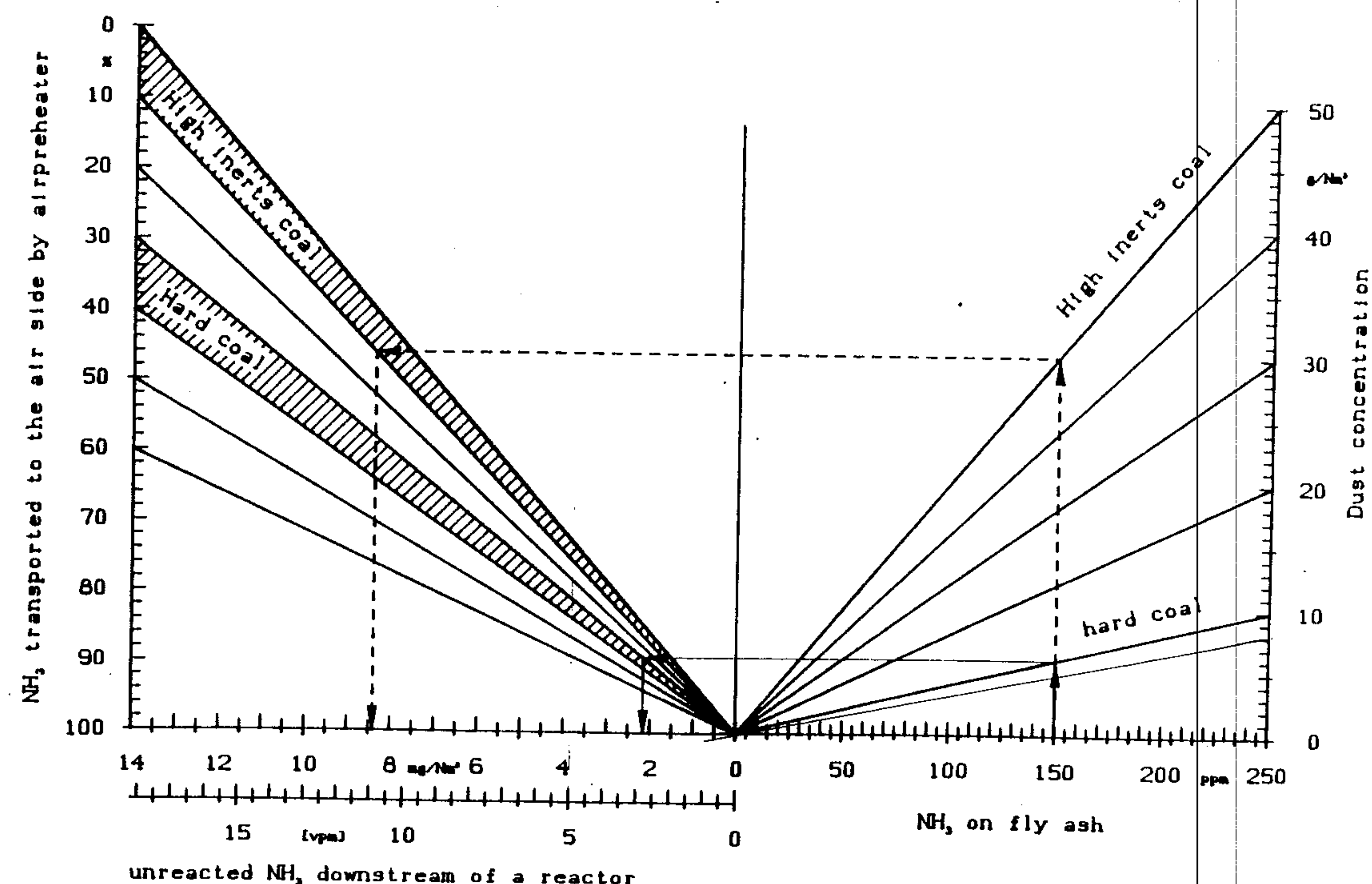
can be desorbed again on the air side of the air preheater or chemically broken down, so that, depending

on the fraction of fly ash, up to 40 % of the unreacted ammonia is returned to the combustion and mill air and oxidized in the furnace to N_2 or NO. To date, (after about 20,000 hours of operation) no negative effects on the combustion plant linked to this ammonia fraction in the combustion air have become evident.

- The greatest share of excess ammonia (low-inerts coal 50 - 70 %, high-inerts coal 90 - 100 % with variation due to structure) is adsorbed by the fly ash during cooling in the heat exchanger from about 350 to 130 °C. If this fly ash is used for making concrete, the ammonia content should not exceed 150 - 200 ppm (equivalent to mg NH_3/kg ash) since mixing with water can release ammonia by desorption.

Depending on the ash content produced by the coal fired, excess ammonia at the reactor outlet should be minimized by appropriate dimensioning of the catalytic converter. Fig. 3.3.4 shows how ammonia slip downstream of the reactor can be calculated from fly ash burdening.

RELATE TO ATROA 600 TOO!



Nomogram for calculating ammonia slip

EXHIBIT 7.2-D

HEAT PIPE PROPOSAL BID PACKAGE
FROM ABB AIR PREHEATER, INC.

ECH

ABB AIR PREHEATER INC.
WELLSVILLE, NEW YORK

CONFIDENTIAL

Q-PIPE® AIR PREHEATER

SOUTHERN COMPANY SERVICES, INC.
BIRMINGHAM, ALABAMA

FOR

DEPARTMENT OF ENERGY
SCR DEMONSTRATION PROJECT
PLANT CRIST #5
GULF POWER COMPANY
PENSACOLA, FLORIDA

PROPOSAL: 8049-D
MARCH 21, 1991

ABB

ASEA BROWN BOVERI

March 21, 1991

Southern Company Services, Inc.
Post Office Box 2625
Birmingham, AL 35202

Attention: Mr. Michael Steppe
Project Purchasing Manager

Gentlemen:

Department of Energy
SCR Demonstration Project
Plant Crist #5
Pensacola, Florida
Your Reference: SCR-700
Our Reference: 8049-D

We are pleased to submit our Proposal 8049-D, dated March 21, 1991 covering one Q-Pipe® Model 30-144-41-DV air preheater for use at the Department of Energy, SCR Demonstration Project, Plant Crist #5, Pensacola, Florida.

We have reviewed the following documents received with this request:

- Letter dated February 18, 1991, 2 pages.
- General Specification Contents, Heat Pipe Air Preheater, 3 pages.
- General Specification for Heat Pipe Air Preheater, pages 1 through 23.
- Supplemental Specification for SCS/DOE ICCT Selective Catalytic Reduction (SCR) Project, pages 1 through 8.
- Vendor Document Submittal Schedule, 3 pages.
- Vendor Deviation Request form, 1 page.
- Drawing submittal specification, 1 page.
- Instructions for Supplying Installation/Erection Drawings, 1 page.
- Quality Assurance Specification (SQAR2), 8 pages.
- Proposal form, 11 pages.
- General Conditions of Contract, 10 pages.

ABB Air Preheater Inc.

Andover Road
Post Office Box 372
Wellsville, New York 14895

Telephone (716) 593-2700

Fax (716) 593-2721

DOE Special Conditions, Attachments A and B - A) 7 pages, B) 7 pages General Arrangement Drawings:

EPS-4029-122	Rev. A
-121	Rev. B
-120	Rev. B
-119	Rev. B
-118	Rev. B
-117	Rev. B
-116	Rev. B
-115	Rev. B

The comments and/or exceptions are listed beginning with page 5 of this proposal.

If you have any questions concerning this proposal or if we any be of further assistance, please contact Mr. Larry Crast.

Very truly yours,

ABB AIR PREHEATER INC.

T. G. Mergler, sw

T. G. Mergler
Manager, Project Management
Heat Recovery Products

TGM:JSW:sg

DJG 3/26/91 ECH 3/26/91

PRICING

Q-PIPE Air Preheater

Proposal: 8049-D

FIRM PRICE THROUGH FEBRUARY 1, 1992 For one Model 30-144-41-DV Q-PIPE air preheater, f.o.b., Pensacola, Florida, (freight prepaid and billed back) (net) .... [redacted]

OPTIONAL PRICING

Transition ducts for one air preheater, f.o.b., Pensacola, Florida (freight prepaid and billed back) (net) .... [redacted]

Ten rotary type sootblowers for one air preheater, f.o.b., Pensacola, Florida (freight prepaid and billed back) (net)................ [redacted]

CONDITIONS OF SALE

Comments and/or exceptions concerning your General Conditions of the Contract, 10 pages, are noted beginning with page 5 of this proposal. We have quoted a firm price through February 2, 1992. If for any reason beyond the control of the Seller shipment cannot be made within the date specified, the price will be subject to the attached Material and Labor Adjustment Clause, Form GS-349-8.

General Description

The equipment offered is one (1) model 30.4-144-41-DV Q-Pipe® air preheater as described further in this specification for use at the Department of Energy, Demonstration Project, Plant Crist #5.

Installation will be near Pensacola, Florida.

The Q-Pipe® air preheater offered has been selected for downward vertical gas flow.

Predicted Performance

(Performance shown is for one air preheater per boiler)

Design Conditions	Flue Gas	Combustion Air
Flow rate (Lb/hr)	24,934	21,759
Entering temp (°F)	700	100
Leaving temp (°F)	300	588
Pressure drop (In wg)	1.60	3.00
Avg. specific heat (Btu/lb °F)	0.263	0.247

Heat recovered (MM Btu/hr)	2.69
Minimum cold end tube temperature (°F)	277
Design fuel	Eastern Bituminous Coal

Performance is based on clean heat transfer surfaces and uniform flow distribution through the heat exchanger.

Performance Guarantee

We guarantee that, if the Q-PIPE air preheater MODEL 30-144-41-DV is installed and operated in accordance with our plans and specifications and provided uniform air and gas flow distributions, when in a clean condition and delivering 21,759 pounds of air per hour at an entering temperature of 100°F, the air preheater will reduce the temperature of 24,934 pounds of gas per hour from an entering temperature of 700°F to an exit temperature of 300°F ±10°F, based on an air side specific heat of 0.247 Btu/lb °F and a gas side specific heat of 0.263 Btu/lb °F, with an average air pressure loss of not more than 3.00 inches WG and an average draft loss not more than 1.60 inches WG (based on a site elevation of 100 ft. above sea level). All other performance data that is listed in this proposal or in any contract that results from this proposal is our estimate of expected performance and is not guaranteed.

The exclusive means for determining whether the Performance Guarantees are satisfied shall be the testing of the equipment in accordance with procedures set forth in the Air Heater Test Code, ASME PTC 4.3. ("Performance Tests"). Performance Tests shall be at Purchaser's expense. If the Performance Tests are not completed before the expiration of the Test Limitation Period, defined below, the equipment shall be deemed to have satisfied the Performance Guarantees, and the Seller shall have no further obligations under this Performance Guarantee. The Test Limitation Period shall expire upon the earlier of either one-hundred twenty (120) days from initial operation of the equipment but no later than December 15, 1992.

If the performance tests indicate that the Q-PIPE air preheater does not meet guaranteed performance in accordance with the above guarantee, then the Seller shall, at its option, either make the necessary repairs, replacements or modifications to permit such performance, or in lieu thereof, may pay the Purchaser as liquidated damages in full satisfaction of the failure to meet this Performance Guarantee, a negotiated sum not to exceed the contract price. If Seller elects to repair, replace, or modify the equipment and the equipment still does not meet guaranteed performance, the Seller shall pay the Purchaser liquidated damages as specified above in full satisfaction of the failure to meet this Performance Guarantee. The remedies and obligations set forth in this Performance Guarantee are Purchaser's exclusive remedy and Seller's exclusive obligations in the event of failure of the equipment to satisfy Performance Guarantees.

ABB Air Preheater Inc.-designated representative must certify that the air preheater overall unit condition is acceptable for testing prior to actual testing. This service is available at a per diem rate.

Scope of Supply (The information below is for one air preheater)

Model Number: 30-144-41-DV

~~Total number of heat pipes~~	~~328~~
Pipe material	Carbon Steel
Pipe o.d. (inches)	2.00
Pipe wall thickness (inches)	0.095
Fin density (fins per inch) (thirty two rows)	3 gas / 3 air
Fin density (fins per inch) (nine cold end rows)	3 gas / 0 air
Fin thickness (inches)	0.059 gas / 0.059 air
Fin height (inches)	0.75
Fin type	Solid
Tube arrangement	Inline
Transverse pitch (inches)	3.75
Longitudinal pitch (inches)	3.75
Total surface area gas side (sq. ft.)	10057
Total surface area air side (sq. ft.)	4076
Total approximate weight (lbs)	54100 with transitions

The equipment is designed for maximum operating pressures of ±20 inches wg on the combustion air side and ±20 inches wg on the flue gas side. The heat pipe fill fluids are suitable for a maximum entering gas temperature of 750°F with a 100°F air entering temperature.

If required, the design of the air preheater can be modified to accommodate higher temperatures and/or static pressures.

The heat pipe fill fluids selected for this application require no special freeze protection and will not generate the excessive internal pressures seen in water based heat pipes.

Air flow must be maintained through the heat exchanger if gases above 550°F are flowing through the gas side.

External surfaces will be prepared per SSPC-SP-2 and painted with one coat of red oxide primer.

The air preheater has been designed to provide essentially zero air-to-gas leakage by utilizing a completely seal welded air-to-gas division wall.

Page 9, Limitation of Liability, Paragraph 32

We agree with your Limitation of Liability paragraph as written, but request that the following sentence be added at the end:

> The Vendor's liability to the Purchaser under this agreement or under any cause of action relating to this agreement, whether based on contract, warranty, tort (including negligence), strict liability, indemnity, or otherwise, shall not exceed the price of the equipment.

Technical

General Specification For Heat Pipe Air Preheater

Pages 2 & 3, Section 2.1:

There are no codes or standards that apply specifically to the heat pipe air preheaters. Our equipment is designed in accordance with commonly accepted industry practices and sound engineering judgement. In establishing design and fabrication practices we are guided by the requirements of the AISC, ASME, and AWS specifications and we use almost exclusively ASTM designated materials, however; we cannot claim that our equipment, methods and procedures comply in all respects with all of the codes listed. If there are specific sections of any of the codes listed with which we are to comply, please identify these and we can review them to determine if we are, or can be, in compliance.

Page 3, Section 2.2, Item 2.2.3:

All comments and exceptions to these specifications will be made in this proposal document. The Vendor Deviation Request Form will be used only during the contract phase and only for deviations from previously agreed upon terms.

Pages 4 & 5, Section 3.0, Items 3.1.7 & 3.3.1:

The tubing used to fabricate the heat pipes is ASTM A178 grade A material which is electric resistance welded tubing.

Page 7, Section 4.0, Item 4.1.1:

All welding procedures used to fabricate the heat pipe casing (the box) are in accordance with AWS D1.1 and all welders are qualified under AWS D1.1. All welding procedures and welder qualifications used in the fabrication of the actual heat pipe assemblies are in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

Page 7, Section 4.0, Item 4.1.2:

There are no requirements for NDE, heat treating, or special processes specified for the Q-Pipe air preheater. All welding procedures used in the fabrication of the Q-PIPE air preheater will be available for customer review at our facilities. This review is for information and instruction only. The processes are not subject to customer approval. ABB Air Preheater Inc. does not accept the responsibility for the costs of plant visits made by customer/buyer personnel.

Page 8, Section 4.0, Item 4.3:

We are offering equipment separated into modules maximizing reasonable shipping and handling constraints. However, we are not familiar with the specific hoistway and access restraints at your plant. We therefore cannot comment as to our compliance with this criteria.

Page 8, Section 4.0, Item 4.6:

We are offering equipment with surface preparation in accordance with our standard procedures. This includes a combination of power tool and hand tool cleaning.

Page 9, Section 4.0, Item 4.7:

The actual heat pipes will be manufactured in Pryor, Oklahoma. The casing, tube sheets, and center partition, will be manufactured and the assembly of the Q-PIPE air preheater will be carried out in Wellsville, New York.

Page 9, Section 5.0, Item 5.1:

The modular design of the Q-Pipe air preheater facilitates the field erection of the equipment. General Q-Pipe air preheater installation instructions are provided in this proposal. Detailed installation instructions will be provided as notes on the contract erection drawings.

Page 9, Section 6.0, Item 6.1.1.1:

We cannot perform hydrostatic tests on the heat pipes due to the method in which a heat pipe is constructed. The heat pipes are evacuated, filled with working fluid, and closed in a single operation. If a hydrostatic test was performed prior to this, it would not test the final closure of the heat pipe. This would also cause severe problems in cleaning the interior of the pipes, as any residual water or oil would contaminate the fill fluids and impair the heat pipe performance. The maximum working pressure for any heat pipe should not exceed approximately 400 psig. Using ASME allowable stresses for our standard tube material yields an allowable pressure of approximately 1000 psig. This gives a minimum safety factor of 2.5. We have performed extensive burst testing of our heat pipes and have found that the average pressure at failure is in excess of 5000 psig at ambient temperatures. These test results can be reviewed at our facilities if desired.

Page 9, Section 6.0, Item 6.1.1.2:

Our standard manufacturing documentation clearly indicates the fill fluid data of each individual heat pipe including traceability. However, we are not clear on the meaning of the "test temperatures" you refer to. We do not conduct temperature tests during the manufacturing phase. Please clarify what your requirements regarding temperature testing are so that we may respond.

Page 9, Section 6.0, Item 6.1.2:

Our test procedures are proprietary in nature and are not subject to approval. A pre-manufacturing design review meeting may be held at our facilities for the purpose of discussing the test procedures if the customer desires. As stated previously, ABB Air Preheater Inc. does not accept the responsibility for costs of plant visits made by customer personnel.

Page 10, Section 6.0, Item 6.1.3:

Reports are available for review at our facilities. As stated previously, ABB Air Preheater Inc. does not accept the responsibility for costs of plant visits made by customer personnel.

Page 11, Section 6.2, Item 6.2.4:

Our engineering department does not require any nondestructive procedures to be carried out on the Q-Pipe air preheater.

Page 12, Section 6.3, Item 6.3.1.4:

Over the years we have established a list of reputable vendors from whom we purchase the materials and component parts required for the fabrication of the Q-Pipe air preheater. All of these vendors are subjected to periodic audits by our QA/QC department. However, we do not permit direct audits of our subcontractors by customer personnel without one of our representatives present.

Page 13, Section 6.4, Item 6.4.7:

Performance testing of the Q-Pipe air preheater is to be conducted in accordance with ASME PTC 4.3.

Pages 14 thru 17, Section 8.0:

We will submit all prints, manuals, and documents required for the erection, operation, and maintenance of the Q-PIPE air preheater. Our Technical Services Department will furnish the following to fulfill these requirements.

1. Installation and erection instructions.

    A. Four (4) sets of air preheater master packing lists.

    B. Four (4) sets of erection drawings.

2. Operation and maintenance instructions.

    A. Ten (10) Operation and Maintenance Manuals.

    B. Preliminary manuals may be sent early for information purposes only, not approval. These may be "typical" manuals.

    C. In general, vendor information will be included as received from our vendors.

    D. We will include sketches of various serviceable components; however, full size equipment drawings folded for manual insertion are not included.

3. If the above does not satisfy your requirements, additional manuals and/or prints, reproducibles, or aperture cards of drawings can be supplied at additional cost.

As stated above, all other documentation that is not proprietary in nature will be available for review at our facilities in Wellsville, N.Y. Visits made by customer/buyer personnel are made at their own expense. Of the documents and drawings mentioned above, only the General Arrangement drawing is subject to approval. All other materials are for information and review only.

Page 15, Section 8.2, Item 8.2.1.3:

We will supply WPS's and PQR's if required, however, we will not furnish weld maps.

Page 16, Section 8.2, Item 8.2.2:

As previously stated, all comments and exceptions to these specifications will be made in this proposal document. The Vendor Deviation Request Form will be used only during the contract phase and only for deviations from previously agreed upon terms.

Page 17, Section 9.0, Item 9.2.2:

If initial performance test data is deemed to be of unacceptable accuracy by both Purchaser and ABB Air Preheater Inc., we reserve the right to disqualify the independent testing agency for future testing. Another mutually acceptable testing agency, or ABB API if acceptable to the Purchaser, will be selected to conduct any additional testing deemed necessary.

Page 18, Section 10.0:

The heat pipe modules will be adequately labeled and matchmarked for installation in the field. Ship loose items consisting of the support feet, soot blowers, and transition ducts will also be adequately labeled and/or tagged.

Pages 18 & 19, Section 11.0:

The air preheater and associated components will be prepared and packaged in a manner that will insure protection against adverse elements during shipment and reasonable storage. This primarily involves the application of plastic covered plywood covers to the upper duct openings in the modules. The red oxide primer provides sufficient protection to the external casing.

If there is to be an extended period of time before the Q-Pipe® air preheater is placed in service or erected, it is preferred that the unit be stored indoors if space is available. Outdoor storage can be achieved with proper protection.

The Q-Pipe air preheater should be uniformly supported on blocks or beams at all support points. The air preheater should be positioned above the affects of surface moisture. Periodic inspection of all painted surfaces should be done to limit rusting. Defects in painted surfaces should be cleaned and repainted as required.

It is acceptable for the finned surfaces of the heat pipes to show a slight coating of surface rust. However, if the air heater is to be stored for an extended period, the finned tubes should be sprayed with an appropriate protective, rust inhibiting oil of the type shown listed below. Protective covers may be shipped with the Q-Pipe air preheater, however, additional covering, such as the use of tarps, may be desirable to protect the finned tubes. Periodic checks should be made of the covering for deterioration, and of the finned tubes for evidence of rusting. If rusting is observed, the areas should be resprayed with a protective oil.

ANTI-RUST OILS FOR USE ON FINNED TUBES

If there is to be an extended period of time before the Q-Pipe® air preheater is placed in service or erected, you might consider spraying the surface with one (1) of the oils listed below to retard rusting.

NOTE: Do not use on finned tubes which, as a result of having been in service, are coated with or have a build-up of deposit thereon. When applied on clean finned tubes, it will not be necessary to wash prior to placing the Q-Pipe air preheater in service.

Kendall - Kencote 60

Gulf No-Rust "C" Polar Type Rust Preventative

BP - Energol -- CPF-C-3

~~Texas Rust Proof Oil No. 564~~

Tidewater Oil Company - Tycol Anorustol No. 38

Texaco No. 1052 - Metal Protective Oil

Mobil - Mobilarama 245 - Low Flash Point

A pressure type spray can of one or two gallon capacity is suitable for applying the anti-rust oil.

Supplemental Specification For Heat Pipe Air Preheater

Page 6, Section 9.0, Item 9.2

In response to the request for a thermal performance guarantee, we are offering thermal performance, air side and gas side pressure drop guarantees as shown in the section of our proposal entitled "Performance Guarantee". Air and gas flow guarantees are not included since the system air and gas flows are dependent upon boiler and not air preheater operation.

Our thermal performance guarantee is based on gas outlet temperature which is the utility standard for thermal performance determination as established by the boiler test code ASME PTC 4.1, supplemented by PTC-4.3 Air Heaters.

DJG 3/26/91
ECA 3/26/91

INQUIRY NO. SCR - 700

PROPOSAL

FROM

VENDOR'S NAME: ABB Air Preheater Inc.

VENDOR'S ADDRESS: Andover Rd.
Wellsville, NY 14895

FOR

HEAT PIPE AIR PREHEATER

FOR

SCS/DOE ICCT SELECTIVE CATALYTIC REDUCTION PROJECT

LOCATED AT

PLANT CRIST UNIT 5

OF

GULF POWER COMPANY

1.0 SCOPE

In accordance with your Inquiry No. SCR-700 for Southern Company Services and having invited proposals for furnishing a heat pipe air preheater subject to all the conditions and requirements of the commercial terms and conditions and of the specifications and supplementary documents, we propose to furnish and to deliver the equipment specified for the prices quoted as follows:

2.0 PRICING

2.1 Proposal I - Base Bid:

For the equipment and material as specified, f.o.b. (as per Supplemental Specification):

Heat pipe air preheater	$[redacted] repa and billed back)
Transition ducts - Purchaser's Option	$[redacted]
Sootblowers - Purchaser's Option	$[redacted]
Total, Base Bid	$[redacted]

DJG 3/26/91 ECH 3/26/91

2.2 Proposal II – Other Optional Equipment or Materials:

For other optional equipment or materials, f.o.b. (as per Supplemental Specification):

____________________	$ N.A.
____________________	$ N.A.
____________________	$ N.A.
____________________	$ N.A.

2.3 Maximum for freight to destination for Proposal I: $ [redacted]

2.4 Maximum for freight to destination for Proposal II: $ N.A.

2.5 Estimated manhours required for installation: [redacted]

2.6 If required, we will furnish a service engineer for receipt of equipment and materials, inspection, erection supervision, etc., under the following terms and conditions:

Our proposal price includes a fiel inspection prior to initial startu by our Technical Service Represen- tative. Should additional service required, refer to the attached WTF form for rate and charges.

2.7 Proposal validity

This proposal is valid for acceptance by the Purchaser until the following date: June 21, 1991

2.8 Cancellation

2.8.1 The latest date for cancelling this contract without incurring charges other than engineering is: [redacted]

2.8.2 Charges with respect to cancellation prior to the date given in 2.8.1 above will be as follows: [redacted]

2.9 Deferment

In the event of deferment up to twelve months as covered in the commercial terms and conditions the price adjustment will be: Will not exceed 10% of the purchase price.

3.0 ESCALATION

3.1 Material prices quoted are:

Firm or Subject to Escalation: Firm thru 2-2-92

3.2 For escalated prices, the following shall apply:

~~a) Indices to be used~~

b) Starting date of escalation

c) Ending date of escalation

d) Limits of escalation

e) Method of calculating escalation

We have quoted a firm price through February 2, 1992. If for any reason beyond the control of the Seller shipment cannot be made within the date specified, th price will be subject to the attac Material and Labor Adjustment Clau Form GS-349-8, copy attached.

4.0 QUALITY ASSURANCE

In addition to the Quality Assurance Documentation required by the specifications, we will furnish the following additional information which is generated as a result of our Quality Assurance Program:

5.0 SCHEDULE

5.1 We will start engineering upon receipt of a verbal award and written confirmation (yes or no): Yes

5.2 Outline drawings of the equipment will be furnished within the following number of days after award: Dates are subject to confirmation upon receipt of Purchase Order. 21-28

5.3 We will complete all necessary engineering within the following number of days after award: 90

5.4 We will start manufacturing within the following number of of days after award: 180

5.5 We will start shipment of the items covered by this inquiry, within the following number of days after award: 220

5.6 We will complete shipment of all items covered by this inquiry within the following number of days after award: 250

Above dates are based on 5-1-91 purchase order.

6.0 DESCRIPTIVE DATA AND ENGINEERING INFORMATION

The following descriptive information and design data are furnished in connection with the equipment and material offered in this proposal:

6.1 Tubes

Total number of tubes	328
Number of tubes per row	(32 rows-256) (9 C.E. rows-72)
Number of tubes in direction of gas flow	41
Tube O. D. – inches	2.0
Minimum average tube wall thickness – inches	.095
Design tube temperature – degrees F	750
Design tube pressure – psig	300
Maximum tube wall metal temperature – degrees	720
Minimum cold end tube temperature (evaporator side) – degrees F	277

6.2 Fins

	Gas Side	Air Side
Fin type	Solid	Solid
Method of fin attachment	Welded	Welded
Fin size (length, height, thickness) – inches	96/.75/.059	48/.75/.059
Fin spacing – inches	3	3

6.3 Heat Pipes

Gas side length – feet	8.1'
Air side length – feet	4'
Total length – feet	12.1'

6.4 Modules

Number of modules	3
Number of heat pipes in each module	168 - upper, 96-lower 64 - middle
Pitch and pattern of heat pipes	3.75
Design temperature for modules and ducts - degrees F	750
Design pressure for modules and ducts - inches WG	20

6.5 Working fluid

Type	Toluene	Napthalene
Flammability (flash point)	45° F.	190° F.
Freezing temperature - degrees F	0° F.	424° F. 176°

6.6 Soot blowers

Number supplied	10
Type	Rotary
Manufacturer	Copes Vulcan
Capacity - lbs/hr steam	3,000 lbs./min. 150,000 lbs/hr
Design steam conditions - lb/hr, psig, degrees F	250 psig, 302° F. Superheat
Power requirements	460 V/3 phase/60 Hz.
Accessories supplied	

6.7 Water wash system

Number of systems supplied	5
Number of nozzels	6 per pipe
Type	Full Jet Square Spray
Manufacturer	ABB Air Preheater Inc.

Capacity – lbs/hr water	28 gallons per minute per nozzle
Water pressure requirement – psig	60 psig

6.8 Weights

Total weight – pounds	54,100
Weight of one module – pounds	26,500 - upper, 15,100-lower 10,000 - middle
Weight of one heatpipe – pounds	84 (approx.)
Weight of soot blowers – pounds	

6.9 Materials

	ASME Type
Tube material	Carbon steel
Fin material	Carbon steel
Casing material	Carbon steel
Support structure and alignment bracing material	Carbon steel
Other material:	
	N.A.
	N.A.
	N.A.

6.10 Operating Conditions

Recommended maximum operating temperature – degrees F	750
Maximum recommended operating hours exceeding above temperature – hrs	0
Never to exceed temperature limit – degrees F	750

6.11 Predicted performance

	100% Load
Flue gas flow – lbs/hr	24,934
Air flow rate – lbs/hr	21,759
Flue gas inlet temperature – degrees F	700
Flue gas outlet temperature – degrees F	300
Air inlet temperature – degrees F	100

Air outlet temperature – degrees F	588
Draft loss gas side – inches wg	1.60
Draft loss air side – inches wg	3.00
Face velocity, gas side – ft/sec	10.05
Face velocity, air side – ft/sec	8.694
Thermal duty – Btu/hr	2.69 mm
Thermal duty per heat pipe – Btu/hr	8201

6.12 Guaranteed performance

Flue gas outlet temperature – degrees F	300 (± 10°F.)
Air outlet temperature – degrees F	588
Draft loss gas side – inches wg	1.60
Draft loss air side – inches wg	3.00

6.13 Codes and Standards

The following codes and standard apply to the equipment and materials supplied:

American Society of Mechanical Engineers (ASME)

	Revision or Addendum
Boiler and Pressure Vessel Code, Section I, Power Boilers	N.A.
Boiler and Pressure Vessel Code, Section II, Material Specifications	N.A.
Boiler and Pressure Vessel Code, Section V, Nondestructive Examination	N.A.
Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications	12/31/90 Addendum
B31.1 Power Piping	N.A.
PTC 4.1 – Steam Generating Units	N.A.
PTC 4.1a – ASME Test Form for Abbreviated Efficiency Test	N.A.
PTC 4.1b – ASME Test Form for Abbreviated Efficiency Test	N.A.
PTC 4.3 – Air Heaters	PTC 4.3

American Society for Testing and Materials (ASTM)	Revision or Addendum
Annual Book of ASTM Standards	1990

American Institute of Steel Construction (AISC)	
Manual of Steel Construction	9th Edition

American Welding Society (AWS)	
AWS Structural Welding Code	D1.1-90

American National Standards Institute (ANSI)	
American National Standard Minimum Design Loads for Buildings and Other Structures	A-58.1-1982

Code of Federal Regulations (CFR)	
OSHA 29CFR	1990
DOT 49CFR	1990

Other Codes and Standards:

6.14 Name and location of fabricators: ABB Air Preheater Inc.
Wellsville, New York

6.15 Name and location of tube supplier: ESCOA Div. Fin Tube
Pryor, Oklahoma

6.16 Shipment will be made by rail or motor freight: Motor freight

6.17 Description of proposed support system and alignment bracing: The Q-Pipe Air Preheater will be supported at four points located on the sides of the lower module. One support foot is completely fixed to the support steel. The remaining three support feet have sliding pads which are guided to allow for thermal growth.

6.18 Description of specific procedures and requirements for performance testing including number and length of tests, instrumentation, and data required: See attached outline of guidelines for Air Preheater ASME Code Testing

6.19 Description of method of correction of performance test results for comparison to design. Vendor shall provide a sample calculation to show each step of correcting each tested value to the specific design points for comparison with guarantees. Included in proposal on Page: Section 7 of ASME PTC 4.3

6.20 Description of preparation of shipment, cleaning, and jobsite storage requirements:

Included in proposal on page 13

6.21 Description of mandatory requirements and recommendations for field cleaning:

Sootblowers should be operated initially once every 8 hours. Blowing frequency & duration should be adjusted periodically as conditions warrant. Water washing may be required if ABS formation begins to affect thermal performance and/or pressure drop.

6.22 Any requirements, restrictions, and recommendations concerning the location and use of Vendor supplied sootblowers or any additional sootblowing equipment required:

Specific sootblowing recommendations will be provided in our Installation Operation and Maintenance Manuals. Locations are shown on the drawings. Access platforms for sootblower operation and maintenance should be considered.

6.23 List of special tools, devices, and wrenches furnished:

N.A.

.3a Recommendations for installation of equipment and materials found on Page: See attached data regarding installation of equipment.

.0 EXCEPTIONS

.1 We have reviewed your specifications and all related attachments. Unless specific exceptions are listed below (or included in our proposal and referenced below), it is undersood that all of the provisions contained therein are acceptable to us.

Without exceptions: With comments and exceptions.

With exceptions as follows: Refer to the Commercial and Technical Comments beginning with page 5 of this proposal.

.2 The Vendor Document Submittal Schedule has been reviewed and the required documentation and submittal dates (time frames) are acceptable to us unless listed below: Refer to page 11 & 12 of this proposal.

8.0 SIGNATURE: T. G. Mergler
T. G. Mergler

TITLE: Manager, Project Management

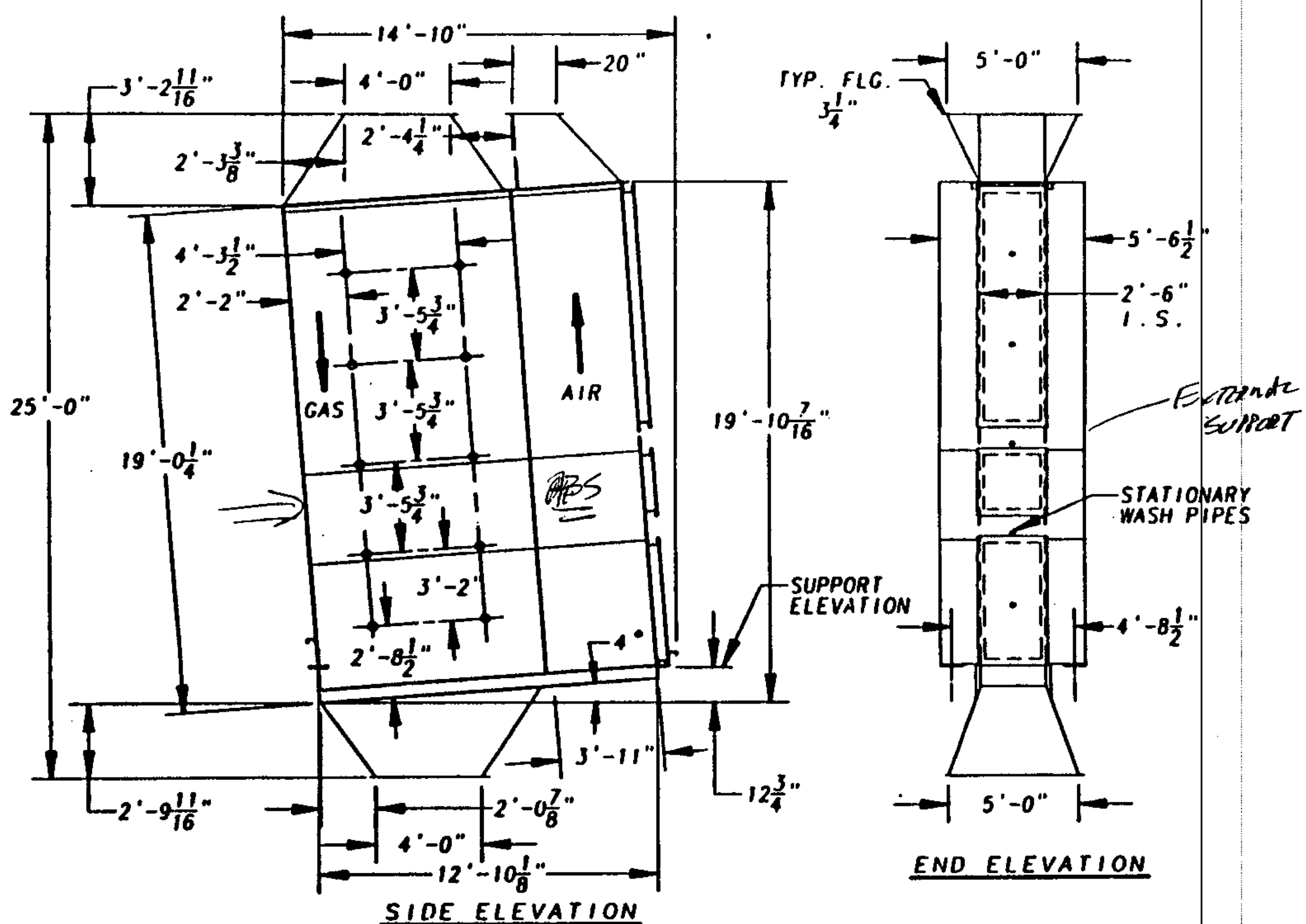
NAME OF COMPANY: ABB Air Preheater Inc.

TELEPHONE NUMBER: 716-593-2700 Extension 403

FAX NUMBER: 716-593-7566

DATE: 3-21-91

MJN/mdn
F: HEATPIPE.WK1
1/25/91



CUSTOMER: SOUTHERN COMPANY SERVICES
MODEL: 30.0-144.0-41-DV
APPROX. WEIGHT: 54,100 LBS.

NO EXTERNAL LOADS APPLIED TO FLANGES
BOLTED CONNECTIONS TYPICAL
ALL DIMENSIONS APPROXIMATE
PRELIMINARY - NOT TO BE USED FOR CONSTRUCTION

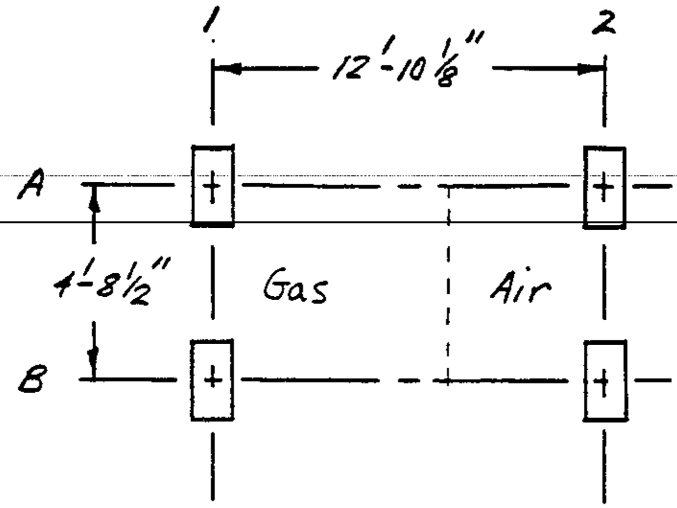
ABB AIR PREHEATER	
TYPE: DV-I	PROPOSED ARRANGEMENT FOR O-PIPE AIR PREHEATER
CHK'D: KJO	
DATE: 3-20-91	
PROPOSAL: 8049-D	REV.:

CALCULATION SHEET

For Southern Company Services — Sheet 1 Of 1

Support Foot Reactions – Dead Loads — Contract No. Proposal 8049-C

Reference Drawing Proposal Sketch



Top Plan View of Support Feet

Load Location	A1	A2	B1	B2
Dead Load (Kips)	14.90	12.15	14.90	12.15

Notes:

1) The loads shown are for ABB API equipment only.
2) Wind and seismic reactions are not included.

THE AIR PREHEATER COMPANY, INC.
Made By Kevin O'Boyle
Checked By ______ Date 3/22/91

REV. 0 | SHEET NO.

Form # 173 6/69

EXHIBIT 7.2-E

HEAT PIPE SPECIFICATIONS

Southern Company Services
Post Office Box 2625
Birmingham, Alabama 35202
Telephone 205 870-6011

ECH

Southern Company Services

April 17, 1991

RE: DOE SCR Project - Heat Pipe Working Fluids

Mr. R. G. Ward
Senior Project Engineer
Power Generation Engineering
Gulf Power Company
P. O. Box 1151
Pensacola, FL 32520-1151

Dear Roy,

Attached you will find some information supplied by ABB Air Preheater addressing your concerns over the flexibility of the heat pipe working fluids. This information indicates that combustion of toluene cannot be sustained with the oxygen content in the flue gas below 9% by volume. From the SRI testing, the oxygen content of the flue gas on Unit 5 varies between 3% and 7% by volume.

Also note that ABB's standard tube material gives a safety factor of 2.5 between allowable pressure and maximum vapor pressure of toluene.

ABB has confirmed that the heat pipe will contain less than 600 pounds of toluene and less than 500 pounds of naphthalene.

The award date for the heat pipe is Monday, April 22, 1991. Therefore, we would appreciate any comments you may have by that date. Please call if you have any questions.

Sincerely

Roy Shanburn for H.R. Bailey

H. Ray Bailey
Project Engineering Manager

cc: Southern Company Services

J. A. Blanco
K. W. Bowers
E. C. Healy
R. W. Ingram
J. D. Maxwell
H. L. Parker
R. E. Rush
S. W. Woodfield
Project File

Gulf Power Company

H. L. Witt
C. R. Lee
C. J. Kelly
O. L. Dixon III
W. T. Lyford III

Q-Pipe® Heat Pipe
Thermal Fluids

The heat transfer fluids used in the Q-Pipe air preheater are aromatic hydrocarbons- toluene and napthalene. These were selected for several reasons, though primarily for their stability and thermal characteristics over a broad operating temperature range.

There are two questions typically asked with regard to the use of hydrocarbon fluids in a heat pipe.

1) Are the fluids flammable?

2) Is there a chance that a tube could rupture, release its fluid and cause a fire?

The hydrocarbon fluids are combustible although napthalene to a significantly lesser degree than toluene. Toluene is a common solvent; napthalene is nothing more than mothballs.

A heat pipe, by design, operates on the saturation curve of its working fluid. Therefore, the internal pressure is a function of the temperature - the higher the temperature the higher the pressure. To maintain an infinite service life, maximum operating temperatures were established for the various thermal fluids. The limit for toluene is 550° F, for napthalene 800° F. These have corresponding maximum internal pressures of 405 and 398 psig respectively. (The ASME allowable pressure for the tube material is 988 psig at temperatures below 650° F).

Comparing our allowable operating pressure to the allowable tube pressure yields a minimum factor of safety of 2.5. This translates into a factor of safety of approximately 5 based on the yeild strength of the material at 650° F. Actual tests have shown that the rupture pressure of the tubes is approximately 4500 psig at temperatures up through 675° F.

Extrapolation of the pressure/temperature curves above the critical temperature of the fluid is somewhat difficult. However, it is conceivable that a toluene filled tube could be ruptured if the tube temperature reached 1000°F. If a tube rupture should occur, the maximum amount of toluene that would leak from a single tube is 1.5 gallons for a tube 20 feet long and 3.0 gallons for a tube 40 feet long. With the assumption that a rupture could possibly occur under such abnormal conditions, an independent specialist was employed to assess the feasibility of a resulting fire. (Since naphthalene is significantly less flammable than toluene, the consultant's report was based solely on toluene).

The consultant concluded that even if combustion would be initiated either above the auto-ignition temperature (947° F) or below that temperature due to some external source, the chances of sustaining and propagating combustion are negligible for two reasons:

1) Toluene vapor in air of normal composition (21% oxygen by volume) will support continuous combustion only when the volumetric proportion of the toluene vapor is between 1.3% and 7.0%. These narrow limits reflect the rather poor combustibility of toluene. As the oxygen content of the gas (flue gas in this case) to be mixed with toluene is reduced, the toluene-gas composition range of flammability will become even smaller. In fact, combustion cannot be sustained at all when the oxygen content of the gas is below 9%, regardless of the toluene concentration. Since flue gasses resulting from the combustion of fossil fuels typically

contain 3 to 6% oxygen depending on the excess air the possibility of sustaining combu on is highly unlikely. (A 9% gen concentration in flue gas reflects firing with approximately 69% excess air).

2) Even if the toluene vapors were combusted and the oxygen content of the flue gas was sufficient to sustain combustion, the extended surface (fins) of the heat pipes would tend to extinguish the flame. A flame cannot propagate in a channel which is smaller than what is known as the "quenching diameter". This is the principle of the Davy Lamp, invented in 1816, which permits a miner to carry an oil flame surrounded only by wire mesh screen safely into an underground pocket of explosive gas.

There are no data currently available on quenching diameters for toluene-air mixtures. However, in natural gas-air mixtures, a flame will not propagate in a channel of less than 1/8 inch diameter, regardless of the natural gas-air composition. Since toluene-air mixtures support combustion much less readily and have a narrower range of composition flammability limits than natural gas-air mixtures, it can be reasonably estimated that the corresponding quenching diameter will be significantly larger. A reduction in oxygen content, as in the case of flue gas, will further increase the quenching diameter. Present applications employ .036" thick fins at a spacing of 7 per inch; it is safe to say that this spacing results in a channel which is less than the expected quenching diameter. It is doubtful that any flame could be propagated.

The large factors of safety to which a Q-Pipe is designed, with respect to both the allowable pressure and the known bursting pressure of the tube material, would seem to preclude the chance of releasing toluene vapor from a heat pipe. If, after a number of years of operation, a toluene leak did occur due to the long term effects of cold end acid attack or fly ash erosion, the release would be into the flue gas stream where initiation and propagation of a flame is nearly impossible.

Our experience confirms these conclusions. We have been using toluene-filled heat pipes since 1975, and with over 23,000 such pipes now in operation in over 560 different heat exchangers we have never had a single fire either sustained, propagated, or even initiated.

EXHIBIT 7.2-F

HOT AIR FANS SPECIFICATIONS

Inquiry No. SCR – 702
SCS/DOE ICCT
Selective Catalytic Reduction (SCR) Project
Fan Data Sheet

In addition to the fan design requirements listed in the Supplemental Specification the following information is specific to each fan in this inquiry:

1.0 General

1.1	Application:	Hot Air Fan (reinjection to system)
1.2	Location:	Air Heater Outlet – Streams 62, 63, 64
1.3	Number of Fans:	One (1)
1.4	Fan Control:	Inlet damper or inlet vane

2.0 Performance

2.1 Air Analysis at MCR (at fan inlet):

Air Component	Mass (lb/hr)
O2	5,208.00
N2	17,149.00
TOTAL	22,357.00

2.2 Expected Conditions

Load	Flow/Fan (acfm)	Ps @ Inlet ("wg)	Ps @ Outlet ("wg)	Ps Rise ("wg)	Density (lb/cuft)	Temp. (deg. F)
Test Block	37,000	-5.50	14.50	20.00	0.037	600
Design	31,784	-4.00	14.00	18.00	0.037	600
Part Load	20,097	-4.00	14.00	18.00	0.037	600
Minimum	9,793	-4.00	14.00	18.00	0.037	600

3.0 Construction

3.1 Peak Design Temperature: 700 deg. F

6.4.5 **Additional proposal data**

6.4.5.1 Dimension sheet — Attached

6.4.5.2 Performance curve — Attached

6.5 Hot Air Fan (Reinjection to unit)

6.5.1 **General**

6.5.1.1 Fan type (model/series) — 520000L4N, SWSI, Arr. #7

6.5.1.2 Type control — Inlet vane control

6.5.1.3 Drive arrangement — Direct connected

6.5.1.4 Number of fans — 1

6.5.2 **Performance**

6.5.2.1 Performance data for each fan at:

	Test Block (guaranteed)	Maximum
a. Speed – rpm	1775	1775
b. Capacity – acfm	37000	31784
c. Density – lbs/cuft	.037	.037
d. Temperature – deg F	600	600
e. Pressures – "wg		
1. Inlet static	-5.5	-4.0
2. Discharge static	14.5	14.0
3. Fan static pressure	20.0	18.0
f. Static efficiency – %	82.5	78.2
g. Power input to fan – bhp	141	115
h. Compressibility	.983	.985

6.5.2.2 Performance data for each fan at:

	Design	Minimum
a. Speed – rpm	1775	1775
b. Capacity – acfm	20097	9793
c. Density – lbs/cuft	.037	.037
d. Temperature – deg F	600	600
e. Pressures – "wg		
1. Inlet static	-4.0	-4.0
2. Discharge static	14.0	14.0
3. Fan static pressure	18.0	18.0
f. Static efficiency – %	73.8	50.4
g. Power input to fan – bhp	77	55
h. Compressibility	.985	.985

6.5.2.3 General performance data

a. Peak horsepower (@ TB density)	175
b. Maximum torque expected (ft-lb)	443 @ TB density
c. Starting torque (ft-lb)	Depends on density

6.5.3 Sound data

6.5.3.1 Sound level data for fan at noisest conditions through casing @ one meter

octave band center frequency (Hz)	Est. Lw dB (re 10^-12 watt)
63	105
125	99
250	95
500	102
1000	93
2000	90
4000	82
8000	73

	Est. Lp dB (re 20 mPa)
6.5.3.2 Sound pressure level at one meter outside housing	90 dba

6.5.3.3 Above estimate includes/does not include:

a. Inlet silencer	Does not
b. Outlet silencer	Does not
c. Casing insulation	Does not

6.5.4 Constructional data

6.5.4.1 Impeller general information

a. Diameter at tip of blade (in.)	52"
b. Width of wheel at tip of blade (in.)	6.25"
c. Type of blade (backward inclined, radial, etc.)	Backward inclined
d. Number of blades	12
e. Tip speed at test block (fpm)	24165
f. Flywheel effect (lb-ft2)	1565
g. Shaft dia. at hub (in.)	5.0
h. Shaft dia. at bearing (in.)	3.44

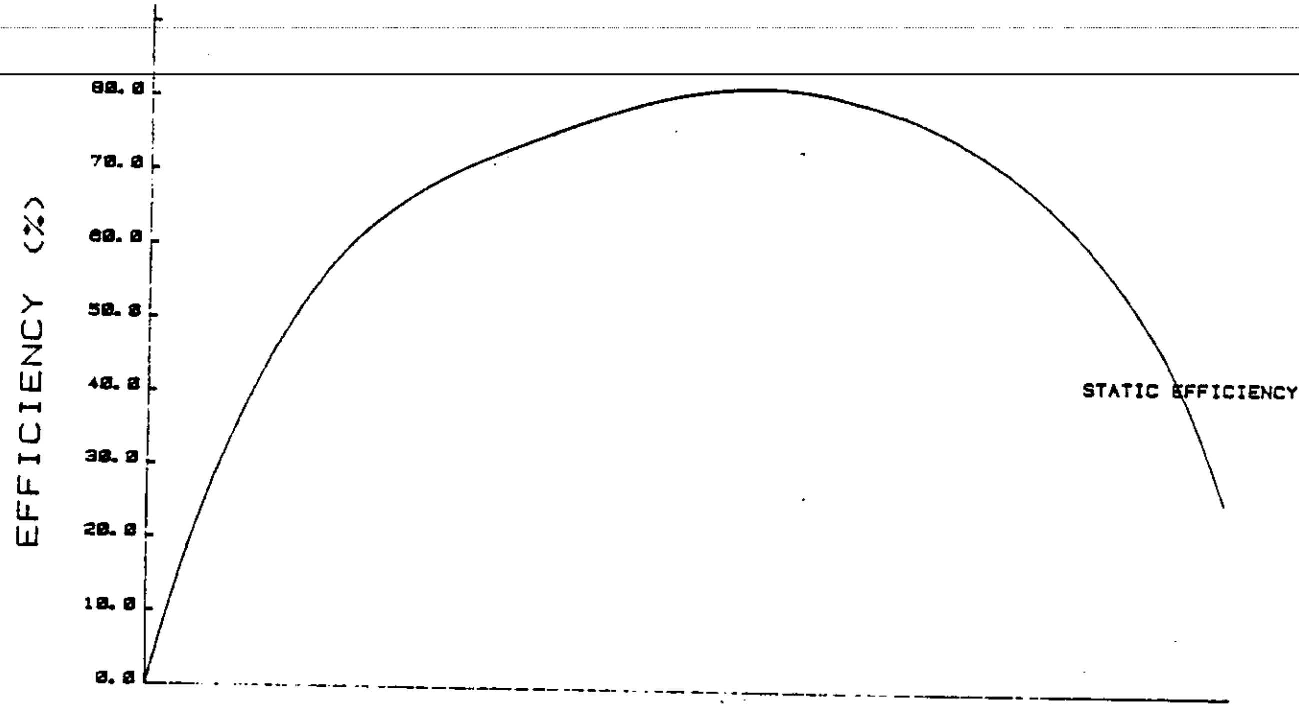
6.5.4.2 Material type

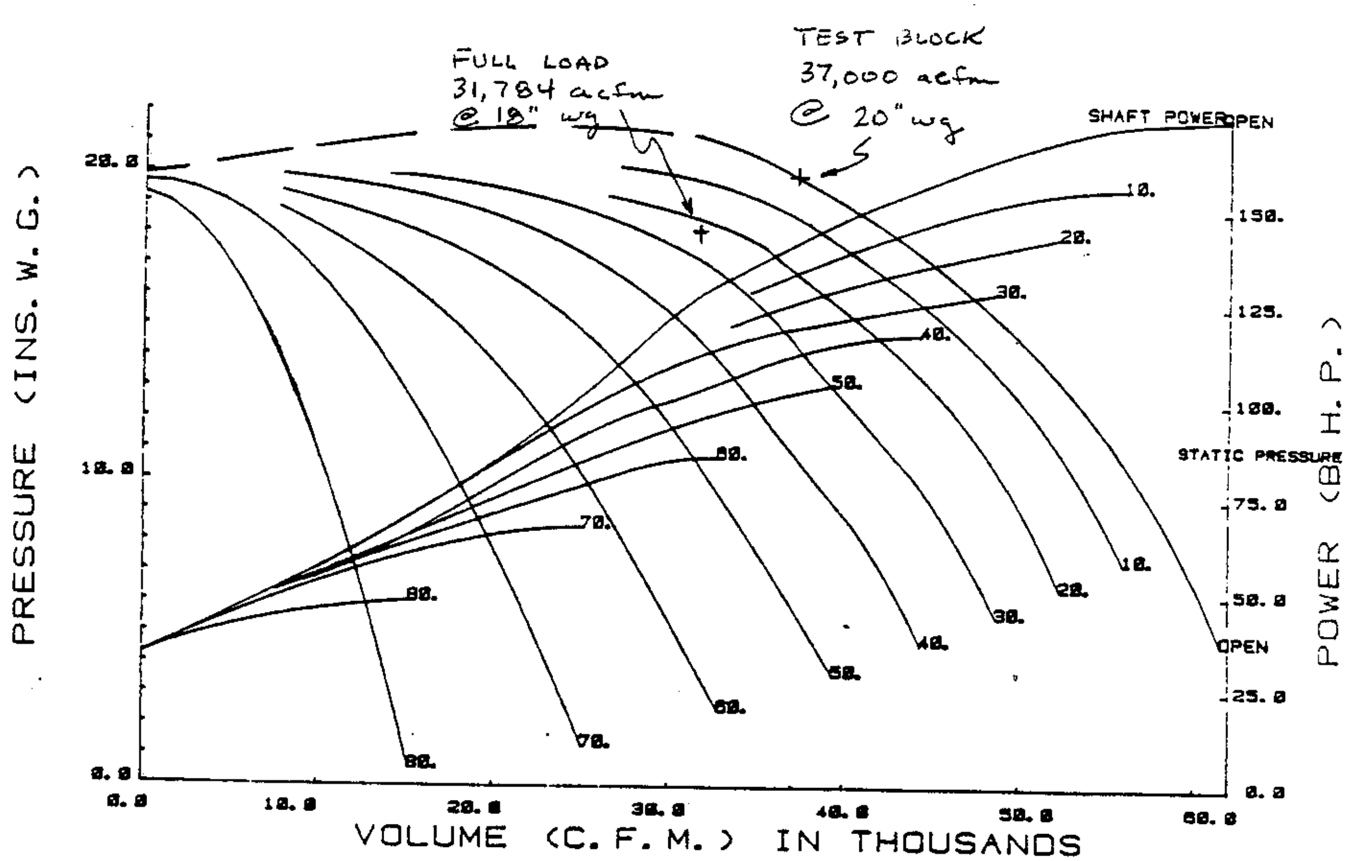
a. Shaft	A668
b. Wheel	A588
c. Liner	N/A
d. Housing	A36
e. Base	A36
f. Damper or Vane	A36

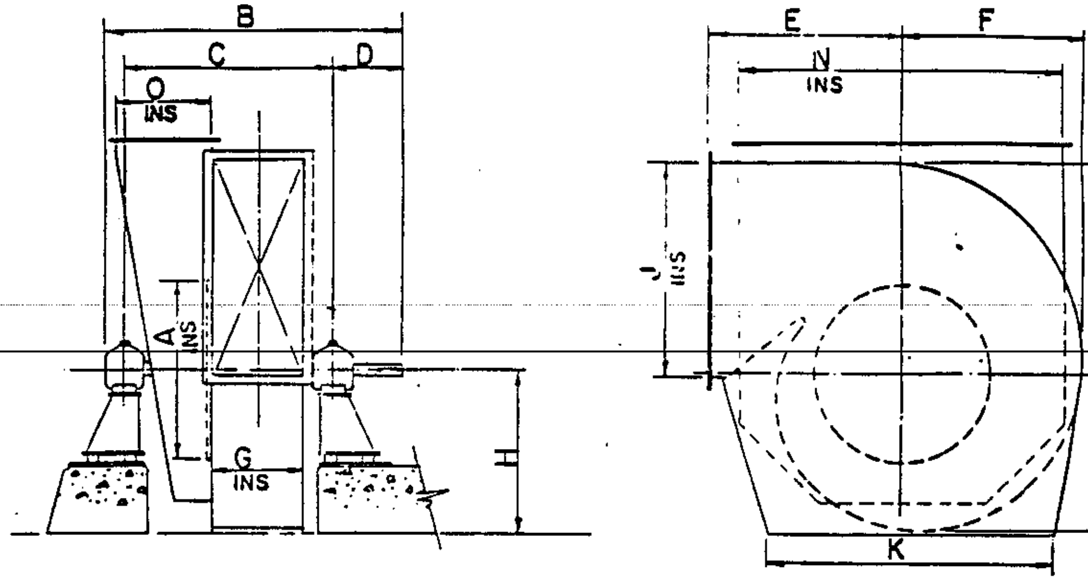
6.5.4.3	Material thickness (in.)	
	a. Blades	.375
	b. Liner	N/A
	c. Center, side or back plates	.375/.375
	d. Housing	.1875
	e. Base	.25
	f. Damper or vane (blade)	.14
6.5.4.4	Weights (lbs.)	
	a. Fan	5000
	b. Motor	1800
	c. Pedestal	4000
	d. Damper of vane	600
	e. Weight of complete assembly	12000
6.5.4.5	Bearings	
	a. Diameter (in.)	3.44
	b. Type	Sleeve
	c. Manufacturer	Dodge
	d. Lubrication	Oil
	e. Reservoir capacity (gal.)	Later
	f. Cooling water per fan (gpm)	2
6.5.4.6	Fan to motor connection	
	a. Type (flexible, belt, etc.)	Flexible
	b. Manufacturer	Falk or Equal
	c. Size	Later
6.5.5	Additional proposal data	
6.5.5.1	Dimension sheet	Attached
6.5.5.2	Performance curve	Attached
6.6	Hot Air Fan (Exhaust to atmosphere)	
6.6.1	General	Not required
6.6.1.1	Fan type (model/series)	Per latest
6.6.1.2	Type control	input.
6.6.1.3	Drive arrangement	
6.6.1.4	Number of fans	

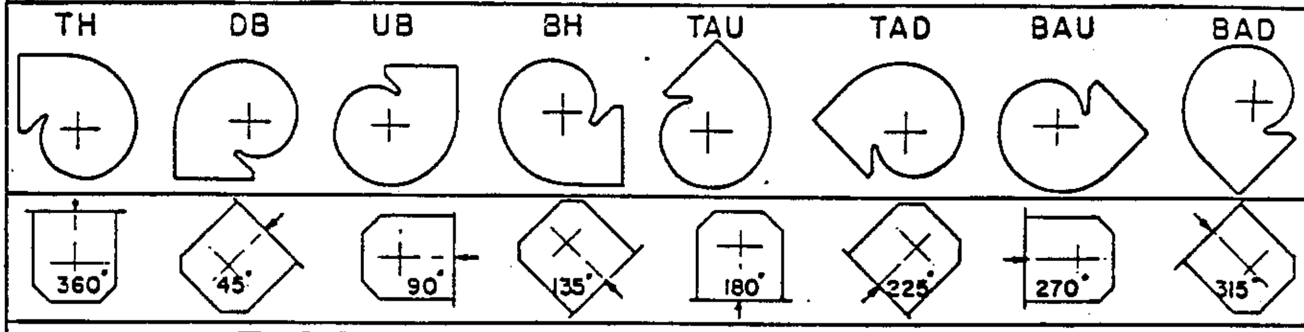
HOWDEN SIROCCO P27123/CF91	SOUTHERN COMPANY GULF PWR SCR	HOT AIR
	L4N DESIGN SINGLE BOX INLET CONSTANT SPEED VANE CONTROL	

L4NSBVC1.00
FAN SIZE 52.00
SPEED RPM 1775.0
INLET DENSITY .03700 LB/FT3
MAY 14, 1991









TYPE L4N. SW - BOX INLET - ARR. 3

Hot Air fan ⇒

FAN SIZE & STD. WHEEL DIA.	UNITS	A	B	C	D	E	F	G	H	J	K	L	M	N	O
5325	MM	1142	2209	1676	431	1549	1142	609	1346	1295	1803	1015	1295	2362	634
	INCHES	45	87	66	17	61	45	24	53	51	71	40	51	93	25
5600	MM	1219	2260	1727	431	1650	1219	634	1396	1346	1904	1066	1346	2489	660
	INCHES	48	89	68	17	65	48	25	55	53	75	42	53	98	26
5875	MM	1269	2336	1803	431	1727	1269	685	1473	1422	2006	1117	1422	2616	711
	INCHES	50	92	71	17	68	50	27	58	56	79	44	56	103	28
6175	MM	1346	2412	1854	431	1803	1346	711	1549	1498	2108	1168	1498	2743	736
	INCHES	53	95	73	17	71	53	28	61	59	83	46	59	108	29
6500	MM	1396	2489	1930	431	1904	1396	761	1625	1574	2209	1244	1574	2895	787
	INCHES	55	98	76	17	75	55	30	64	62	87	49	62	114	31
6825	MM	1473	2565	2006	457	2006	1473	787	1701	1650	2336	1295	1650	3047	812
	INCHES	58	101	79	18	79	58	31	67	65	92	51	65	120	32
7175	MM	1549	2641	2082	457	2108	1549	838	1777	1727	2438	1371	1727	3200	863
	INCHES	61	104	82	18	83	61	33	70	68	96	54	68	126	34
7525	MM	1625	2743	2158	457	2209	1625	863	1879	1828	2565	1447	1828	3352	888
	INCHES	64	108	85	18	87	64	34	74	72	101	57	72	132	35
7925	MM	1727	2844	2235	457	2311	1727	914	1955	1904	2692	1523	1904	3530	939
	INCHES	68	112	88	18	91	68	36	77	75	106	60	75	139	37
8325	MM	1803	2920	2336	482	2438	1803	965	2057	2006	2844	1600	2006	3708	990
	INCHES	71	115	92	19	96	71	38	81	79	112	63	79	146	39
8750	MM	1904	3022	2438	482	2565	1904	1015	2158	2108	2997	1676	2108	3886	1041
	INCHES	75	119	96	19	101	75	40	85	83	118	66	83	153	41
9200	MM	1981	3149	2514	482	2692	1981	1066	2260	2209	3149	1752	2209	4089	1092
	INCHES	78	124	99	19	106	78	42	89	87	124	69	87	161	43

DIMENSIONS—THESE ARE APPROXIMATE AND ARE NOT TO BE USED FOR CONSTRUCTION

Howden Sirocco Inc.
P27123/CF91

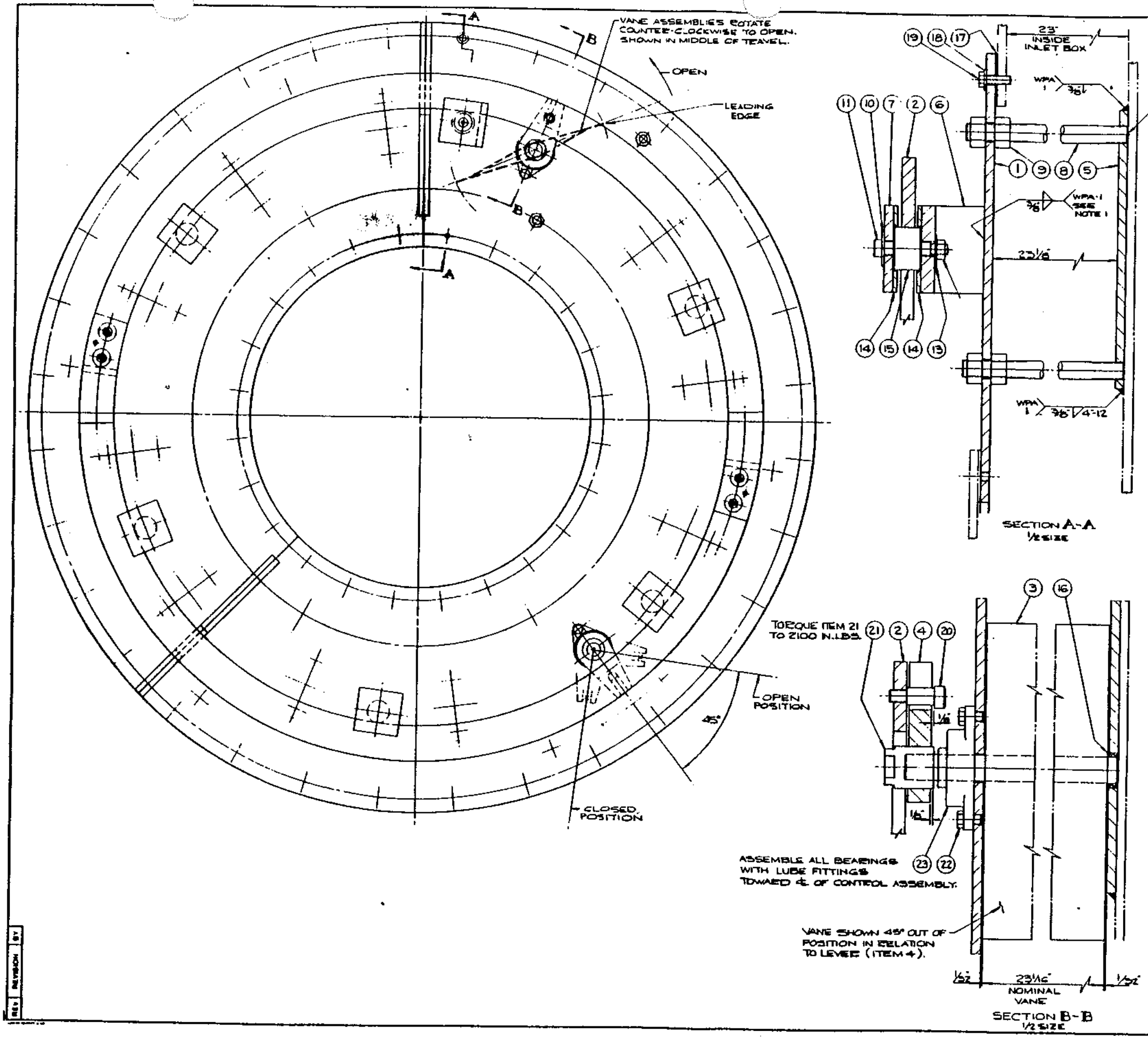
General Bill of Material

~~The following general bill of material applies with the exception of the~~ Ammonia Dilution Fan.

- Fan Housing and Boxes
- Side and Scroll Liners - Where Shown on Data Pages
- Arr. #3 Rotor
- Carbon Ring Shaft Seal
- Water Cooled Sleeve Bearings
- Arr. #7 Support System
- Spring Insulators
- TEFC Motor
- Variable Speed Controller - Except Hot Air Fan
- Inlet Vane Control - Hot Air Fan
- Electric Actuator - Hot Air Fan
- Bearing RTD's
- 110% Overspeed Test (Wheel)
- 2.5 Mils Alkyd Enamel
- Housing Split for Rotor Removal
- Doors, Drains, Flanged Inlet/Outlet
- Forged Steel Shaft
- Stress Relief
- Coupling or V-Belt Drive
- Coupling or V-Belt Drive or Guard
- Complete Shop Assembly - One Piece Shipment, Final Alignment Required, etc.

Option: Axial Vane Control with Electric Actuator.
Large or Small Reactor Fans

Large Fans: [redacted] per fan
Small Fans: [redacted] per fan



ALL THREADED RODS (ITEM 8) TO BE FLUSH WITH, TO 1/32" BELOW THIS SURFACE OF BACKING PLATE (ITEM 5)

TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL
DECIMAL
ANGULAR

NOTES:

1. CENTRALIZE CONTROL RING, POSITION ROLLERS & WELD SUPPORT ANGLES (ITEM 6) TO ASSEMBLY.
2. BRIDGE ON CONTROL RING (ITEM 2) TO BE FACING OUTWARD.
3. SPLIT FLANGE JOINT TO BE SEALED AT FINAL ASSEMBLY WITH SILICONE SEALING COMPOUND.
4. ONE VANE CONTROL ASSEMBLY AS DRAWN. ONE OPPOSITE TO DRAWING.

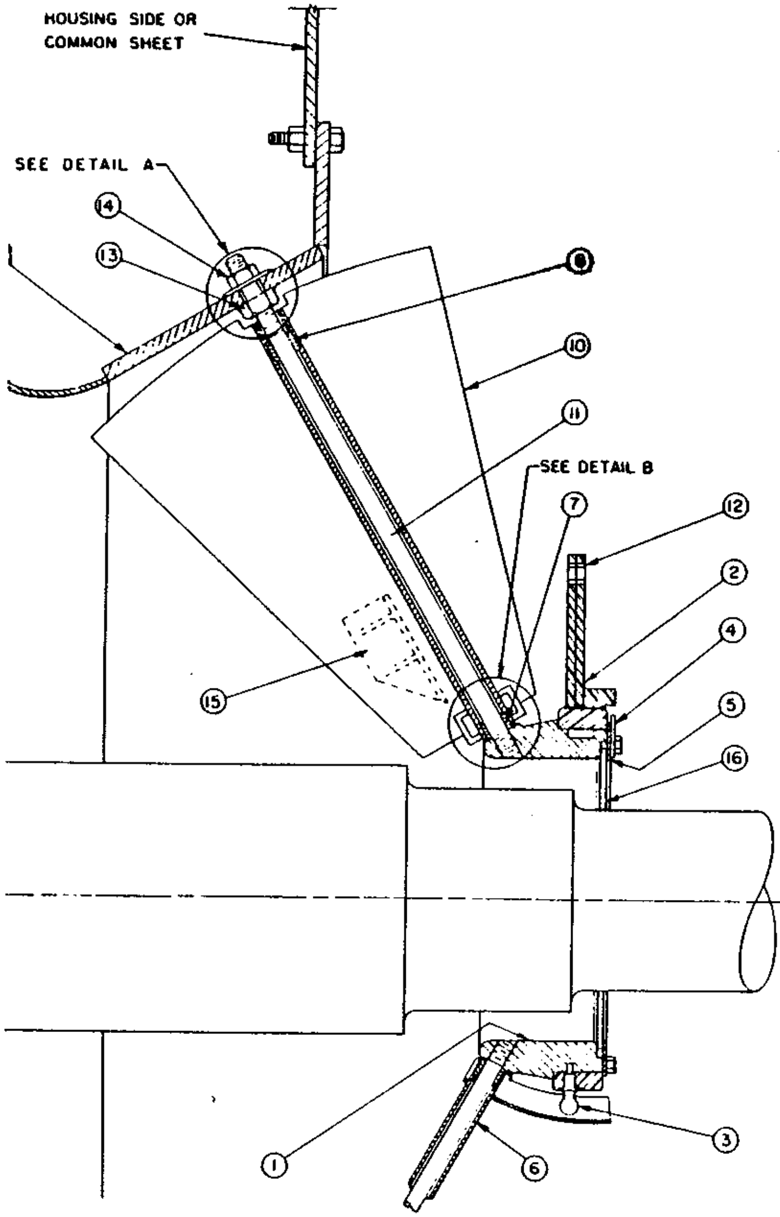
ITEM	REQ'D	DWG. NO.	MAT'L	DESCRIPTION
23	12		SEAL-MASTER	1 1/2 DIA. MNTD. BALL BRG. MSFT-24
22	24		GR. 2	9/16-12UNC × 1" LG. HEX HD BOLT
21	12		TRAN-TORQUE	MNTG. SLEEVE 1 1/2 I.D. × 2 3/8 O.D. × 2 3/4 LG.
20	12	UNBRAKO LOCWEL	GR. 2	1" DIA. × 1 1/2 LG. HEX SOC. SLDE SCR.
19	32		GR. 2	1/2-13UNC × 1 1/2" LG. HEX HD. BOLT
18	32		STL.	1/2" DIA. STD TYPE B PLAIN WASHER
17	1	NON-ASBESTOS	KLINGER SIL	GASKET 7'-6" O.D. × 7'-0" I.D. × 1/8" THK.
16	12	CUT TO LENGTH	OILITE AA-2001	SLEEVE BRG. 1 1/2 I.D. × 2" O.D. × 2" LG.
15	6		MCGILL KAMROL	CAM YOKE ROLLER BRG. "CYR 2 1/2
14	12		STL.	2 1/2" DIA. STD. TYPE A PLAIN WASHER
13	6		STL.	5/8 DIA STD TYPE B PLAIN WASHER
12	6		STL.	5/8-11 UNC REG HEX. NUT
11	6	UNBRAKO LOCWEL	GR. 2	3/4 DIA × 2 3/4 LG. HEX SOC. SLDE SCR.
10	6		STL	3/4 DIA. STD. TYPE A PLAIN WASHER
9	24		STL.	1"-14 UNF REG. HEX. NUT
8	12		1018	1"-14 UNF × 2'-1 1/4" LG THRD. ROD
7	6	C-1-1604		SUPPORT PLATE
6	6	C-1-1604		SUPPORT ANGLE
5	1	D-1-2776		BACKING PLATE
4	12	D-1-2775		VANE LEVER
3	12	D-1-2774		VANE ASSEMBLY
2	1	D-1-2773		CONTROL RING ASS'Y.
1	1	D-1-2772		MOUNTING PLATE ASS'Y.

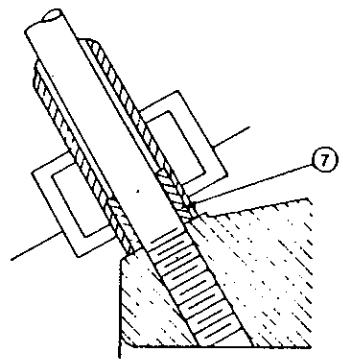
AXIAL VANE CONTROL ASSEMBLY

DATE 12-21-87
SCALE 1/4 & 1/2
DRAWN FWW
CHKD PPN

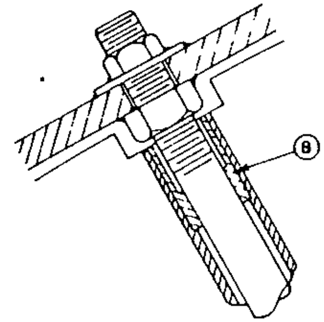
HOWDEN FANS
DIVISION OF JAMES HOWDEN AMERICA INC.

DRAWING NUMBER E-1-2777 REV. 0

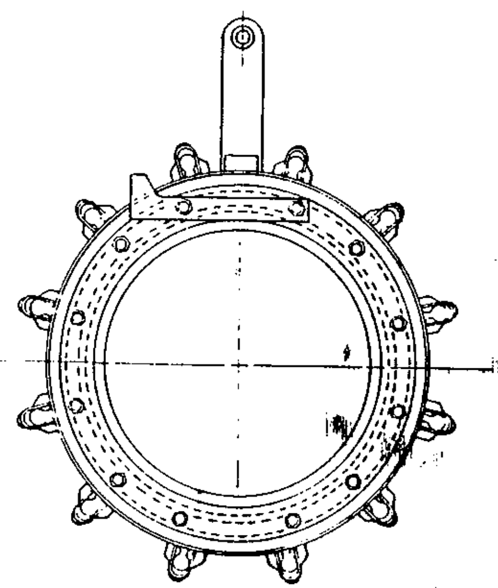




DETAIL B



DETAIL A



ITEM	BILL [illegible]ATERIAL DE[illegible]TION
1	BASE CASTING
2	OPERATING LEVER AND RING ASSEMBLY
3	BALL PIN
4	STOP PLATE
5	HOLDING RING
6	VANE TUBING AND ARM
7	LOWER BUSHING
8	UPPER BUSHING
9	INLET
10	VANE - (SEE FIGURE 8 I-8)
11	VANE ROD
12	BUSHING FOR OPERATING LEVER AND RING ASSEMBLY
13	JAM NUT
14	NUT
15	VANE TAB
16	SHAFT SEAL RING-(SPLIT)

NOTE - VANE TABS, ITEM 15, ARE NOT SUPPLIED FOR ALL APPLICATIONS.

HOT AIR FAN

150 HP, 1800 RPM, 445T

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (1565 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

LARGE REACTOR FAN - WITH CYCLONE

100 HP, 1800 RPM, 405T

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (1509 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

CONTROLLER DESCRIPTION ALL SIZES

NEMA 1 Enclosure
M/N 2EC1100
FlexPak AC

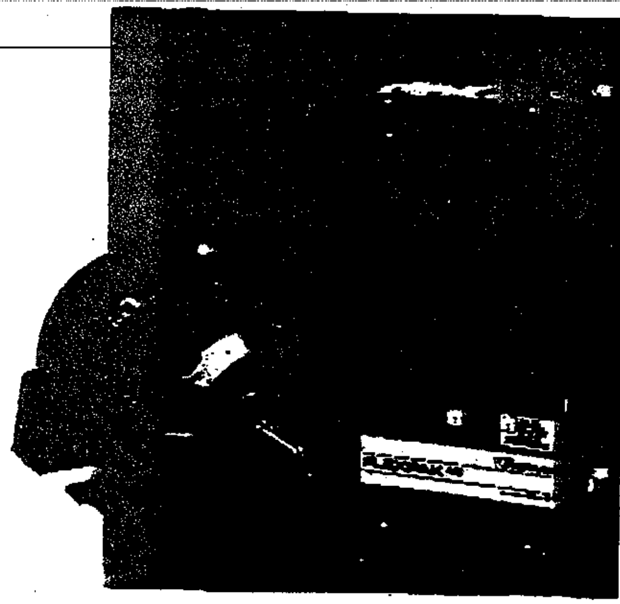
STANDARD FEATURES:

- Constant torque operating speed range of 20:1(1)
- Output frequency from 1.4 to 60 hertz with option for 120 and 240 hertz
- Near-unity displacement power factor throughout the speed range
- Insensitive to incoming power phase sequence
- Input line reactors to permit operation on a distribution system with 50,000 amp fault current rating without an isolation transformer
- Robust power circuit design safeguards controller from damaging line transients
- Line-to-line and line-to-ground output short circuit protection
- AC input point contactor
- Single-board regulator utilizing LSI and surface-mount technology for increased reliability and reduced size
- Electronic reversing from any speed
- Start/stop and speed selection with coast-to-rest or ramp-to-rest on stop
- Standard adjustments:
  - Acceleration rate
  - Deceleration rate
  - Minimum hertz
  - Maximum hertz
  - Current limit
  - Volts per hertz
  - Low hertz voltage boost
  - Motor stability
  - Automatic voltage boost
- Automatic shutdown and first fault indication via LEDs under any of the following conditions:
  - Undervoltage
  - Overcurrent
  - Overvoltage
  - DC bus fault
  - Ground fault
  - Overtemperature
- Fault monitor card latches specific type and location of first fault condition sensed in the inverter power module
- Relay contacts for external interlocking of the drive "Running" and drive "Fault"
- Provisions for remote drive "Running" and drive "Ready" pilot lights
- 24 VDC isolated operator's control for safety and drive noise immunity
- 0-10 VDC, 4-20 mA and 0-20 mA speed reference input signal capability
- 0-10 VDC metering output signal for voltage, frequency and motor amps
- Slip compensation for 1% speed regulation full load to no load
- Heatsink and regulator thermostats

Continued on next page.

- Regulator board drive status LEDs - "Power Supply Okay" and "Ready to Run"
- Motor overload kit - installed
- Input disconnect kit - installed
- Remote reset kit - installed
- Door interlocks (1)
- Space heaters
- 115 VAC control circuit transformer
- Door mounted MAN/OFF/AUTO selector switch
- Speed pot
- Start pushbutton
- Stop pushbutton

FlexPak® A-C
A-C V*S
General-Purpose Drives



V*S®
DRIVES

RELIANCE ELECTRIC

General-Purpose FlexPak A-C Drives
Application Specifications

3 Phase 460 VAC Input Controller Ratings

Input Amps RMS	Controller Input KVA
25.4	18.4
29.7	23.6
36.3	28.9
46.2	36.8
55.0	43.8
66.0	54.5
78.0	65.4
97.0	80.3
127.0	105
158.0	131
188.0	156
256	200
305	239
380	298
437	327

(1) NEMA B induction motor rating only. Application load and speed requirements must be considered to properly size the motor and controller. See Selection and Application of A-C V*S Drives Manual, D-9084, or contact your Reliance Electric Sales Office for assistance.

(2) In order to obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current.

(3) Load rating is 100% continuous, 150% for one minute.

(4) Motor may limit use of available controller frequency range.

Adjustments

Acceleration Time .... 1 to 35, 2 to 70, or 4 to 140 sec.

Deceleration Time .... 1 to 35, 2 to 70, or 4 to 140 sec.

Volts/Hertz .... Preset at 460V/60Hz or adjustable

Voltage Offset (RMS) .... 0 to 18V max

Minimum Frequency .... 2% to 80% of Maximum Frequency

Maximum Frequency .... 50% to 100% of Maximum Frequency

Automatic Torque Boost .... 0 to 100% of Rated Current

Service Conditions

Ambient Temperature Rating
- Chassis .... 0°C to 55°C (131°F)
- Enclosed Cabinet Drive .. 0°C to 40°C (104°F)

Elevation
- Chassis and Cabinet .... 3300 ft (1000m) above sea level
- Above 3300 ft .... Derate 3% for every 1000 ft up to 10,000 ft

Humidity
- Chassis and Cabinet .... 5 to 90% Non-condensing

A-C Line Voltage Variation ... ±10% of nominal 460 volts

A-C Line Frequency Variation ..... ±2 Hertz of nominal 60 Hz

Storage Temperature .... -25°C to 55°C (-13°F to 131°F)

Application Data

Service Factor .... 1.0 Continuous

Maximum Overload ..... 150% for one minute

Continuous Speed Range .... 1.4 to 60 Hz

Jumper Selectable Ranges (4) .. 2.8 to 120 Hz or 5.6 to 240 Hz

Maximum RMS Output Voltage ...... 460 VAC

Voltage Regulation .... ±1%

Frequency Regulation .... ±0.5%

Slip Compensation .... $^1/_3$ of motor normal slip over a 20:1 speed range with a 95% load change

Customer is responsible for meeting requirements of the National Electrical Code and all local codes.

FlexPak A-C Controller Dimensions and Weights

Cabinet Mounting	Width	WT
WALL	26.1	110
WALL	26.1	165
FLOOR	33.6	600
FLOOR	84.0	1100

All dimensions in inches
All weights in pounds
Consult Reliance Electric for cabinet dimensions when adding bypass options.

General-Purpose PWM FlexPak A-C Drives
Three-Phase Input 15–350 HP on 460 VAC

■ Can Reduce Your Operating Cost

- Variable speed controls are proven to be more efficient than systems employing constant speed motors

- The more often your system operates at reduced speed, the greater the cost savings will be for your system, as well as wear and tear on components

■ Will Eliminate Inrush Currents

- Demand charges are reduced since variable speed drives prevent the motor from drawing locked rotor currents on start-up due to a controlled ramp acceleration

- Fan belt wear is reduced, yielding an increase in belt life because of "soft start" feature of the variable speed drive

■ Provide Performance Matched Controller and Motor

- Reliance Electric provides a "power matched" A-C drive package when both the A-C controller and A-C motor are supplied. With a "power matched" drive package, you will get a motor and controller that are designed to work together resulting in optimum drive performance.

- With FlexPak A-C you can specify a Reliance XE Duty Master Motor to optimize drive package efficiency, or you can choose the RPM A-C motor to help solve your constant torque, wide speed range application needs.

■ Utilize Proven Technology

- Reliance FlexPak A-C transistorized drives are more efficient than traditional mechanical control methods

- The FlexPak A-C Drive uses transistor technology and common regulation from 5 through 350 HP. This results in common regulator technology to simplify maintenance or training

- Full line-to-line and line-to-ground output short-circuit protection – starting and running

- Single-board regulator utilizes LSI and surface-mount technology for increased reliability and reduced size

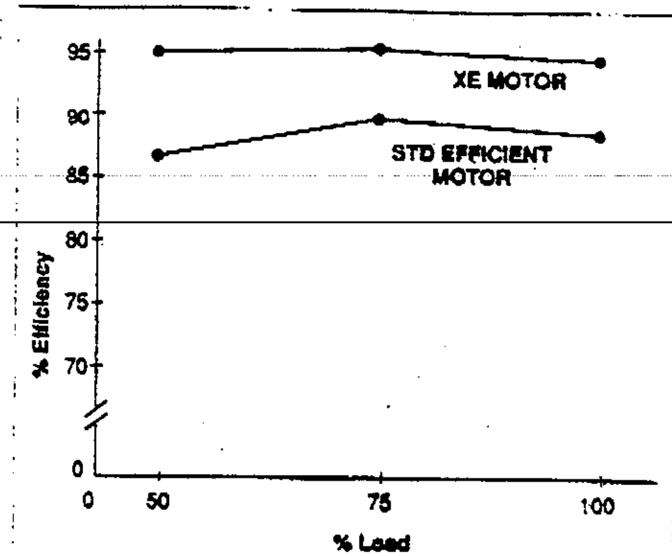
5–40 HP FlexPak A-C Drive and Duty Master XE Motor

Standard Features

- ■ Constant-torque operating speed range of 20:1
- ■ Slip compensation circuit to hold motor speed to 1% regardless of no load to full load fluctuations
- ■ Output frequency from 0.6 to 60 Hertz with option for 120 and 240 Hertz
- ■ Near-unity displacement power factor throughout the speed range
- ■ Input line reactors to help eliminate the need for isolation transformers
- ■ Line-to-line and line-to-ground output short circuit protection during both running and starting conditions
- ■ A-C input power contactor
- ■ Electronic reversing from any speed
- ■ Start/Stop and speed selection with coast-to-rest or ramp-to-rest on stop
- ■ Standard Adjustments:
  - Acceleration rate
  - Deceleration rate
  - Minimum hertz
  - Maximum hertz
  - Automatic Torque boost
  - Current limit
  - Volts per hertz
  - Low hertz voltage boost
  - Motor Stability
- ■ Automatic shutdown and first fault indication via LEDs under any of the following conditions
  - Undervoltage
  - Overcurrent
  - Overvoltage
  - D-C bus fault
  - Ground fault
  - Overtemperature

Every Motor Is Not Energy Efficient

- Motor efficiency can be compared only when the same rules are applied to all motors under the same consideration. Reliance follows industry accepted IEEE 112 specifications
- Guaranteed minimum efficiencies on sinusoidal wave form should be used for comparisons
- Adjustable-frequency drives do not exactly replicate a smooth sinusoidal output waveform and therefore result in higher motor operating temperatures. To assure proper motor life this temperature must not exceed the motor insulation class or rating. Reliance Electric FlexPak A-C Controllers, RPM A-C motors and XE motors are performance-matched to assure proper drive performance and motor life
- Reliance Electric XE Duty Master Motors will improve drive system efficiency. Typical efficiency profiles for energy efficient and standard efficient motors are shown. Because of the excellent partial load efficiency of the Reliance Electric XE motors the efficiency remains nearly constant over most of the speed range.



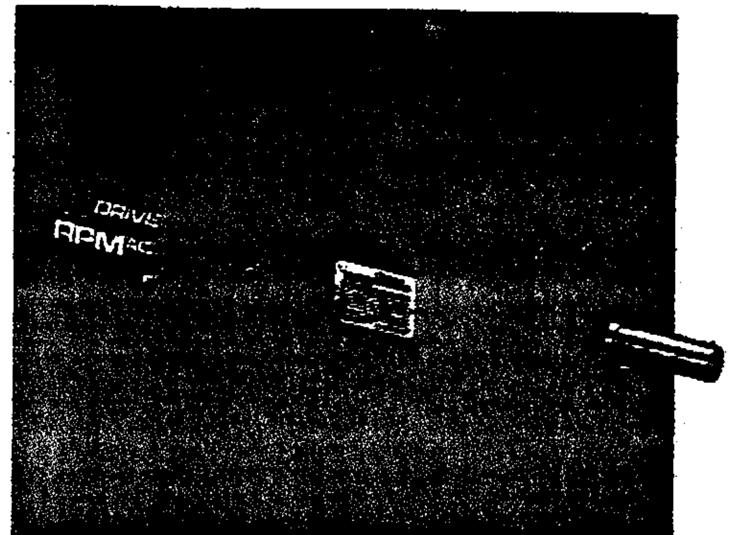
Motor Efficiency vs Load
Typical 100 HP

Every Motor Is Not Created Equal

Applications requiring constant torque or constant horsepower over a wide speed range are ideal candidates for RPM A-C. This exclusive motor from Reliance is designed solely to operate from variable frequency controller power. With this one objective in mind, performance can be optimized by discarding any unnecessary fixed speed motor design constraints. The RPM A-C motors' square laminated frame construction is patterned off the Reliance variable speed D-C motor taking advantage of the many years of D-C variable speed experience. This square laminated frame results in greater power density which yields a very compact motor - up to two sizes smaller in diameter than a standard NEMA induction motor.

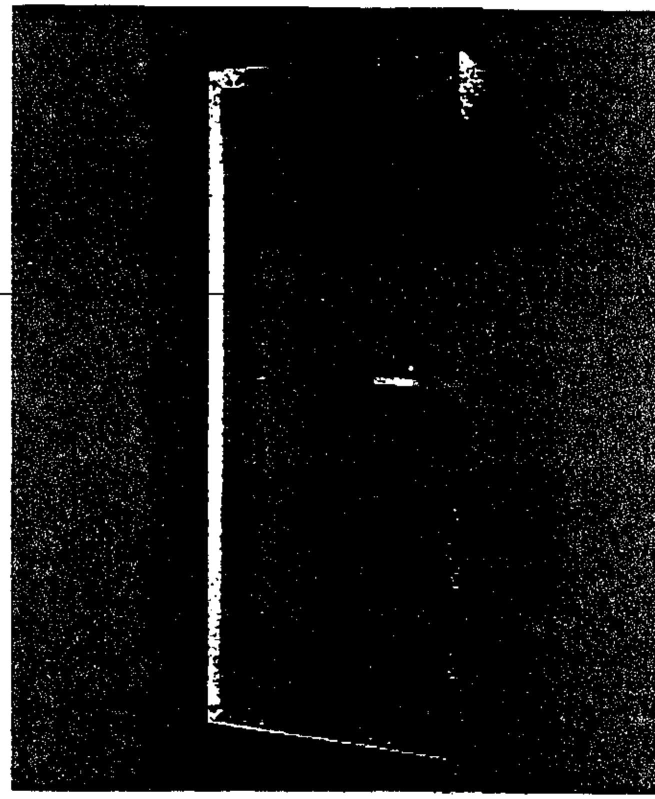
Other RPM A-C advantages include:

- Easily mounted blower option to assure proper motor cooling even down to zero speed
- Provisions for mounting a tachometer or feedback device
- Perpendicular feet to bearing location to result in smooth operation at all speeds
- Cooling ducts integral to motor laminations result in a totally enclosed motor that allows no free exchange of inside to outside air


RPM A-C

- Relay contacts for external interlocking of drive "Running" and drive "Fault"
- Provisions for remote drive "Running" and drive "Fault" pilot lights
- 24 VDC isolated operator's control for safety and drive noise immunity
- 0–10 VDC, 4–20 mA and 0–20 mA speed reference input signal capability
- 0–10 VDC metering output signals for voltage, frequency and amps
- Insensitive to incoming power-phase sequence
- Heatsink and regulator thermostats
- Regulator board drive status LEDs – "Power Supply Okay" and "Ready to Run"
- PWM switching technique to reduce the 5th and 7th motor current harmonics from 20% and 14%, respectively, of the fundamental to 6% each for reduced motor heating
- Chassis, NEMA 1 or NEMA 12 enclosures

Note: Standard off-the-shelf, NEMA Design B and synchronous motors can be used with the PWM controller. However, application load and speed range must be considered in determining motor frame size, controller rating, and overall PWM A-C V*S drive performance.



150 HP FlexPak A-C Drive

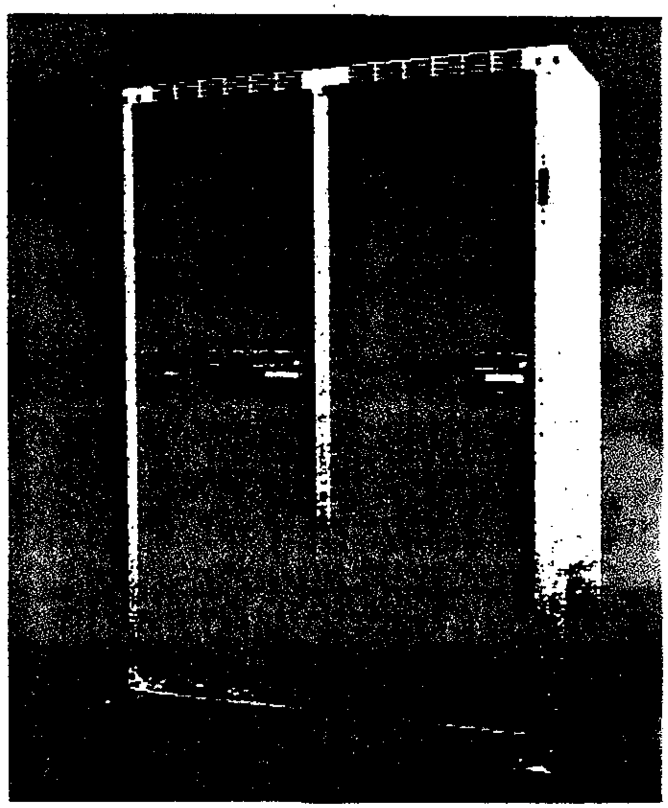
Optional Features

- Hand-held, plug-in tester with digital readout to monitor 26 regulator signal points. The tester has a drive test/speed set potentiometer, forward/reverse switch and start/stop switch
- Metering, either for remote station or drive cabinet mounting:
  - Voltmeter . . . . 0 to 500 volt scale
  - Ammeter . . . . scale dependent on rating
  - Frequency/speed meter . . . . 0 to 66 Hz
0 to 110% speed
- Dynamic braking kits
- Motor overload kits
- Input power disconnect kit
- Motor blower kit (for RPM A-C motors)
- Remote fault reset
- Other options available. Contact your Reliance Electric sales office or your Reliance Electric distributor for information.

Product Publications

Instruction Manuals

- 15–40 HP D2-3132
- 50–150 HP D2-3163
- 200–350 HP D2-3156



350 HP FlexPak A-C Drive

General-Purpose FlexPak A-C V*S Controller

Specifications

The adjustable frequency controller (AFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, A-C power for stepless motor control from 10% to 150% of base speed. The AFC shall be a PWM design as manufactured by Reliance Electric.

The AFC shall have the ability to operate on a distribution system up to 4000 KVA without the need for isolation transformers.

The AFC together with all options and modifications shall mount within standard NEMA 1 enclosure suitable for continuous operation at a maximum ambient temperature of 40°C. All high voltage components within enclosure shall be isolated with steel covers.

AFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:

1. 150% of the controller maximum sine wave current rating is exceeded
2. Output phase-to-phase and phase-to-ground short circuit condition: both starting and running conditions
3. High/low input line voltage
4. D-C bus fault
5. External fault. This protective circuit shall permit, by means of a terminal strip, wiring of remote NC safety contacts such as limit switches, motor overloads etc., to shut down the drive
6. Overtemperature

The following adjustments shall be available in the controller:

1. Maximum Frequency .... 50 to 100% of max. frequency
2. Minimum Frequency .... 2% to 80% of max. frequency
3. Acceleration .... 1 to 35, 2 to 70 or 4 to 140 sec.
4. Deceleration .... 1 to 35, 2 to 70 or 4 to 140 sec.
5. Volts/Hertz ..... Factory set at 460V/60 Hz or adjustable
6. Voltage Offset .... 0 to 18V max
7. Current Limit .. 150% max. controller rating or adjustable
8. Slip Compensation
9. Automatic Torque Boost .... 0–100% of rated current

Each controller shall include a diagnostic panel which shall provide a quick means for monitoring the different signals within the AFC for start-up and troubleshooting

Standard Features

- **Input Contactor** to provide a positive disconnect between the controller and all phases of input power. The contactor will be utilized to isolate the drive from the power line during "stop" and "fault" conditions
- **Input Line Reactor** to permit operation on a distribution system with 100,000 amp fault current rating
- **Isolated Process Control Interface** – shall enable the AFC to follow a 0–20, 4–20 mA; 0–10 VDC grounded or ungrounded signal from a process controller
- **Isolated Output Signals** – shall provide isolated 0–10 VDC output signals from the VFD proportional to load, voltage and frequency for metering.
- **Heatsink and Regulator Thermostats**

Options and Modifications

- **Input Disconnect** – shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be designed to mount inside the controller enclosure and include a mounting bracket and through-the-door interlocking handle with provisions for padlocking.
- **Motor Overload** – shall contain a thermal overload relay designed to protect one A-C motor.
- **Manual Bypass with Magnetic Contactors** – Manual bypass shall provide all the circuitry necessary to safely transfer the motor from the AFC to the power line, or from the line to the controller while the motor is at zero speed.

  Two motor contactors, electrically interlocked, shall be utilized: one contactor between the controller output and the motor, controlled by the controller regulator, and the other one is to be between the bypass power line and the motor providing across-the-line starting. Motor protection is to be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 115 VAC relay control logic, allowing common start-stop commands in the "controller" mode and the "bypass" mode shall also be included within this enclosure
- **Voltage, Current and Frequency Meters** – shall be provided to indicate the output voltage, output frequency and output current.

Reliance Electric / 24701 Euclid Avenue / Cleveland, Ohio 44117 / 216-266-7000

RELIANCE ELECTRIC

Printed in U.S.A.

D-2790-2

TRI FLOW SYSTEMS INC.

T.F.S.

P.O. BOX 450
Mansfield, Texas 76063
817/483-0001
FAX 817/483-1959

Southern Company Services
P.O. Box 2625
Birmingham, AL 35202

Attn: Mr. Jerry Bandura

April 12, 1991

Dear Mr. Bandura:

Per our telephone conversation enclosed please find the information you requested.

I would like to bring your attention to Fig. 1-15-13 for the overall pressure loss as percentage of differential pressure at maximum flow. I have designed the plates to give you adequate drops for your purpose.

Please study the bore calculation and if I could be of further assistance please let me know. Any purchase order resulting from this matter should be sent to our representatives office at:

Pande Controls
P.O. Box 279
Pelham, AL 35124

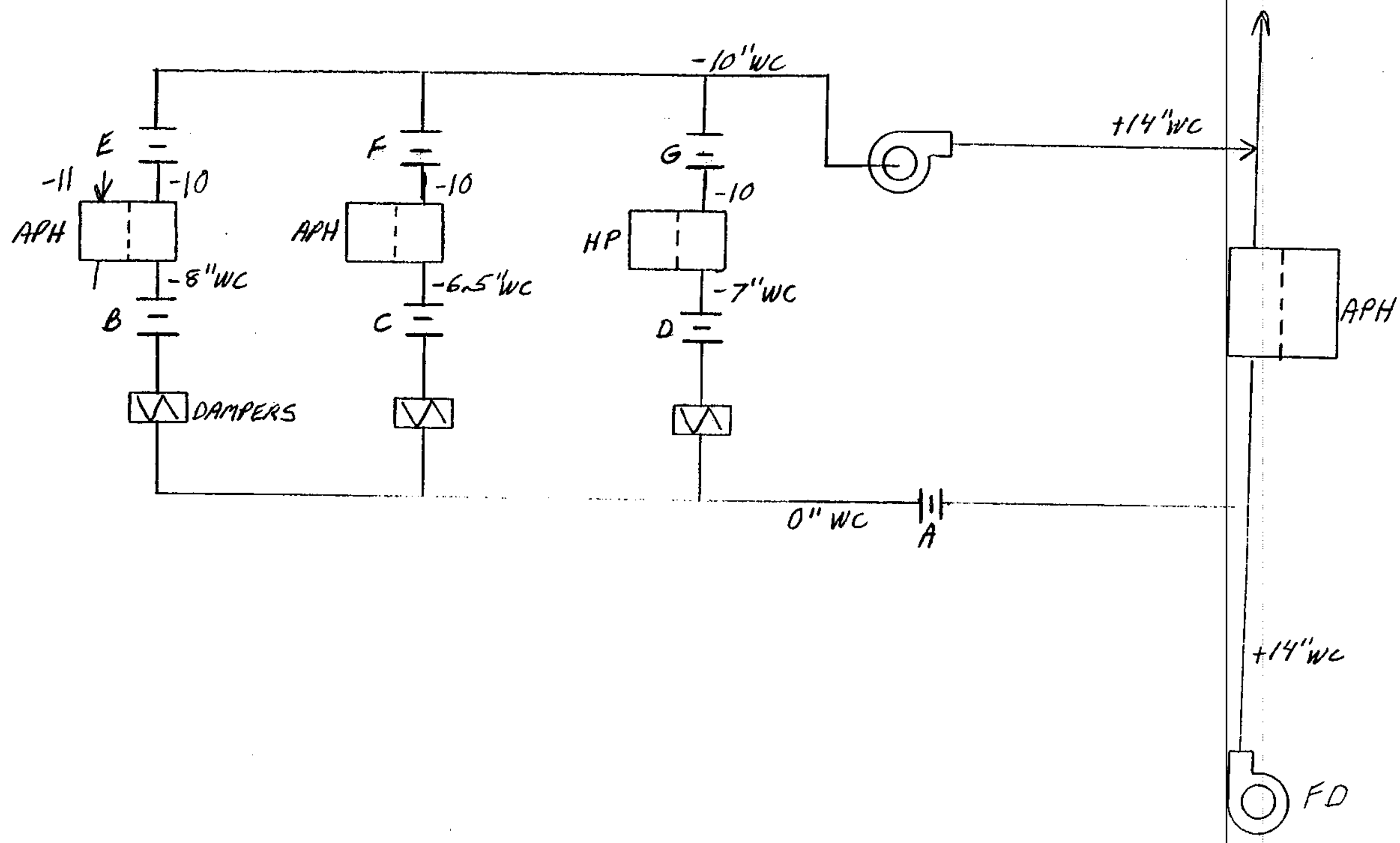
Attn: Mr. Mark Slaton
Tel: (205) 664-8450

Sincerely,

Shawn Moradian

SM/ljt

cc: Mark Slaton @ Pande Controls



-10"WC
+14"WC
E
F
G
-11
-10
-10
-10
APH
APH
HP
APH
-8"WC
-6.5"WC
-7"WC
B
C
D
DAMPERS
0" WC
A
+14"WC
FD

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER:SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.:RFQ. R302-12
TAG NO.:FE-A

DATE:4-11-91
JOB NO.:041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	27.00
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	73,366.00 LB/HR
AVERAGE FLOW	70,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0732
FLOWING TEMPERATURE (DEG. F)	100.00
FLOWING PRESSURE (P.S.I.A.)	15.20
OPERATING VISCOSITY (CP)	0.0185
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316SS
REYNOLDS NUMBER	1,107,824.01

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	73366.0000
(2) D * D =	511.8454
(3) Fa =	1.0005
(4) K =	0.6695
(5) Y =	0.9784
(6) Z =	1.0000
(7) SQR. ROOT DENSITY, (P) =	0.2706
(8) SQR. ROOT DIFFERENTIAL, (H) =	5.1962
(9) 358.9403 * [(2) THRU (8)] =	169276.3296
(10) B * B = (1) / (9) =	0.4334
BETA =	0.6583
BORE =	14.894

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-1
REV. NO.:0 BY:SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER: SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.: RFQ. R302-12
TAG NO.: FE-B

DATE: 4-11-91
JOB NO.: 041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	17.00
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	27,757.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0722
FLOWING TEMPERATURE (DEG. F)	100.00
FLOWING PRESSURE (P.S.I.A.)	14.99
OPERATING VISCOSITY (CP)	0.0185
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	419,129.73

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	27757.0000
(2) D * D =	511.8454
(3) Fa =	1.0005
(4) K =	0.6182
(5) Y =	0.9876
(6) Z =	1.0000
(7) SQR. ROOT DENSITY, (P) =	0.2687
(8) SQR. ROOT DIFFERENTIAL, (H) =	4.1231
(9) 358.9403 * [(2) THRU (8)] =	124337.1285
(10) B * B = (1) / (9) =	0.2232
BETA =	0.4725
BORE =	10.689

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-2
REV. NO.: 0 BY: SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER:SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.:RFQ. R302-12
TAG NO.:FE-C

DATE:4-11-91
JOB NO.:041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	14.30
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	23,850.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0720
FLOWING TEMPERATURE (DEG. F)	100.00
FLOWING PRESSURE (P.S.I.A.)	14.94
OPERATING VISCOSITY (CP)	0.0185
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	360,134.18

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	23850.0000
(2) D * D =	511.8454
(3) Fa =	1.0005
(4) K =	0.6161
(5) Y =	0.9896
(6) Z =	1.0000
(7) SQR. ROOT DENSITY, (P) =	0.2683
(8) SQR. ROOT DIFFERENTIAL, (H) =	3.7815
(9) 358.9403 * [(2) THRU (8)] =	113710.4691
(10) B * B = (1) / (9) =	0.2097
BETA =	0.4580
BORE =	10.361

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-3
REV. NO.:0
BY:SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER:SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.:RFQ. R302-12
TAG NO.:FE-D

DATE:4-11-91
JOB NO.:041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)
DIFFERENTIAL RANGE (INCHES H2O)
METER TUBE I. D. (INCHES)
ORIFICE TYPE (BORE)
METER TAP (TYPE)
FLOWING MATERIAL
MAXIMUM FLOW
AVERAGE FLOW
DENSITY AT FLOWING CONDITIONS
FLOWING TEMPERATURE (DEG. F)
FLOWING PRESSURE (P.S.I.A.)
OPERATING VISCOSITY (CP)
ATMOSPHERIC PRESSURE (P.S.I.A.)
ORIFICE PLATE MATERIAL
REYNOLDS NUMBER

DRY
15.20
22.624
CONC.
FLANGE TAPS
AIR
21,759.00 LB/HR
20,000.00 LB/HR
0.0720
100.00
14.95
0.0185
14.70
316 SS
328,560.14

CALCULATIONS :

B * B = M / 358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]

(1) M =
(2) D * D =
(3) Fa =
(4) K =
(5) Y =
(6) Z =
(7) SQR. ROOT DENSITY, (P) =
(8) SQR. ROOT DIFFERENTIAL, (H) =
(9) 358.9403 * [(2) THRU (8)] =
(10) B * B = (1) / (9) =

21759.0000
511.8454
1.0005
0.6125
0.9890
1.0000
0.2683
3.8987
116489.9604
0.1868

BETA =
BORE =

0.4322
9.778

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-4
REV. NO.:0
BY:SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER:SOUTHRN COMPANY SERVICES.
CUSTOMER P. O. NO.:RFQ. R302-12
TAG NO.:FE-E

DATE:4-11-91
JOB NO.:041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	21.70
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	22,357.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0390
FLOWING TEMPERATURE (DEG. F)	579.00
FLOWING PRESSURE (P.S.I.A.)	15.07
OPERATING VISCOSITY (CP)	0.0280
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	223,050.48

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	22357.0000
(2) D * D =	511.8454
(3) Fa =	1.0100
(4) K =	0.6177
(5) Y =	0.9843
(6) Z =	1.0003
(7) SQR. ROOT DENSITY, (P) =	0.1975
(8) SQR. ROOT DIFFERENTIAL, (H) =	4.6583
(9) 358.9403 * [(2) THRU (8)] =	103825.8013
(10) B * B = (1) / (9) =	0.2153
BETA =	0.4640
BORE =	10.498

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-5
REV. NO.:0 BY:SM

TRI FLOW SYSTEMS INC.

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MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER: SOUTHRN COMPANY SERVICES. DATE: 4-11-91
CUSTOMER P. O. NO.: RFQ. R302-12 JOB NO.: 041191SM
TAG NO.: FE-F

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	20.70
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	18,250.00 LB/HR
AVERAGE FLOW	17,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0372
FLOWING TEMPERATURE (DEG. F)	633.00
FLOWING PRESSURE (P.S.I.A.)	15.07
OPERATING VISCOSITY (CP)	0.0300
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	169,937.52

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	18250.0000
(2) D * D =	511.8454
(3) Fa =	1.0110
(4) K =	0.6132
(5) Y =	0.9852
(6) Z =	1.0003
(7) SQR. ROOT DENSITY, (P) =	0.1929
(8) SQR. ROOT DIFFERENTIAL, (H) =	4.5497
(9) 358.9403 * [(2) THRU (8)] =	98490.9414
(10) B * B = (1) / (9) =	0.1853
BETA =	0.4305
BORE =	9.739

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-F
REV. NO.: 0 BY: SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
MANSFIELD, TEXAS 76063
PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER:SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.:RFQ. R302-12
TAG NO.:FE-G

DATE:4-11-91
JOB NO.:041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	21.00
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	21,759.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0390
FLOWING TEMPERATURE (DEG. F)	588.00
FLOWING PRESSURE (P.S.I.A.)	15.07
OPERATING VISCOSITY (CP)	0.0285
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	213,275.88

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	21759.0000
(2) D * D =	511.8454
(3) Fa =	1.0105
(4) K =	0.6174
(5) Y =	0.9848
(6) Z =	1.0003
(7) SQR. ROOT DENSITY, (P) =	0.1975
(8) SQR. ROOT DIFFERENTIAL, (H) =	4.5826
(9) 358.9403 * [(2) THRU (8)] =	102185.6716
(10) B * B = (1) / (9) =	0.2129
BETA =	0.4615
BORE =	10.440

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-7
REV. NO.:0 BY:SM

TRI FLOW SYSTEMS INC.

P.O. BOX 450
Mansfield, Texas 76063
817/483-0001

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
ASME-6TH EDITION

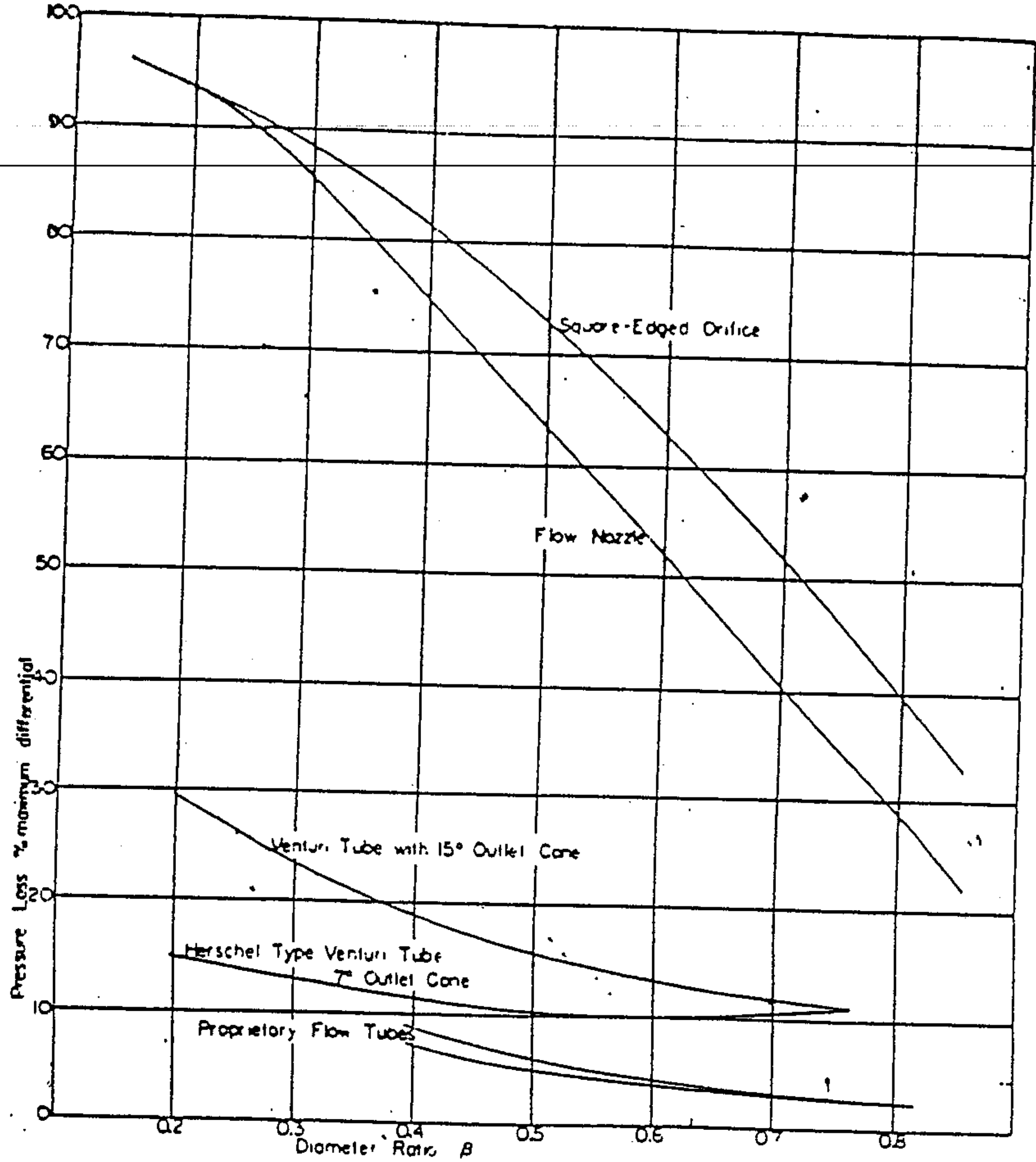
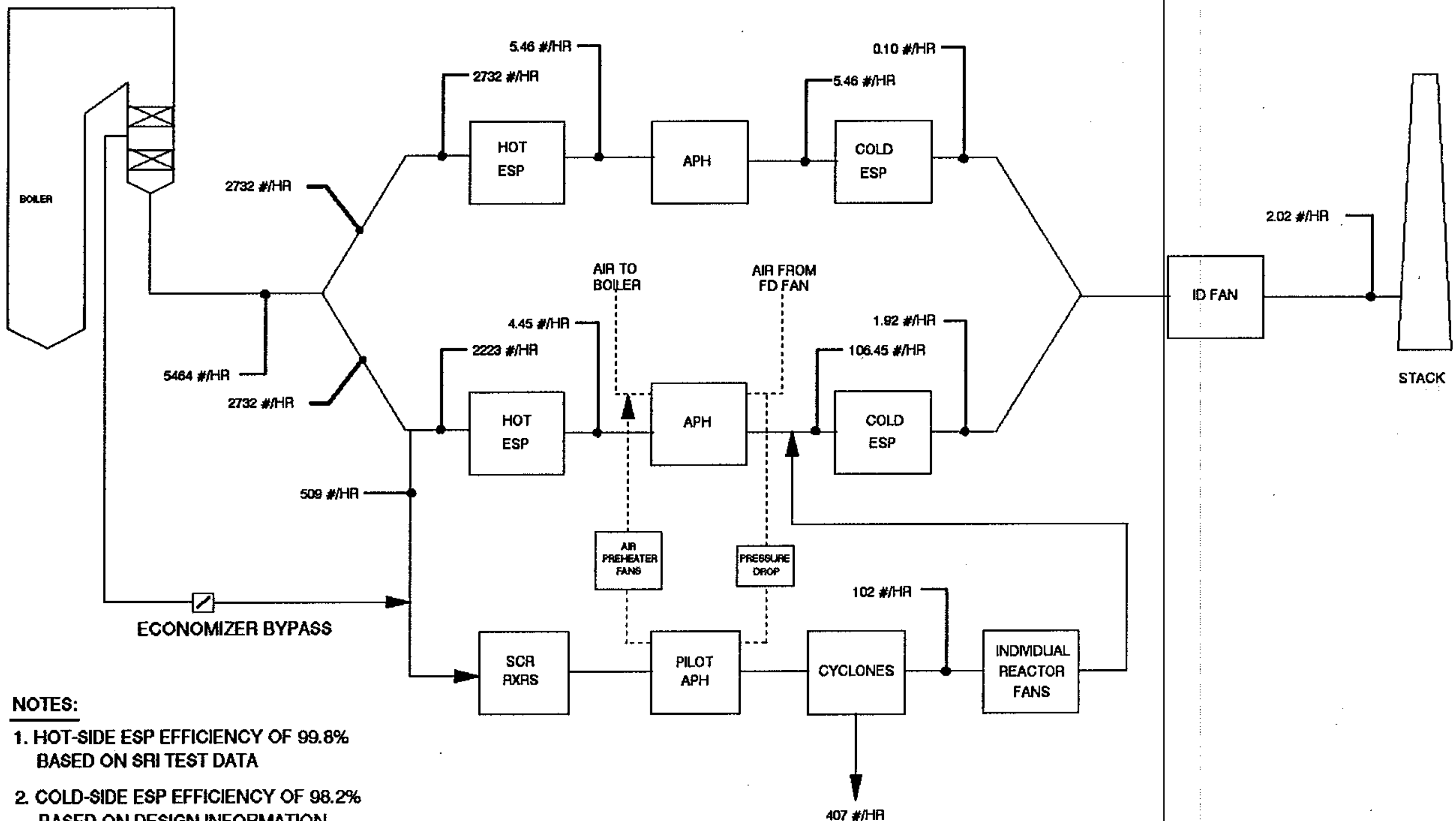


FIG. I-5-13 OVERALL PRESSURE LOSS THROUGH SEVERAL PRIMARY ELEMENTS

CUSTOM CRAFTED FLOW ELEMENTS

FIGURE 4A
DOE/SCR PROJECT
ASH BALANCE AND FLUE GAS DISPOSITION

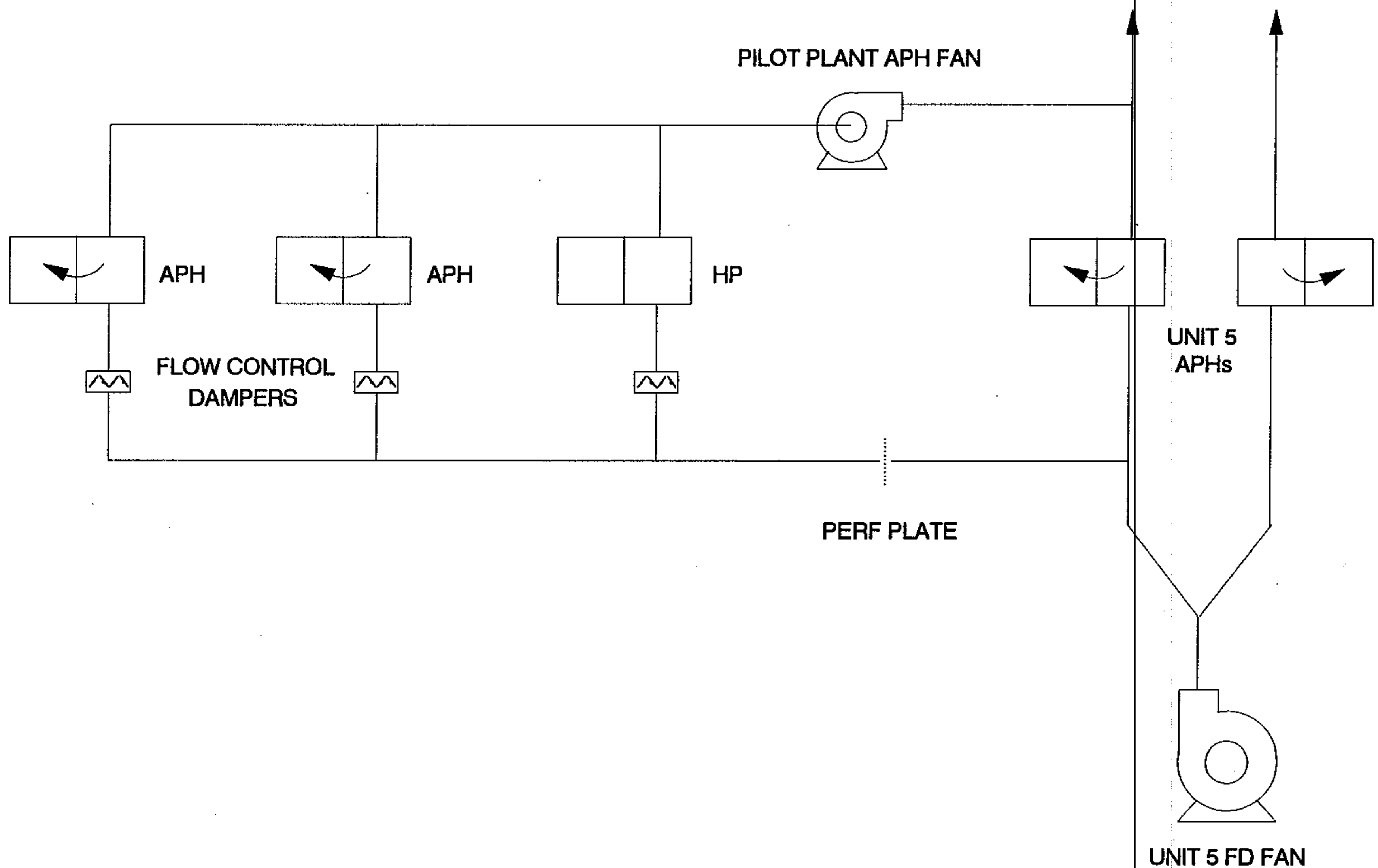


NOTES:

1. HOT-SIDE ESP EFFICIENCY OF 99.8% BASED ON SRI TEST DATA
2. COLD-SIDE ESP EFFICIENCY OF 98.2% BASED ON DESIGN INFORMATION
3. CYCLONE EFFICIENCY ASSUMED TO BE 80%

GULFAIR7.DRW

DOE SCR PROJECT
AIR PREHEATER INTEGRATION



TRI FLOW SYSTEMS INC.

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SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER: SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.: RFQ. R302-12
TAG NO.: FE-C

DATE: 4-11-91
JOB NO.: 041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	14.30
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	23,850.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0720
FLOWING TEMPERATURE (DEG. F)	100.00
FLOWING PRESSURE (P.S.I.A.)	14.94
OPERATING VISCOSITY (CP)	0.0185
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	360,134.18

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)^{1/2} * (H)^{1/2}]}$$

(1) M =	23850.0000
(2) D * D =	511.8454
(3) Fa =	1.0005
(4) K =	0.6161
(5) Y =	0.9896
(6) Z =	1.0000
(7) SQR. ROOT DENSITY, (P) =	0.2683
(8) SQR. ROOT DIFFERENTIAL, (H) =	3.7815
(9) 358.9403 * [(2) THRU (8)] =	113710.4691
(10) B * B = (1) / (9) =	0.2097
BETA =	0.4580
BORE =	10.361

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-3
REV. NO.: 0
BY: SM

TRI FLOW SYSTEMS INC.

P.O.BOX 450 .
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PHONE 817 - 483 - 0001
SHAWN MORADIAN

ORIFICE PLATE BORE CALCULATION
GAS FLOW

CUSTOMER: SOUTHERN COMPANY SERVICES.
CUSTOMER P. O. NO.: RFQ. R302-12
TAG NO.: FE-D

DATE: 4-11-91
JOB NO.: 041191SM

OPERATING CONDITIONS:

METER TYPE (DRY OR HG)	DRY
DIFFERENTIAL RANGE (INCHES H2O)	15.20
METER TUBE I. D. (INCHES)	22.624
ORIFICE TYPE (BORE)	CONC.
METER TAP (TYPE)	FLANGE TAPS
FLOWING MATERIAL	AIR
MAXIMUM FLOW	21,759.00 LB/HR
AVERAGE FLOW	20,000.00 LB/HR
DENSITY AT FLOWING CONDITIONS	0.0720
FLOWING TEMPERATURE (DEG. F)	100.00
FLOWING PRESSURE (P.S.I.A.)	14.95
OPERATING VISCOSITY (CP)	0.0185
ATMOSPHERIC PRESSURE (P.S.I.A.)	14.70
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER	328,560.14

CALCULATIONS :

$$B * B = \frac{M}{358.9403 * [D * D * Fa * K * Y * Z * (P)1/2 * (H)1/2]}$$

(1) M =	21759.0000
(2) D * D =	511.8454
(3) Fa =	1.0005
(4) K =	0.6125
(5) Y =	0.9890
(6) Z =	1.0000
(7) SQR. ROOT DENSITY, (P) =	0.2683
(8) SQR. ROOT DIFFERENTIAL, (H) =	3.8987
(9) 358.9403 * [(2) THRU (8)] =	116489.9604
(10) B * B = (1) / (9) =	0.1868
BETA =	0.4322
BORE =	9.778

REFERENCE: FLUID METERS, THEIR THEORY AND APPLICATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS - SIXTH EDITION

DOCUMENT NO.: BC-041191SM-4
REV. NO.: 0
BY: SM

8.0 AREA 600: CYCLONES TO HOST BOILER DUCT

Area 600 is from the cyclones to the host boiler duct and includes the cyclones, flow control dampers, fan and fan motors, isolation damper for each reactor train for the large reactors, and the exhaust gas heaters.

8.1 DESCRIPTION

The process configuration in Area 600 is different for the large reactor compared to the small reactors, due to the APH (Area 500) used in the large reactor train configuration. Although, the flow control concept of using a fan with a variable speed motor, in conjunction with a flow control damper, is similar for both the large and small reactor trains.

8.1.1 Cyclones

The cyclones are for particulate removal to help protect down stream equipment such as the fan and flow control damper.

Large Reactor Steady State Operation

During normal operation, the large reactors will be operated at steady state around a set of design conditions. Once the gas passes through the reactor, it enters and air heater and is cooled to approximately 300°F. (See Figure 8.1-1) The predicted flue gas conditions at the large reactor cyclone inlet are shown in Table 8.1-1.

Large Reactor Off-Design Operation

The pilot plant will periodically operate at various off-design conditions to stress the catalyst performance, and quantify the deactivation rate. These off-design conditions involve variations of flue gas flow and temperature. The large reactor trains are equipped with and air preheater bypass, which operates when the reactor is operated at any condition other than the design point. (See Figure 8.1-2) Therefore, there is no air preheater leakage to consider when the reactor is operated at any condition other than the design point. Each bypass line is equipped with a finned-tube heat exchanger, which cools the gas to approximately 300°F when entering the cyclones. However, during off-design operation, the bypass heat exchanger is likely to either plug, causing the thermal performance to decline, or over-perform, causing

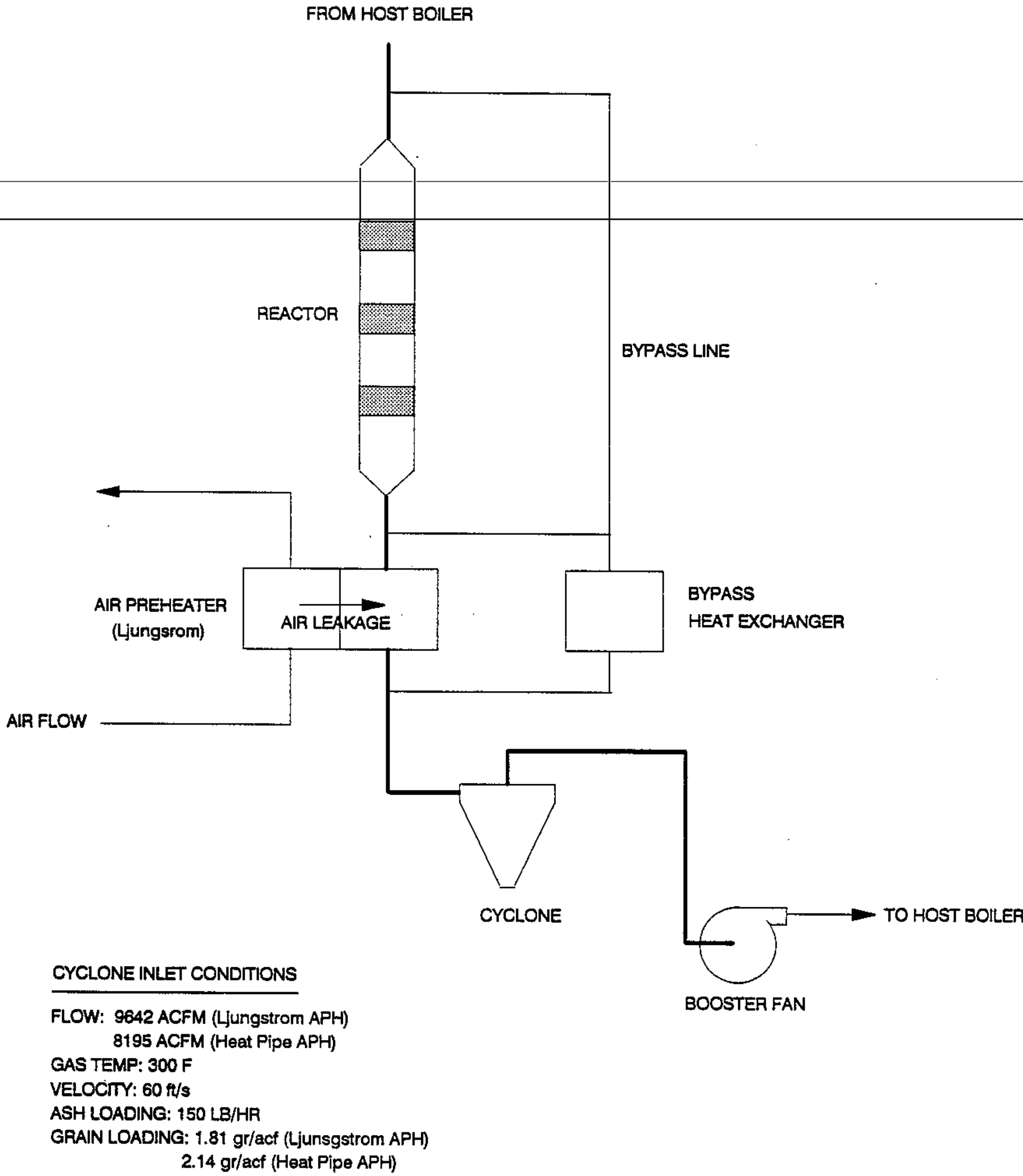
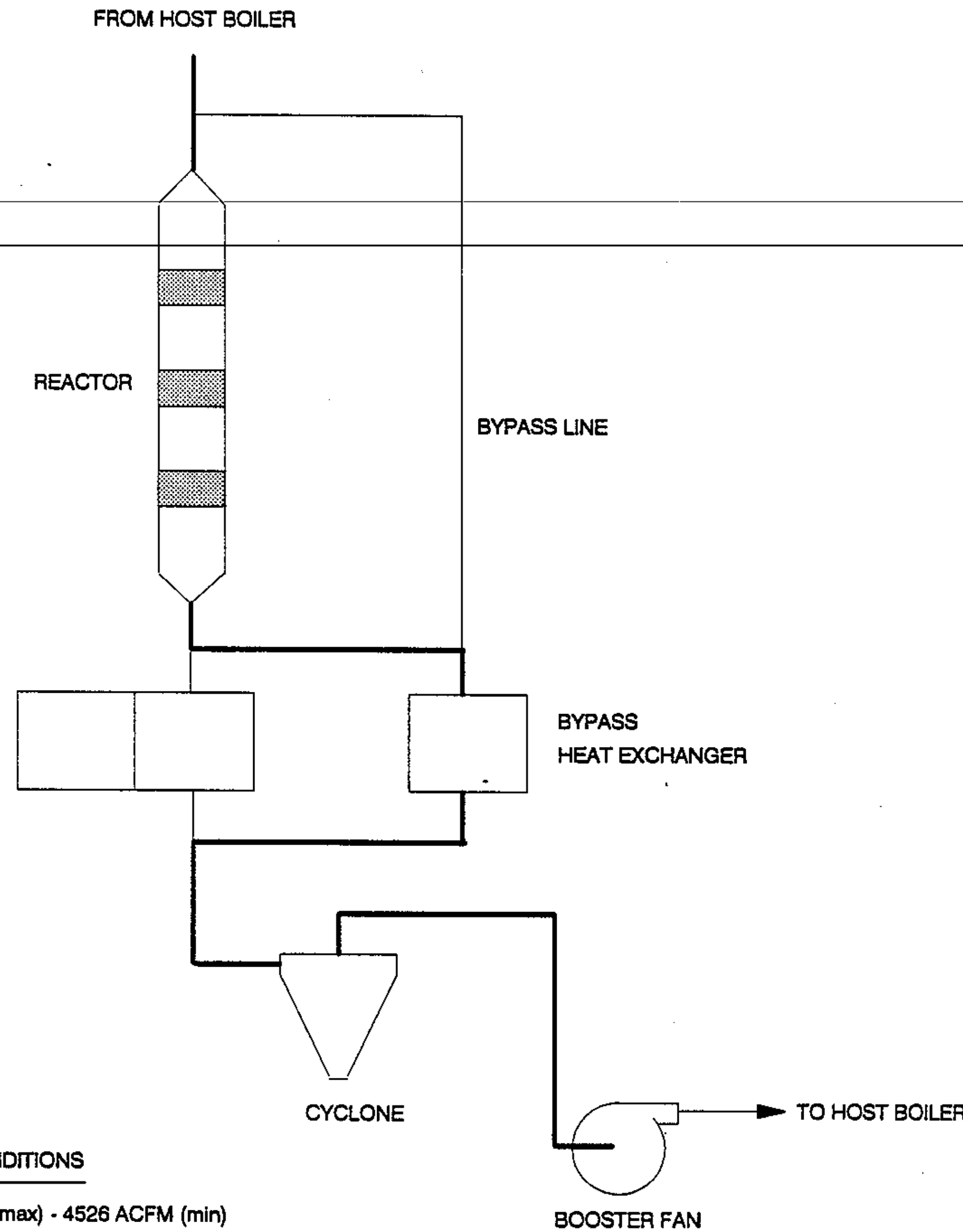


Figure 8.1-1. Large reactor steady state operation.



CYCLONE INLET CONDITIONS

FLOW: 14354 ACFM (max) - 4526 ACFM (min)
GAS TEMP: 400 F (max) - 250 F (min)
VELOCITY: 95 ft/s (max) - 30 f/s (min)
ASH LOADING: 225 LB/HR (max) - 90 LB/HR (min)
GRAIN LOADING: 2.32 GR/ACF (max) - 1.83 GR/ACF (min)

Figure 8.1-2. Large reactor off-design operation.

Table 8.1-1

Large Reactor Steady State Operating Conditions

	Ljungstrom APH	Heat Pipe APH
Number of Cyclones Per Reactor Train	1	1
~~Flue gas flowrate~~	~~9642 acfm~~	~~8195 acfm~~
~~Flue gas temperature~~	~~300° F~~	~~300° F~~
Inlet gas velocity	60 ft/sec	60 ft/sec
Ash flow rate	150 lb/hr	150 lb/hr
Grain loading	1.81 gr/acf	2.14 gr/acf

Note: Preliminary design considers one cyclone for each large reactor flue gas temperatures at less than 300°F. It is likely that the cyclone inlet will operate somewhere between 250°F and 400°F during off-design conditions. The flue gas flow ranges from 60 percent to 150 percent of design flow. Flow rate will be controlled using variable speed fans.

The off-design operation of the large reactors can best be visualized in a matrix form, as shown below in Table 8.1-2. The center of the matrix represents the steady state flow condition specified above in Table 8.1-1. The cyclones will likely operate anywhere inside the matrix during off-deign operation.

Small Reactor Steady State Operation

Similar to the large reactors, the small reactors will be operated at steady state around a set of design conditions. Because there are no air preheaters cooling the flue gas on the small reactors, the cyclones will operate at the full temperature of the flue gas. The small reactors are arranged into groups of three, each with its own cyclone. (Figure 8.1-3) The predicted flue gas conditions at the small reactor cyclone inlet are shown below in Table 8.1-3.

Small Reactor Off-Design Operation

Similar to the large reactors, the small reactors will also operate in off-design conditions. You will notice that the small reactors are manifolded into groups of three. (Figure 8.1-3) The operation criteria of the pilot plant is to let any one of a group of three operate in an off-design mode, while maintaining the other two reactors in a steady state operation. The small reactor banks contain no air preheater, no finned tubed heat exchanger, and no bypass. Therefore, the cyclone is subject to all temperature and flow variations of a small reactor.

Temperature variation will range between 620°F and 750°F during off-design conditions. The flue gas flow ranges from 60 percent of design flow to 150 percent of design flow for each reactor. The range of off-design operation is shown below in Table 8.1-4.

Table 8.1-2

Large Reactor Off-Design Operating Matrix

	Nominal Flowrate 7500 SCFM (150%)	Nominal Flowrate 5000 SCFM (100%)	Nominal Flowrate 3000 SCFM (60%)
400°F	Flow: 14354 ACFM Temp: 400°F Velocity: 95 f/s Ash: 225 lb/hr Gr load: 1.83 gr/acf	Flow: 9297 ACFM Temp: 400°F Velocity: 64 f/s Ash: 150 lb/hr Gr load: 1.88 gr/acf	Flow: 5500 ACFM Temp: 400°F Velocity: 38 f/s Ash: 90 lb/hr Gr load: 1.91 gr/acf
300°F	Flow: 12635 ACFM Temp: 300°F Velocity: 80 f/s Ash: 225 lb/hr Gr load: 2.08 gr/acf	Steady State Operating Point	Flow: 4851 ACFM Temp: 300°F Velocity: 32 f/s Ash: 90 lb/hr Gr load: 2.16 gr/acf
250°F	Flow: 11752 ACFM Temp: 250° F Velocity: 74 f/s Ash: 225 lb/hr Gr load: 2.23 gr/acf	Flow: 7638 ACFM Temp: 250°F Velocity: 50 f/s Ash: 150 lb/hr Gr load: 2.29 gr/acf	Flow: 4526 ACFM Temp: 250°F Velocity: 30 f/s Ash: 90 lb/hr Gr load: 2.32 gr/acf

Table 8.1-3

Small Reactor Steady State Operating Conditions

Number of cyclones	5
Flue gas flowrate	984 acfm
Flue gas temperature	700°F
Inlet gas velocity	60 ft/sec
Ash flow rate	12 lb/hr
Grain loading	1.42 gr/acf

Note: Preliminary design considers one cyclone for each reactor

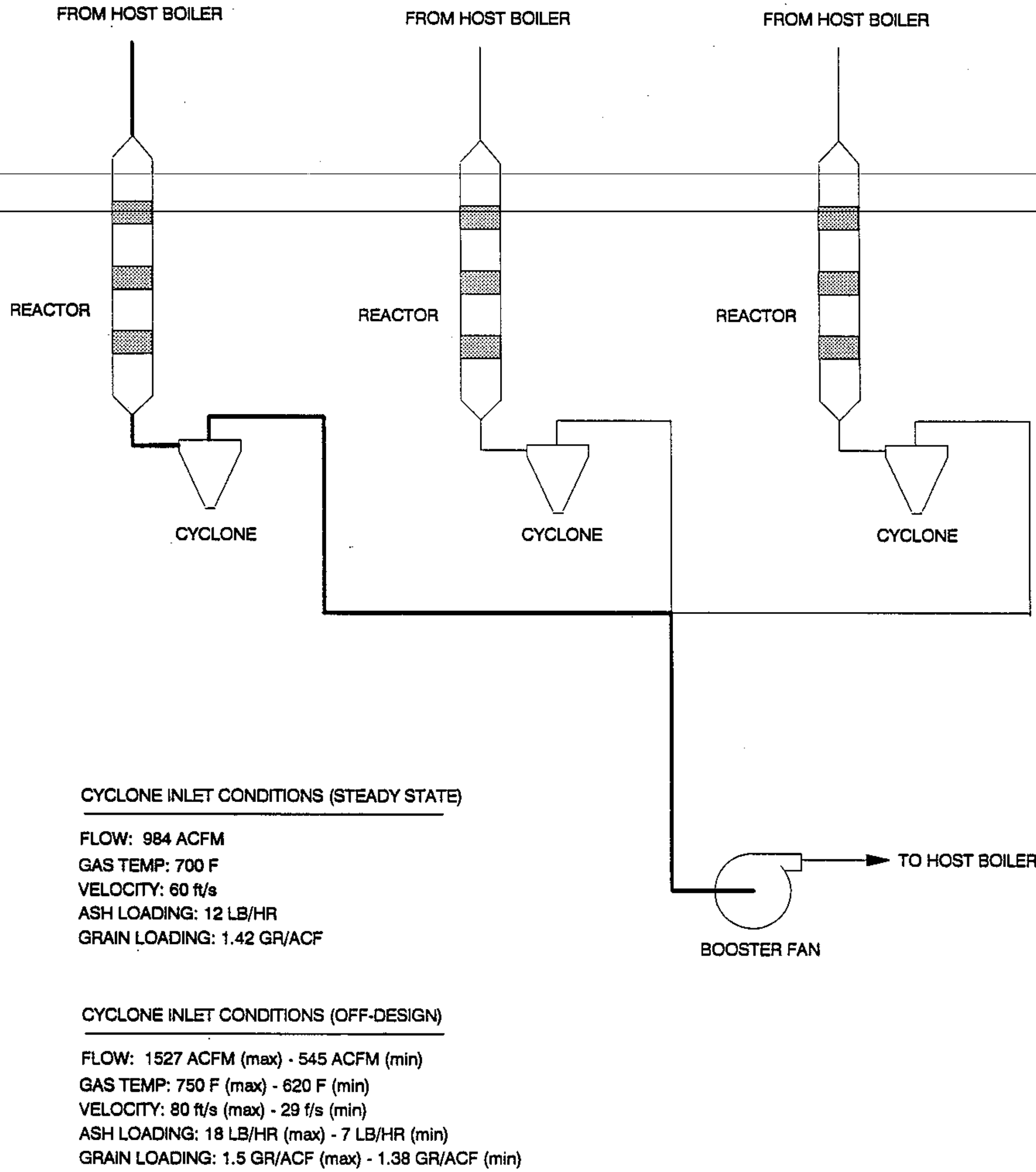


Figure 8.1-3. Small reactor operation.

Table 8.1-4
Small Reactor Off-Design Operating Matrix

Nominal Flowrate

	600 SCFM (150%)	400 SCFM (100%)	240 SCFM (60%)
750°F	Flow: 1527 ACFM Temp: 750°F Velocity: 80 f/s Ash: 18 lb/hr Gr load: 1.38 gr/acf	Flow: 1027 ACFM Temp: 750°F Velocity: 54 f/s Ash: 12 lb/hr Gr load: 1.36 gr/acf	Flow: 611 ACFM Temp: 750°F Velocity 32 f/s Ash: 7 lb/hr Gr load: 1.34 gr/acf
700°F	Flow: 1462 ACFM Temp: 700°F Velocity: 77 f/s Ash: 18 lb/hr Gr load: 1.44 gr/acf	Steady State Operating Point	Flow: 585 ACFM Temp: 700°F Velocity: 31 f/s Ash: 7 lb/hr Gr load: 1.4 gr/acf
620°F	Flow: 1363 ACFM Temp: 620°F Velocity: 72 f/s Ash: 18 lb/hr Gr load: 1.54 gr/acf	Flow: 915 ACFM Temp: 620°F Velocity: 48 f/s Ash: 12 lb/hr Gr load: 1.53 gr/acf	Flow: 545 ACFM Temp: 620°F Velocity: 29 f/s Ash: 7 lb/hr Gr load: 1.5 gr/acf

Note: Nominal flow rate are at standard conditions of 0°F (32°F) at 1 atm.

Desired Cyclone Removal Efficiencies

An average of 80 to 85 percent removal efficiency is desired at the steady state design point for large and small reactors. While it is possible to obtain higher removal efficiencies with cyclones, it will not be needed, since the flue gas is being returned ahead of the cold side ESP.

Realizing that the trade-off between removal efficiency and pressure drop across the cyclone is important, we generally have some flexibility, within reason, to compensate for higher than normal cyclone pressure drop from the 150 percent flow case, with the design of the new booster fans. After the cyclone has been sized for the steady state operating point, the high and low removal efficiencies and pressure drops should be calculated, using any of the off-design conditions for both the large and small reactor cyclones. It is desired that performance of the cyclone be bracketed between a best removal, highest pressure drop case, and a worst removal, lowest pressure drop case, with the steady state operating case somewhere in between.

Flue Gas Particle Size Distribution

Cumulative particle size distributions of the flue gas are shown in Table 8.1-5 and Exhibit 2.1-C. This data is reproduced from Southern Research Institute duct testing.

Flue Gas Composition

Table 8.1-6 shows the predicted flue gas composition for the large and small reactors at the steady state design point.

8.1.2 Large Reactor Fans

The flue gas for the large reactor train will be taken out of the main unit gas stream, upstream of the main unit hot side precipitator. Each of the large reactor trains will require one exhaust gas fan. Two of the large reactors will be equipped with Ljungstrom type air heaters downstream of the reactor vessel; the other large reactor will have a heat pipe heat exchanger. The gas stream from each air heater will then pass through a cyclone dust collector before entering each fan. At various time intervals, the pilot plant will undergo parametric testing, where the flowrate will vary between 60 and 150 percent of the design flow. During these periods on each reactor, the Ljungstrom-type air heater, or the heat pipe heat exchanger, will be bypassed. A water-cooled heat exchanger is provided in the bypass line to cool the gas to approximately the same temperature as the Ljungstrom, or heat pipe exit gas temperature, at design flow. The exhaust gas fan will reinject the flue gas into the gas flow upstream of the main unit cold side precipitator. See Exhibit 8.1-A for detailed specifications on the large reactor fans.

Table 8.1-5
Cumulative Particle Size Distribution

Weight	Particle size less than (μ)
95	90
90	57
80	38
60	21
50	16
40	13
20	6.6
10	3.4
1	1.1

Table 8.1-6
Flue Gas Composition At Steady State Operation

	Large Reactor Cyclone Inlet		Small Reactor Cyclone Inlet	
Component	lb/hr	Weight %	lb/hr	Weight %
CO_2	5095	17.33	408	20.45
O_2	1870	6.36	66	3.31
N_2	20709	70.43	1382	69.27
SO_2	118	0.40	9.44	0.47
SO_3	2.23	0.01	0.20	0.01
NO	1.90	0.01	0.15	0.01
NO_2	0.15	0.0005	0.01	0.00
HCl	3.16	0.01	0.25	0.01
H_2O	1456	4.95	117	5.86
NH_3	0.012	0.00	0.0048	0.00
Ash	150	0.51	12	0.60
Total	29405	100	1955	100

Each large reactor will have an individual variable speed fan to accurately control the gas flow. Trim flow control will be accomplished with inlet vanes on the fan. Fan outlets will be manifolded together and discharged to the same point. Electrical frequency interference problems with variable speed drives and motors are not anticipated.

8.1.3 Small Reactor Fans

The small reactors will be grouped in banks of three. Each small reactor on high dust service will have its own cyclone, for particulate control. The small reactor on low dust services will not have a cyclone. Damper control will be used for the small reactors for flow control of the flue gas. Due to the physical size of the ductwork, valves may be used instead of dampers. Each bank of three small reactors will have one variable speed fan. See EXHIBIT 8.1-B for detailed specifications on the small reactor fans.

The flue gas from the pilot plant is to be reinjected ahead of the cold-side ESP. Advantages of this arrangement include: (1) injecting the flue gas ahead of the particulate control device will give the ESP and opportunity to remove any particulate that gets by the cyclones; (2) injecting after the APH removes any risk of increased cold end corrosion caused by SO_3 concentration, ammonium bisulfite formation, and localized temperature dilution brought on by inadequate mixing; (3) any SO_3 which leaks out of the SCR reactors should improve the performance of the cold side ESP; (4) flue gas temperatures from the pilot and the host plants will be compatible.

EXHIBIT 8.1-A

SPECIFICATIONS ON THE LARGE REACTOR FANS

Inquiry No. SCR – 702
SCS/DOE ICCT
Selective Catalytic Reduction (SCR) Project
Fan Data Sheet

In addition to the fan design requirements listed in the Supplemental Specification the following information is specific to each fan in this inquiry:

1.0 General

1.1 Application: Large Reactor Fans (with cyclones)
1.2 Location: At cyclone outlet – Streams 65, 66, 67 on PFD
1.3 Number of Fans: Three (3)
1.4 Fan Control: Variable speed drive

2.0 Performance

2.1 Gas Analysis at MCR (at fan inlet):

Gas Component	Mass (lb/hr)
CO2	5,095.00
O2	1,870.00
N2	20,709.00
SO2	118.00
SO3	2.23
NO	1.90
NO2	0.15
HCl	3.16
H2O	1,456.00
ash	22.00
NH3	0.01
TOTAL	29,277.45

2.2 Expected Conditions

Load	Flow/Fan (acfm)	Ps @ Inlet ("wg)	Ps @ Outlet ("wg)	Ps Rise ("wg)	Density (lb/cuft)	Temp. (deg. F)
Test Block	16,000	-34.00	-8.00	26.00	0.0434	400
Maximum	14,354	-32.10	-9.00	23.10	0.0434	400
Design	9,642	-18.30	-9.00	9.30	0.0506	300
Minimum	4,526	-14.30	-9.00	5.30	0.0551	250

2.3 Inlet Grain Loading: 0.4 gr/cfm

3.0 Construction

3.1 Erosion Protection: Partial blade liners
3.2 Corrosion Protection: Material should be resistant to ammonia
3.3 Peak Design Temperature: 500 deg. F

5.4	We will start manufacturing within the following number of of days after award:	90
5.5	We will start shipment of the items covered by this inquiry, within the following number of days after award:	250
5.6	We will complete shipment of all items covered by this inquiry within the following number of days after award:	260

6.0 DESCRIPTIVE DATA AND ENGINEERING INFORMATION

The following descriptive information and design data are furnished in connection with the equipment offered in this proposal:

6.1 Large Reactor Fans (suction from cyclones)

6.1.1	General	
6.1.1.1	Fan type (model/series)	540000L1, SWSI, Arr. #7
6.1.1.2	Type control	Variable Frequency Controller
6.1.1.3	Drive arrangement	Direct Connected
6.1.1.4	Number of fans	3
6.1.2	Performance	

6.1.2.1	Performance data for each fan at:	Test Block (guaranteed)	Maximum
	a. Speed – rpm	1775	1621
	b. Capacity – acfm	16000	14354
	c. Density – lbs/cuft	.0434	.0434
	d. Temperature – deg F	400	400
	e. Pressures – "wg		
	1. Inlet static	-34	32.1
	2. Discharge static	-8	-9.0
	3. Fan static pressure	26.0	23.1
	f. Static efficiency – %	79.75	85.44
	g. Power input to fan – bhp	82	61
	h. Compressibility	.976	.979

6.1.2.2 Performance data for each fan at:

	Design	Minimum
a. Speed – rpm	993	665
b. Capacity – acfm	9642	4526
c. Density – lbs/cuft	.0506	.0551
d. Temperature – deg F	300	250
e. Pressures – "wg		
1. Inlet static	-18.30	-14.30
2. Discharge static	-9.0	-9.0
3. Fan static pressure	9.3	5.3
f. Static efficiency – %	78.3	
g. Power input to fan – bhp	18	5
h. Compressibility	1.0	1.0

6.1.2.3 General performance data

a. Peak horsepower (@ TB density)	95
b. Maximum torque expected (ft–lb)	280 @ TB density
c. Starting torque (ft–lb)	Depends on density

6.1.3 Sound data

6.1.3.1 Sound level data for fan at noisest conditions through casing @ one meter

octave band center frequency (Hz)	Est. Lw dB (re 10^–12 watt)
63	100
125	96
250	102
500	96
1000	95
2000	91
4000	78
8000	69

	Est. Lp dB (re 20 mPa)
6.1.3.2 Sound pressure level at one meter outside housing	90 dba

6.1.3.3 Above estimate includes/does not include:

a. Inlet silencer	does not
b. Outlet silencer	does not
c. Casing insulation	does not

6.1.4 Constructional data

6.1.4.1 Impeller general information

a. Diameter at tip of blade (in.)	54.0
b. Width of wheel at tip of blade (in.)	3.7
c. Type of blade (backward inclined, radial, etc.)	Backward Inclined
d. Number of blades	11
e. Tip speed at test block (fpm)	25094
f. Flywheel effect (lb-ft2)	1509
g. Shaft dia. at hub (in.)	3.5
h. Shaft dia. at bearing (in.)	3.44

6.1.4.2 Material type

a. Shaft	A668
b. Wheel	A588
c. Liner	N/A
d. Housing	A36
e. Base	A36
f. Damper or Vane	A36

6.1.4.3 Material thickness (in.)

a. Blades	.1875
b. Liner	N/A
c. Center, side or back plates	.375/.375
d. Housing	.315
e. Base	.25
f. Damper or vane (blade)	.14

6.1.4.4 Weights (lbs.)

a. Fan	6000
b. Motor	1260
c. Pedestal	4000
d. Damper of vane	Option - 600
e. Weight of complete assembly	12000

6.1.4.5 Bearings

a. Diameter (in.)	3.44
b. Type	Sleeve
c. Manufacturer	Dodge
d. Lubrication	Oil
e. Reservoir capacity (gal.)	Later
f. Cooling water per fan (gpm)	2

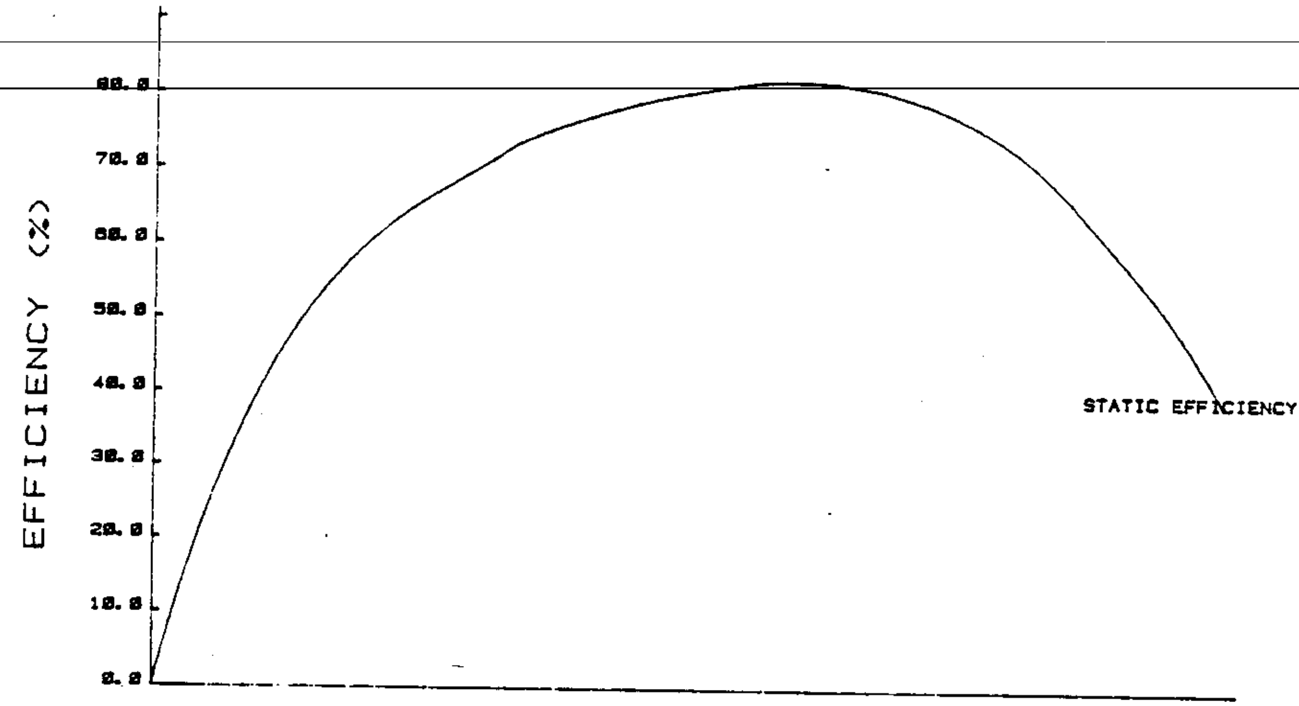
6.1.4.6 Fan to motor connection

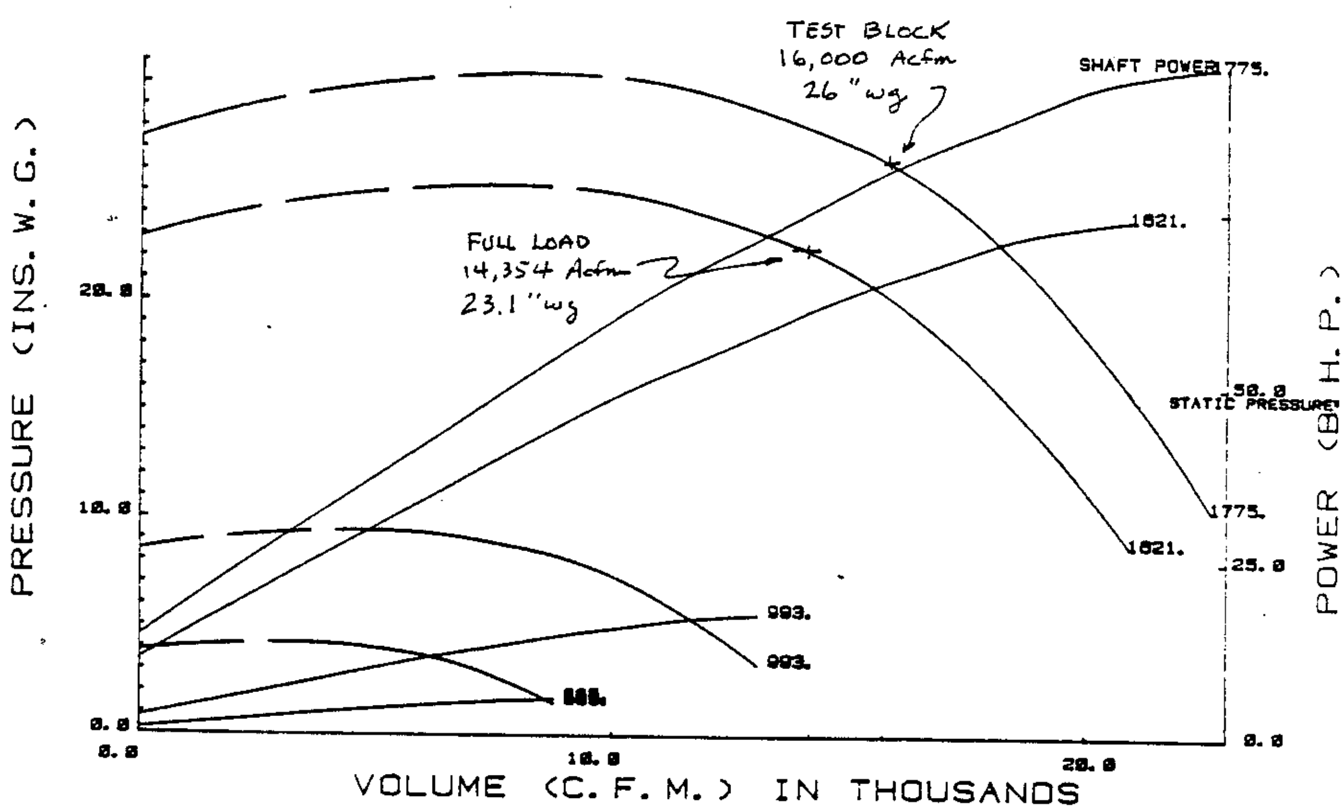
a. Type (flexible, belt, etc.)	Flexible
b. Manufacturer	Falk or equal
c. Size	Later

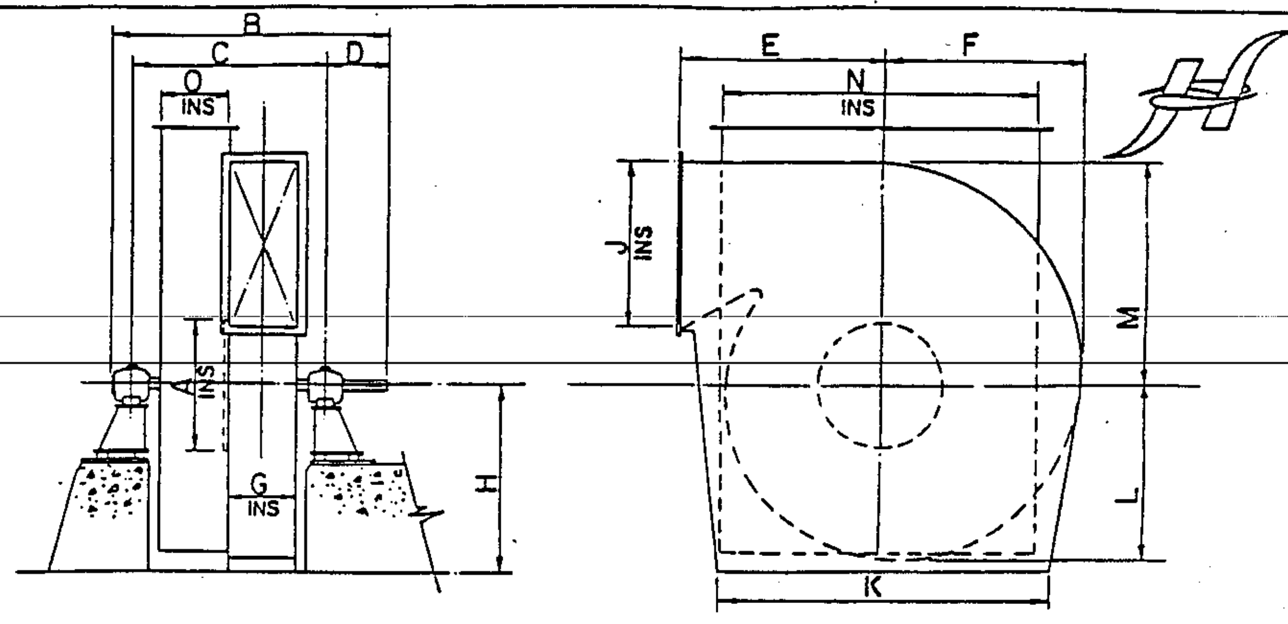
HOWDEN SIROCCO P27123/CF91	SOUTHERN CO / GULF PWR / SCR / W/CYC	LARGE REAC
	L1 DESIGN SINGLE BOX INLET VARIABLE SPEED	

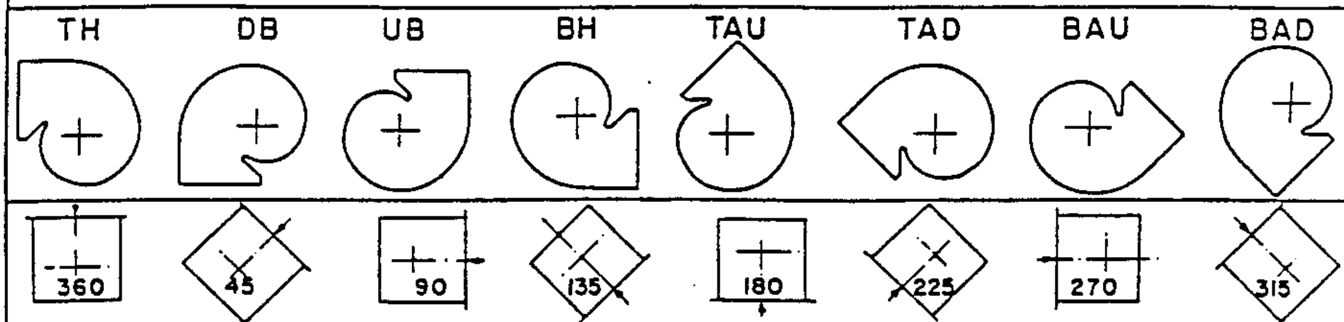
L1SBVC1.00

FAN SIZE	54.00
SPEED RPM	1775.0
INLET DENSITY	.04340 LB/FT3
MAY 14, 1991	









TYPE L1 SW-BOX INLET - ARR. 3

	FAN SIZE & STD. WHEEL DIA.	UNITS	A	B	C	D	E	F	G	H	J	K	L	M	N	O
	2950	INCHES	11	36	22	10	23	23	4	26	19	41	20	25	41	4
	3150	INCHES	12	38	24	10	24	24	5	28	20	43	22	27	43	5
Small Reactor w ⇒	3350	INCHES	13	38	24	10	26	26	5	29	22	46	23	29	46	5
Small Reactor w/o ⇒	3550	INCHES	14	39	25	10	27	27	5	30	23	49	24	31	49	5
	3750	INCHES	15	40	26	10	29	29	6	32	24	52	26	32	52	6
	3950	INCHES	15	49	30	14	31	31	6	33	25	54	27	34	54	6
	4175	INCHES	16	50	31	14	32	32	6	35	27	57	29	36	57	6
	4425	INCHES	17	53	33	15	34	34	7	36	29	61	30	38	61	7
	4650	INCHES	18	53	33	15	36	36	7	38	30	64	32	40	64	7
	4925	INCHES	19	54	34	15	38	38	7	40	32	68	34	42	68	7
	5200	INCHES	20	58	36	16	40	40	8	42	34	72	36	45	72	8
Large Reactor w ⇒	5525	INCHES	21	59	37	16	43	43	8	44	36	76	38	48	76	8

DIMENSIONS—THESE ARE APPROXIMATE AND ARE NOT TO BE USED FOR CONSTRUCTION

Howden Sirocco Inc.
P27123/CF91

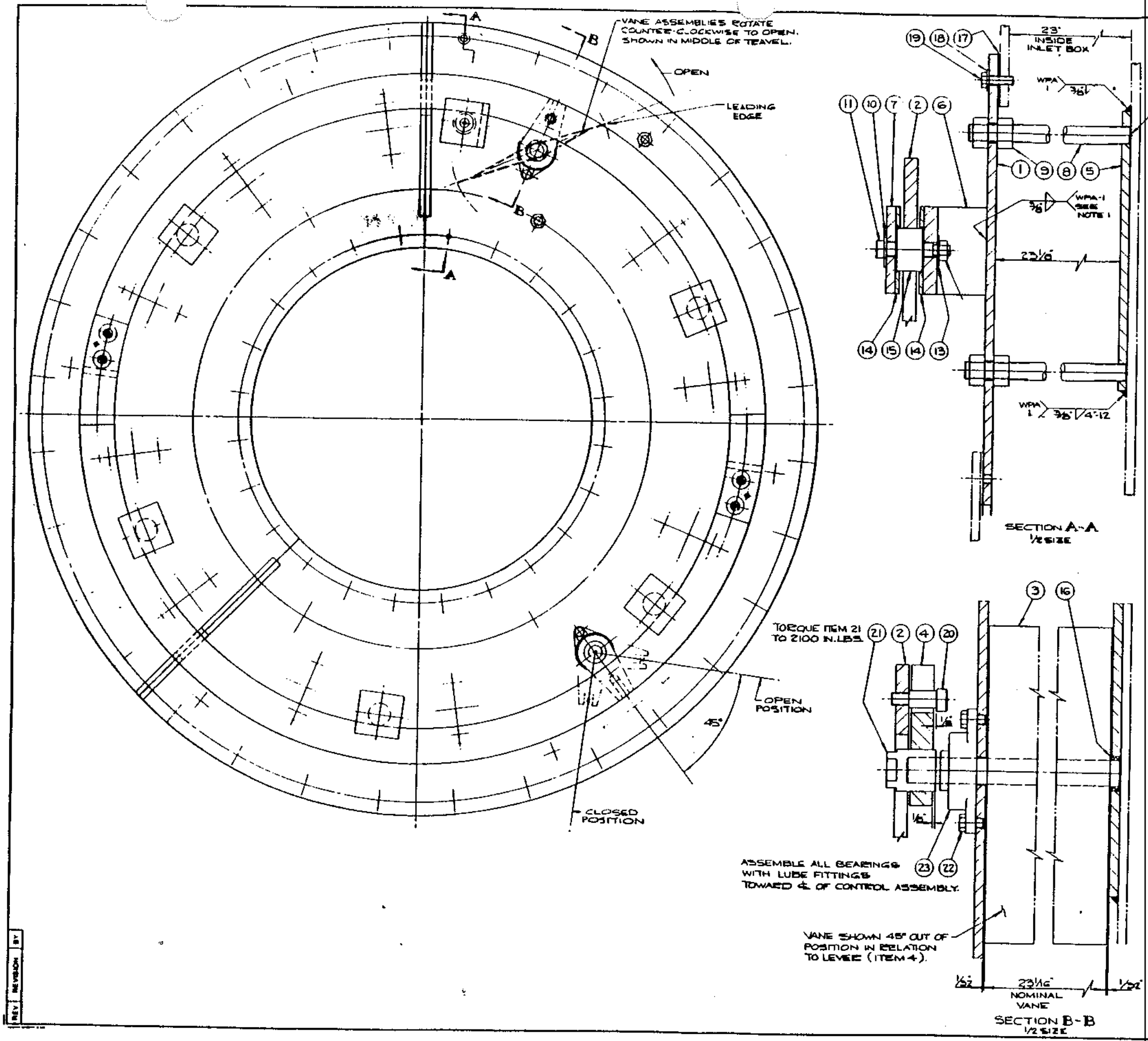
General Bill of Material

The following general bill of material applies with the exception of the Ammonia Dilution Fan.

- Fan Housing and Boxes
- Side and Scroll Liners - Where Shown on Data Pages
- Arr. #3 Rotor
- Carbon Ring Shaft Seal
- Water Cooled Sleeve Bearings
- Arr. #7 Support System
- Spring Insulators
- TEFC Motor
- Variable Speed Controller - Except Hot Air Fan
- Inlet Vane Control - Hot Air Fan
- Electric Actuator - Hot Air Fan
- Bearing RTD's
- 110% Overspeed Test (Wheel)
- 2.5 Mils Alkyd Enamel
- Housing Split for Rotor Removal
- Doors, Drains, Flanged Inlet/Outlet
- Forged Steel Shaft
- Stress Relief
- Coupling or V-Belt Drive
- Coupling or V-Belt Drive or Guard
- Complete Shop Assembly - One Piece Shipment, Final Alignment Required, etc.

Option: Axial Vane Control with Electric Actuator.
Large or Small Reactor Fans

Large Fans: [redacted] per fan
Small Fans: [redacted] per fan



NOTES:

1. CENTRALIZE CONTROL RING, POSITION ROLLERS & WELD SUPPORT ANGLES (ITEM 6) TO ASSEMBLY.
2. BRIDGE ON CONTROL RING (ITEM 2) TO BE FACING OUTWARD.
3. SPLIT FLANGE JOINT TO BE SEALED AT FINAL ASSEMBLY WITH SILICONE SEALING COMPOUND.
4. ONE VANE CONTROL ASSEMBLY AS DRAWN. ONE OPPOSITE TO DRAWING.

ITEM	REQ'D	DWG. NO	MAT'L	DESCRIPTION
23	12		SEAL-MASTER	1½ DIA. MNTD. BALL BRG. MSFT-24
22	24		GR.2	9/16-12UNC × 1" LG. HEX HD BOLT
21	12		TRAN-TORQUE	MNTG. SLEEVE 1½ I.D. × 2 3/16 O.D. × 2¾ LG.
20	12	UNBRAKO LOCWEL	GR.2	1 DIA. × 1½ LG. HEX. SOC. SLDR. SCR.
19	32		GR.2	½-13UNC × 1½ LG. HEX. HD. BOLT
18	32		STL.	½ DIA. STD. TYPE B PLAIN WASHER
17	1	NON-ASBESTOS	KLINGER SIL.	GASKET 7'-6 O.D. × 7'-0 I.D. × 1/8 THK.
16	12	CUT TO LENGTH	OILITE AA-2001	SLEEVE BRG. 1½ I.D. × 2 O.D. × 2" LG.
15	6		MCGILL CAMROL	CAM YOKE ROLLER BRG. "CYR 2½
14	12		STL.	2½ DIA. STD TYPE A PLAIN WASHER
13	6		STL.	7/8 DIA STD TYPE B PLAIN WASHER
12	6		STL.	7/8-11 UNC REG HEX. NUT
11	6	UNBRAKO LOCWEL	GR.2	¾ DIA. × 2¾ LG. HEX. SOC. SLDR. SCR.
10	6		STL.	¾ DIA. STD. TYPE A PLAIN WASHER
9	24		STL.	1"-14 UNF REG. HEX. NUT
8	12		1018	1"-14 UNF × 2'-1¼ LG. THD'D. ROD
7	6	C-1-1604		SUPPORT PLATE
6	6	C-1-1604		SUPPORT ANGLE
5	1	D-1-2776		BACKING PLATE
4	12	B-1-2775		VANE LEVER
3	12	D-1-2774		VANE ASSEMBLY
2	1	D-1-2773		CONTROL RING ASS'Y.
1	1	D-1-2772		MOUNTING PLATE ASS'Y.

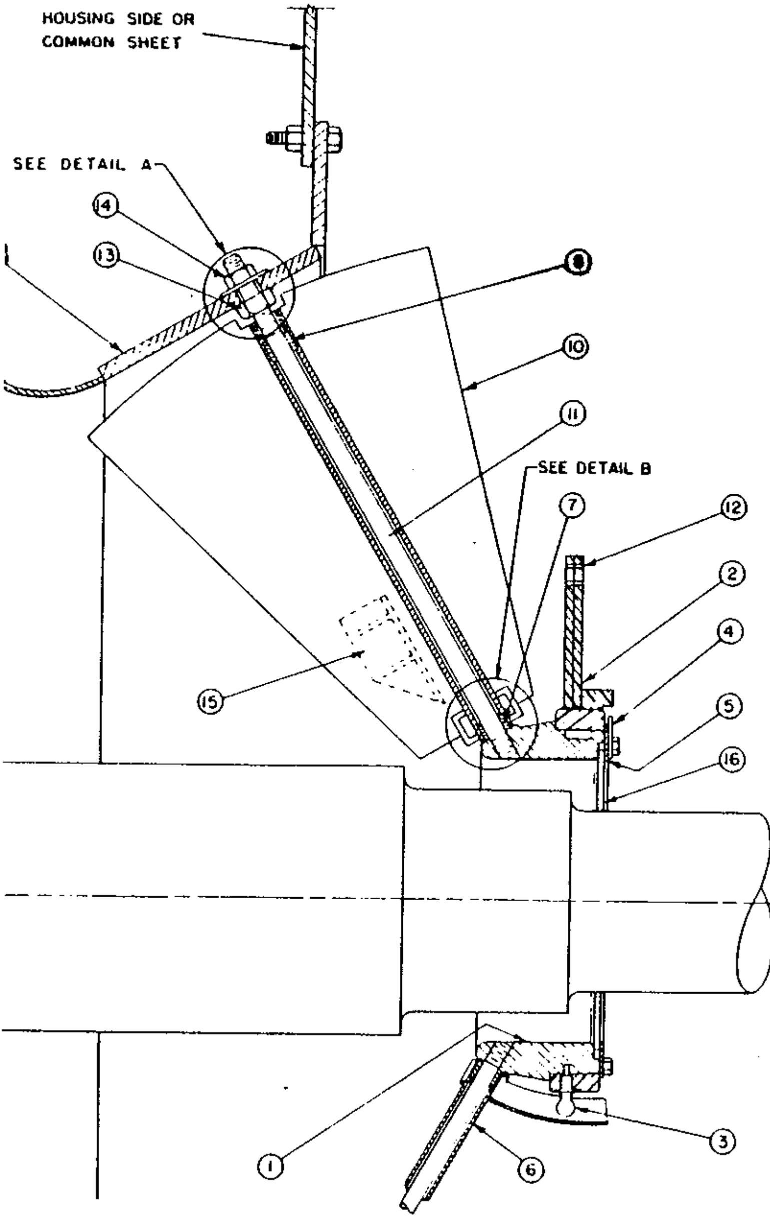
AXIAL VANE CONTROL ASSEMBLY

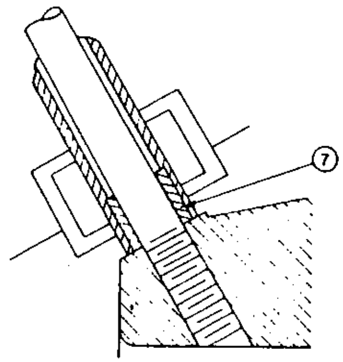
DATE 12-21-87 | SCALE 1/4 & 1/2 | DRAWN FWW | CHKD PPN

HOWDEN FANS

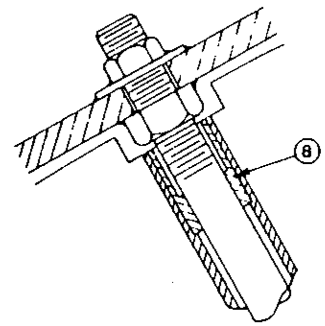
DIVISION OF JAMES HOWDEN AMERICA INC.

DRAWING NUMBER E-1-2777 | REV 0

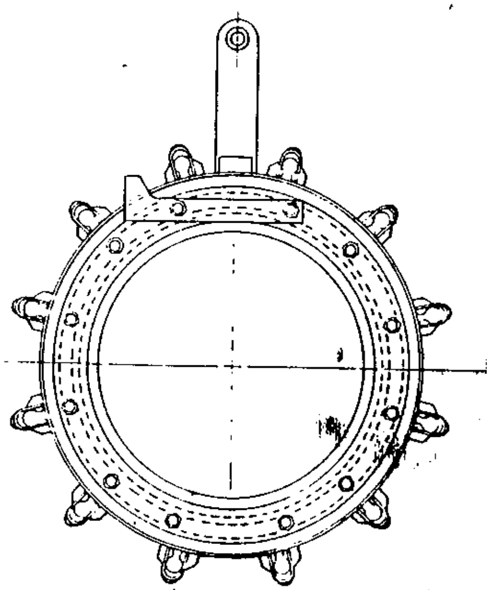




DETAIL B



DETAIL A



ITEM	BILL ATERIAL DE TION
1	BASE CASTING
2	OPERATING LEVER AND RING ASSEMBLY
3	BALL PIN
4	STOP PLATE
5	HOLDING RING
6	VANE TUBING AND ARM
7	LOWER BUSHING
8	UPPER BUSHING
9	INLET
10	VANE - (SEE FIGURE B I - 8)
11	VANE ROD
12	BUSHING FOR OPERATING LEVER AND RING ASSEMBLY
13	JAM NUT
14	NUT
15	VANE TAB
16	SHAFT SEAL RING - (SPLIT)

NOTE - VANE TABS, ITEM 15, ARE NOT SUPPLIED FOR ALL APPLICATIONS.

CONTROLLER DESCRIPTION ALL SIZES

NEMA 1 Enclosure
M/N 2EC1100
FlexPak AC

STANDARD FEATURES:

- Constant torque operating speed range of 20:1(1)
- Output frequency from 1.4 to 60 hertz with option for 120 and 240 hertz
- Near-unity displacement power factor throughout the speed range
- Insensitive to incoming power phase sequence
- Input line reactors to permit operation on a distribution system with 50,000 amp fault current rating without an isolation transformer
- Robust power circuit design safeguards controller from damaging line transients
- Line-to-line and line-to-ground output short circuit protection
- AC input point contactor
- Single-board regulator utilizing LSI and surface-mount technology for increased reliability and reduced size
- Electronic reversing from any speed
- Start/stop and speed selection with coast-to-rest or ramp-to-rest on stop
- Standard adjustments:
  - Acceleration rate
  - Deceleration rate
  - Minimum hertz
  - Maximum hertz
  - Current limit
  - Volts per hertz
  - Low hertz voltage boost
  - Motor stability
  - Automatic voltage boost
- Automatic shutdown and first fault indication via LEDs under any of the following conditions:
  - Undervoltage
  - Overcurrent
  - Overvoltage
  - DC bus fault
  - Ground fault
  - Overtemperature
- Fault monitor card latches specific type and location of first fault condition sensed in the inverter power module
- Relay contacts for external interlocking of the drive "Running" and drive "Fault"
- Provisions for remote drive "Running" and drive "Ready" pilot lights
- 24 VDC isolated operator's control for safety and drive noise immunity
- 0-10 VDC, 4-20 mA and 0-20 mA speed reference input signal capability
- 0-10 VDC metering output signal for voltage, frequency and motor amps
- Slip compensation for 1% speed regulation full load to no load
- Heatsink and regulator thermostats

Continued on next page.

HOT AIR FAN

150 HP, 1800 RPM, 445T

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (1565 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

LARGE REACTOR FAN - WITH CYCLONE

100 HP, 1800 RPM, 405T

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (1509 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

EXHIBIT 8.1-B

SPECIFICATIONS ON THE SMALL REACTOR FANS

Inquiry No. SCR – 702
SCS/DOE ICCT
Selective Catalytic Reduction (SCR) Project
Fan Data Sheet

In addition to the fan design requirements listed in the Supplemental Specification the following information is specific to each fan in this inquiry:

1.0 General

1.1 Application: Small Reactor Fans (with cyclones)

1.2 Location: At cyclone outlet – Streams 81, 82 on PFD

1.3 Number of Fans: Two (2)

1.4 Fan Control: Variable speed drive

2.0 Performance

2.1 Gas Analysis at MCR (at fan inlet):

Gas Component	Mass (lb/hr)
CO2	1,223.00
O2	199.00
N2	4,147.00
SO2	28.31
SO3	0.59
NO	0.46
NO2	0.04
HCl	0.76
H2O	349.54
ash	4.97
NH3	0.01
TOTAL	5,953.68

2.2 Expected Conditions

Load	Flow/Fan (acfm)	Ps @ Inlet ("wg)	Ps @ Outlet ("wg)	Ps Rise ("wg)	Density (lb/cuft)	Temp. (deg. F)
Test Block	4,000	-25.50	-8.50	17.00	0.0314	750
Maximum	3,683	-23.87	-9.00	14.87	0.0314	750
Design	2,952	-14.25	-9.00	5.25	0.0336	700
Minimum	2,354	-9.58	-9.00	0.58	0.0365	620

2.3 Inlet Grain Loading: 0.3 gr/cfm

3.0 Construction

3.1 Erosion Protection: Partial blade liners

3.2 Corrosion Protection: Material should be resistant to ammonia

3.3 Peak Design Temperature: 900 deg. F

6.2.4.3	Material thickness (in.)	
	a. Blades	.1875
	b. Liner	N/A
	c. Center, side or back plates	.25/.375
	d. Housing	.25
	e. Base	.25
	f. Damper or vane (blade)	.14
6.2.4.4	Weights (lbs.)	
	a. Fan	5000
	b. Motor	1260
	c. Pedestal	4000
	d. Damper of vane	Option - 600
	e. Weight of complete assembly	11000
6.2.4.5	Bearings	
	a. Diameter (in.)	3.44
	b. Type	Sleeve
	c. Manufacturer	Dodge
	d. Lubrication	Oil
	e. Reservoir capacity (gal.)	Later
	f. Cooling water per fan (gpm)	2
6.2.4.6	Fan to motor connection	
	a. Type (flexible, belt, etc.)	Flexible
	b. Manufacturer	Falk or Equal
	c. Size	Later
6.2.5	Additional proposal data	
6.2.5.1	Dimension sheet	Attached
6.2.5.2	Performance curve	Attached
6.3	Small Reactor Fans (suction from cyclones)	
6.3.1	General	
6.3.1.1	Fan type (model/series)	355000L1, SWSI, Arr. #7
6.3.1.2	Type control	Variable Frequency Controller
6.3.1.3	Drive arrangement	V belt
6.3.1.4	Number of fans	2

6.3.2 Performance

6.3.2.1 Performance data for each fan at:

	Test Block (guaranteed)	Maximum
a. Speed – rpm	2600	2404
b. Capacity – acfm	4000	3683
c. Density – lbs/cuft	.0314	.0314
d. Temperature – deg F	750	750
e. Pressures – "wg		
1. Inlet static	-25.5	-23.87
2. Discharge static	-8.5	-9.0
3. Fan static pressure	17.0	14.87
f. Static efficiency – %	76.3	78.2
g. Power input to fan – bhp	14	11
h. Compressibility	1.0	1.0

6.3.2.2 Performance data for each fan at:

	Design	Minimum
a. Speed – rpm	1497	680
b. Capacity – acfm	2952	2354
c. Density – lbs/cuft	.0336	.0365
d. Temperature – deg F	700	620
e. Pressures – "wg		
1. Inlet static	-14.25	-9.58
2. Discharge static	-9.0	-9.0
3. Fan static pressure	5.25	0.58
f. Static efficiency – %	74.9	36
g. Power input to fan – bhp	3.25	.6
h. Compressibility	1.0	1.0

6.3.2.3 General performance data

a. Peak horsepower (@ TB density)	24
b. Maximum torque expected (ft-lb)	48 @ TB density
c. Starting torque (ft-lb)	Depends on density

6.3.3 Sound data

6.3.3.1 Sound level data for fan at noisest conditions through casing @ one meter

octave band center frequency (Hz)	Est. Lw dB (re 10^-12 watt)
63	94
125	90
250	86
500	100
1000	90
2000	87
4000	74
8000	66

Est. Lp dB

6.3.3.2	Sound pressure level at one meter outside housing	90 dba
6.3.3.3	Above estimate includes/does not include:	
	a. Inlet silencer	does not
	b. Outlet silencer	does not
	c. Casing insulation	does not
6.3.4	Constructional data	
6.3.4.1	Impeller general information	
	a. Diameter at tip of blade (in.)	33.5
	b. Width of wheel at tip of blade (in.)	2.0
	c. Type of blade (backward inclined, radial, etc.)	Backward inclined
	d. Number of blades	11
	e. Tip speed at test block (fpm)	22796
	f. Flywheel effect (lb-ft2)	150
	g. Shaft dia. at hub (in.)	3.75
	h. Shaft dia. at bearing (in.)	3.44
6.3.4.2	Material type	
	a. Shaft	A668
	b. Wheel	A514
	c. Liner	N/A
	d. Housing	A36
	e. Base	A36
	f. Damper or Vane	A36
6.3.4.3	Material thickness (in.)	
	a. Blades	.1875
	b. Liner	N/A
	c. Center, side or back plates	.1875/.25
	d. Housing	.25
	e. Base	.25
	f. Damper or vane (blade)	.14
6.3.4.4	Weights (lbs.)	
	a. Fan	3000
	b. Motor	250
	c. Pedestal	2000
	d. Damper or vane	Option - 500
	e. Weight of complete assembly	5500
6.3.4.5	Bearings	
	a. Diameter (in.)	3.44
	b. Type	Sleeve
	c. Manufacturer	Dodge
	d. Lubrication	Oil
	e. Reservoir capacity (gal.)	Later
	f. Cooling water per fan (gpm)	2

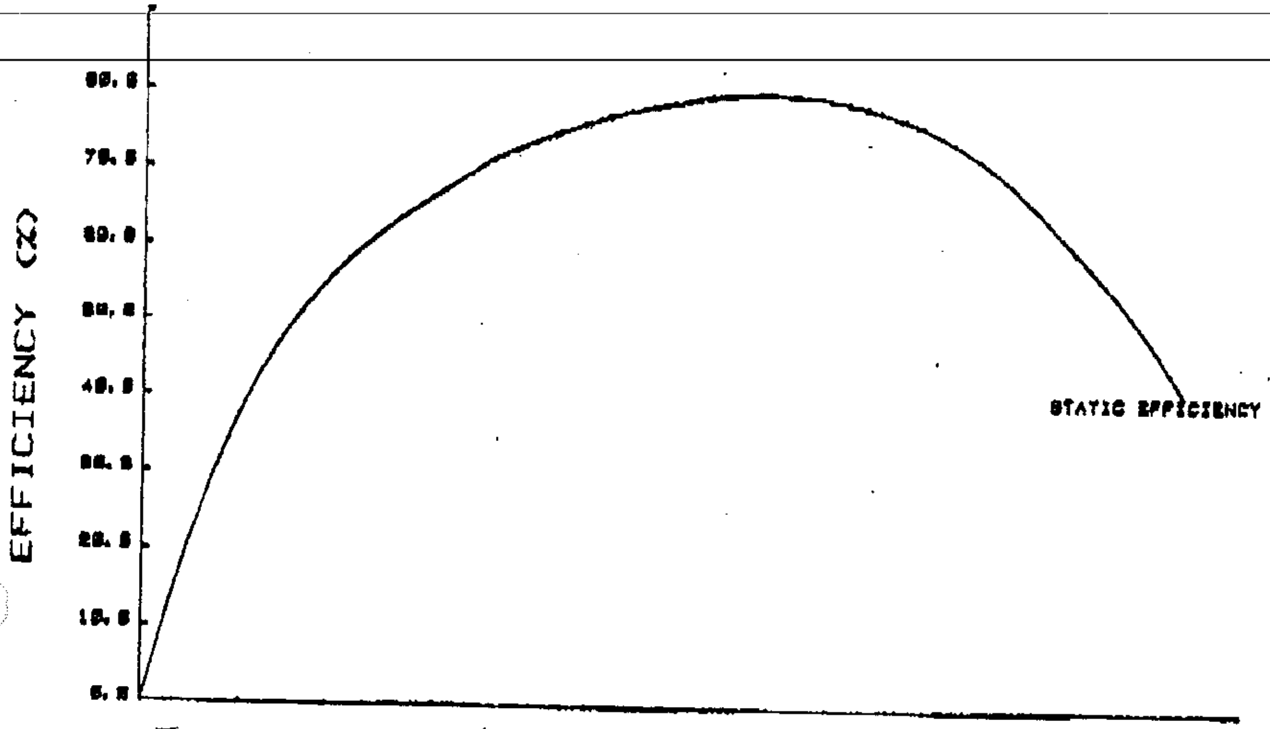
6.3.4.6	Fan to motor connection	
	a. Type (flexible, belt, etc.)	V-belt
	b. Manufacturer	Dodge or equal
	c. Size	Later
6.3.5	Additional proposal data	
6.3.5.1	Dimension sheet	Attached
6.3.5.2	Performance curve	Attached
6.4	~~Small Reactor Fans (dirty gas)~~	
6.4.1	~~General~~	
6.4.1.1	~~Fan type (model/series)~~	354004L1, SWSI, Arr. #7
6.4.1.2	~~Type control~~	Variable Frequency Controller
~~6.4.1.3~~	~~Drive arrangement~~	Direct Connected
6.4.1.4	~~Number of fans~~	2
6.4.2	Performance	

		Test Block (guaranteed)	Maximum
6.4.2.1	Performance data for each fan at:		
	a. Speed - rpm	1775	1572
	b. Capacity - acfm	4000	3621
	c. Density - lbs/cuft	.0321	.0321
	d. Temperature - deg F	750	750
	e. Pressures - "wg		
	1. Inlet static	-18	-16.64
	2. Discharge static	-8.5	-9.0
	3. Fan static pressure	9.5	7.64
	f. Static efficiency - %	74.6	72.5
	g. Power input to fan - bhp	8	6
	h. Compressibility	1.0	1.0

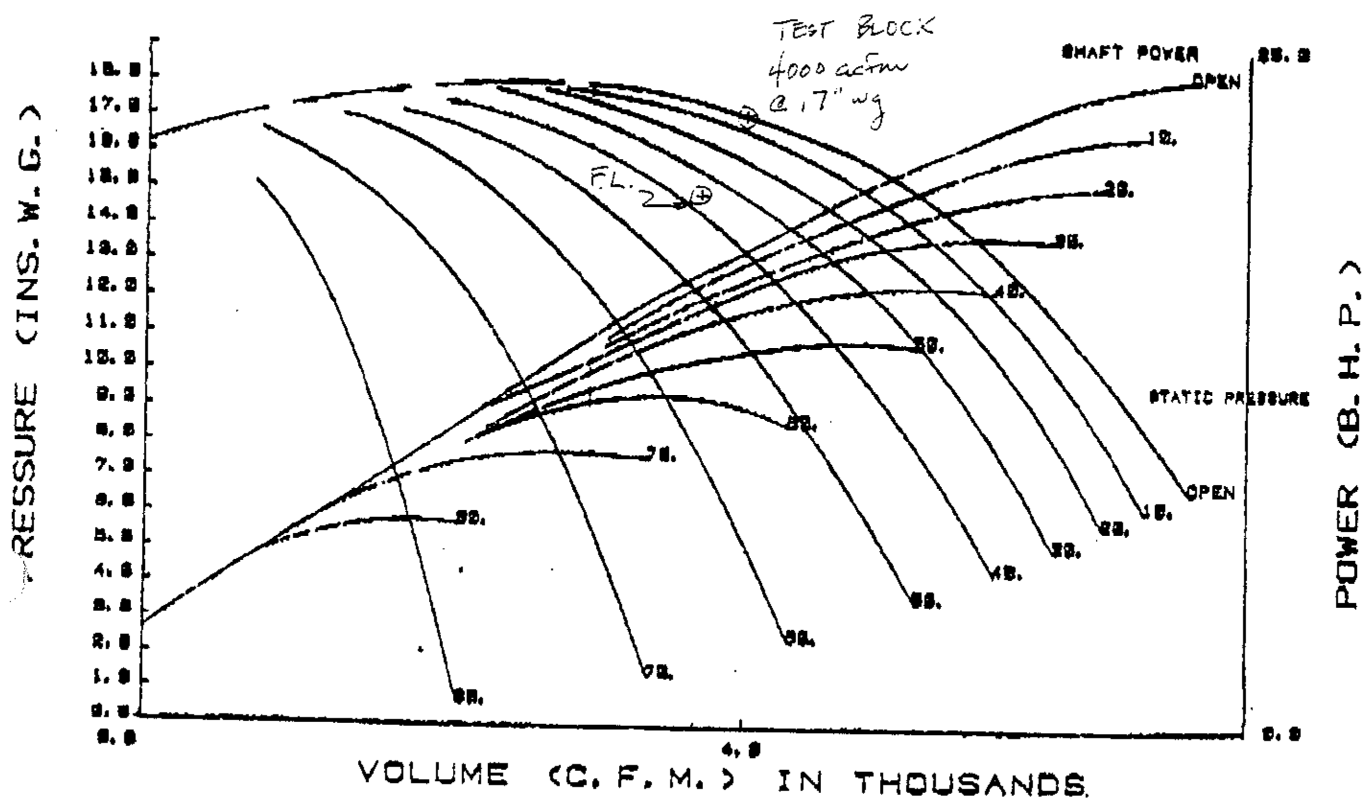
HOWDEN SIROCCO P27128/CF01	SOUTHERN COMPANY SCR WITH CYCLONE SMALL REAC
	L1 DESIGN SINGLE BOX INLET CONSTANT SPEED VANE CONTROL

L1SBVC1.00

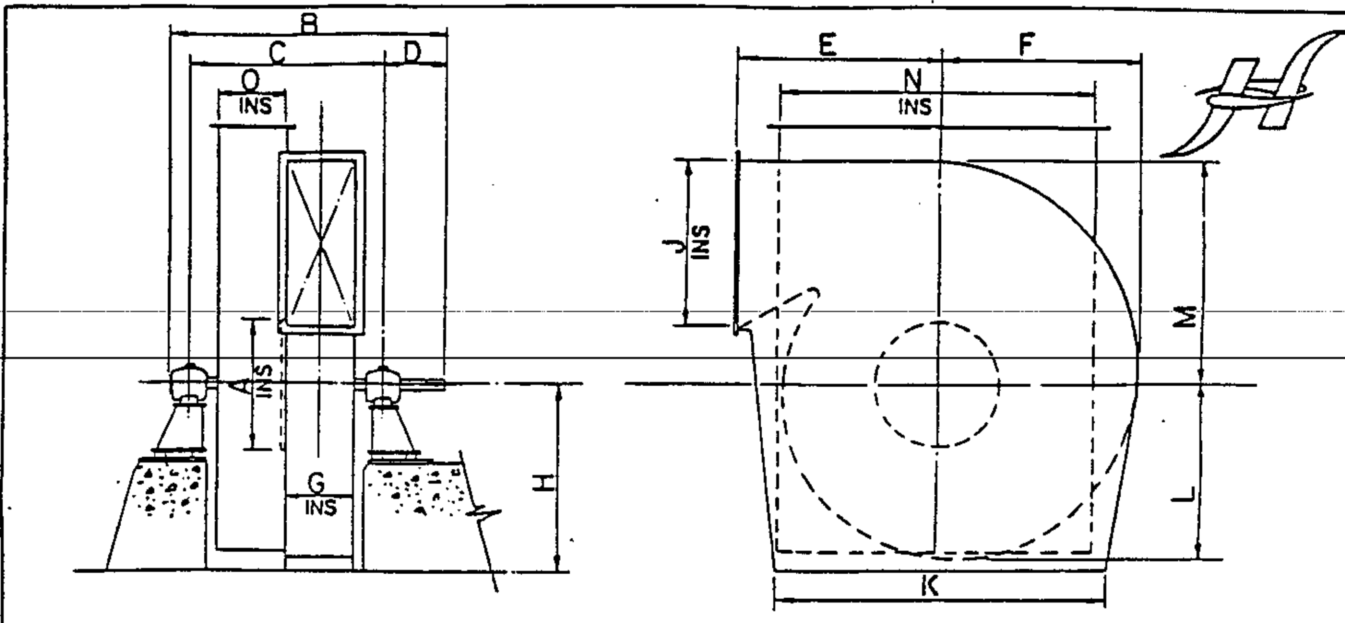
FAN SIZE	29.50
SPEED RPM	2500.0
INLET DENSITY	.03140 LB/FT3
JUNE 8, 1991	

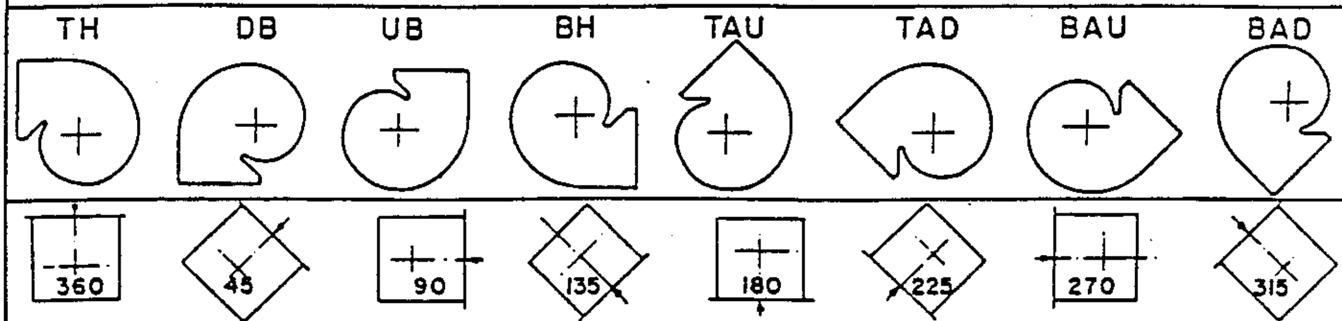


THIS IS A INLET VANE CONTROL CURVE - THIS FAN IS ALSO EQUIPPED WITH VARIABLE SPEED MOTORS



HOWDEN CENTRIFUGAL FANS P27123/CF91





TYPE L1 SW-BOX INLET - ARR. 3

	FAN SIZE & STD. WHEEL DIA.	UNITS	A	B	C	D	E	F	G	H	J	K	L	M	N	O
	2950	INCHES	11	36	22	10	23	23	4	26	19	41	20	25	41	4
	3150	INCHES	12	38	24	10	24	24	5	28	20	43	22	27	43	5
Small Reactor w	3350	INCHES	13	38	24	10	26	26	5	29	22	46	23	29	46	5
Small Reactor w/o	3550	INCHES	14	39	25	10	27	27	5	30	23	49	24	31	49	5
	3750	INCHES	15	40	26	10	29	29	6	32	24	52	26	32	52	6
	3950	INCHES	15	49	30	14	31	31	6	33	25	54	27	34	54	6
	4175	INCHES	16	50	31	14	32	32	6	35	27	57	29	36	57	6
	4425	INCHES	17	53	33	15	34	34	7	36	29	61	30	38	61	7
	4650	INCHES	18	53	33	15	36	36	7	38	30	64	32	40	64	7
	4925	INCHES	19	54	34	15	38	38	7	40	32	68	34	42	68	7
	5200	INCHES	20	58	36	16	40	40	8	42	34	72	36	45	72	8
Large Reactor w	5525	INCHES	21	59	37	16	43	43	8	44	36	76	38	48	76	8

DIMENSIONS—THESE ARE APPROXIMATE AND ARE NOT TO BE USED FOR CONSTRUCTION

Howden Sirocco Inc.
P27123/CF91

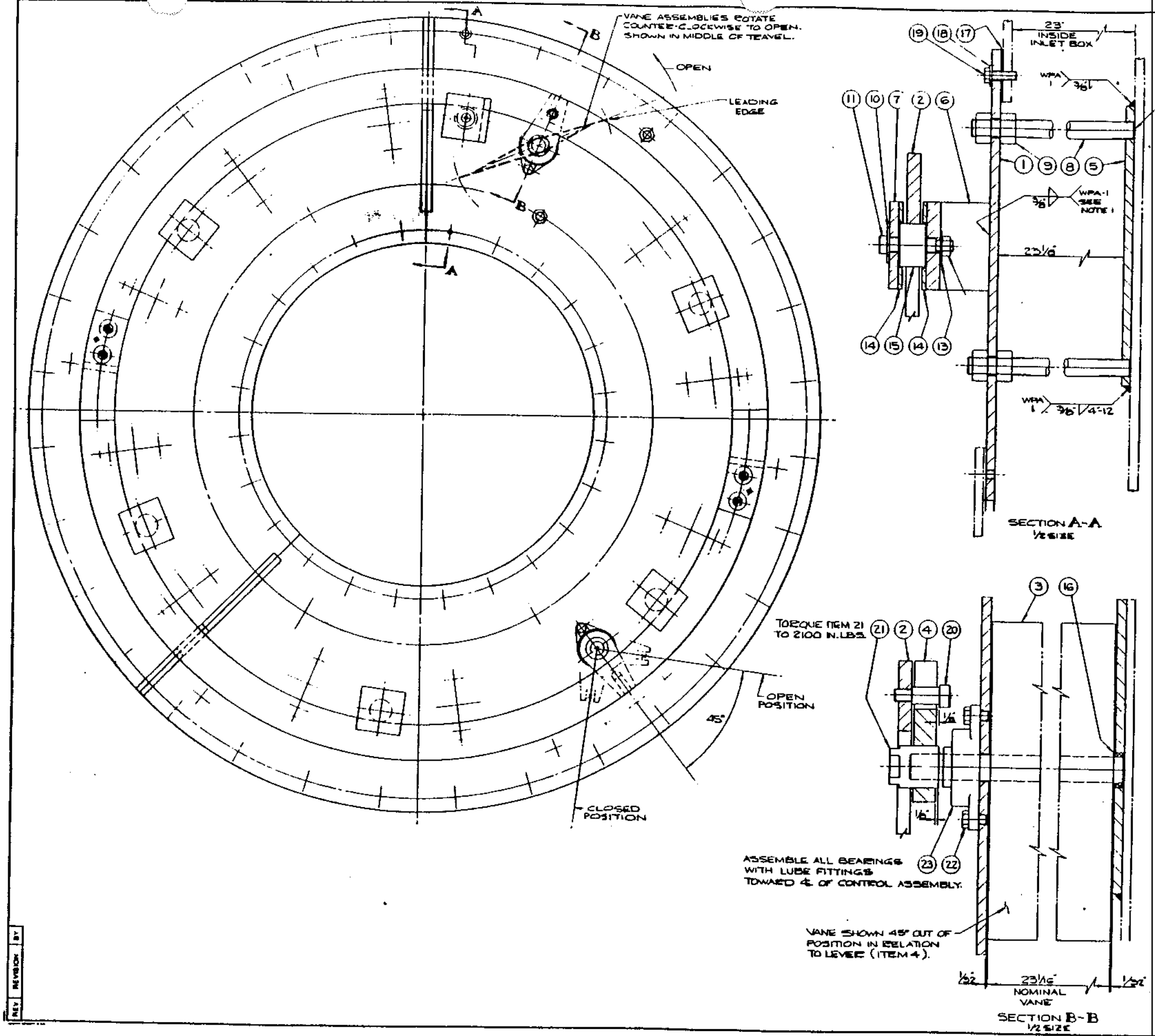
General Bill of Material

The following general bill of material applies with the exception of the Ammonia Dilution Fan.

- Fan Housing and Boxes
- Side and Scroll Liners - Where Shown on Data Pages
- Arr. #3 Rotor
- Carbon Ring Shaft Seal
- Water Cooled Sleeve Bearings
- Arr. #7 Support System
- Spring Insulators
- TEFC Motor
- Variable Speed Controller - Except Hot Air Fan
- Inlet Vane Control - Hot Air Fan
- Electric Actuator - Hot Air Fan
- Bearing RTD's
- 110% Overspeed Test (Wheel)
- 2.5 Mils Alkyd Enamel
- Housing Split for Rotor Removal
- Doors, Drains, Flanged Inlet/Outlet
- Forged Steel Shaft
- Stress Relief
- Coupling or V-Belt Drive
- Coupling or V-Belt Drive or Guard
- Complete Shop Assembly - One Piece Shipment, Final Alignment Required, etc.

Option: Axial Vane Control with Electric Actuator.
Large or Small Reactor Fans

Large Fans: [redacted] per fan
Small Fans: [redacted] per fan



ALL THREADED RODS (ITEM 8) TO BE FLUSH WITH TO 1/32" BELOW THIS SURFACE OF BACKING PLATE (ITEM 5)

TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL
DECIMAL
ANGULAR

NOTES:

1. CENTRALIZE CONTROL RING, POSITION ROLLERS & WELD SUPPORT ANGLES (ITEM 6) TO ASSEMBLY.
2. BRIDGE ON CONTROL RING (ITEM 2) TO BE FACING OUTWARD.
3. SPLIT FLANGE JOINT TO BE SEALED AT FINAL ASSEMBLY WITH SILICONE SEALING COMPOUND.
4. ONE VANE CONTROL ASSEMBLY AS DRAWN. ONE OPPOSITE TO DRAWING.

ITEM	REQ'D	DWG. NO	MAT'L	DESCRIPTION
23	12		SEAL-MASTER	1 1/2 DIA. MNTD. BALL BRG. MSFT-24
22	24		GR.2	5/16-12UNC × 1" LG. HEX HD BOLT
21	12		TRAN-TORQUE	MNTG. SLEEVE 1 1/2 I.D. × 2 3/16 O.D. × 2 3/4 LG.
20	12	UNBRAKO LOCWEL	GR.2	1"DIA. × 1 1/2 LG. HEX. SOC. SLDR. SCR.
19	32		GR.2	1/2-13UNC × 1 1/2" LG. HEX. HD. BOLT
18	32		STL.	1/2" DIA. STD. TYPE B PLAIN WASHER
17	1	NON-ASBESTOS CUT TO LENGTH	KLINGER-SIL	GASKET 7'-6" O.D. × 7'-0" I.D. × 1/8" THK.
16	12		GR.TE IAA-2007	SLEEVE BRG. 1 1/2 I.D. × 2" O.D. × 2" LG.
15	6		MCGILL CAMROL	CAMYOKE ROLLER BRG. #CYR 2 1/2
14	12		STL.	2 1/2" DIA. STD. TYPE 'A' PLAIN WASHER
13	6		STL.	7/8 DIA STD TYPE B PLAIN WASHER
12	6		STL.	7/8"-11 UNC REG HEX. NUT
11	6	UNBRAKO LOCWEL	GR.2	3/4 DIA × 2 3/4 LG. HEX. SOC. SLDR. SCR.
10	6		STL.	3/4 DIA. STD. TYPE A PLAIN WASHER
9	24		STL.	1"-14 UNF REG. HEX. NUT
8	12		1018	1"-14UNF × 2'-1 1/4" LG. THD'D. ROD
7	6	C-1-1604		SUPPORT PLATE
6	6	C-1-1604		SUPPORT ANGLE
5	1	D-1-2776		BACKING PLATE
4	12	B-1-2775		VANE LEVER
3	12	D-1-2774		VANE ASSEMBLY
2	1	D-1-2773		CONTROL RING ASS'Y.
1	1	D-1-2772		MOUNTING PLATE ASS'Y.

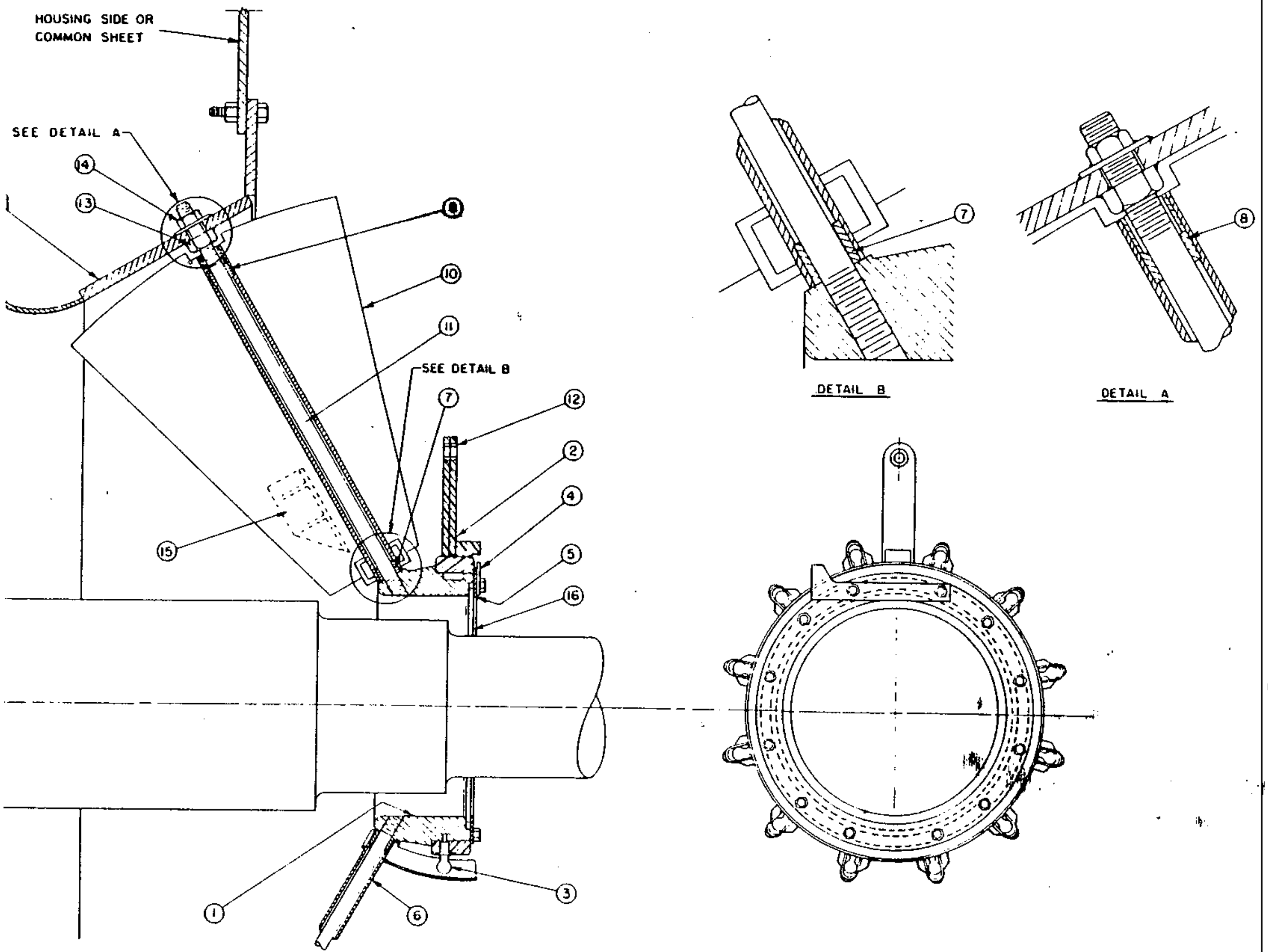
AXIAL VANE CONTROL ASSEMBLY

DATE 12-21-87
SCALE 1/4 & 1/2
DRAWN PWW
CHKD P?N

HOWDEN FANS
DIVISION OF JAMES HOWDEN AMERICA INC.

DRAWING NUMBER E-1-2777
REV. 0

REV | REVISION | BY



ITEM	BIL[illegible] MATERIAL [illegible]IPTION
1	BASE CASTING
2	OPERATING LEVER AND RING ASSEMBLY
3	BALL PIN
4	STOP PLATE
5	HOLDING RING
6	VANE TUBING AND ARM
7	LOWER BUSHING
8	UPPER BUSHING
9	INLET
10	VANE - (SEE FIGURE 8 I - 8)
11	VANE ROD
12	BUSHING FOR OPERATING LEVER AND RING ASSEMBLY
13	JAM NUT
14	NUT
15	VANE TAB
16	SHAFT SEAL RING - (SPLIT)

NOTE - VANE TABS, ITEM 15, ARE NOT SUPPLIED FOR ALL APPLICATIONS.

LARGE REACTOR FAN - WITHOUT CYCLONE

~~75 HP, 1800 RPM, 365T~~

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (766 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

⟹ SMALL REACTOR FAN - BOTH CASES

20 HP, 1800 RPM, 256T

- TEFC-XE-XT
- Class F Insulation (VPI Treatment)
- 3/60/460 Volts
- 1.0 Service Factor*
- Burndy Type Lugs
- 40°C Ambient
- Horizontal (Footmounted)
- Inertia (196 Lb.Ft.^{2})
- NEMA Design B
- Antifriction Bearings (Grease Lubricated)
- Oversize Main Conduit Box
- Space Heaters
- Auxiliary Conduit Box
- Routine Test and Report (Unwitnessed)
- Omega Paint System

CONTROLLER DESCRIPTION ALL SIZES

NEMA 1 Enclosure
M/N 2EC1100
FlexPak AC

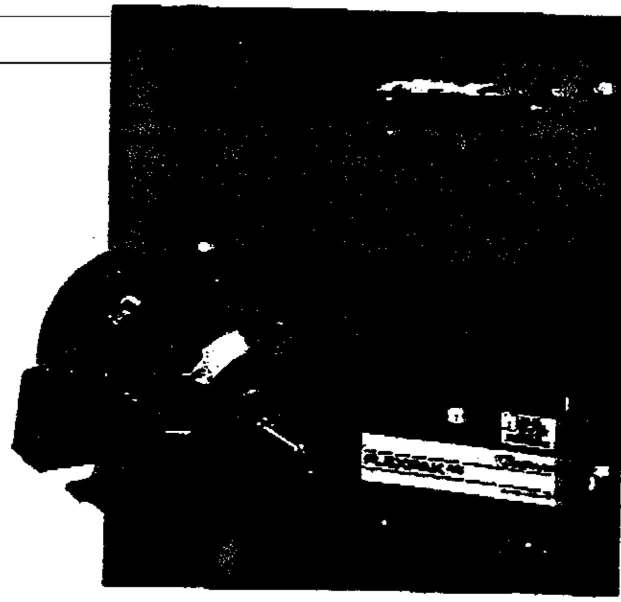
STANDARD FEATURES:

- ~~Constant torque operating speed range of 20:1(1)~~
- Output frequency from 1.4 to 60 hertz with option for 120 and 240 hertz
- Near-unity displacement power factor throughout the speed range
- Insensitive to incoming power phase sequence
- Input line reactors to permit operation on a distribution system with 50,000 amp fault current rating without an isolation transformer
- Robust power circuit design safeguards controller from damaging line transients
- Line-to-line and line-to-ground output short circuit protection
- AC input point contactor
- Single-board regulator utilizing LSI and surface-mount technology for increased reliability and reduced size
- Electronic reversing from any speed
- Start/stop and speed selection with coast-to-rest or ramp-to-rest on stop
- Standard adjustments:
  - Acceleration rate
  - Deceleration rate
  - Minimum hertz
  - Maximum hertz
  - Current limit
  - Volts per hertz
  - Low hertz voltage boost
  - Motor stability
  - Automatic voltage boost
- Automatic shutdown and first fault indication via LEDs under any of the following conditions:
  - Undervoltage
  - Overcurrent
  - Overvoltage
  - DC bus fault
  - Ground fault
  - Overtemperature
- Fault monitor card latches specific type and location of first fault condition sensed in the inverter power module
- Relay contacts for external interlocking of the drive "Running" and drive "Fault"
- Provisions for remote drive "Running" and drive "Ready" pilot lights
- 24 VDC isolated operator's control for safety and drive noise immunity
- 0-10 VDC, 4-20 mA and 0-20 mA speed reference input signal capability
- 0-10 VDC metering output signal for voltage, frequency and motor amps
- Slip compensation for 1% speed regulation full load to no load
- Heatsink and regulator thermostats

Continued on next page.

- Regulator board drive status LEDs - "Power Supply Okay" and "Ready to Run"
- Motor overload kit - installed
- Input disconnect kit - installed
- Remote reset kit - installed
- Door interlocks (1)
- Space heaters
- 115 VAC control circuit transformer
- Door mounted MAN/OFF/AUTO selector switch
- Speed pot
- Start pushbutton
- Stop pushbutton

FlexPak® A-C
A-C V*S
General-Purpose Drives



V*S® DRIVES

RELIANCE ELECTRIC

Application Specifications

3 Phase 460 VAC Input Controller Ratings

Input Amps RMS	Controller Input KVA
25.4	18.4
29.7	23.6
36.3	28.9
46.2	36.8
55.0	43.8
66.0	54.5
78.0	65.4
97.0	80.3
127.0	105
158.0	131
188.0	156
256	200
305	239
380	298
437	327

(1) NEMA B induction motor rating only. Application load and speed requirements must be considered to properly size the motor and controller. See Selection and Application of A-C V*S Drives Manual, D-9084, or contact your Reliance Electric Sales Office for assistance.

(2) In order to obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current.

(3) Load rating is 100% continuous, 150% for one minute.

(4) Motor may limit use of available controller frequency range.

Adjustments

Acceleration Time .... 1 to 35, 2 to 70, or 4 to 140 sec.

Deceleration Time .... 1 to 35, 2 to 70, or 4 to 140 sec.

Volts/Hertz .... Preset at 460V/60Hz or adjustable

Voltage Offset (RMS) .... 0 to 18V max

Minimum Frequency .... 2% to 80% of Maximum Frequency

Maximum Frequency .... 50% to 100% of Maximum Frequency

Automatic Torque Boost .... 0 to 100% of Rated Current

Service Conditions

Ambient Temperature Rating
- Chassis .... 0°C to 55°C (131°F)
- Enclosed Cabinet Drive .. 0°C to 40°C (104°F)

Elevation
- Chassis and Cabinet .... 3300 ft (1000m) above sea level
- Above 3300 ft .... Derate 3% for every 1000 ft up to 10,000 ft

Humidity
- Chassis and Cabinet .... 5 to 90% Non-condensing

A-C Line Voltage Variation ... ±10% of nominal 460 volts

A-C Line Frequency Variation ..... ±2 Hertz of nominal 60 Hz

Storage Temperature .... −25°C to 55°C (−13°F to 131°F)

Application Data

Service Factor .... 1.0 Continuous

Maximum Overload ..... 150% for one minute

Continuous Speed Range .... 1.4 to 60 Hz

Jumper Selectable Ranges (4) .. 2.8 to 120 Hz or 5.6 to 240 Hz

Maximum RMS Output Voltage ...... 460 VAC

Voltage Regulation .... ±1%

Frequency Regulation .... ±0.5%

Slip Compensation .... $^1/_3$ of motor normal slip over a 20:1 speed range with a 95% load change

Customer is responsible for meeting requirements of the National Electrical Code and all local codes

FlexPak A-C Controller Dimensions and Weights

Cabinet Mounting	Width	WT
WALL	26.1	110
WALL	26.1	165
FLOOR	33.6	600
FLOOR	84.0	1100

All dimensions in inches
All weights in pounds
Consult Reliance Electric for cabinet dimensions when adding bypass options.

General-Purpose PWM FlexPak A-C Drives
Three-Phase Input 15–350 HP on 460 VAC

■ Can Reduce Your Operating Cost

- Variable speed controls are proven to be more efficient than systems employing constant speed motors
- The more often your system operates at reduced speed, the greater the cost savings will be for your system, as well as wear and tear on components

■ Will Eliminate Inrush Currents

- Demand charges are reduced since variable speed drives prevent the motor from drawing locked rotor currents on start-up due to a controlled ramp acceleration
- Fan belt wear is reduced, yielding an increase in belt life because of "soft start" feature of the variable speed drive

■ Provide Performance Matched Controller and Motor

- Reliance Electric provides a "power matched" A-C drive package when both the A-C controller and A-C motor are supplied. With a "power matched" drive package, you will get a motor and controller that are designed to work together resulting in optimum drive performance.
- With FlexPak A-C you can specify a Reliance XE Duty Master Motor to optimize drive package efficiency, or you can choose the RPM A-C motor to help solve your constant torque, wide speed range application needs.

■ Utilize Proven Technology

- Reliance FlexPak A-C transistorized drives are more efficient than traditional mechanical control methods
- The FlexPak A-C Drive uses transistor technology and common regulation from 5 through 350 HP. This results in common regulator technology to simplify maintenance or training
- Full line-to-line and line-to-ground output short-circuit protection – starting and running
- Single-board regulator utilizes LSI and surface-mount technology for increased reliability and reduced size

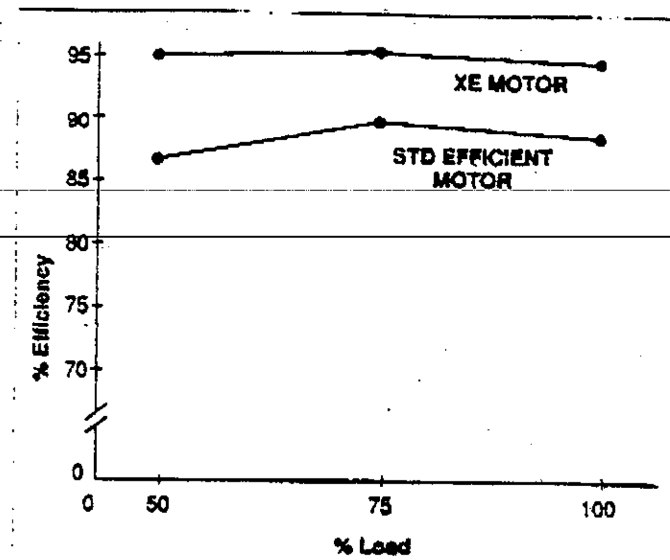
5–40 HP FlexPak A-C Drive and Duty Master XE Motor

Standard Features

- Constant-torque operating speed range of 20:1
- Slip compensation circuit to hold motor speed to 1% regardless of no load to full load fluctuations
- Output frequency from 0.6 to 60 Hertz with option for 120 and 240 Hertz
- Near-unity displacement power factor throughout the speed range
- Input line reactors to help eliminate the need for isolation transformers
- Line-to-line and line-to-ground output short circuit protection during both running and starting conditions
- A-C input power contactor
- Electronic reversing from any speed
- Start/Stop and speed selection with coast-to-rest or ramp-to-rest on stop
- Standard Adjustments:
  - Acceleration rate
  - Deceleration rate
  - Minimum hertz
  - Maximum hertz
  - Automatic Torque boost
  - Current limit
  - Volts per hertz
  - Low hertz voltage boost
  - Motor Stability
- Automatic shutdown and first fault indication via LEDs under any of the following conditions
  - Undervoltage
  - Overcurrent
  - Overvoltage
  - D-C bus fault
  - Ground fault
  - Overtemperature

Every Motor Is Not Energy Efficient

- Motor efficiency can be compared only when the same rules are applied to all motors under the same consideration. Reliance follows industry accepted IEEE 112 specifications
- Guaranteed minimum efficiencies on sinusoidal wave form should be used for comparisons
- Adjustable-frequency drives do not exactly replicate a smooth sinusoidal output waveform and therefore result in higher motor operating temperatures. To assure proper motor life this temperature must not exceed the motor insulation class or rating. Reliance Electric FlexPak A-C Controllers, RPM A-C motors and XE motors are performance-matched to assure proper drive performance and motor life
- Reliance Electric XE Duty Master Motors will improve drive system efficiency. Typical efficiency profiles for energy efficient and standard efficient motors are shown. Because of the excellent partial load efficiency of the Reliance Electric XE motors the efficiency remains nearly constant over most of the speed range.



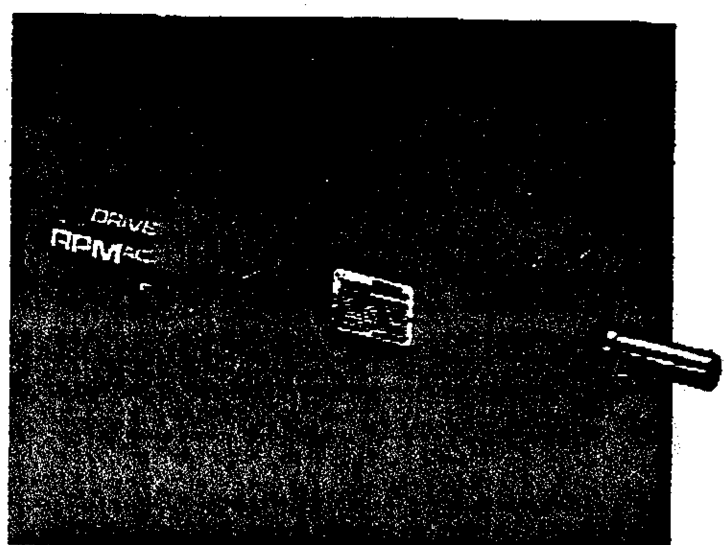
Motor Efficiency vs Load
Typical 100 HP

Every Motor Is Not Created Equal

Applications requiring constant torque or constant horsepower over a wide speed range are ideal candidates for RPM A-C. This exclusive motor from Reliance is designed solely to operate from variable frequency controller power. With this one objective in mind, performance can be optimized by discarding any unnecessary fixed speed motor design constraints. The RPM A-C motors' square laminated frame construction is patterned off the Reliance variable speed D-C motor taking advantage of the many years of D-C variable speed experience. This square laminated frame results in greater power density which yields a very compact motor – up to two sizes smaller in diameter than a standard NEMA induction motor.

Other RPM A-C advantages include:

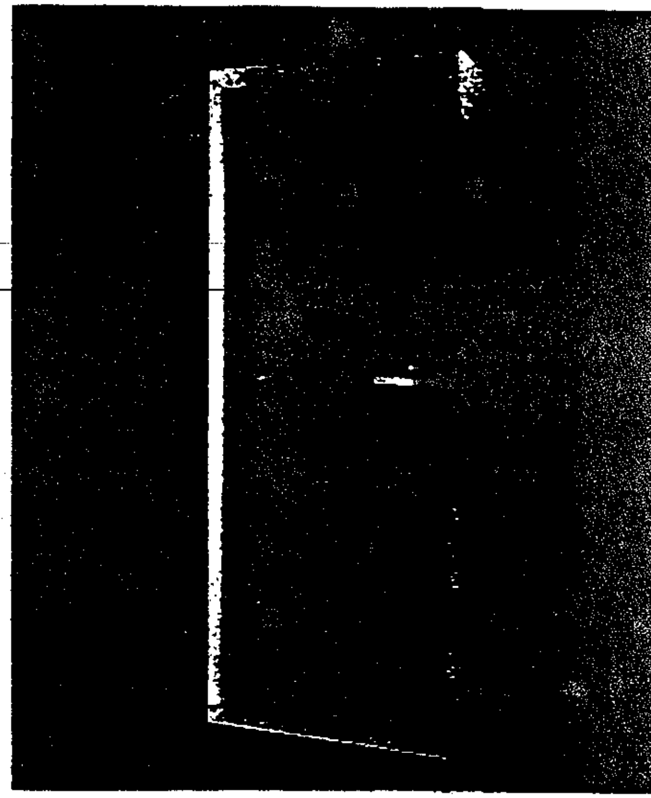
- Easily mounted blower option to assure proper motor cooling even down to zero speed
- Provisions for mounting a tachometer or feedback device
- Perpendicular feet to bearing location to result in smooth operation at all speeds
- Cooling ducts integral to motor laminations result in a totally enclosed motor that allows no free exchange of inside to outside air



RPM A-C

- Relay contacts for external interlocking of drive "Running" and drive "Fault"
- Provisions for remote drive "Running" and drive "Fault" pilot lights
- 24 VDC isolated operator's control for safety and drive noise immunity
- 0–10 VDC, 4–20 mA and 0–20 mA speed reference input signal capability
- 0–10 VDC metering output signals for voltage, frequency and amps
- Insensitive to incoming power-phase sequence
- Heatsink and regulator thermostats
- Regulator board drive status LEDs – "Power Supply Okay" and "Ready to Run"
- PWM switching technique to reduce the 5th and 7th motor current harmonics from 20% and 14%, respectively, of the fundamental to 6% each for reduced motor heating
- Chassis, NEMA 1 or NEMA 12 enclosures

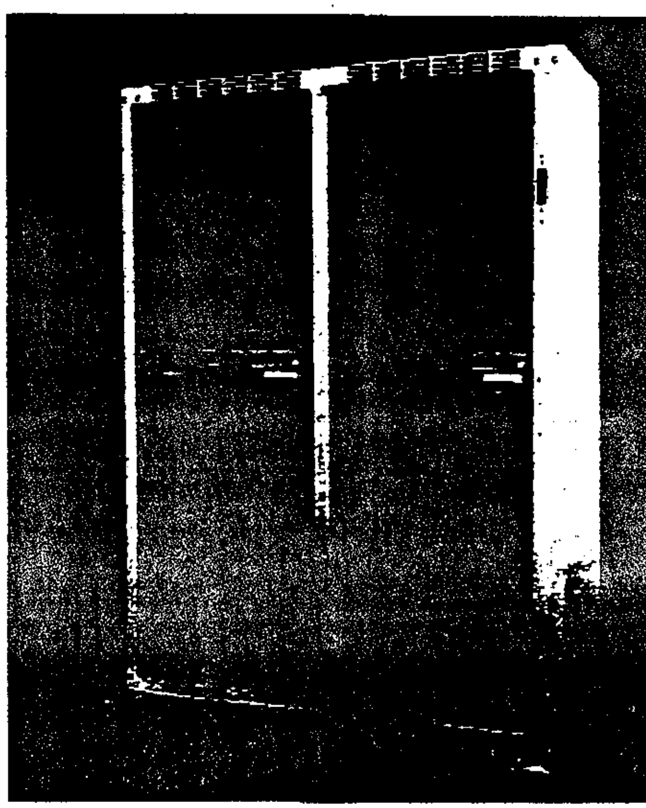
Note: Standard off-the-shelf, NEMA Design B and synchronous motors can be used with the PWM controller. However, application load and speed range must be considered in determining motor frame size, controller rating, and overall PWM A-C V*S drive performance.



150 HP FlexPak A-C Drive

Optional Features

- Hand-held, plug-in tester with digital readout to monitor 26 regulator signal points. The tester has a drive test/speed set potentiometer, forward/reverse switch and start/stop switch
- Metering, either for remote station or drive cabinet mounting:
  - Voltmeter .... 0 to 500 volt scale
  - Ammeter .... scale dependent on rating
  - Frequency/speed meter .... 0 to 66 Hz, 0 to 110% speed
- Dynamic braking kits
- Motor overload kits
- Input power disconnect kit
- Motor blower kit (for RPM A-C motors)
- Remote fault reset
- Other options available. Contact your Reliance Electric sales office or your Reliance Electric distributor for information.



350 HP FlexPak A-C Drive

Product Publications

Instruction Manuals

- 15–40 HP D2-3132
- 50–150 HP D2-3163
- 200–350 HP D2-3156

General-Purpose FlexPak A-C V*S Controller

Specifications

The adjustable frequency controller (AFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, A-C power for stepless motor control from 10% to 150% of base speed. The AFC shall be a PWM design as manufactured by Reliance Electric.

The AFC shall have the ability to operate on a distribution system up to 4000 KVA without the need for isolation transformers.

The AFC together with all options and modifications shall mount within standard NEMA 1 enclosure suitable for continuous operation at a maximum ambient temperature of 40°C. All high voltage components within enclosure shall be isolated with steel covers.

AFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:

1. 150% of the controller maximum sine wave current rating is exceeded
2. Output phase-to-phase and phase-to-ground short circuit condition: both starting and running conditions
3. High/low input line voltage
4. D-C bus fault
5. External fault. This protective circuit shall permit, by means of a terminal strip, wiring of remote NC safety contacts such as limit switches, motor overloads etc., to shut down the drive
6. Overtemperature

The following adjustments shall be available in the controller:

1. Maximum Frequency .... 50 to 100% of max. frequency
2. Minimum Frequency .... 2% to 80% of max. frequency
3. Acceleration .... 1 to 35, 2 to 70 or 4 to 140 sec.
4. Deceleration .... 1 to 35, 2 to 70 or 4 to 140 sec.
5. Volts/Hertz ..... **Factory** set at 460V/60 Hz or adjustable
6. Voltage Offset .... 0 to 18V max
7. Current Limit .. 150% max. controller rating or adjustable
8. Slip Compensation
9. Automatic Torque Boost .... 0–100% of rated current

Each controller shall include a diagnostic panel which shall provide a quick means for monitoring the different signals within the AFC for start-up and troubleshooting

Standard Features

- **Input Contactor** to provide a positive disconnect between the controller and all phases of input power. The contactor will be utilized to isolate the drive from the power line during "stop" and "fault" conditions
- **Input Line Reactor** to permit operation on a distribution system with 100,000 amp fault current rating
- **Isolated Process Control Interface** – shall enable the AFC to follow a 0–20, 4–20 mA; 0–10 VDC grounded or ungrounded signal from a process controller
- **Isolated Output Signals** – shall provide isolated 0–10 VDC output signals from the VFD proportional to load, voltage and frequency for metering.
- **Heatsink and Regulator Thermostats**

Options and Modifications

- **Input Disconnect** – shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be designed to mount inside the controller enclosure and include a mounting bracket and through-the-door interlocking handle with provisions for padlocking.
- **Motor Overload** – shall contain a thermal overload relay designed to protect one A-C motor.
- **Manual Bypass with Magnetic Contactors** – Manual bypass shall provide all the circuitry necessary to safely transfer the motor from the AFC to the power line, or from the line to the controller while the motor is at zero speed.

  Two motor contactors, electrically interlocked, shall be utilized: one contactor between the controller output and the motor, controlled by the controller regulator, and the other one is to be between the bypass power line and the motor providing across-the-line starting. Motor protection is to be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 115 VAC relay control logic, allowing common start-stop commands in the "controller" mode and the "bypass" mode shall also be included within this enclosure
- **Voltage, Current and Frequency Meters** – shall be provided to indicate the output voltage, output frequency and output current.

Reliance Electric / 24701 Euclid Avenue / Cleveland, Ohio 44117 / 216-266-7000

RELIANCE ELECTRIC

Printed in U.S.A.

D-2790-2

EXHIBIT 8.1-C

AMMONIA IN ASH

Design Calculations — Southern Company Services

Project	Prepared By	Date
DOE SCR PROJECT	ECH	8/1/91
Subject/Title	**Reviewed By**	**Date**
AMMONIA CONC ON FLYASH		
(REPLACES CALC # 91077-1)	**Calculation Number**	**Sheet** 1 of 3

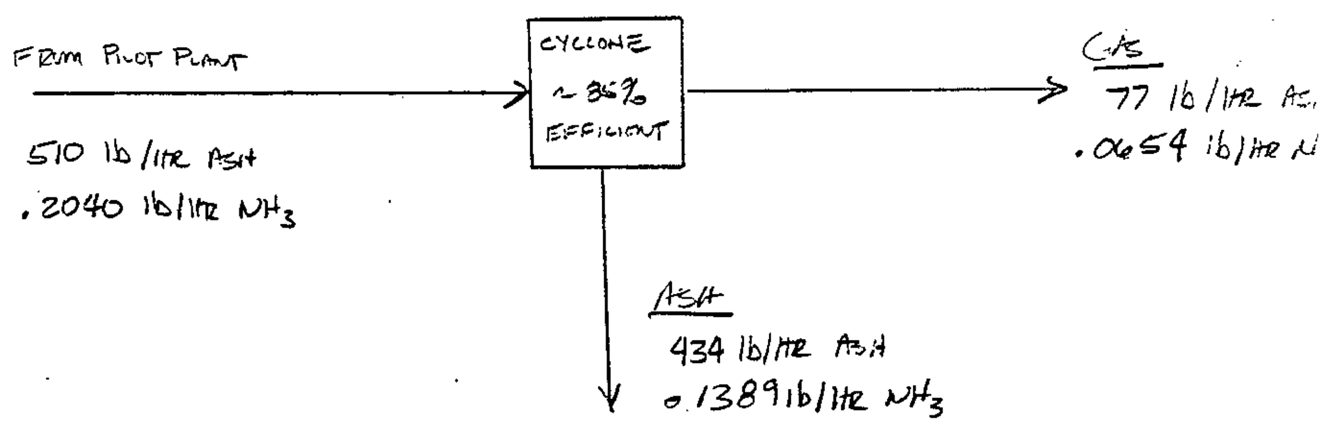
AMMONIA CONCENTRATION IN FLYASH (FROM PILOT PLANT ONLY)

ASSUME PILOT PLANT STEADY STATE OPERATION SHOWN ON MATERIAL BALANCE.

	AMMONIA #/HR	FLYASH #/HR
STREAM 47 (RXR A)	.06 lb/HR	150 lb/HR
STREAM 48 (RXR B)	.06 lb/HR	150 lb/HR
STREAM 49 (RXR C)	.06 lb/HR	150 lb/HR
STREAM 50 (RXR D)	.0048 lb/HR	12 lb/HR
STREAM 51 (RXR E)	.0048 lb/HR	12 lb/HR
STREAM 52 (RXR F)	.0048 lb/HR	12 lb/HR
STREAM 53 (RXR G)	.0048 lb/HR	12 lb/HR
STREAM 54 (RXR H)	.0048 lb/HR	12 lb/HR
	.2040 lb/HR	510 lb/HR

BASED ON PREVIOUS PILOT PLANT EXPERIENCE, ASSUME 80% OF AMMONIA SLIP IS ABSORBED ON FLYASH. ASSUME THE REMAINING 20% STICKS TO THE DUCT, CONDENSES TO FORM AMMONIUM BISULFATE OR GOES UP STACK.

ASSUME NH_3 ABSORPTION IS COMPLETE UPON GAS LEAVING CYCLONE.



Design Calculations Southern Company Services

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DOE SCR PROJECT	ECA	8/1/91
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AMMONIA CONC ON FLYASH		
	Calculation Number	**Sheet**
		2 of 3

ASH BALANCE

ASSUME 85% ASH REMOVAL IN CYCLONE

$$\frac{510 \text{ lb}}{\text{HR}} \Big| .85 = 434 \text{ lb/HR ASH REMOVED IN CYCLONE}$$

$$510 - 434 = 77 \text{ lb/HR ASH RETURNED TO UNIT 5}$$

AMMONIA BALANCE

20% OF NH_3 IS NOT ABSORBED AND PASSES THROUGH CYCLONE

$$\frac{.2040 \text{ lb}}{\text{HR}} \Big| .20 = .0408 \text{ lb/HR } NH_3 \text{ PASSES THROUGH.}$$

$$.2040 - .0408 = .1632 \text{ lb/HR } NH_3 \text{ ABSORBED ON ASH}$$

NH_3 ABSORBED ON ASH LEAVING IN GAS STREAM:

$$\frac{77 \text{ lb}}{\text{HR}} \Big| \frac{\text{HR}}{510 \text{ lb}} \Big| \frac{.1632 \text{ lb } NH_3}{\text{HR}} = .0246 \frac{\text{lb } NH_3}{\text{HR}}$$

NH_3 ABSORBED ON ASH LEAVING IN ASH STREAM:

$$\frac{434 \text{ lb}}{\text{HR}} \Big| \frac{\text{HR}}{510 \text{ lb}} \Big| \frac{.1632 \text{ lb } NH_3}{\text{HR}} = .1389 \frac{\text{lb } NH_3}{\text{HR}}$$

Design Calculations — Southern Company Services

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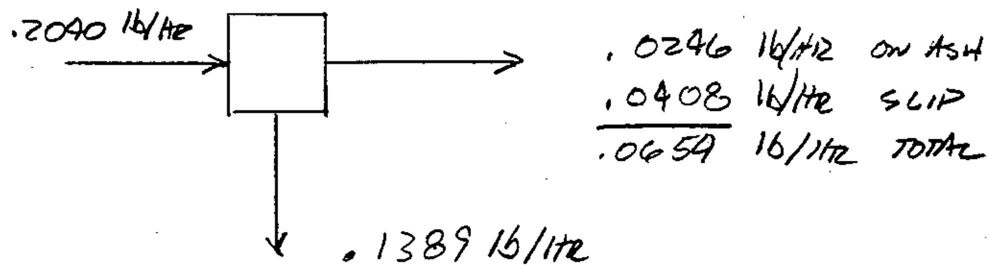
		3 of 3

∴ TOTAL AMMONIA BALANCE



TOTAL WT % NH_3 IN ASH STREAM

$$\frac{.1389\ \text{lb}}{\text{HR}} \left| \frac{\text{HR}}{434\ \text{lb}} \right| \frac{100\%}{} = .0320\% \quad \text{OR} \quad \underline{\underline{320\ \text{ppm}}} \leftarrow$$

FOR UNIT 5 TOTAL FLYASH

FROM SRI TEST DATA, FLYASH IS 5464 lb/HR

ASSUME OVERALL REMOVAL OF 99.6 %

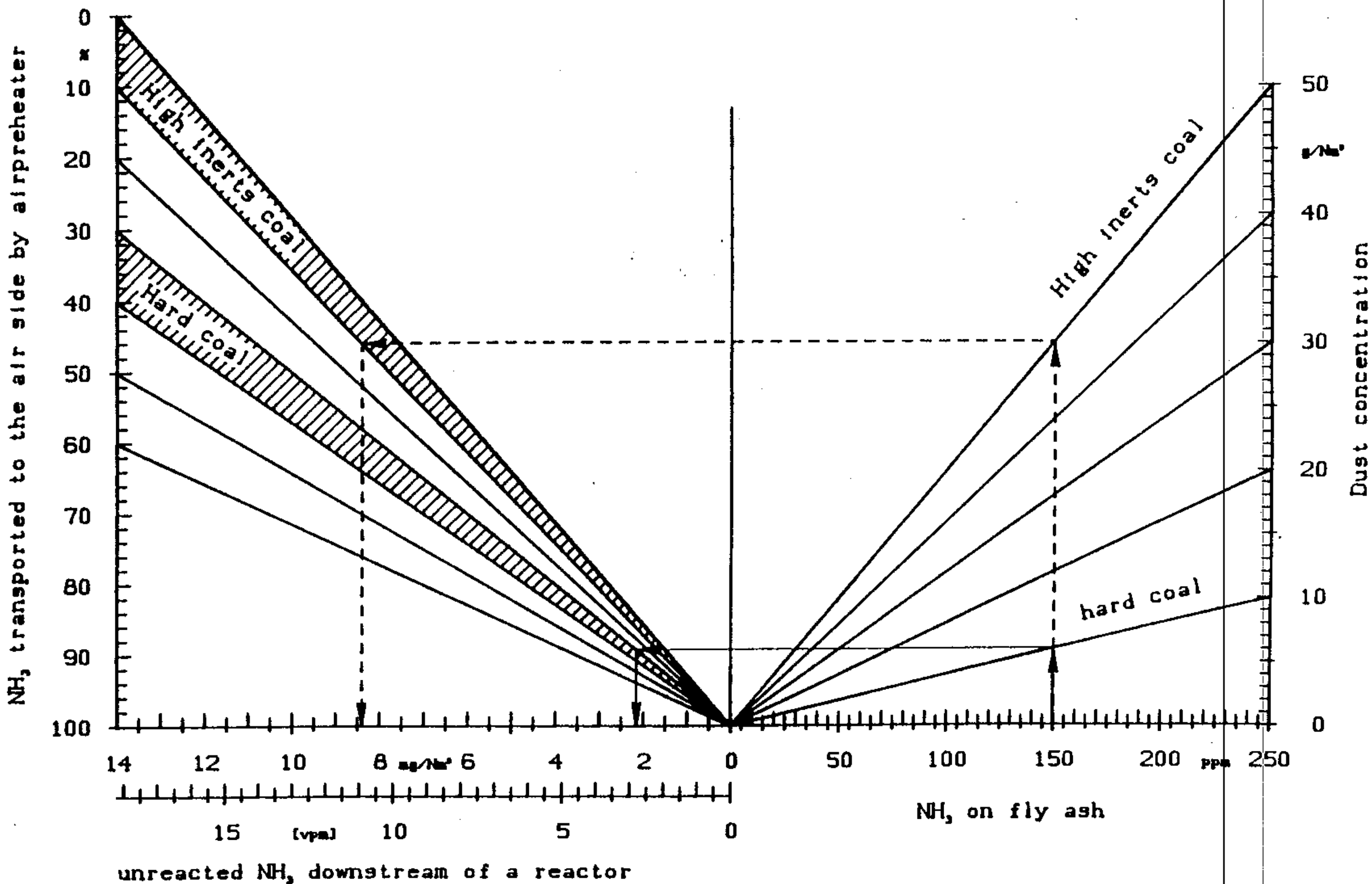
TOTAL ASH REMOVED: $\frac{5464\ \text{lb}}{\text{HR}} \left| \frac{.996}{} \right. = 5442\ \text{lb/HR}$

TOTAL AMMONIA FROM PILOT PLANT = .1389 lb/HR

TOTAL WT % NH_3 FOR UNIT 5 FLYASH

$$\frac{.1389\ \text{lb}}{\text{HR}} \left| \frac{\text{HR}}{5442\ \text{lb}} \right| \frac{100\%}{} = .0026\% \quad \text{OR} \quad \underline{\underline{26\ \text{ppm}}} \leftarrow$$

Form No. [illegible]



Nomogram for calculating ammonia slip

8.2 MAJOR EQUIPMENT

Table 8.2-1
Major Equipment Listing - Area 600

Area	Description	Equipment No.
600	Reactor train A cyclone	CYC-601A
600	Reactor train B cyclone	CYC-601B
600	Reactor train C cyclone	CYC-601C
600	Reactor train D cyclone	CYC-601D
600	Reactor train E cyclone	CYC-601E
600	Reactor train F cyclone	CYC-601F
600	Reactor train G cyclone	CYC-601G
600	Reactor train H cyclone	CYC-601H
600	Reactor train D flow control damper	FCD-601D
600	Reactor train E flow control damper	FCD-601E
600	Reactor train F flow control damper	FCD-601F
600	Reactor train G flow control damper	FCD-601G
600	Reactor train H flow control damper	FCD-601H
600	Reactor train J flow control damper	FCD-601J
600	Reactor train A ID fan	F-601A
600	Reactor train B ID fan	F-601B
600	Reactor train C ID fan	F-601C
600	ID fan for reactor trains D, E & F	F-602
600	ID fan for reactor trains G, H & J	F-603
600	Fan motor for F-601A	MTR-601A
600	Fan motor for F-601B	MTR-601B
600	Fan motor for F-601C	MTR-601C
600	Fan motor for F-602	MTR-602
600	Fan motor for F-603	MTR-603
600	Reactor train A isolation damper	DMP-601A
600	Reactor train B isolation damper	DMP-601B
600	Reactor train C isolation damper	DMP-601C
600	Reactor trains D, E & F isolation damper	DMP-602
600	Reactor trains G, H & J isolation damper	DMP-603

9.0 AREA 700: PILOT-PLANT AIR COMPRESSOR STATION

Area 700 is the air compression station that will supply pressurized air to the SCR pilot-plant. Compressed air will be utilized for instrumentation on a continuous basis and various services, such as sootblowing of the small SCR reactors, on a periodic basis.

9.1 DESCRIPTION

The compressed air station will be self-contained and separate from Plant Crist. This area includes the air filter, dryers, compressor, surge tanks/cylinders, pressure regulation for service and instrument air. ~~A leased air compressor is being considered for the duration of the project to minimize costs.~~

9.2 MAJOR EQUIPMENT

Table 9.2-1
Listing of Major Equipment in Area 700

Area	Description	Equipment No.
700	Air Filter	FIL-701
700	Air Dryer	DRY-701
700	Air Compressor	COM-701
700	Compressed Air Surge Cylinders	TNK-701
700	Pressure Regulator	PR-701
700	Pressure Relief Valve	PRV-701
700	Instrument Air Filter	FIL-702
700	Instrument Air Dryer	DRY-702
700	Instrument Air Pressure Regulator	PR-702

10.0 AREA 800: EXTRACTIVE GAS SAMPLING SYSTEM

Area 800 is the gas analysis system for measuring the flue gas components, particularly NO_x and O_2 at various points throughout the SCR pilot-plant. Figure 10.0-1 indicates the sampling locations designated by 800 numbers. There are two system alternatives being considered: dilution/extractive system, and a purely extractive gas sampling system. Both are described in this section.

10.1 DESCRIPTION

Since there are many similarities in the descriptions, the dilution/extractive system is described first. Then, major differences are highlighted to describe the purely extractive sampling system, beginning in Section 10.1.4 The concept for the gas analysis system is to use four analyzer banks, plus continuous in-situ O_2 measurement at each sample location. The four analyzer banks will consist of the following:

Analyzer Bank #1
- CO (0-500 PPM)
- CO_2 (0-20 %)
- SO_2 (0-2500 PPM)
- NO_x (0-1000 PPM)

Analyzer Bank #2
- NO_x (0-1000 PPM)

Analyzer Bank #3
- NO_x (0-250 PPM)

Analyzer Bank #4
- NO_x (0-100 PPM)

10.1.1 Sample and Conditioning Methods

O_2 Analysis

The in-situ analyzer will be utilized for all O_2 sample requirements. This method uses a heated zirconium oxide sensor mounted in the flue gas stream. It requires no external pumps or other mechanical hardware to acquire a sample. The calibration method will be remote/auto. The operator will have the option of initiating the calibration of each sample point. The calibration will be completed using two cal gases, one near the lower end of the measured span and one near the upper end of the measured span. The calibration procedure will be set up using a minimum amount of down time and a minimum amount of cal. gas. The output of each analyzer will be 4-20 ma continuous, with no requirement for time sharing.

CO, CO_2, SO_2, and NO_x Analysis

One method of sampling these gas components is the dilution/extractive system. This method, using dry air as the dilution medium, practically eliminates the problems associated with the transport and measurement of these gases as compared to other available methods. The sample will be filtered and cool when it reaches the analyzers.

The automated sampling system will consist of electrically actuated solenoid gas sampling valves that operate in sequence set by the main prototype plant's control logic. The assignments of sample streams to the different analyzer banks, and the sequence of sample points for shared analyzer banks, along with the layout of the gas sampling system, are shown in Figure 10.0. The concept of controlling the NH_3/NO_x ratio is that all the reactors can be continuously controlled, using the NO_x readings from analyzer bank 1. The control for a particular reactor train can then be fine tuned, based on the NO_x reading from analyzer bank 2. The sequencing for each analyzer bank will be such that each reactor will be sampled from top to bottom simultaneously.

In the automatic mode, the gas sampling valves will open as programmed for each desired sample sequence. Since this is a dilution extractive system, the sample line is always pressurized. Therefore, continuous venting between samples is the only requirement to have a ready sample for the subsequent cycle. Since dilution is with dry air and the actual sample quantity is very small, this should minimize the need for NH_3 or SO_3 traps.

Analyzer bank 3 will be used to continuously monitor a single sample point between the catalyst layers for a single reactor. There will be no sequential sampling between the catalyst layer for the pilot plant, due to the higher ammonia concentrations and increased potential for pluggage of the sample line from ammonium bisulfate formation. Manual connection of the sampling line to analyzer bank 3 will be required to change sampling points between the reactors or catalyst layers.

Calibration means will be provided to calibrate each probe using the required calibration gases. This will be a remote/auto system, which allows an ~~operator to initiate the sequence, if desired. A means will be provided for blowing back the probe, which can also be controlled by the operator.~~

10.1.2 <u>Gas Analyzers</u>

<u>NO_x Analyzers</u>

The NO_x analyzers will be of the chemiluminescent type, which senses radiation emitted when electrically excited NO_2 molecules are produced by reaction of NO with ozone. About 7 percent of the NO molecules are converted to excited NO_2 molecules. The resulting chemi-luminescence is monitored through an optical filter by a high sensitivity photomultiplier tube, and the output is linearly proportional to the initial NO concentration. Air from the ozonator is drawn from ambient supply, through an air dryer, and is mixed with the sample gas within the instrument's reaction chamber to generate the activated NO_2 molecule, which then decays emitting visible light. The following specifications will apply:

Accuracy	+/- 1% of full scale
Zero drift	+/- 1% of full scale in 24hrs.
Span drift	+/- 1% of full scale in 24hrs.
Repeatability	+/- 1% of full scale
Power requirements	115 VAC/60 Hz/1000 watts
Range	1000/dilution ratio (AB-1,AB-2) 250/dilution ratio (AB-3) 100/dilution ratio (AB-4)
Output	4-20 ma.
Sensitivity	0.5 PPM or better
Response to 90% of full scale 5 sec.	

O_2 Analyzers

The O_2 analyzers will be of the zirconium oxide in-situ type. Each analyzer will have a 4-20 ma linear output which will input to the SCR control system.

The following specifications will apply:

~~Maximum probe insertion diameter~~	~~2.5"~~
~~Probe insertion length~~	~~3' or 1 meter~~
Probe mounting	4"/150#/4 bolt SS flange
Flue gas temperature	750°F
Probe filter	ceramic
Probe material	316 SS
Power requirement	115 VAC/60 Hz/300 VA
Accuracy	+/- 2% of reading
Measurementrange	0-10% O_2

CO_2 Analyzers

The CO_2 analyzers will be of the single beam, non-despersive infrared-type. The following specifications apply:

Accuracy	+/- 1% of full scale
Noise	+/- 1% of full scale
Zero drift scale/week	+/- 2% of full
Span drift scale/week	+/- 2% of full
Response time to 90%	10 seconds
Range	0-20%/dilution ratio
Output	4-20 ma.
Power requirements	115 VAC/60 Hz./250 W.

CO Analyzer

The CO analyzer will be of a single beam, non-despersive, infrared-type, using a microflow detector to provide a reliable measurement of CO that is stable and interference free. It should have a high degree of sensitivity and selectivity. The following specifications apply:

Noise	Less than .5% of full scale
Zero drift	+/- 1% of full scale/day
~~Span drift~~	~~+/- 1% of full scale/day~~
~~Repeatability~~	~~+/- 1% of full scale~~
Response time to 90%	10 seconds
Range	0-500 PPM/dilution ratio
Output	4-20 ma.
Power requirements	115 VAC/60 Hz./250 W.

SO_2 Analyzer

The SO_2 analyzer will use the ultraviolet spectrophotometric process to measure the SO_2 concentration, by comparing absorption between a measured wavelength passing through the gas sample and a reference wavelength. The output will be linearly proportional to the concentration of the sample. The following specifications apply:

Noise	Less than .5% full scale
Accuracy	+/- 1% of full scale
Zero drift	+/- 1% of full scale/day
Span drift	+/- 1% of full scale/day
Linearity	2% of full scale
Range	0-2500PPM/dilution ratio
Output	4-20 ma.
Power requirements	115 VAC/60 Hz./200 W.

10.1.3 Non-Routine Gas Analysis

Manual gas sampling for non-routine analysis of NH_3, SO_3, HCl and N_2O gaseous component and particulates will be conducted periodically, using the sample ports at various points of the reactor train. The analysis of each gaseous component will be done using standard wet chemical methods described below.

$\underline{NH_3}$

Ammonia measurement will be critical to the success of the project, given the importance of slip NH_3 to SCR efficiency. Trace levels of NH_3 will be measured in the flue gas by bubbling a known amount of gas through a 0.1N sulfuric acid solution. The gas can be filtered to remove all solid particulate (including any solid $(NH_4)_2HSO_4$ or NH_4HSO_4) in order to measure only gas phase species, or it can be unfiltered to allow solids to enter the sampling solution for ammonia slip analysis. Ammonia values can then be determined in the solution by use of an ion-specific electrode. Alternately, NH_3 can be measured using colorimetric methods by analyzing liquid solutions resulting from contact of NH_3 and a phenol-hypochlorite solution. A continuous NH_3 monitor is currently under development, and may be included in the program at a later date. However, no funds are budgeted for this monitor.

$\underline{SO_3}$

Equally important to the NH_3 are the levels of SO_3 in the flue gas. SO_3 is generated by the combustion process and converted from SO_2 brought about by oxidation on the SCR catalyst. SO_3 is routinely measured via a controlled condensation technique, where SO_3 is condensed and absorbed in an 85 percent solution of isopropyl alcohol in water, and ti-trated using the Barium-Thorin titration method (EPA method 8).

<u>HCl</u>

This acid gas is measured by bubbling the gas through a basic solution (NaOH) to trap the chloride ion. Quantification of the chloride ion is accomplished by use of an ion-specific electrode, or by acidification and subsequent titration.

$\underline{N_2O}$

N_2O measurements from combustion sources are typically made by taking flask samples of flue gas, with subsequent analysis by gas chromatography (GC with an electron capture detector being the preferred method). Alternately, this component can be measured directly from a collected gaseous sample, by passing the sample through a flame ionization detector using a hot electron capture detector. A continuous N_2O analyzer is currently being developed, and it may be included in the program at a later date. Currently, no funds are budgeted for this analyzer.

10.1.3 Particulates

The particulate measurements will include total mass concentrations, particle size distributions and chemical analysis of the size fractionated particulate samples. These extensive measurements are being performed, in as much as one of the major deactivation mechanisms for SCR catalyst, when applied to high sulfur coal, is expected to be caused by particulates.

Total mass loading will be determined by the EPA test method 17. This method uses an extractive flue gas sampling technique, with an in-situ filter to capture the total quantity of flyash for a given volume of sampled gas. Samples are taken uniformly across duct cross sections to assure that flue gas flow distributions are accounted for in the extraction method. This method is a variation of EPA method 5, and is the preferred technique when sampling hot gas (i.e., 700°F).

Particle size distribution will be achieved through the use of cyclone samplers, when sampling high dust locations, and cascade impactors when sampling in low dust situations. Cyclones are preferred over impactors in high dust locations, since the large quantity of particles tend to quickly overload impactors. The use of cyclones also allows the collection of relatively large quantities of size segregated samples, suitable for chemical analysis by size category. Impactors are used in low dust situations, where sampled gas volumes must be high to collect sufficient sample quantity for analysis.

The method for chemical measurements of size fractionated samples will depend upon the quantity of sample available. When the sample quantity is not limited, the typical measurement technique is atomic absorption spectroscopy (AA), which is typically used to determine flyash compositions. When the quantity of sample is limited, either instrumental neutron activation analysis (INAA) or inductively coupled argon plasma (ICAP) atomic emission spectroscopy can be used. INAA is a non-destructive technique that can supply data on 40 or 50 elements. ICAP has a higher accuracy and precision, but requires sample dissolution and yields data on fewer elements.

10.1.4 Extractive Sampling

The preliminary concept for the extractive gas sampling system is to use four analyzer banks, as previously mentioned under section 10.1, Description. Insitu O_2 measurements may be used, as reported in the same section, with extractive methods for remaining samples, in which case the four analyzer banks are identical to the list of analyzer banks in section 10.1. However, the extractive method may also be used for O_2 measurement, in which case each of the four analyzer banks would have an O_2 analyzer, as follows:

Analyzer Bank No. 1

- CO Analyzer
- CO_2 Analyzer
- SO_2 Analyzer
- NOx Analyzer (0 to 1,000 ppm range)
- O_2 Analyzer

Analyzer Bank No. 2

- NOx Analyzer (1 to 1,000 ppm range)
- O_2 Analyzer

Analyzer Bank No. 3

- NOx Analyzer (0 to 250 ppm range)
- O_2 Analyzer

Analyzer Bank No. 4

- NOx Analyzer (0 to 100 ppm range)
- O_2 Analyzer

The automated sampling system would consist of electrically-activated solenoid gas sampling valves that operate in sequence set by the main prototype plant's control logic. The sampling locations designated by 800 numbers are shown in Figure 10.1-1, as well as the assignment of sample streams to the different analyzer banks and sequence of sample points for shared analyzer banks.

With the extractive system, sintered metal or ceramic filters will be used on the sample probes at each sampling location, to prevent particulates from entering the gas sampling lines. The particulate free gas will then go to a sample conditioning system to remove moisture before analyzing the gas constituents. The sampling trains for the analyzer banks 3 and 4 will require a NH_3 or SO_3 removal step prior to, or as part of, the sample conditioning step for prevention of deposition of ammonium sulfate compounds in the sampling lines.

With the exception of the above means of sampling, and the question of in-situ versus extractive O_2 measurements, descriptions are similar as those previously given under the dilution/extractive system, including the sections on CO, CO_2, SO_2, NOx analysis (See page 10.1-2), gas analyzers (Page 10.1-3), and non-routine gas analysis (Page 10.1-5). Even with extractive O_2 measurement, the O_2 analyzer specifications are similar to those already given.

10.1.5 Equipment List and Exhibits

The major equipment list for the extractive gas sampling area is given in Table 10.2-1. This will be better defined once a specific sampling system is chosen. Also attached are EXHIBITS 10.1-A, a vendor list for emission mointoring systems; 10.1-B, Holdor-Topsoe's gas sampling experience, and 10.1-C, Siemens recommendations on extractive gas sampling system.

AREA 800 - EXTRACTIVE GAS SAMPLING SYSTEM: SAMPLING SEQUENCE

TIME	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12	t13	t14	t15	t16	t17	t18
ANALYZER BANK # 1																		
CO	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
CO2	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
SO2	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
NOx	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
O2	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801	801
ANALYZER BANK # 2																		
NOx	802	803	804	805	806	807	808	809	810	802	803	804	805	806	807	808	809	810
O2	802	803	804	805	806	807	808	809	810	802	803	804	805	806	807	808	809	810
ANALYZER BANK # 3																		
NOx	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828
O2	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828
ANALYZER BANK # 4																		
NOx	829	830	831	832	833	834	835	836	837	838	839	840	832	833	834	835	836	837
O2	829	830	831	832	833	834	835	836	837	838	839	840	832	833	834	835	836	837

NOTE: Analyzer Bank # 1 NOx range: 0 to 1000 ppm
Analyzer Bank # 2 NOx range: 0 to 1000 ppm
Analyzer Bank # 3 NOx range: 0 to 250 ppm
Analyzer Bank # 4 NOx range: 0 to 100 ppm

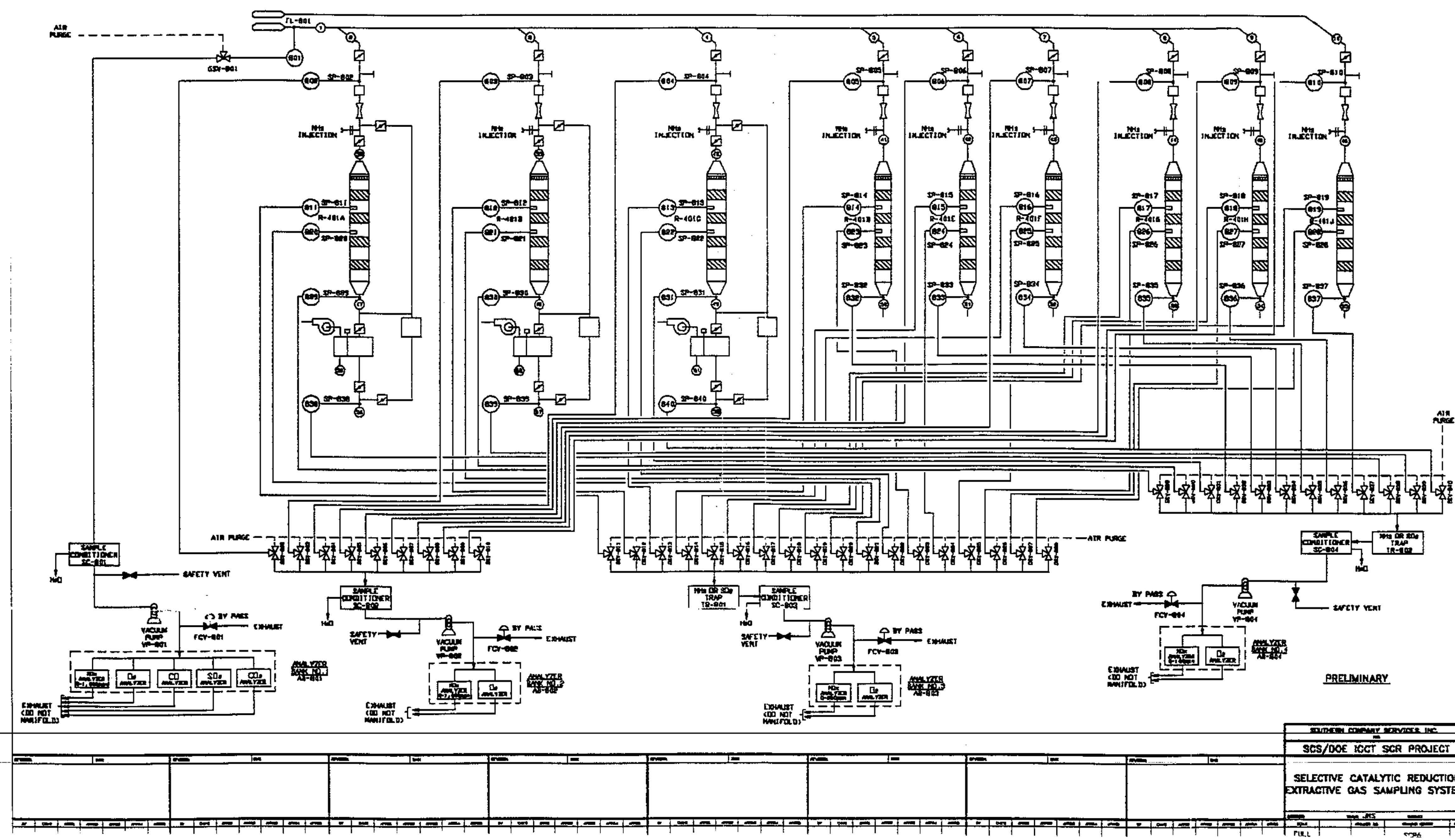


Figure 10.1-1.
Extractive gas sampling system.

EXHIBIT 10.1-A

CONTINUOUS EMISSION MONITORING SYSTEMS VENDOR LIST

PLANT CRIST SCR PROJECT

CONTINUOUS EMISSION MONITORING SYSTEMS

VENDOR LIST

1. Spectrum Systems Inc.
   3410 W. Nine Mile Road
   Pensacola, FL 32526-7808
   (904) 944-3392
   Mr. W. Clay Knapp
   Mr. Chuck W. McDonald
   Mr. Gordon Jones

2. KVB (Eastern Regional Office)
   123 Greenwich Avenue
   Greenwich, CT 06830
   (203) 661-4300
   (203) 661-0077
   Mr. Patrick Pappano

   KVB (Corporate Office)
   18006 Skylark Boulevard
   P.O. Box 19518
   Irvine, CA 92714
   (714) 250-6200

   KVB is represented locally by:

   As-Tech Engineering Company
   P.O. Box 921269
   Norcross, GA 30092-1269
   (404) 448-2341
   Mr. Douglas L. Stinson

3. United Sciences, Inc.
   5310 North Pioneer Road
   Gibsonia, PA 15044
   (414) 443-8610
   Mr. Dick Myers
   Mr. John Trainia

   United Sciences is represented locally by:

   Hile Controls of Alabama, Inc.
   P.O. Box 530866
   Birmingham, AL 35253
   (205) 995-0030
   Mr. Grady Andrews

SCR PROJECT CEM VENDOR LIST

4. Fossil Energy Research Corporation
   23342 C South Pointe
   Laguna Hills, CA 92653
   (714) 859-4466
   Mr. Larry Muzio

5. Enviroplan
   59 Main Street
   West Orange, N.J. 07052
   (201) 325-1544

   Enviroplan is represented locally by:

   George S. Edwards Co., Inc.
   Hwy. 31 South, Belcher Drive
   P.O. Box 175
   Pelham, AL 35124
   (205) 663-0707

6. Entropy Environmentalists Inc.
   P.O. Box 12291
   Research Triangle Park, NC 27709-2291
   (919) 781-3550
   Mr. Pete Watson

7. Measurement Controls Corporation
   214 Greenridge Drive
   Pensacola, FL 32534
   Mr. Bob James
   (904) 484-6802
   (Lear Siegler)

8. Land Combustion
   Suite 400
   6666 Harwin Drive
   Houston, TX 77036
   Mr. Dan Menniti
   (713) 977-5574

EXHIBIT 10.1-B

HALDOR TOPSOE GAS SAMPLING EXPERIENCE

Stigsnæsværket SCR Pilot Plant Visit

The Stigsnæsværket SCR pilot plant was built by Haldor-Topsoe and Burmeister & Wain Energy for Elkraft. SCS personnel visited the plant on October 12, 1990.

2. Ammonia measurements are based on titrations, which remove the Venturi flow measurement error.

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4. NH_3 measurement techniques are via the German standard VDI 3496 BLATT 1 (also JiS K0099-1983). However, in HT experience, the technique should be modified to include a glass frit to catch some of the NH_3 to prevent the loss of NH_3 as NH_4HSO_4 and NH_4Cl (Figure 2-3). The glass sampling train uses standard EPA impingers. However, they do not use sparger tubes in the bubblers since they let the particles come through into the impinger since the flyash can absorb appreciable NH_3. They let the gas sample impinge on the bottom of the bubbler from the nozzle of the inlet gas tubing. The NH_3 is absorbed in 0.4 N H_2SO_4 with the determination of ammonia using an ion specific electrode. (NH_3 sensitive probe by Orion). All exposed equipment is washed down and collected for measurement. Also, the quartz wool that was used to filter out fly ash in the sample probe was removed and fly ash was allowed to enter the bubbler train. Due to the time needed to collect an NH_3 sample and the importance of the data, it was recommended that two samples be collected simultaneously.

5. SO_2 and SO_3 are measured simultaneously using a measurement train similar to the one used for NH_3 (Figure 2-4). ASTM D3226-73T is used for measuring the SO_3 by controlled condensation. EPA Method 6 is used for measurement by absorption in 3-percent H_2O_2. The H_2SO_4 condenser is operated between 60 and 70°C through the use of a circulating water bath. Titration of SO_4 is with $Ba(ClO_4)_2$ using Thorin indicator. When testing for SO_3, the ammonia injection is limited. Quartz wool is used in the sample probe to collect flyash particles. Flyash specific trace metal analysis can be performed on the quartz wool wash.

6. HT is having trouble with SO_3 measurements under low operating temperatures (330 - 340°C) w/ high dust conditions. They have no problems at 380°C with or without high dust. However, they have seen an SO_3 relationship that shows the presence of a threshold (Figure 2-5), but they don't believe it. They think there is some condensation or SO_3 adsorption on flyash in filter probes or elsewhere under lower operating temperatures. They haven't yet solved the problems.

7. Separate sample probes are used for NH_3 and SO_2/SO_3 sampling. The probes are made out of pyrex glass and are enclosed in a metal casing to prevent breakage. The metal enclosure is connected to a flange to get a fairly tight sampling point (Figure 2-6). As shown, it is made of a glass tubing, with four inlet ports, that appeared to be about 0.25 inch in diameter.

17. An ammonia trap utilizing oxalic acid is used to remove the ammonia from a gas sample. The oxalic acid is in a solid crystal form and housed in a bomb type apparatus. There is a small microfilter downstream of the trap to catch any particulate that may slip out. A three-way valve is used in order to bypass the trap during the air purge blowback cycle. All components of the ammonia trap are housed in a thermally-controlled box hanging on the flange of the sample port. (See Section 2.1 - Photo 10.) Temperature is controlled between the water dew point, approximately 125°F, and the ammonium oxalate decomposition temperature.

18. The extractive gas sampling system utilizes heat traced Teflon lines (180°C) supplied by Technical Heaters, Inc. 818-361-7185. The length of the prefabricated, heat-traced sample line is approximately 50 meters. HT keeps two (of 4 lines) connected to the inlet at all times (for inlet NO_x concentration for the NH_3 control system and for inlet NO_x data logging to the data logger.) The other two lines are typically used for intermediate layer measurements, but can be moved to other locations if so desired. (The lines are moved often.)

19. A flange heater is used on the sample probe connection to the sample line to prevent a cold spot immediately after sampling the gas. Flange heaters are commercially available. HT made their own by cutting an aluminum block to size, bolting it to the flange, and inserting several heater elements through the block.

20. The sample probes ahead of the reactor are sintered metal, stainless steel probes enclosed in a concentric shield with holes drilled through it (Figure 2-7). Sample probes for intermediate catalyst levels are ceramic. It was discovered that the sintered metal probes were catalytically active.

21. Air blowback on the gas sampling system is done every second hour using manual control. During the sampling period, it takes approximately 1.5 minutes to equilibrate and 2 minutes to sample. (The equilibrium time of 1.5 minutes is reduced due to a pre-purge cycle which leads the sampling cycle. The pre purge is accomplished using an air jet eductor.)

22. The gas sampling system (Figure 2-7) is a wet system for NO_x and dry system for O_2. The wet system was chosen to allow the ammonia control to be calculated using the flue gas (wet) flow signal measured by the venturi times the wet NO_x concentration. Otherwise, the moisture content of the flue gas must be measured. NO_2 absorption in water must also be considered. HT recommends having a spare vacuum pump and filters for the gas analyzers.

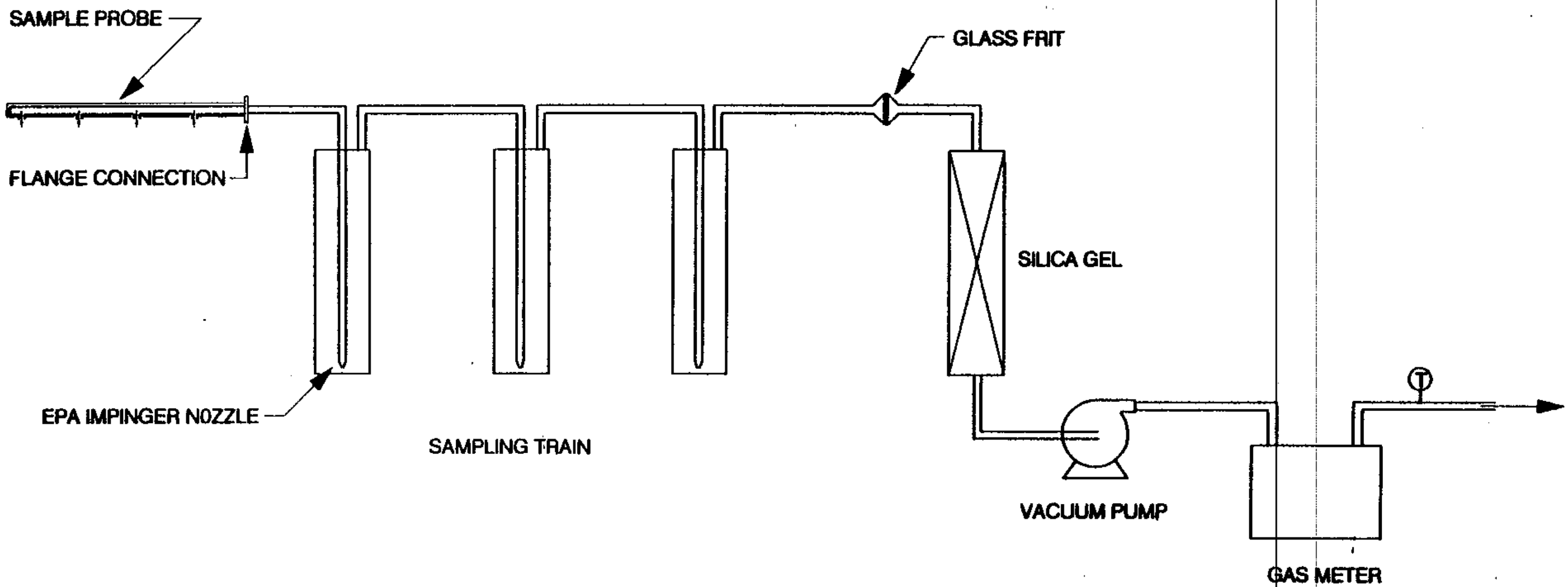


Figure 2-3 SCS/DOE Selective Catalytic Reduction Project Ammonia Sampling Train

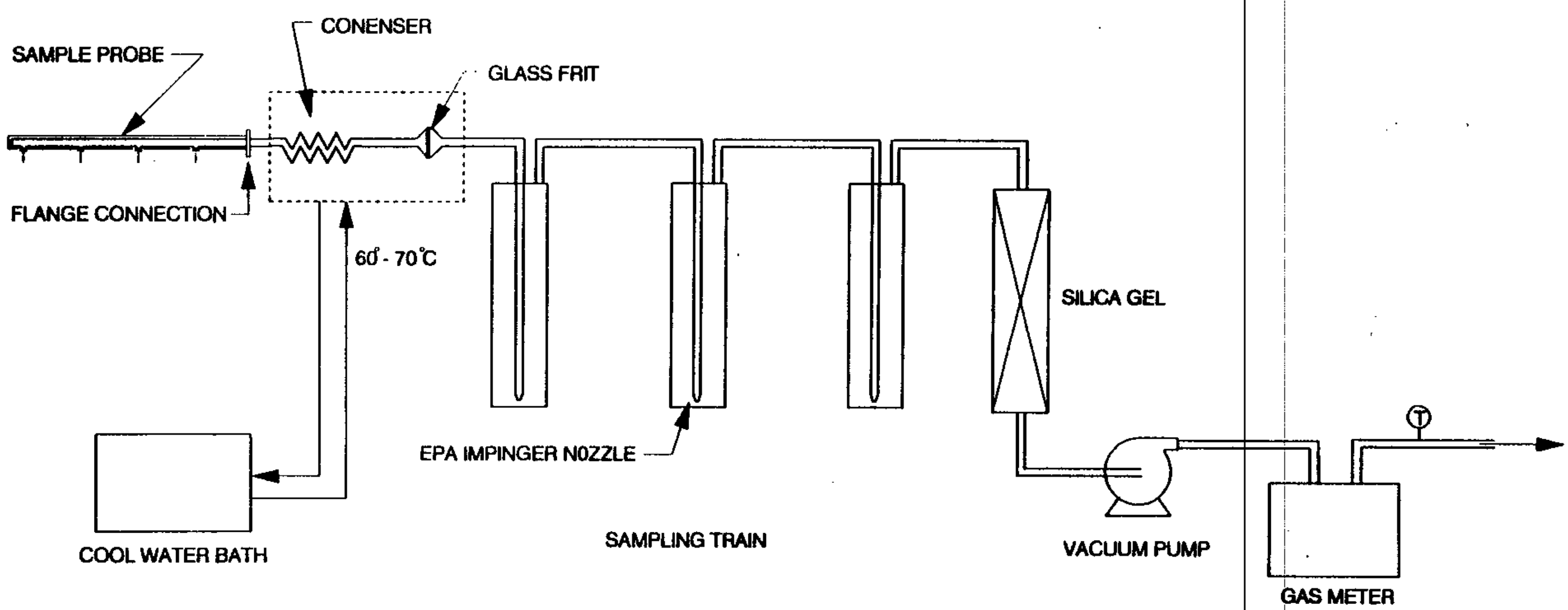


Figure 2-4 SCS/DOE Selective Catalytic Reduction Project SO3/SO2 Sampling Train

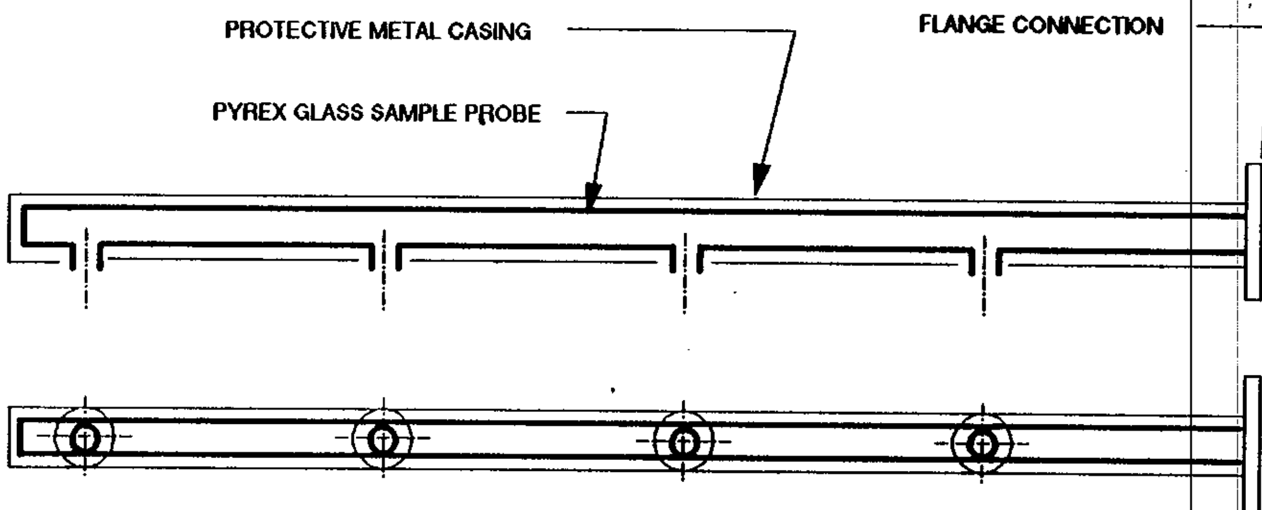


Figure 2-6 SCS/DOE Selective Catalytic Reduction Project Haldor Topsoe Gas Sampling Probe

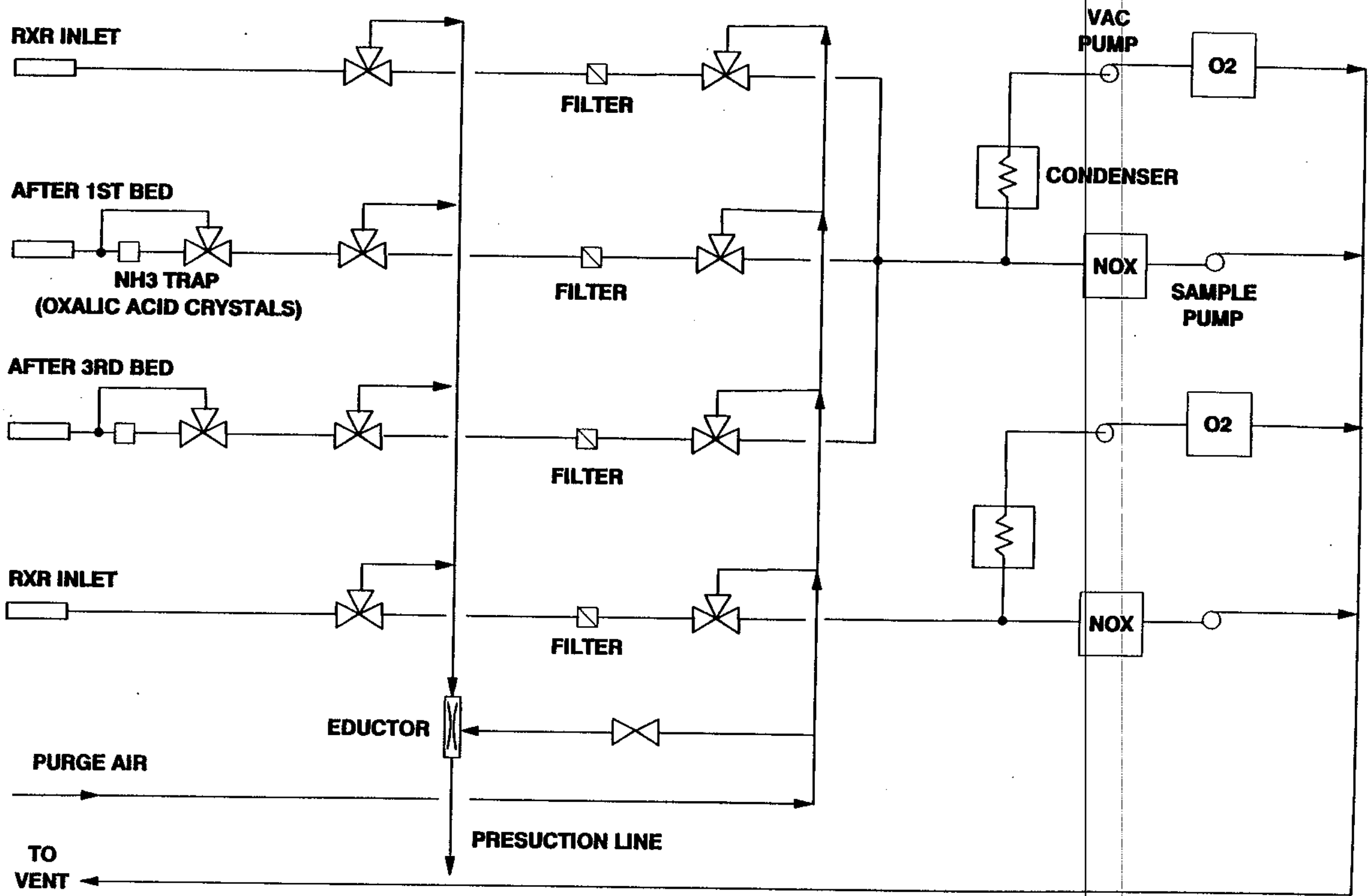


Figure 2-7 Haldor-Topsoe Pilot Plant Extractive Gas Sampling System

EXHIBIT 10.1-C

SIEMENS RECOMMENDATIONS ON EXTRACTIVE GAS SAMPLING SYSTEM

Extractive gas system

- Siemens recommends removing the probe from after the second catalyst layer and putting it ahead of the first catalyst layer.

- ~~Siemens uses (and offers commercially) NH_3 and SO_3 traps.~~

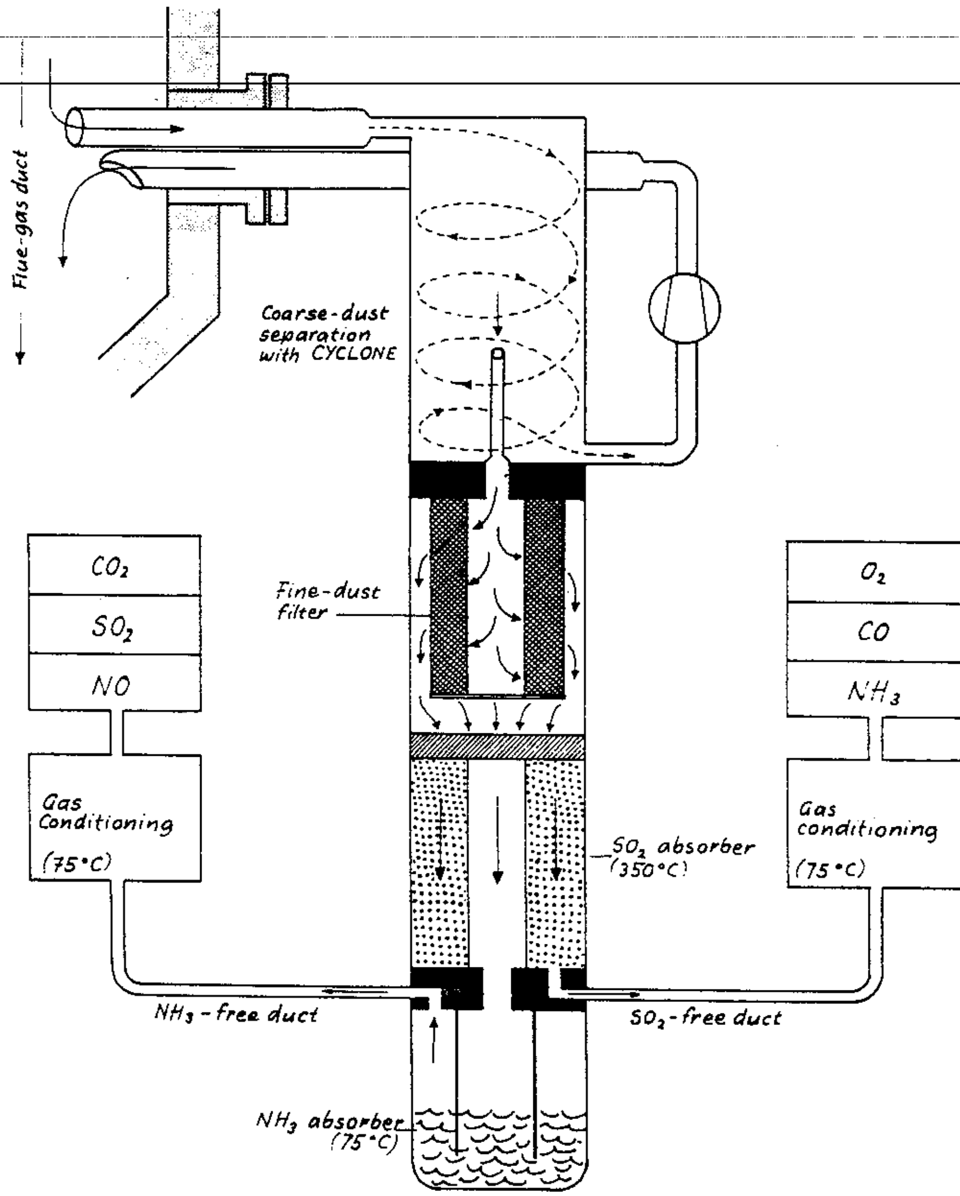
- Possible elimination of NO_x analyzers at reactors inlet and control on the one analyzer on the main header. May leave capability to check inlet to NO_x to each reactor periodically and compare to main pilot plant duct NO_x. (This assumes equal NO_x to each reactor.)

- Siemens recommended a continuous suction of sample gas (dumping those that are not needed) with valving in/out of sample lines as needed for sample measurement.

- Siemens acknowledged catalytic activity of sintered metal sample probes but due to cost of ceramic probes, metal probes are used anyway.

- Multiple calibration points for span gas are included.

SIEMENS



Schematic of SIEMENS/KWU DeNOx flue-gas probe with integrated dust filters, heated gas paths and selective absorption of NH_3 and SO_x

SIEMENS

Technical data

Connection to power plant

A65 flange to DIN 2573:

- ☐ flange diameter 160 mm
- ☐ bolt circle diameter 130 mm
- ☐ bore 14 mm
- ☐ 4 holes at angles of 45° to the vertical

NH_3 absorber

- ☐ granulate
- ☐ operating temperature 50°C
- ☐ replacement after about one week of service downstream of first layer of catalytic converter elements
- ☐ replacement after about three weeks of service downstream of DENOX reactors
- ☐ volume required: 400 ml

SO_x absorber

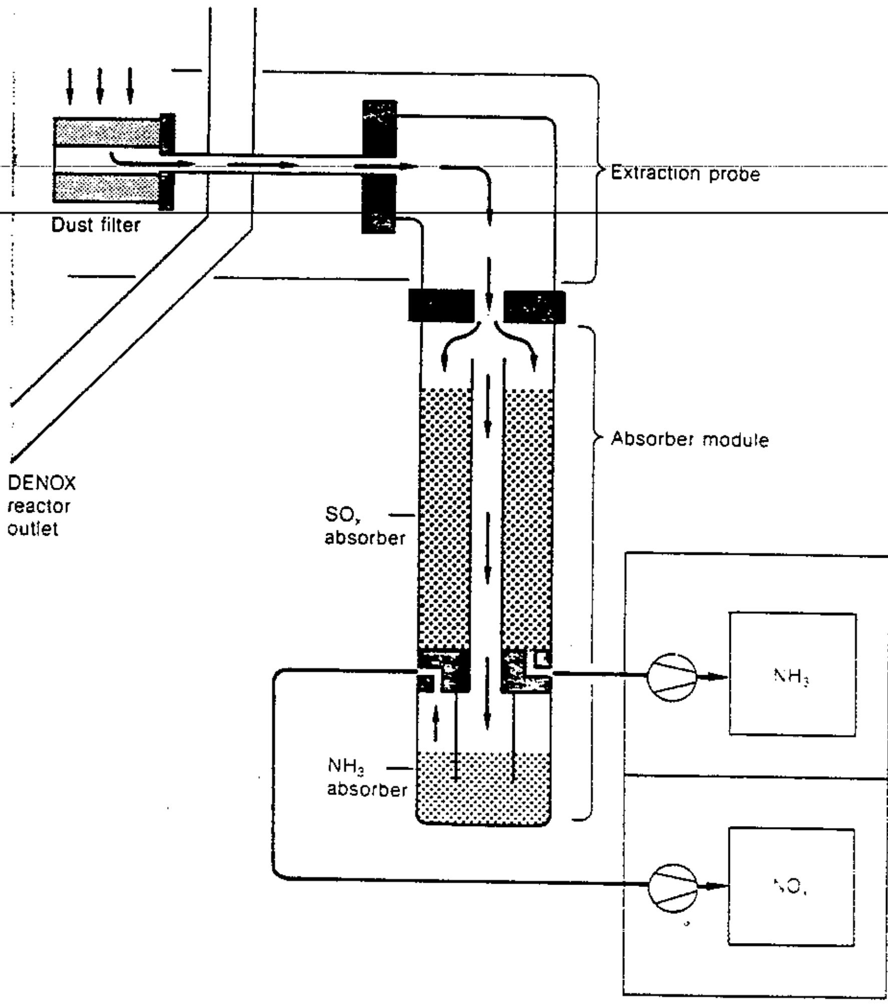
- ☐ granulate
- ☐ replacement after about two weeks of service
- ☐ volume required: 800 ml

Electrical enclosure

- ☐ IP30 (screen protection)
- ☐ IP43 (dust and splashproof)

Heating

Heaters are provided with PT 100 temperature sensors and draw power (220 V AC, 16 A fuse) through temperature controllers.



DENOX flue gas probe for continous monitoring of NOx and NH_3

10.2 MAJOR EQUIPMENT

Table 10.2-1 (Page 1 of 3)
Listing of Major Equipment in Area 800

Area	Description	Equipment No.
800	Analyzer Bank No. 1	AB-801
800	Analyzer Bank No. 2	AB-802
800	Analyzer Bank No. 3	AB-803
800	Analyzer Bank No. 4	AB-804
800	Bypass flow control valve for AB-801	FCV-801
800	Bypass flow control valve for AB-802	FCV-802
800	Bypass flow control valve for AB-803	FCV-803
800	Bypass flow control valve for AB-804	FCV-804
800	Gas sampling valve for point 801	GSV-801
800	Gas sampling valve for point 802	GSV-802
800	Gas sampling valve for point 803	GSV-803
800	Gas sampling valve for point 804	GSV-804
800	Gas sampling valve for point 805	GSV-805
800	Gas sampling valve for point 806	GSV-806
800	Gas sampling valve for point 807	GSV-807
800	Gas sampling valve for point 808	GSV-808
800	Gas sampling valve for point 809	GSV-809
800	Gas sampling valve for point 810	GSV-810
800	Gas sampling valve for point 811	GSV-811
800	Gas sampling valve for point 812	GSV-811
800	Gas sampling valve for point 813	GSV-811
800	Gas sampling valve for point 814	GSV-811
800	Gas sampling valve for point 815	GSV-811
800	Gas sampling valve for point 816	GSV-811
800	Gas sampling valve for point 817	GSV-811
800	Gas sampling valve for point 818	GSV-811
800	Gas sampling valve for point 819	GSV-811
800	Gas sampling valve for point 820	GSV-811
800	Gas sampling valve for point 821	GSV-811
800	Gas sampling valve for point 822	GSV-811
800	Gas sampling valve for point 823	GSV-811
800	Gas sampling valve for point 824	GSV-811
800	Gas sampling valve for point 825	GSV-811
800	Gas sampling valve for point 826	GSV-811
800	Gas sampling valve for point 827	GSV-811
800	Gas sampling valve for point 828	GSV-811
800	Gas sampling valve for point 829	GSV-829
800	Gas sampling valve for point 830	GSV-830
800	Gas sampling valve for point 831	GSV-831
800	Gas sampling valve for point 832	GSV-832
800	Gas sampling valve for point 833	GSV-833
800	Gas sampling valve for point 834	GSV-834
800	Gas sampling valve for point 835	GSV-835
800	Gas sampling valve for point 836	GSV-836
800	Gas sampling valve for point 837	GSV-837

800	Gas sampling valve for point 838	GSV-838
800	Gas sampling valve for point 839	GSV-839
800	Gas sampling valve for point 840	GSV-840
800	Sample conditioner for AB-801	SC-801
800	Sample conditioner for AB-802	SC-802
800	Sample conditioner for AB-803	SC-803
800	Sample conditioner for AB-804	SC-804
800	Sample probe for point 801	SP-801
800	Sample probe for point 802	SP-802
800	Sample probe for point 803	SP-803
800	Sample probe for point 804	SP-804
800	Sample probe for point 805	SP-805
800	Sample probe for point 806	SP-806
800	Sample probe for point 807	SP-807
800	Sample probe for point 808	SP-808
800	Sample probe for point 809	SP-809
800	Sample probe for point 810	SP-810
800	Sample probe for point 811	SP-811
800	Sample probe for point 812	SP-812
800	Sample probe for point 813	SP-813
800	Sample probe for point 814	SP-814
800	Sample probe for point 815	SP-815
800	Sample probe for point 816	SP-816
800	Sample probe for point 817	SP-817
800	Sample probe for point 818	SP-818
800	Sample probe for point 819	SP-819
800	Sample probe for point 820	SP-820
800	Sample probe for point 821	SP-821
800	Sample probe for point 822	SP-822
800	Sample probe for point 823	SP-823
800	Sample probe for point 824	SP-824
800	Sample probe for point 825	SP-825
800	Sample probe for point 826	SP-826
800	Sample probe for point 827	SP-827
800	Sample probe for point 828	SP-828
800	Sample probe for point 829	SP-829
800	Sample probe for point 830	SP-830
800	Sample probe for point 831	SP-831
800	Sample probe for point 832	SP-832
800	Sample probe for point 833	SP-833
800	Sample probe for point 834	SP-834
800	Sample probe for point 835	SP-835
800	Sample probe for point 836	SP-836
800	Sample probe for point 837	SP-837
800	Sample probe for point 838	SP-838
800	Sample probe for point 839	SP-839
800	Sample probe for point 840	SP-840
800	Sample probe for point 841	SP-841
800	NH3 or SO3 trap for AB-803	TR-801
800	NH3 or SO3 trap for AB-804	TR-802

800	Vacuum pump for AB-801	VP-801
800	Vacuum pump for AB-802	VP-802
800	Vacuum pump for AB-803	VP-803
800	Vacuum pump for AB-804	VP-804

11.0 AREA 900: CONTROL ROOM

Area 900 is the control for the SCR pilot-plant. Information is provided in this section on the layout of the control room, control room equipment, and design of operator interfaces.

Drawings of the layout of equipment are provided in EXHIBIT 11.1-A and a listing of major equipment in Table 11.2-1

11.1 DESCRIPTION

Layout of Control Room

Figure 11.1-1 is a drawing of the control room layout. Drawings of the layout of equipment are provided in EXHIBIT 11.1-A.

Control Room Equipment

A listing of major equipment in Area 900 is provided in Table 11.2-1.

Control Panel

The control panel should be a CRT-based system with sufficient duplicated analog controls to shutdown the pilot-plant in case the CRT-based system is rendered inoperable.

Instrument abbreviations are found in Figure 11.1-2.

11.1.1 Control System Description

Instrument and Control System Description

Area 100

The flue gas to the distribution header will be measured by temperature element and sent to the distributed control system (DCS) to position flow control damper. This will introduce hotter flue gas from the boiler-superheater region and raise the temperature of the flue gas entering the SCR system.

INSTRUMENT IDENTIFICATION
TABLE 1

	FIRST - LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIBLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	CLOSE
D	DIFFERENTIAL				
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS. VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		INSERTED
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE	MOMENTARY			MIDDLE INTERMEDIATE
N	FLAME		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		RETRACTED
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X-AXIS	NOZZLE	TRANSFORMER	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y-AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z-AXIS		DRIVER, ACTUATOR UNCLASSIFIED FINAL CONTROL ELEMENT	

Figure 11.1-2. Instrument abbreviations for SCR project.

Area 200

Each reactor will have an isolation damper, controlled by the DCS, between the flue gas extraction header and its inlet. Downstream of the isolation damper is an air purge line connection which has a locally controlled damper. This damper is opened for startup and shutdown.

An electric heater, with staged resistance elements, is on each reactor inlet to control the flue gas temperature. A temperature element, located downstream of the reactor flow straightening grid, will input to the DCS for heater control.

Downstream of the heater is the venturi type flow element for measuring the flue gas flow to the reactor. A venturi was chosen for the gas flow measurement because of the experience of similar installations and the historical data available for standard dimension venturis. A flow straightener may be used upstream of the venturi inlet to eliminate swirl. This will be determined by the supplier based on this specific installation. The low and high pressure taps will be provided with a piezometer ring or averaging annulus to increase accuracy. The rings will have an automatic air blowback system to clear the taps of fly ash periodically. The venturi differential pressure, inlet pressure, and inlet temperature will input to the DCS to produce the flue gas mass flow measurement. The gas flow measurement will be compared to the desired setpoint and an output will be sent from the DCS to the variable frequency drive controls on the reactor ID fan. The ID fan speed will be adjusted to control flue gas flow on the large reactors and to some degree on the small reactors. On the small reactors, a damper on the outlet of the reactor will be used in conjunction with the ID fan speed control to regulate gas flow.

Area 300

The ammonia NH_3 delivery system contains two storage tanks. Each tank has two pressure safety valves which are piped to the vent tank system. Each tank also has a local pressure indicator and a level indicator, which is used during tank filling. An ammonia vaporizer, or electric heater, for each tank is controlled by a pressure switch and temperature switch on its associated tank. The discharge from each tank has a shutoff valve to allow the ammonia supply tank to be selected for service.

The discharge from the selected storage tank passes through a flow control valve and into the ammonia accumulator tank. The flow control valve is regulated to maintain a constant pressure in the accumulator tank. Redundant pressure transmitters are used to measure this pressure.

The accumulator tank has a local pressure indicator and temperature indicator. A temperature switch located on the accumulator controls the heat tracing surrounding the tank to keep the temperature near 135°F. The tank also has a pressure safety valve which is piped to the vent tank system.

The vent tank system consists of piping to a bubbler tank filled with water, a bubbler tank vent, and an overflow pipe. Should an ammonia pressure safety valve open, a flow switch would detect this and sound an alarm. The ammonia would pass through the water and resulting gas vented to atmosphere.

The ammonia injection control for each reactor consists of a shutoff valve, flow element(s), and flow control valve(s). The flow element and control valve may consist of one pair for low flow and one pair for high flow. This would depend on the degree of measuring and controlling accuracy available from suppliers. The ammonia flow will be controlled based on the gas flow, NOx measurement, and the NH3/NOx ratio.

The ammonia is mixed with dilution air before going to the ammonia injection nozzle. A flow switch monitors dilution air flow. A temperature element measures the ammonia/air mix temperature and regulates an air flow damper accordingly. A local pressure indicator is installed prior to the injection nozzle.

Area 400

The large reactors have a bypass line around each reactor with shutoff dampers before the reactor inlet and in the bypass line. These dampers are used to control the route of the flue gas. All of the reactors have temperature and differential pressure measuring devices from the inlet, through all the catalyst beds, and at the outlet. These will be used to evaluate conditions throughout the reactor.

Retractable sootblowers are located on the large reactors only, upstream of each catalyst bed. These will be operated on an automatic timed basis, high differential pressure detection, or operator initiated.

Area 500

This area consists of the air preheaters and bypass heat exchangers on the large reactors only. The flue gas can be routed through the air preheaters or bypassed through the heat exchangers by operation of shutoff dampers.

The rotary air preheaters on trains A and B have temperature elements and differential pressure transmitters to monitor the conditions of the preheater. Flow elements on the gas and air side will also be monitored. The temperatures and flows will be displayed in the Unit 5 and pilot plant control rooms.

The differential pressure from the gas inlet to the air outlet will be controlled at approximately one inch water gauge. This is to minimize the amount of flue gas leaking through the rotary air preheater seals to the gas side. This differential will be controlled by manipulation of the hot air fan inlet dampers. The rotary air preheaters' speed of rotation will be controlled by variable frequency motors.

The rotary air preheaters will have a stationary sootblower on the inlet and outlet of the gas side. These will be operated on a timed basis, through a high differential pressure detection, or operator initiated.

The heat pipe will have ten retractable sootblowers along the length of the gas side. These will be operated on a timed basis, through high differential pressure detection, or operator initiated.

The heat exchanger is used to reduce the temperature of the flue gas when the air preheater is bypassed. The differential pressure across the heat exchanger is monitored for plugging. The cooling water for the heat exchanger is monitored on the supply side and is measured on the discharge side to control the cooling water flow.

Area 600

This area runs from the inlet of the cyclones to the inlet of the existing cold-side ESP. Each cyclone has a differential pressure measurement from gas inlet to outlet to detect blocking. The cyclone ash will discharge through the bottom via a rotating valve. A blower will then convey the ash to the tie with the existing Unit 5 fly ash system.

The large reactors' flue gas flow is controlled by adjusting the speed of the associated ID fan. The flue gas is measured by the venturi in Area 200, the mass flow is then calculated and compared to the setpoint. The resulting difference is an output to the ID fan variable frequency motors.

The six small reactors have one ID fan for each group of three reactors. The flue gas flow is controlled by adjusting the speed of the ID fan as a course adjustment for three reactors, and the damper associated with each reactor as a fine adjustment.

Area 900

The control room, Area 900, will contain the DCS control consoles. Two operator consoles will each consist of two high resolution color CRTs and one keyboard. One engineer work station will consist of one color CRT, one keyboard, and a color printer, which can be used as an operator console when not engaged in its primary role.

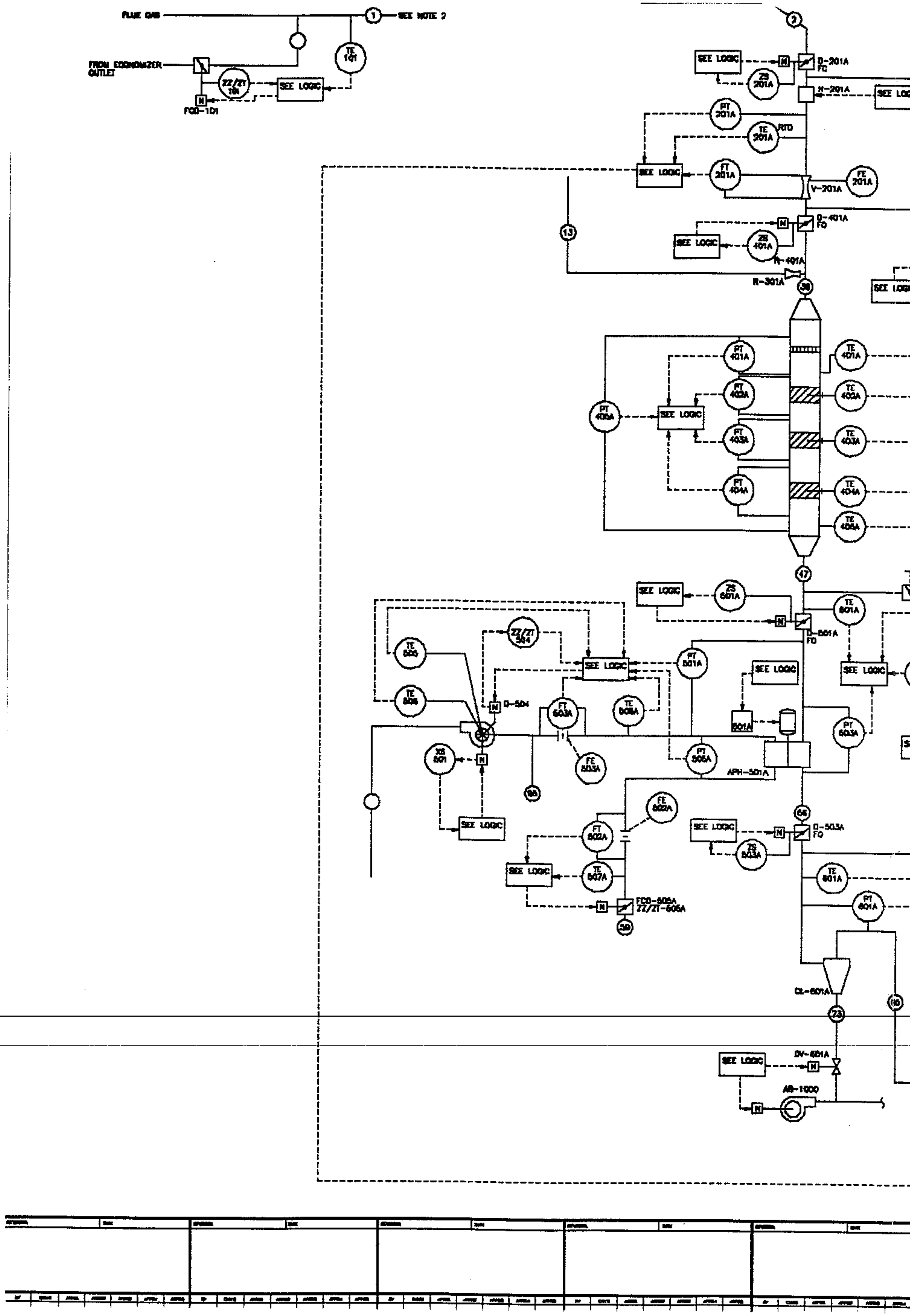
A personal computer, with color monitor and keyboard, will be used for data gathering and modem transmission.

Two dot matrix printers will be provided with the operator consoles for logs, reports, and CRT screen copies.

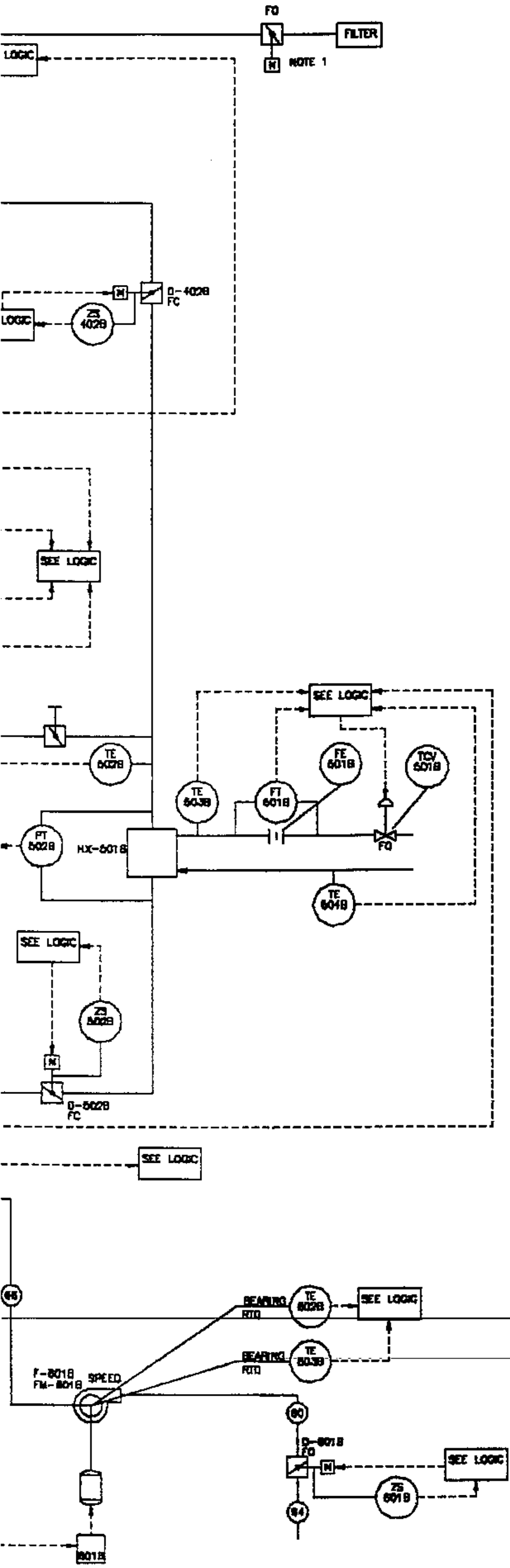
Behind the control room will be the electronics room, which will contain the DCS cabinets. These cabinets will have top entry for all field wiring and bottom entry for all cross cabinet wiring. The cabinets will contain all terminations, input/output cards, and microprocessors.

EXHIBIT 11.1-A

PLAN AND INSTRUMENTATION DRAWINGS FOR AREA 900



FLUE GAS
SEE NOTE 2
FROM ECONOMIZER OUTLET
TE 101
ZZ/ZT 101
FCD-101
SEE LOGIC
D-201A FO
ZS 201A
H-201A
PT 201A
TE 201A
RTD
FT 201A
FE 201A
V-201A
D-401A FO
ZS 401A
R-401A
R-301A
PT 401A
PT 402A
PT 403A
PT 404A
PT 405A
TE 401A
TE 402A
TE 403A
TE 404A
TE 405A
ZS 501A
TE 501A
D-501A FO
ZZ/ZT 504
TE 505
TE 506
D-504
FT 503A
TE 505A
PT 501A
FE 503A
PT 505A
XS 501
501A
APH-501A
PT 503A
FE 502A
FT 502A
TE 507A
FCD-505A
ZZ/ZT-505A
D-503A FO
ZS 503A
TE 601A
PT 601A
CL-601A
DV-601A
AB-1000



INSTRUMENTATION NOTES:

1. PURGE AIR VALVE. LOCAL CONTROL ONLY.

PRELIMINARY

SOUTHERN COMPANY SERVICES, INC.

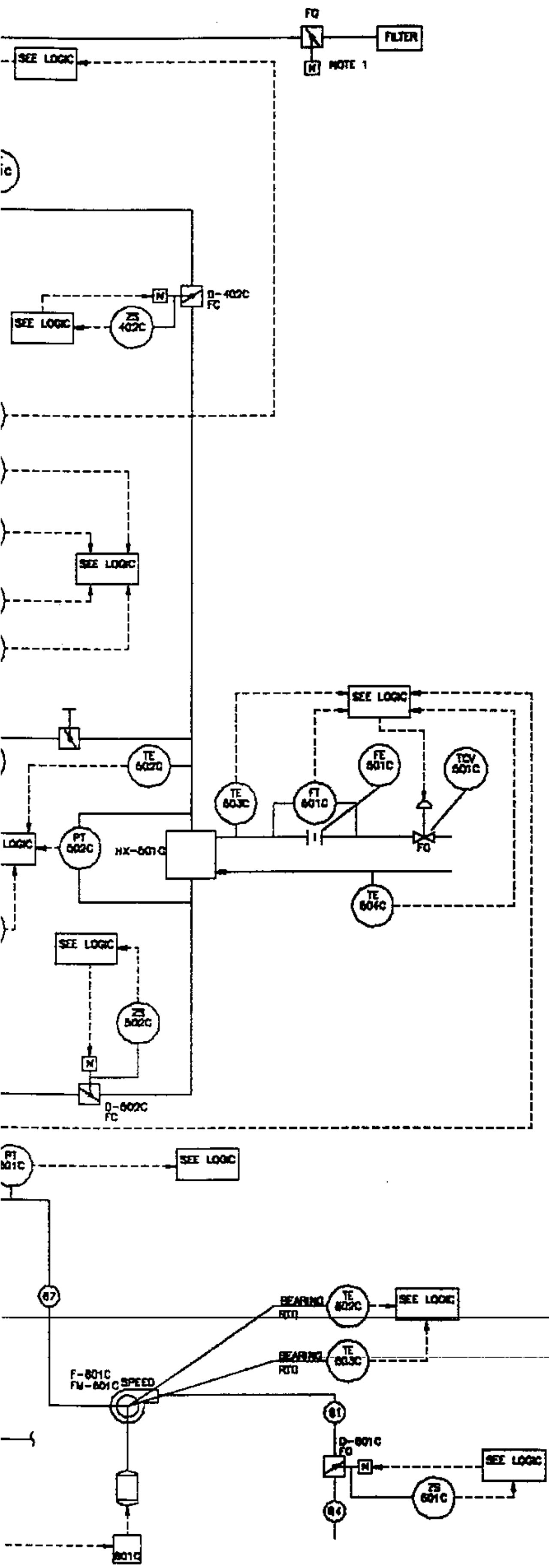
SCS/DOE ICCT SCR PROJECT

SELECTIVE CATALYTIC REDUCTION

JMS

NO SCALE

SCR2



INSTRUMENTATION NOTES:

1. PURGE AIR VALVE. LOCAL CONTROL ONLY.

PRELIMINARY

SOUTHERN COMPANY SERVICES, INC.

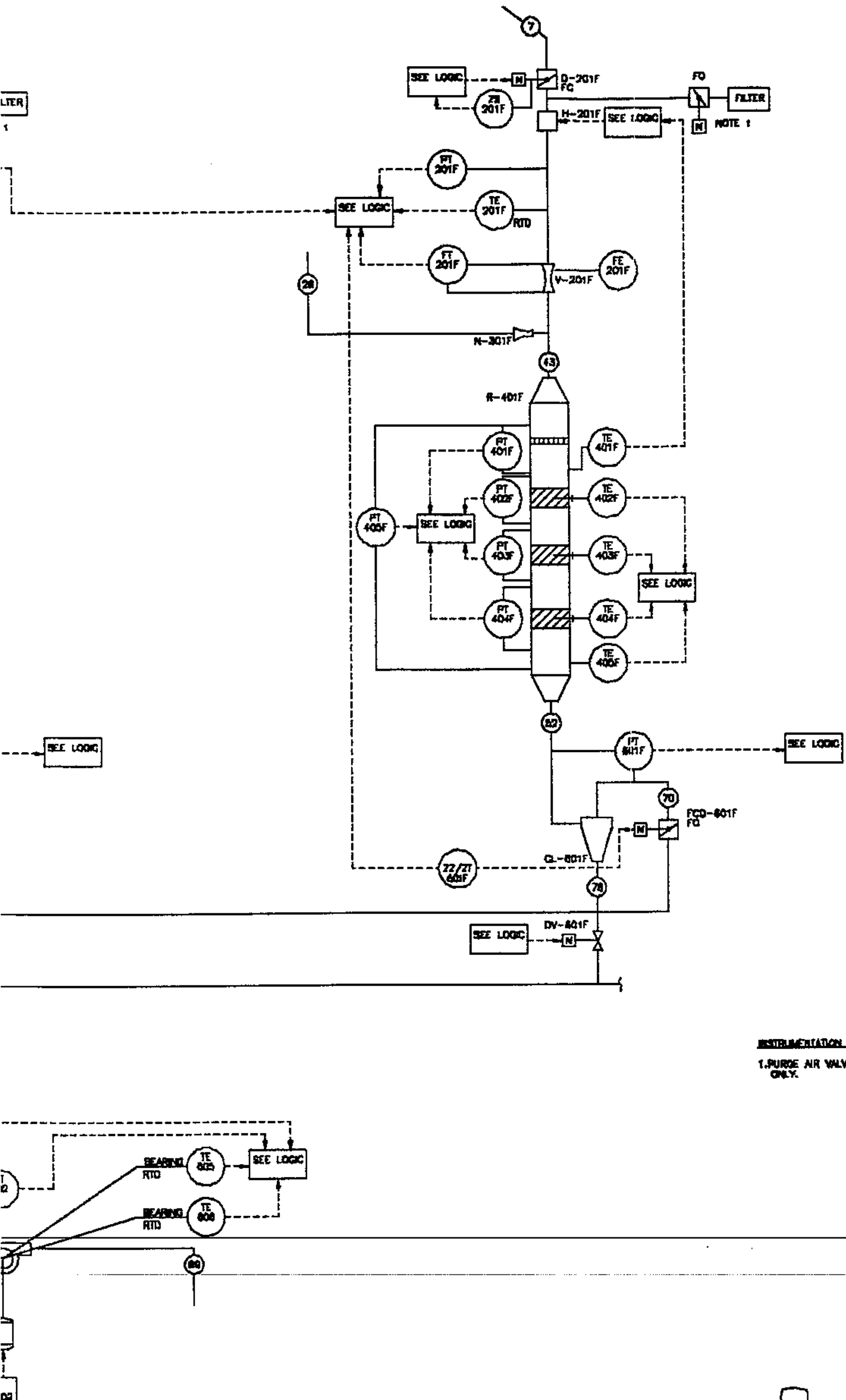
SCS/DOE ICCT SCR PROJECT

SELECTIVE CATALYTIC REDUCTION

JMS

NO SCALE

SCR3



INSTRUMENTATION NOTES:

1. PURGE AIR VALVE. LOCAL CONTROL ONLY.

PRELIMINARY

SOUTHERN COMPANY SERVICES, INC.

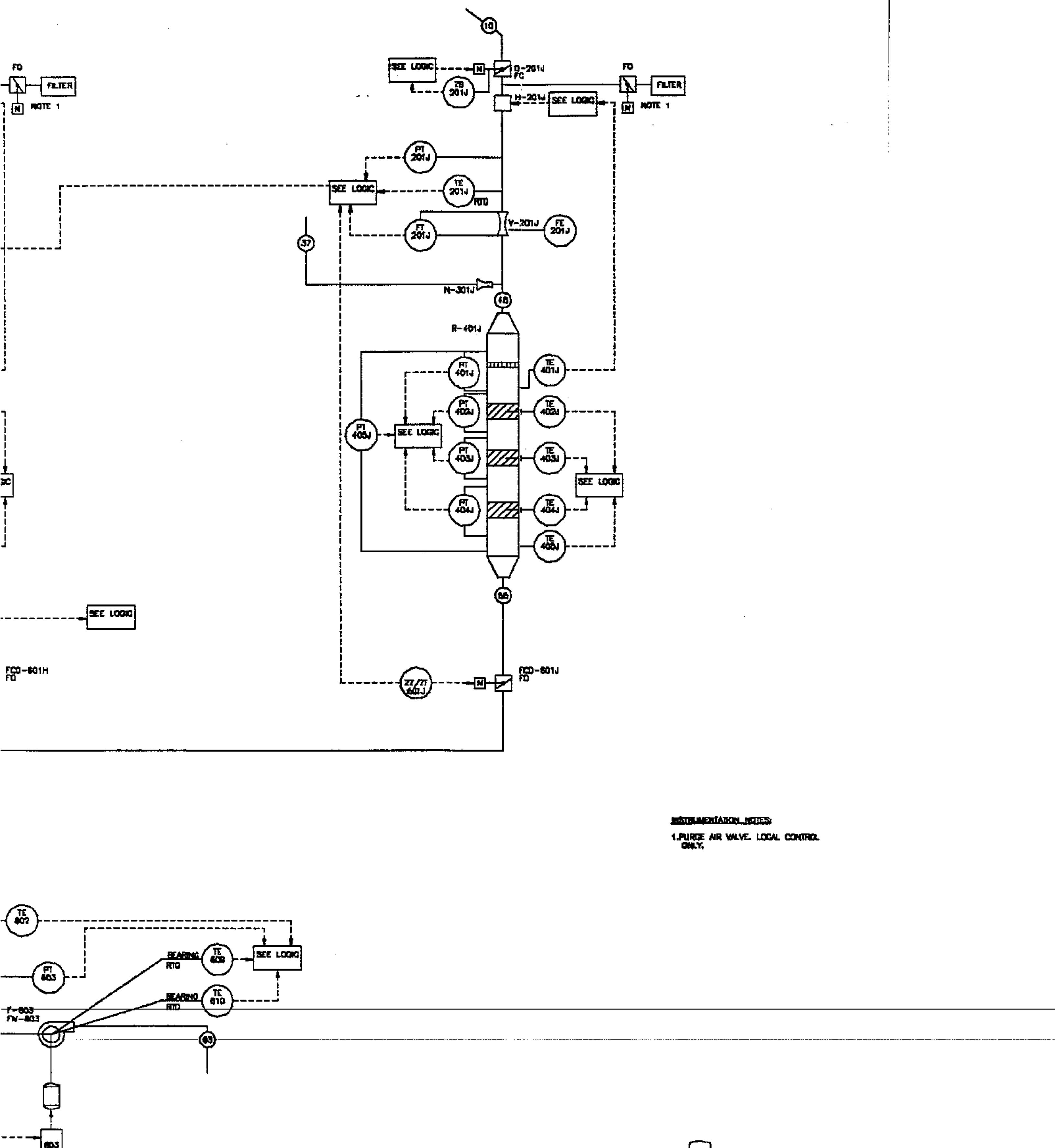
SCS/DOE ICCT SCR PROJECT

SELECTIVE CATALYTIC REDUCTION

JMS

NO SCALE

SCR4



INSTRUMENTATION NOTES:

1. PURGE AIR VALVE. LOCAL CONTROL ONLY.

PRELIMINARY

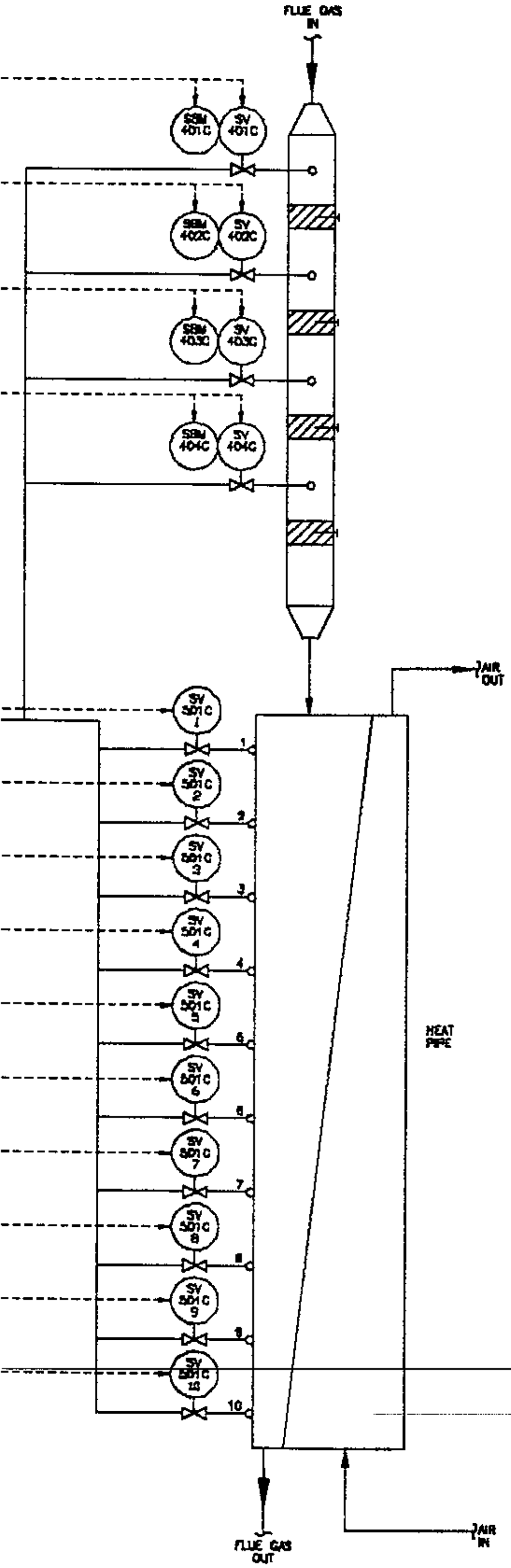
SOUTHERN COMPANY SERVICES, INC.

SCS/DOE ICCT SCR PROJECT

SELECTIVE CATALYTIC REDUCTION

NO SCALE

SCR5



TRAIN C

PRELIMINARY

SOUTHERN COMPANY SERVICES, INC.

SCS/DOE ICCT SCR PROJECT

SELECTIVE CATALYTIC REDUCTION
SOOT BLOWER SYSTEM

JHS

NO SCALE

SCR8

11.2 MAJOR EQUIPMENT

Table 11.2-1
Listing of Major Equipment in Area 900
Page 1 of 12

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
D201A	REACTOR TRAIN A ISOLATION DAMPER	DO	1
D201B	REACTOR TRAIN B ISOLATION DAMPER	DO	1
D201C	REACTOR TRAIN C ISOLATION DAMPER	DO	1
D201D	REACTOR TRAIN D ISOLATION DAMPER	DO	1
D201E	REACTOR TRAIN E ISOLATION DAMPER	DO	1
D201F	REACTOR TRAIN F ISOLATION DAMPER	DO	1
D201G	REACTOR TRAIN G ISOLATION DAMPER	DO	1
D201H	REACTOR TRAIN H ISOLATION DAMPER	DO	1
D201J	REACTOR TRAIN J ISOLATION DAMPER	DO	1
D401A	REACTOR A INLET ISOLATION DAMPER	DO	1
D401B	REACTOR B INLET ISOLATION DAMPER	DO	1
D401C	REACTOR C INLET ISOLATION DAMPER	DO	1
D402A	REACTOR A BYPASS ISOLATION DAMPER	DO	1
D402B	REACTOR B BYPASS ISOLATION DAMPER	DO	1
D402C	REACTOR C BYPASS ISOLATION DAMPER	DO	1
D501A	REACTOR A APH INLET ISOLATION DAMPR	DO	1
D501B	REACTOR B APH INLET ISOLATION DAMPR	DO	1
D501C	REACTOR C APH INLET ISOLATION DAMPR	DO	1
D502A	REACTOR A APH BYPASS ISOLATION DMPR	DO	1
D502B	REACTOR B APH BYPASS ISOLATION DMPR	DO	1
D502C	REACTOR C APH BYPASS ISOLATION DMPR	DO	1
D503A	REACTOR A APH OUTLET ISOLATION DMPR	DO	1
D503B	REACTOR B APH OUTLET ISOLATION DMPR	DO	1
D503C	REACTOR C APH OUTLET ISOLATION DMPR	DO	1
DCSWGR1	SWITCHGEAR FRAME 1 CLOSE	DO	1
DCSWGR2	SWITCHGEAR FRAME 2 CLOSE	DO	1
DCSWGR3	SWITCHGEAR FRAME 3 CLOSE	DO	1
DCSWGR4	SWITCHGEAR FRAME 4 CLOSE	DO	1
DOA501A	RUN APH 501A	DO	1
DOA501B	RUN APH 501B	DO	1
DOAB1000	RUN ASH BLOWER	DO	1
DOAC1000	RUN AIR COMPRESSOR AC-1000	DO	1
DOF301A	RUN INJECTION AIR BLOWER F-301A	DO	1
DOF301B	RUN INJECTION AIR BLOWER F-301B	DO	1
DOF301C	RUN INJECTION AIR BLOWER F-301C	DO	1
DOF301D	RUN INJECTION AIR BLOWER F-301D	DO	1
DOF301E	RUN INJECTION AIR BLOWER F-301E	DO	1
DOF301F	RUN INJECTION AIR BLOWER F-301F	DO	1
DOF301G	RUN INJECTION AIR BLOWER F-301G	DO	1
DOF301H	RUN INJECTION AIR BLOWER F-301H	DO	1
DOF301J	RUN INJECTION AIR BLOWER F-301J	DO	1
DOF501	RUN FAN F-501	DO	1
DOF601A	RUN FAN F-601A	DO	1
DOF601B	RUN FAN F-601B	DO	1
DOF601C	RUN FAN F-601C	DO	1
DOF602	RUN FAN F-602	DO	1
DOF603	RUN FAN F-603	DO	1
DOH300	AMMONIA HEATER H-300	DO	1
DOH301	AMMONIA HEATER H-301	DO	1
DOP1000	RUN SERVICE WATER PUMP 1000	DO	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
DTSWGR1	SWITCHGEAR FRAME 1 TRIP	DO	1
DTSWGR2	SWITCHGEAR FRAME 2 TRIP	DO	1
DTSWGR3	SWITCHGEAR FRAME 3 TRIP	DO	1
DTSWGR4	SWITCHGEAR FRAME 4 TRIP	DO	1
DV601A	CYCLONE A DISCH VALVE	DO	1
DV601B	CYCLONE B DISCH VALVE	DO	1
DV601C	CYCLONE C DISCH VALVE	DO	1
DV601D	CYCLONE D DISCH VALVE	DO	1
DV601E	CYCLONE E DISCH VALVE	DO	1
DV601F	CYCLONE F DISCH VALVE	DO	1
DV601G	CYCLONE G DISCH VALVE	DO	1
DV601H	CYCLONE H DISCH VALVE	DO	1
FCD101	ECONOMIZER OUTLET DAMPER	AO	1
FCD505A	APH 501A AIR INLET FLOW CONTROL	AO	1
FCD505B	APH 501B AIR INLET FLOW CONTROL	AO	1
FCD505C	APH 501C AIR INLET FLOW CONTROL	AO	1
FCV300	FLOW CNTRL VLV NH3 ACCUM TANK	AO	1
FCV301A	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301B	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301C	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301D	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301E	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301F	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301G	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301H	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301J	FLOW CNTRL VLV NH3 DELIV	AO	1
FE201A	STREAM 2 FLOW ELEMENT	--	1
FE201B	STREAM 3 FLOW ELEMENT	--	1
FE201C	STREAM 4 FLOW ELEMENT	--	1
FE201D	STREAM 5 FLOW ELEMENT	--	1
FE201E	STREAM 6 FLOW ELEMENT	--	1
FE201F	STREAM 7 FLOW ELEMENT	--	1
FE201G	STREAM 8 FLOW ELEMENT	--	1
FE201H	STREAM 9 FLOW ELEMENT	--	1
FE201J	STREAM 10 FLOW ELEMENT	--	1
FE300A	FLOW ELEMENT NH3 DELIVERY	--	1
FE300B	FLOW ELEMENT NH3 DELIVERY	--	1
FE300C	FLOW ELEMENT NH3 DELIVERY	--	1
FE300D	FLOW ELEMENT NH3 DELIVERY	--	1
FE300E	FLOW ELEMENT NH3 DELIVERY	--	1
FE300F	FLOW ELEMENT NH3 DELIVERY	--	1
FE300G	FLOW ELEMENT NH3 DELIVERY	--	1
FE300H	FLOW ELEMENT NH3 DELIVERY	--	1
FE300J	FLOW ELEMENT NH3 DELIVERY	--	1
FE301A	FLOW ELEMENT FOR FAN F-301A	--	1
FE301B	FLOW ELEMENT FOR FAN F-301B	--	1
FE301C	FLOW ELEMENT FOR FAN F-301C	--	1
FE301D	FLOW ELEMENT FOR FAN F-301D	--	1
FE301E	FLOW ELEMENT FOR FAN F-301E	--	1
FE301F	FLOW ELEMENT FOR FAN F-301F	--	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
FE301G	FLOW ELEMENT FOR FAN F-301G	--	1
FE301H	FLOW ELEMENT FOR FAN F-301H	--	1
FE301J	FLOW ELEMENT FOR FAN F-301J	--	1
FE501A	HX-501A FLOW ELEMENT-WATER	--	1
FE501B	HX-501B FLOW ELEMENT-WATER	--	1
FE501C	HX-501C FLOW ELEMENT-WATER	--	1
FE601	HX-601 FLOW ELEMENT-WATER	--	1
FE602	HX-602 FLOW ELEMENT-WATER	--	1
FI1001	STEAM FLOW TO PILOT PLANT	AO	1
FI201	SUM OF STREAM GAS FLOWS	AO	1
FI501	SUM OF APH AIR INLET FLOW	AO	1
FI502	SUM OF APH AIR OUTLET FLOW	AO	1
FS300	FLOW SWITCH IN NH3 VENT PIPING	DI	1
FT001	UNIT 5 LIGHTER OIL FLOW	AI	1
FT1001	STEAM FLOW TO PILOT PLANT	AI	1
FT201A	STREAM 2 FLOW TRANSMITTER	AI	1
FT201B	STREAM 3 FLOW TRANSMITTER	AI	1
FT201C	STREAM 4 FLOW TRANSMITTER	AI	1
FT201D	STREAM 5 FLOW TRANSMITTER	AI	1
FT201E	STREAM 6 FLOW TRANSMITTER	AI	1
FT201F	STREAM 7 FLOW TRANSMITTER	AI	1
FT201G	STREAM 8 FLOW TRANSMITTER	AI	1
FT201H	STREAM 9 FLOW TRANSMITTER	AI	1
FT201J	STREAM 10 FLOW TRANSMITTER	AI	1
FT300A1	FLOW TRANS NH3 DELIVERY	AI	1
FT300A2	TRAIN A FLOW TRANS NH3 DELIVERY	AI	1
FT300B1	FLOW TRANS NH3 DELIVERY	AI	1
FT300B2	TRAIN B FLOW TRANS NH3 DELIVERY	AI	1
FT300C1	FLOW TRANS NH3 DELIVERY	AI	1
FT300C2	TRAIN C FLOW TRANS NH3 DELIVERY	AI	1
FT300D1	FLOW TRANS NH3 DELIVERY	AI	1
FT300D2	TRAIN D FLOW TRANS NH3 DELIVERY	AI	1
FT300E1	FLOW TRANS NH3 DELIVERY	AI	1
FT300E2	TRAIN E FLOW TRANS NH3 DELIVERY	AI	1
FT300F1	FLOW TRANS NH3 DELIVERY	AI	1
FT300F2	TRAIN F FLOW TRANS NH3 DELIVERY	AI	1
FT300G1	FLOW TRANS NH3 DELIVERY	AI	1
FT300G2	TRAIN G FLOW TRANS NH3 DELIVERY	AI	1
FT300H1	FLOW TRANS NH3 DELIVERY	AI	1
FT300H2	TRAIN H FLOW TRANS NH3 DELIVERY	AI	1
FT300J1	FLOW TRANS NH3 DELIVERY	AI	1
FT300J2	TRAIN J FLOW TRANS NH3 DELIVERY	AI	1
FT301A	FLOW TRANSMITTER FOR FAN F-301A	AI	1
FT301B	FLOW TRANSMITTER FOR FAN F-301B	AI	1
FT301C	FLOW TRANSMITTER FOR FAN F-301C	AI	1
FT301D	FLOW TRANSMITTER FOR FAN F-301D	AI	1
FT301E	FLOW TRANSMITTER FOR FAN F-301E	AI	1
FT301F	FLOW TRANSMITTER FOR FAN F-301F	AI	1
FT301G	FLOW TRANSMITTER FOR FAN F-301G	AI	1
FT301H	FLOW TRANSMITTER FOR FAN F-301H	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
FT301J	FLOW SWITCH FOR FAN F-301J	DI	1
FT501A	HX-501A FLOW TRANSMITTER--WATER	AI	1
FT501B	HX-501B FLOW TRANSMITTER--WATER	AI	1
FT501C	HX-501C FLOW TRANSMITTER--WATER	AI	1
FT502A	APH 501A AIR INLET FLOW	AI	1
FT502B	APH 501B AIR INLET FLOW	AI	1
FT502C	APH 501C AIR INLET FLOW	AI	1
FT503A	APH 501A AIR OUTLET FLOW	AI	1
FT503B	APH 501B AIR OUTLET FLOW	AI	1
FT503C	APH 501C AIR OUTLET FLOW	AI	1
IP300	I TO P POSITIONER, FCV300	AO	1
IP301A1	I TO P POSITIONER, FCV301A1	AO	1
IP301A2	I TO P POSITIONER, FCV301A2	AO	1
IP301B1	I TO P POSITIONER, FCV301B1	AO	1
IP301B2	I TO P POSITIONER, FCV301B2	AO	1
IP301C1	I TO P POSITIONER, FCV301C1	AO	1
IP301C2	I TO P POSITIONER, FCV301C2	AO	1
IP301D1	I TO P POSITIONER, FCV301D1	AO	1
IP301D2	I TO P POSITIONER, FCV301D2	AO	1
IP301E1	I TO P POSITIONER, FCV301E1	AO	1
IP301E2	I TO P POSITIONER, FCV301E2	AO	1
IP301F1	I TO P POSITIONER, FCV301F1	AO	1
IP301F2	I TO P POSITIONER, FCV301F2	AO	1
IP301G1	I TO P POSITIONER, FCV301G1	AO	1
IP301G2	I TO P POSITIONER, FCV301G2	AO	1
IP301H1	I TO P POSITIONER, FCV301H1	AO	1
IP301H2	I TO P POSITIONER, FCV301H2	AO	1
IP301J1	I TO P POSITIONER, FCV301J1	AO	1
IP301J2	I TO P POSITIONER, FCV301J2	AO	1
IP302A	I TO P POSITIONER, FCV302A	AO	1
IP302B	I TO P POSITIONER, FCV302B	AO	1
IP302C	I TO P POSITIONER, FCV302C	AO	1
IP302D	I TO P POSITIONER, FCV302D	AO	1
IP302E	I TO P POSITIONER, FCV302E	AO	1
IP302F	I TO P POSITIONER, FCV302F	AO	1
IP302G	I TO P POSITIONER, FCV302G	AO	1
IP302H	I TO P POSITIONER, FCV302H	AO	1
IP302J	I TO P POSITIONER, FCV302J	AO	1
JI100	PILOT PLANT STATION SERVICE	AO	1
JT100	PILOT PLANT WATT TRANSDUCER	AI	1
LI300	LEVEL IND ANDYDROUS NH3 STOR TNK 1	--	1
LI301	LEVEL IND ANDYDROUS NH3 STOR TNK 2	--	1
PI300	PRESS IND ANDYDROUS NH3 STOR TNK 1	--	1
PI300A	STREAM 13 PRESS INDICATOR	--	1
PI300B	STREAM 16 PRESS INDICATOR	--	1
PI300C	STREAM 19 PRESS INDICATOR	--	1
PI300D	STREAM 22 PRESS INDICATOR	--	1
PI300E	STREAM 25 PRESS INDICATOR	--	1
PI300F	STREAM 28 PRESS INDICATOR	--	1
PI300G	STREAM 31 PRESS INDICATOR	--	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
PI300H	STREAM 34 PRESS INDICATOR	--	1
PI300J	STREAM 37 PRESS INDICATOR	--	1
PI301	PRESS IND, ANDYDROUS NH3 STOR TNK 2	--	1
PI302	PRESS IND, NH3 ACCUM TANK	--	1
PS1000	SOOTBLOWER STEAM SUPPLY AVAILABLE	DI	1
PS300	PRESS SW ANHYDROUS NH3 STOR TNK 1	DI	1
PS301	PRESS SW ANHYDROUS NH3 STOR TNK 2	DI	1
PSV300A	SAFE VLV ANHYDROUS NH3 STOR TNK 1	DI	1
PSV300B	SAFE VLV ANHYDROUS NH3 STOR TNK 1	DI	1
PSV301A	SAFE VLV ANHYDROUS NH3 STOR TNK 2	DI	1
PSV301B	SAFE VLV ANHYDROUS NH3 STOR TNK 2	DI	1
PT201A	STREAM 2 PRESSURE	AI	1
PT201B	STREAM 3 PRESSURE	AI	1
PT201C	STREAM 4 PRESSURE	AI	1
PT201D	STREAM 5 PRESSURE	AI	1
PT201E	STREAM 6 PRESSURE	AI	1
PT201F	STREAM 7 PRESSURE	AI	1
PT201G	STREAM 8 PRESSURE	AI	1
PT201H	STREAM 9 PRESSURE	AI	1
PT201J	STREAM 10 PRESSURE	AI	1
PT300A	STREAM 11 PRESSURE	AI	1
PT300B	STREAM 14 PRESSURE	AI	1
PT300C	STREAM 17 PRESSURE	AI	1
PT300D	STREAM 20 PRESSURE	AI	1
PT300E	STREAM 23 PRESSURE	AI	1
PT300F	STREAM 26 PRESSURE	AI	1
PT300G	STREAM 29 PRESSURE	AI	1
PT300H	STREAM 32 PRESSURE	AI	1
PT300J	STREAM 35 PRESSURE	AI	1
PT302A	PRESS TRANS, NH3 ACCUM TANK	AI	1
PT302B	PRESS TRANS, NH3 ACCUM TANK	AI	1
PT401A	INLET TO BED 1 DIFF PRESS	AI	1
PT401B	INLET TO BED 1 DIFF PRESS	AI	1
PT401C	INLET TO BED 1 DIFF PRESS	AI	1
PT401D	INLET TO BED 1 DIFF PRESS	AI	1
PT401E	INLET TO BED 1 DIFF PRESS	AI	1
PT401F	INLET TO BED 1 DIFF PRESS	AI	1
PT401G	INLET TO BED 1 DIFF PRESS	AI	1
PT401H	INLET TO BED 1 DIFF PRESS	AI	1
PT401J	INLET TO BED 1 DIFF PRESS	AI	1
PT402A	TRAIN A BED 1 DIFF PRESS	AI	1
PT402B	TRAIN B BED 1 DIFF PRESS	AI	1
PT402C	TRAIN C BED 1 DIFF PRESS	AI	1
PT402D	TRAIN D BED 1 DIFF PRESS	AI	1
~~PT402E~~	~~TRAIN E BED 1 DIFF PRESS~~	~~AI~~	~~1~~
PT402F	TRAIN F BED 1 DIFF PRESS	AI	1
~~PT402G~~	~~TRAIN G BED 1 DIFF PRESS~~	~~AI~~	~~1~~
PT402H	TRAIN H BED 1 DIFF PRESS	AI	1
PT402J	TRAIN J BED 1 DIFF PRESS	AI	1
PT403A	TRAIN A BED 2 DIFF PRESS	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
PT403B	TRAIN B BED 2 DIFF PRESS	AI	1
PT403C	TRAIN C BED 2 DIFF PRESS	AI	1
PT403D	TRAIN D BED 2 DIFF PRESS	AI	1
PT403E	TRAIN E BED 2 DIFF PRESS	AI	1
PT403F	TRAIN F BED 2 DIFF PRESS	AI	1
PT403G	TRAIN G BED 2 DIFF PRESS	AI	1
PT403H	TRAIN H BED 2 DIFF PRESS	AI	1
PT403J	TRAIN J BED 2 DIFF PRESS	AI	1
PT404A	TRAIN A BED 3 DIFF PRESS	AI	1
PT404B	TRAIN B BED 3 DIFF PRESS	AI	1
PT404C	TRAIN C BED 3 DIFF PRESS	AI	1
PT404D	TRAIN D BED 3 DIFF PRESS	AI	1
PT404E	TRAIN E BED 3 DIFF PRESS	AI	1
PT404F	TRAIN F BED 3 DIFF PRESS	AI	1
PT404G	TRAIN G BED 3 DIFF PRESS	AI	1
PT404H	TRAIN H BED 3 DIFF PRESS	AI	1
PT404J	TRAIN J BED 3 DIFF PRESS	AI	1
PT405A	TRAIN A INLET TO OUTLET DIFF PRESS	AI	1
PT405B	TRAIN B INLET TO OUTLET DIFF PRESS	AI	1
PT405C	TRAIN C INLET TO OUTLET DIFF PRESS	AI	1
PT405D	TRAIN D INLET TO OUTLET DIFF PRESS	AI	1
PT405E	TRAIN E INLET TO OUTLET DIFF PRESS	AI	1
PT405F	TRAIN F INLET TO OUTLET DIFF PRESS	AI	1
PT405G	TRAIN G INLET TO OUTLET DIFF PRESS	AI	1
PT405H	TRAIN H INLET TO OUTLET DIFF PRESS	AI	1
PT405J	TRAIN J INLET TO OUTLET DIFF PRESS	AI	1
PT501A	APH-501A AIR TO GAS DIFF-INLET	AI	1
PT501B	APH-501B AIR TO GAS DIFF-INLET	AI	1
PT502A	HX-501A INLET TO OUTLET DIFF	AI	1
PT502B	HX-501B INLET TO OUTLET DIFF	AI	1
PT502C	HX-501C INLET TO OUTLET DIFF	AI	1
PT503A	APH-501A INLET TO OUTLET DIFF	AI	1
PT503B	APH-501B INLET TO OUTLET DIFF	AI	1
PT503C	APH-501C INLET TO OUTLET DIFF	AI	1
PT505A	APH 501A AIR IN/AIR OUT DIFF PRESS	AI	1
PT505B	APH 501B AIR IN/AIR OUT DIFF PRESS	AI	1
PT601A	CYCLONE CL-601A INL TO OUTL DIFF	AI	1
PT601B	CYCLONE CL-601B INL TO OUTL DIFF	AI	1
PT601C	CYCLONE CL-601C INL TO OUTL DIFF	AI	1
PT601D	CYCLONE CL-601D INL TO OUTL DIFF	AI	1
PT601E	CYCLONE CL-601E INL TO OUTL DIFF	AI	1
PT601F	CYCLONE CL-601F INL TO OUTL DIFF	AI	1
PT601G	CYCLONE CL-601G INL TO OUTL DIFF	AI	1
PT601H	CYCLONE CL-601H INL TO OUTL DIFF	AI	1
PT602	CYCLONE CL-601E OUTLET PRESSURE	AI	1
PT603	CYCLONE CL-601H OUTLET PRESSURE	AI	1
SBM401A	TRAIN A BED 1 SOOTBLOWER MOTOR	DO	1
SBM401B	TRAIN B BED 1 SOOTBLOWER MOTOR	DO	1
SBM401C	TRAIN C BED 1 SOOTBLOWER MOTOR	DO	1
SBM402A	TRAIN A BED 2 SOOTBLOWER MOTOR	DO	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
SBM402B	TRAIN B BED 2 SOOTBLOWER MOTOR	DO	1
SBM402C	TRAIN C BED 2 SOOTBLOWER MOTOR	DO	1
SBM403A	TRAIN A BED 3 SOOTBLOWER MOTOR	DO	1
SBM403B	TRAIN B BED 3 SOOTBLOWER MOTOR	DO	1
SBM403C	TRAIN C BED 3 SOOTBLOWER MOTOR	DO	1
SBM404A	TRAIN A BED 4 SOOTBLOWER MOTOR	DO	1
SBM404B	TRAIN B BED 4 SOOTBLOWER MOTOR	DO	1
SBM404C	TRAIN C BED 4 SOOTBLOWER MOTOR	DO	1
SQA501A	APH 501A INPUT SPEED SIGNAL	AO	1
SQA501B	APH 501B INPUT SPEED SIGNAL	AO	1
SQF601A	FAN F-601A INPUT SPEED SIGNAL	AO	1
SQF601B	FAN F-601B INPUT SPEED SIGNAL	AO	1
SQF601C	FAN F-601C INPUT SPEED SIGNAL	AO	1
SQF602	FAN F-602 INPUT SPEED SIGNAL	AO	1
SQF603	FAN F-603 INPUT SPEED SIGNAL	AO	1
STA501A	APH 501A SPEED	AI	1
STA501B	APH 501B SPEED	AI	1
STF601A	FAN F-601A SPEED	AI	1
STF601B	FAN F-601B SPEED	AI	1
STF601C	FAN F-601C SPEED	AI	1
STF602	FAN F-602 SPEED	AI	1
STF603	FAN F-603 SPEED	AI	1
SV1000	OPEN STEAM VALVE FOR SOOTBLOWER	DO	1
SV201A	V201A VENTURI TAP BLOWBACK	DO	1
SV201B	V201B VENTURI TAP BLOWBACK	DO	1
SV201C	V201C VENTURI TAP BLOWBACK	DO	1
SV201D	V201D VENTURI TAP BLOWBACK	DO	1
SV201E	V201E VENTURI TAP BLOWBACK	DO	1
SV201F	V201F VENTURI TAP BLOWBACK	DO	1
SV201G	V201G VENTURI TAP BLOWBACK	DO	1
SV201H	V201H VENTURI TAP BLOWBACK	DO	1
SV201J	V201J VENTURI TAP BLOWBACK	DO	1
SV300	SOLENOID OPERATED VLV FV300	DO	1
SV300A	SOLENOID OPERATED VLV FV300A	DO	1
SV300B	SOLENOID OPERATED VLV FV300B	DO	1
SV300C	SOLENOID OPERATED VLV FV300C	DO	1
SV300D	SOLENOID OPERATED VLV FV300D	DO	1
SV300E	SOLENOID OPERATED VLV FV300E	DO	1
SV300F	SOLENOID OPERATED VLV FV300F	DO	1
SV300G	SOLENOID OPERATED VLV FV300G	DO	1
SV300H	SOLENOID OPERATED VLV FV300H	DO	1
SV300J	SOLENOID OPERATED VLV FV300J	DO	1
SV301	SOLENOID OPERATED VLV FV301	DO	1
SV401A	TRAIN A BED 1 SOOTBLOWER VALVE	DO	1
SV401B	TRAIN B BED 1 SOOTBLOWER VALVE	DO	1
SV401C	TRAIN C BED 1 SOOTBLOWER VALVE	DO	1
SV402A	TRAIN A BED 2 SOOTBLOWER VALVE	DO	1
SV402B	TRAIN B BED 2 SOOTBLOWER VALVE	DO	1
SV402C	TRAIN C BED 2 SOOTBLOWER VALVE	DO	1
SV403A	TRAIN A BED 3 SOOTBLOWER VALVE	DO	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
SV403B	TRAIN B BED 3 SOOTBLOWER VALVE	DO	1
SV403C	TRAIN C BED 3 SOOTBLOWER VALVE	DO	1
SV404A	TRAIN A BED 4 SOOTBLOWER VALVE	DO	1
SV404B	TRAIN B BED 4 SOOTBLOWER VALVE	DO	1
SV404C	TRAIN C BED 4 SOOTBLOWER VALVE	DO	1
SV501A1	APH A SOOTBLOWER #1	DO	1
SV501A2	APH A SOOTBLOWER #2	DO	1
SV501B1	APH B SOOTBLOWER #1	DO	1
SV501B2	APH B SOOTBLOWER #2	DO	1
SV501C1	AIR PIPE SOOTBLOWER # 1	DO	1
SV501C10	AIR PIPE SOOTBLOWER #10	DO	1
SV501C2	AIR PIPE SOOTBLOWER # 2	DO	1
SV501C3	AIR PIPE SOOTBLOWER # 3	DO	1
SV501C4	AIR PIPE SOOTBLOWER # 4	DO	1
SV501C5	AIR PIPE SOOTBLOWER # 5	DO	1
SV501C6	AIR PIPE SOOTBLOWER # 6	DO	1
SV501C7	AIR PIPE SOOTBLOWER # 7	DO	1
SV501C8	AIR PIPE SOOTBLOWER # 8	DO	1
SV501C9	AIR PIPE SOOTBLOWER # 9	DO	1
TCV501A	HX-501A CONTROL VALVE FOR WATER	AO	1
TCV501B	HX-501B CONTROL VALVE FOR WATER	AO	1
TCV501C	HX-501C CONTROL VALVE FOR WATER	AO	1
TCV602	HX-602 CONTROL VALVE FOR WATER	AO	1
TE101	STREAM 1 TEMPERATURE	AI	1
TE201A	STREAM 2 TEMPERATURE	AI	1
TE201B	STREAM 3 TEMPERATURE	AI	1
TE201C	STREAM 4 TEMPERATURE	AI	1
TE201D	STREAM 5 TEMPERATURE	AI	1
TE201E	STREAM 6 TEMPERATURE	AI	1
TE201F	STREAM 7 TEMPERATURE	AI	1
TE201G	STREAM 8 TEMPERATURE	AI	1
TE201H	STREAM 9 TEMPERATURE	AI	1
TE201J	STREAM 10 TEMPERATURE	AI	1
TE300A	STREAM 11 TEMPERATURE	AI	1
TE300B	STREAM 14 TEMPERATURE	AI	1
TE300C	STREAM 17 TEMPERATURE	AI	1
TE300D	STREAM 20 TEMPERATURE	AI	1
TE300E	STREAM 23 TEMPERATURE	AI	1
TE300F	STREAM 26 TEMPERATURE	AI	1
TE300G	STREAM 29 TEMPERATURE	AI	1
TE300H	STREAM 32 TEMPERATURE	AI	1
TE300J	STREAM 35 TEMPERATURE	AI	1
TE301A	STREAM 13 TEMPERATURE	AI	1
TE301B	STREAM 16 TEMPERATURE	AI	1
TE301C	STREAM 19 TEMPERATURE	AI	1
TE301D	STREAM 22 TEMPERATURE	AI	1
TE301E	STREAM 25 TEMPERATURE	AI	1
TE301F	STREAM 28 TEMPERATURE	AI	1
TE301G	STREAM 31 TEMPERATURE	AI	1
TE301H	STREAM 34 TEMPERATURE	AI	1

TAG NUMBER	DESCRIPTION		IO TYPE	QTY
TE301J	STREAM 37 TEMPERATURE		AI	1
TE401A	TRAIN A REACTOR INLET	TEMPERATURE	AI	1
TE401B	TRAIN B REACTOR INLET	TEMPERATURE	AI	1
TE401C	TRAIN C REACTOR INLET	TEMPERATURE	AI	1
TE401D	TRAIN D REACTOR INLET	TEMPERATURE	AI	1
TE401E	TRAIN E REACTOR INLET	TEMPERATURE	AI	1
TE401F	TRAIN F REACTOR INLET	TEMPERATURE	AI	1
TE401G	TRAIN G REACTOR INLET	TEMPERATURE	AI	1
TE401H	TRAIN H REACTOR INLET	TEMPERATURE	AI	1
TE401J	TRAIN J REACTOR INLET	TEMPERATURE	AI	1
TE402A	TRAIN A REACTOR BED 1	TEMPERATURE	AI	1
TE402B	TRAIN B REACTOR BED 1	TEMPERATURE	AI	1
TE402C	TRAIN C REACTOR BED 1	TEMPERATURE	AI	1
TE402D	TRAIN D REACTOR BED 1	TEMPERATURE	AI	1
TE402E	TRAIN E REACTOR BED 1	TEMPERATURE	AI	1
TE402F	TRAIN F REACTOR BED 1	TEMPERATURE	AI	1
TE402G	TRAIN G REACTOR BED 1	TEMPERATURE	AI	1
TE402H	TRAIN H REACTOR BED 1	TEMPERATURE	AI	1
TE402J	TRAIN J REACTOR BED 1	TEMPERATURE	AI	1
TE403A	TRAIN A REACTOR BED 2	TEMPERATURE	AI	1
TE403B	TRAIN B REACTOR BED 2	TEMPERATURE	AI	1
TE403C	TRAIN C REACTOR BED 2	TEMPERATURE	AI	1
TE403D	TRAIN D REACTOR BED 2	TEMPERATURE	AI	1
TE403E	TRAIN E REACTOR BED 2	TEMPERATURE	AI	1
TE403F	TRAIN F REACTOR BED 2	TEMPERATURE	AI	1
TE403G	TRAIN G REACTOR BED 2	TEMPERATURE	AI	1
TE403H	TRAIN H REACTOR BED 2	TEMPERATURE	AI	1
TE403J	TRAIN J REACTOR BED 2	TEMPERATURE	AI	1
TE404A	TRAIN A REACTOR BED 3	TEMPERATURE	AI	1
TE404B	TRAIN B REACTOR BED 3	TEMPERATURE	AI	1
TE404C	TRAIN C REACTOR BED 3	TEMPERATURE	AI	1
TE404D	TRAIN D REACTOR BED 3	TEMPERATURE	AI	1
TE404E	TRAIN E REACTOR BED 3	TEMPERATURE	AI	1
TE404F	TRAIN F REACTOR BED 3	TEMPERATURE	AI	1
TE404G	TRAIN G REACTOR BED 3	TEMPERATURE	AI	1
TE404H	TRAIN H REACTOR BED 3	TEMPERATURE	AI	1
TE404J	TRAIN J REACTOR BED 3	TEMPERATURE	AI	1
TE405A	TRAIN A REACTOR OUTLET	TEMPERATURE	AI	1
TE405B	TRAIN B REACTOR OUTLET	TEMPERATURE	AI	1
TE405C	TRAIN C REACTOR OUTLET	TEMPERATURE	AI	1
TE405D	TRAIN D REACTOR OUTLET	TEMPERATURE	AI	1
TE405E	TRAIN E REACTOR OUTLET	TEMPERATURE	AI	1
TE405F	TRAIN F REACTOR OUTLET	TEMPERATURE	AI	1
TE405G	TRAIN G REACTOR BED 3	TEMPERATURE	AI	1
TE405H	TRAIN H REACTOR BED 3	TEMPERATURE	AI	1
TE405J	TRAIN J REACTOR BED 3	TEMPERATURE	AI	1
TE501A	APH-501A INLET TEMPERATURE		AI	1
TE501B	APH-501B INLET TEMPERATURE		AI	1
TE501C	APH-501C INLET TEMPERATURE		AI	1
TE502A	HX-501A INLET TEMPERATURE-GAS		AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
TE502B	HX-501B INLET TEMPERATURE-GAS	AI	1
TE502C	HX-501C INLET TEMPERATURE-GAS	AI	1
TE503A	HX-501A OUTLET TEMPERATURE-WATER	AI	1
TE503B	HX-501B OUTLET TEMPERATURE-WATER	AI	1
TE503C	HX-501C OUTLET TEMPERATURE-WATER	AI	1
TE504A	HX-501A INLET TEMPERATURE-WATER	AI	1
TE504B	HX-501B INLET TEMPERATURE-WATER	AI	1
TE504C	HX-501C INLET TEMPERATURE-WATER	AI	1
TE505	FAN F-501 INBOARD BEARING TEMP	AI	1
TE506	FAN F-501 OUTBOARD BEARING TEMP	AI	1
TE507A	APH 501A AIR INLET TEMPERATURE	AI	1
TE507B	APH 501B AIR INLET TEMPERATURE	AI	1
TE507C	APH 501C AIR INLET TEMPERATURE	AI	1
TE508A	APH 501A AIR OUTLET TEMPERATURE	AI	1
TE508B	APH 501B AIR OUTLET TEMPERATURE	AI	1
TE508C	APH 501C AIR OUTLET TEMPERATURE	AI	1
TE601	CYCLONE CL-601E OUTLET TEMP-GAS	AI	1
TE601A	CYCLONE CL-601A INLET TEMP	AI	1
TE601B	CYCLONE CL-601B INLET TEMP	AI	1
TE601C	CYCLONE CL-601C INLET TEMP	AI	1
TE602	CYCLONE CL-601H OUTLET TEMP-GAS	AI	1
TE602A	FAN F-601A INBOARD BEARING TEMP	AI	1
TE602B	FAN F-601B INBOARD BEARING TEMP	AI	1
TE602C	FAN F-601C INBOARD BEARING TEMP	AI	1
TE603A	FAN F-601A OUTBOARD BEARING TEMP	AI	1
TE603B	FAN F-601B OUTBOARD BEARING TEMP	AI	1
TE603C	FAN F-601C OUTBOARD BEARING TEMP	AI	1
TE605	FAN F-602 INBOARD BEARING TEMP	AI	1
TE606	FAN F-602 OUTBOARD BEARING TEMP	AI	1
TE609	FAN F-603 INBOARD BEARING TEMP	AI	1
TE610	FAN F-603 OUTBOARD BEARING TEMP	AI	1
TI101	STREAM 1 TEMPERATURE	AO	1
TI300	TEMP INDICATOR NH3 ACCUM TANK	--	1
TI501	SUM OF APH AIR INLET TEMP	AO	1
TI502	SUM OF APH AIR OUTLET TEMP	AO	1
TI503	SUM OF APH GAS OUTLET TEMP	AO	1
TS300	TEMP SW NH3 VAPORIZER TANK 1	DI	1
TS301	TEMP SW NH3 VAPORIZER TANK 2	DI	1
TS302	TEMP SW NH3 ACCUM TANK	DI	1
XS10002	TRANSFORMER 1000-2 MISC. ALARM	DI	1
XS10003	TRANSFORMER 1000-3 MISC. ALARM	DI	1
XS10004	TRANSFORMER 1000-4 MISC. ALARM	DI	1
XS10005	TRANSFORMER 1000-5 MISC. ALARM	DI	1
XS501	FAN F-501 RUNNING	DI	1
XSA501A1	APH 501A STATUS 1	DI	1
XSA501A2	APH 501A STATUS 2	DI	1
XSA501B1	APH 501B STATUS 1	DI	1
XSA501B2	APH 501B STATUS 2	DI	1
XSAC1000	AIR COMPRESSOR AC-1000 RUNNING	DI	1
XSF601A1	FAN F-601A STATUS 1	DI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
XSF601A2	FAN F-601A STATUS 2	DI	1
XSF601B1	FAN F-601B STATUS 1	DI	1
XSF601B2	FAN F-601B STATUS 2	DI	1
XSF601C1	FAN F-601C STATUS 1	DI	1
XSF601C2	FAN F-601C STATUS 2	DI	1
XSF6021	FAN F-602 STATUS 1	DI	1
XSF6022	FAN F-602 STATUS 2	DI	1
XSF6031	FAN F-603 STATUS 1	DI	1
XSF6032	FAN F-603 STATUS 2	DI	1
XSP1000	SERVICE WATER PUMP 1000 RUNNING	DI	1
XSSWGR1	SWITCHGEAR 1 TRIP	DI	1
XSSWGR2	SWITCHGEAR 2 TRIP	DI	1
XSSWGR3	SWITCHGEAR 3 TRIP	DI	1
XSSWGR4	SWITCHGEAR 4 TRIP	DI	1
XSSWGR5	SWITCHGEAR 5 TRIP	DI	1
XXH201A	REACTOR TRAIN A FLUE GAS HEATER	AO	1
XXH201B	REACTOR TRAIN B FLUE GAS HEATER	AO	1
XXH201C	REACTOR TRAIN C FLUE GAS HEATER	AO	1
XXH201D	REACTOR TRAIN D FLUE GAS HEATER	AO	1
XXH201E	REACTOR TRAIN E FLUE GAS HEATER	AO	1
XXH201F	REACTOR TRAIN F FLUE GAS HEATER	AO	1
XXH201G	REACTOR TRAIN G FLUE GAS HEATER	AO	1
XXH201H	REACTOR TRAIN H FLUE GAS HEATER	AO	1
XXH201J	REACTOR TRAIN J FLUE GAS HEATER	AO	1
YI802	O2 ANALYZER	AO	1
YI803	CO ANALYZER	AO	1
YI804	CO2 ANALYZER	AO	1
ZS201A	ISOLATION DAMPER D-201A CLOSED	DI	1
ZS201B	ISOLATION DAMPER D-201B CLOSED	DI	1
ZS201C	ISOLATION DAMPER D-201C CLOSED	DI	1
ZS201D	ISOLATION DAMPER D-201D CLOSED	DI	1
ZS201E	ISOLATION DAMPER D-201E CLOSED	DI	1
ZS201F	ISOLATION DAMPER D-201F CLOSED	DI	1
ZS201G	ISOLATION DAMPER D-201G CLOSED	DI	1
ZS201H	ISOLATION DAMPER D-201H CLOSED	DI	1
ZS201J	ISOLATION DAMPER D-201J CLOSED	DI	1
ZS300	NH3 TANK 1 DISCH VALVE CLOSED	DI	1
ZS300A	NH3 TRAIN A SHUTOFF VALVE CLOSED	DI	1
ZS300B	NH3 TRAIN B SHUTOFF VALVE CLOSED	DI	1
ZS300C	NH3 TRAIN C SHUTOFF VALVE CLOSED	DI	1
ZS300D	NH3 TRAIN D SHUTOFF VALVE CLOSED	DI	1
ZS300E	NH3 TRAIN E SHUTOFF VALVE CLOSED	DI	1
ZS300F	NH3 TRAIN F SHUTOFF VALVE CLOSED	DI	1
ZS300G	NH3 TRAIN G SHUTOFF VALVE CLOSED	DI	1
~~ZS300H~~	~~NH3 TRAIN H SHUTOFF VALVE CLOSED~~	~~DI~~	~~1~~
ZS300J	NH3 TRAIN J SHUTOFF VALVE CLOSED	DI	1
~~ZS301~~	~~NH3 TANK 2 DISCH VALVE CLOSED~~	~~DI~~	~~1~~
ZS401A	ISOLATION DAMPER D-401A CLOSED	DI	1
ZS401B	ISOLATION DAMPER D-401B CLOSED	DI	1
ZS401C	ISOLATION DAMPER D-401C CLOSED	DI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
ZS402A	ISOLATION DAMPER D-402A CLOSED	DI	1
ZS402B	ISOLATION DAMPER D-402B CLOSED	DI	1
ZS402C	ISOLATION DAMPER D-402C CLOSED	DI	1
ZS501A	ISOLATION DAMPER D-501A CLOSED	DI	1
ZS501B	ISOLATION DAMPER D-501B CLOSED	DI	1
ZS501C	ISOLATION DAMPER D-501C CLOSED	DI	1
ZS502A	ISOLATION DAMPER D-502A CLOSED	DI	1
ZS502B	ISOLATION DAMPER D-502B CLOSED	DI	1
ZS502C	ISOLATION DAMPER D-502C CLOSED	DI	1
ZS503A	ISOLATION DAMPER D-503A CLOSED	DI	1
ZS503B	ISOLATION DAMPER D-503B CLOSED	DI	1
ZS503C	ISOLATION DAMPER D-503C CLOSED	DI	1
ZS601A	ISOLATION DAMPER D-601A CLOSED	DI	1
ZS601B	ISOLATION DAMPER D-601B CLOSED	DI	1
ZS601C	ISOLATION DAMPER D-601C CLOSED	DI	1
ZT101	ECONOMIZER OUT DMPR POSITION	AI	1
ZT504	FAN F501 INLET DMPR POSITION	AI	1
ZT505A	APH 501A AIR INLET DMPR POSITION	AI	1
ZT505B	APH 501B AIR INLET DMPR POSITION	AI	1
ZT505C	APH 501C AIR INLET DMPR POSITION	AI	1
ZT601D	REACTOR TRAIN D FLOW DMPR POSITION	AI	1
ZT601E	REACTOR TRAIN E FLOW DMPR POSITION	AI	1
ZT601F	REACTOR TRAIN F FLOW DMPR POSITION	AI	1
ZT601G	REACTOR TRAIN G FLOW DMPR POSITION	AI	1
ZT601H	REACTOR TRAIN H FLOW DMPR POSITION	AI	1
ZT601J	REACTOR TRAIN J FLOW DMPR POSITION	AI	1
ZZ101	ECONOMIZER OUT DMPR POSITIONER	AO	1
ZZ504	FAN F501 INLET DMPR POSITIONER	AO	1
ZZ505A	APH 501A AIR INLET DMPR POSITIONER	AO	1
ZZ505B	APH 501B AIR INLET DMPR POSITIONER	AO	1
ZZ505C	APH 501C AIR INLET DMPR POSITIONER	AO	1
ZZ601D	REACTOR TRAIN D FLOW CNTRL DAMPER	AO	1
ZZ601E	REACTOR TRAIN E FLOW CNTRL DAMPER	AO	1
ZZ601F	REACTOR TRAIN F FLOW CNTRL DAMPER	AO	1
ZZ601G	REACTOR TRAIN G FLOW CNTRL DAMPER	AO	1
ZZ601H	REACTOR TRAIN H FLOW CNTRL DAMPER	AO	1
ZZ601J	REACTOR TRAIN J FLOW CNTRL DAMPER	AO	1
*** Total ***			587

12.0 AREA 1000: UTILITY SYSTEMS

Area 1000 includes all the various utility systems for the SCR pilot-plant and each are discussed in further detail in this section.

12.1 DESCRIPTION

12.1.1 Electric Service

The electric service distribution system scope has changed significantly from the earlier, original proposal. The original design was rather simple, and was based on using station service from Gulf Power Company (Gulf) through an existing 4160-volt switchgear as the main source feed and tie point for the entire SCR electrical station service. This source fed two transformers, with each transformer feeding a 600-volt motor control center (MCC), and each MCC had a distribution capability of five frames. See Figure 12.1-1 for a sketch representing this original concept.

The scope for electrical station service loading has increased substanitally. The primary reasons for the scope changes are the growth of electrical demands for the pilot plant over original design, limitation of Plant Crist station service reserves (less than the required SCR pilot plant load), and the rearrangement of the Crist 115-KV bus. The scope changes include the following:

1. The 600-volt system has been replaced with a 480-volt, low voltage distribution system, which is state of the art, and a stock or off the shelf equipment.

2. An entire 115-KV system has been added. This system consists of cable bus (4160-volt, 3000-amp), transformer (12/16/20 MVA), oil circuit breaker, 115-KV bus work at the tie in point, 4160V protective relaying, 115-KV disconnects, 7.5-KV disconnects, and 115-KV relaying. The transformer listed is existing equipment on site, which may be made available at no cost to the project.

3. A medium voltage 4160-volt distribution system, consisting of 4 feeds, with 4 transformers and 4 MCCs, instead of the single 4160-volt tie breaker described in the original design. Each of four 4160-volt switchgear breakers feed a 4160-volt/480-volt transformer, which in turn feeds four 480-volt MCCs.

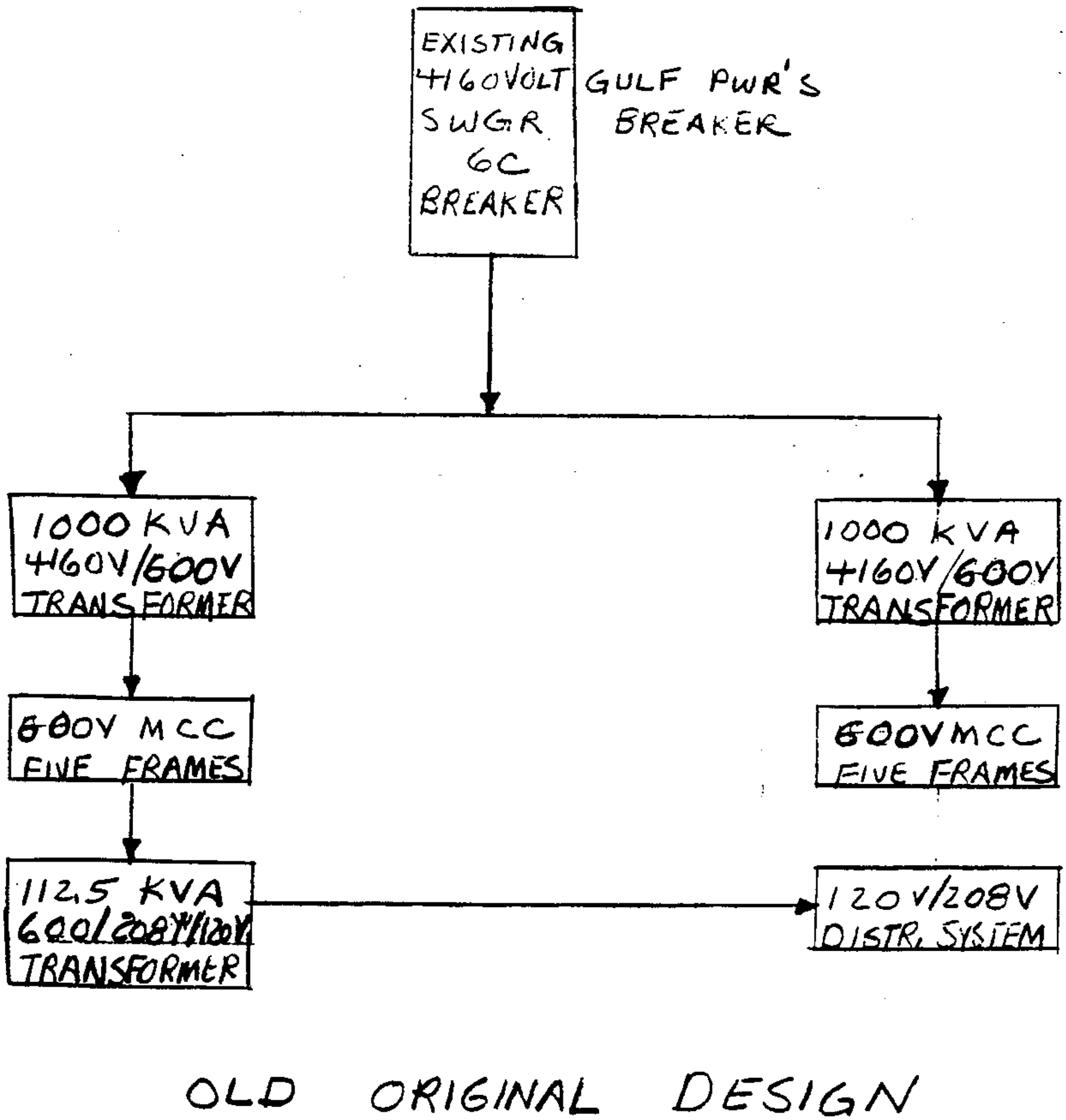


Figure 12.1-1. Sketch of origianal concept of SCR pilot plant.

One of the 480-volt MCCs feeds three 225-KVA, 480V-208Y/120V transformers, for 120/208V low voltage distribution.

4. Seven variable speed motors and controllers have been added to the original design. In addition, the greater power loads increased the requirements for power and control cables, conduits, and cable trays. Direct current (DC) supply, from the powerhouse at Gulf's existing station battery, is also proposed.

A single line diagram of the electrical distribution system is shown in Figure 12.1-2. A sketch of the estimated spacing of the major equipment areas is given in Figure 12.1-3.

The electrical design has the flexibility to operate any two of three reactors, should equipment failure cause reactor shut down. This flexibility, however, exists only at the 4160-volt level. The 115-KV system has no redundancy because of costly equipment.

The power consumed by the SCR pilot plant will be metered, and Gulf will be reimbursed for this power usage. A watthour meter will be used at the 4.16-KV station service switchgear, grouping and metering the SCR plant's power consumption.

Proper isolation of the silicon controlled rectifiers, used with the duct heaters and adjustable speed drive systems, will be incorporated into the station service design of the SCR project. Heater manufacturers are being advised of the tendencey of porcelain insulators to fail under reactor operating temperatures.

12.1.2 Potable Water

A 2" potable water line will be installed to provide drinking and sanitary water to the project's control room. This line will come off the existing potable water line located along the turbine room crane rail. The routing of the line has already been selected.

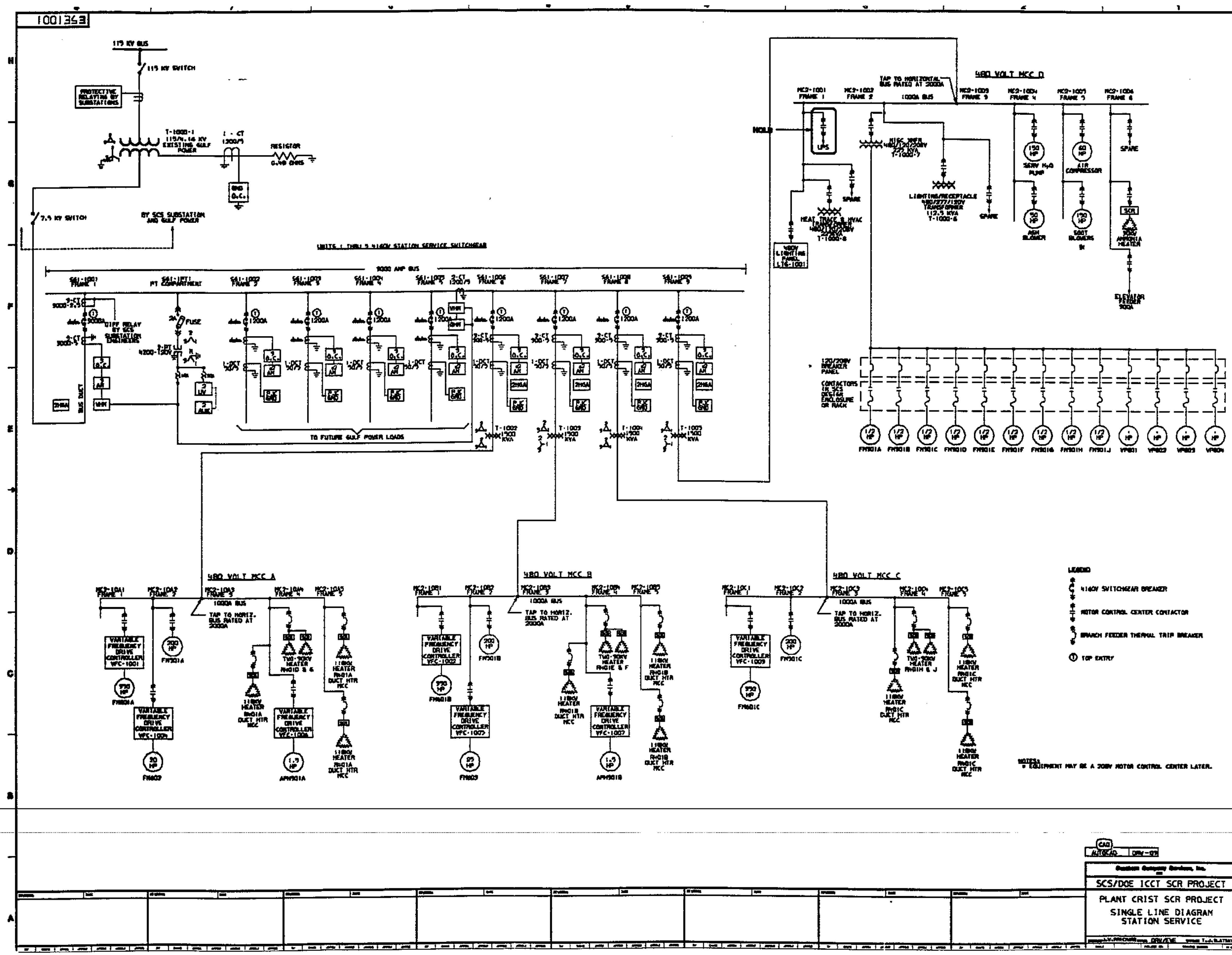


Figure 12.1-2.
Single line drawing of the electrical distribution system.

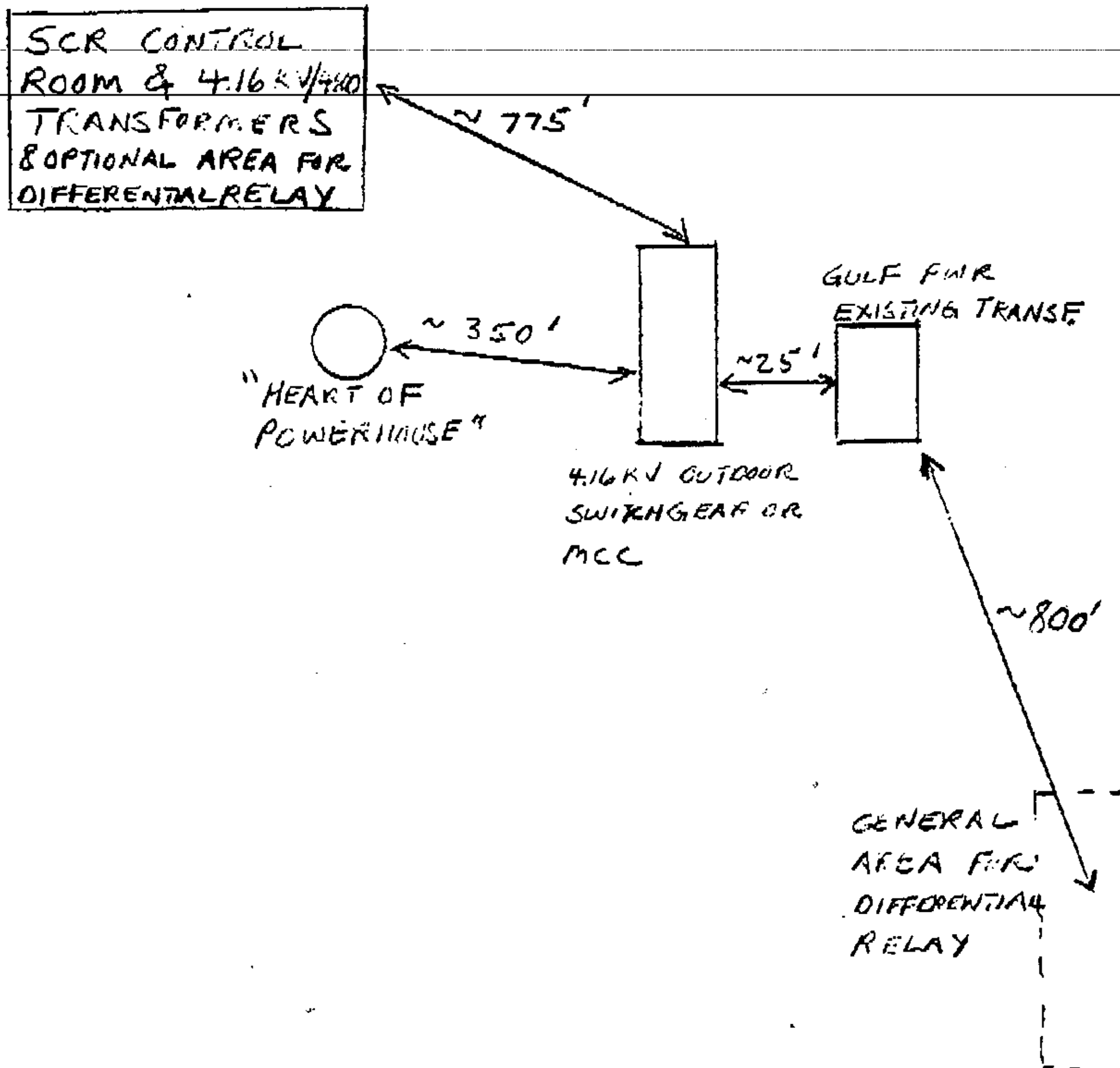


Figure 12.1-3. Sketch showing estimated spacing of the major equipment areas.

12.1.3 Service Water

A service water pump with a preliminary capacity of 2200 gpm is to be installed in the basement of the Unit 4 turbine room. The water source for the pump will be the Unit 4 and 5 circulating water tunnel. The water will be strained prior to entering the pump and is to then be conveyed through an 8-inch diameter line to the project's consumption points in the Unit 5 precipitator area. A preliminary routing of the line has already been determined.

12.1.4 Steam

A steam supply piping system will be installed from the Unit 5 boiler to provide the high temperature steam to the reactor sootblower systems. This system will be designed according to established codes and will consist of the isolation valves, steam control and pressure regulating valves, piping, hangers, and accessories.

12.1.5 Fire Protection System

The plant's existing fire protection system will be extended to incorporate the addition of project equipment and improvements. The system will be designed to meet the Southern electric system insurance requirements for personnel safety, property protection, and any additional U.S. Department of Energy requirements.

12.1.6 Nitrogen System

A nitrogen system will be installed (or the existing system will be modified) to provide safety blanketing of project equipment during extended equipment shutdown.

12.1.7 Heating, Ventilation and Air Conditioning System

Heating and air condition systems will be installed in the project control room for equipment protection and operator comfort. Ventilation systems will be installed in the control room areas where slightly higher temperatures can be tolerated by electrical equipment and plant personnel.

12.1.8 Telecommunications System

(Later)

12.2 Major Equipment

Table 12.2-1
Listing of Major Equipment in Area 1000

Area	Description	Equipment No.
1000	480V Lighting Panel	LTG-1001
1000	480V Motor Control Center A, Frame #1	MC2-10A1
1000	480V Motor Control Center A, Frame #2	MC2-10A2
1000	480V Motor Control Center A, Frame #3	MC2-10A3
1000	480V Motor Control Center A, Frame #4	MC2-10A4
1000	480V Motor Control Center A, Frame #5	MC2-10A5
1000	480V Motor Control Center B, Frame #1	MC2-10B1
1000	480V Motor Control Center B, Frame #2	MC2-10B2
1000	480V Motor Control Center B, Frame #3	MC2-10B3
1000	480V Motor Control Center B, Frame #4	MC2-10B4
1000	480V Motor Control Center B, Frame #5	MC2-10B5
1000	480V Motor Control Center C, Frame #1	MC2-10C1
1000	480V Motor Control Center C, Frame #2	MC2-10C2
1000	480V Motor Control Center C, Frame #3	MC2-10C3
1000	480V Motor Control Center C, Frame #4	MC2-10C4
1000	480V Motor Control Center C, Frame #5	MC2-10C5
1000	480V Motor Control Center D, Frame #1	MC2-10D1
1000	480V Motor Control Center D, Frame #2	MC2-10D2
1000	480V Motor Control Center D, Frame #3	MC2-10D3
1000	480V Motor Control Center D, Frame #4	MC2-10D4
1000	480V Motor Control Center D, Frame #5	MC2-10D5
1000	480V Motor Control Center D, Frame #6	MC2-10D6
1000	4160V Switchgear, Frame #1	SG1-1001
1000	4160V Switchgear, Frame #2	SG1-1002
1000	4160V Switchgear, Frame #3	SG1-1003
1000	4160V Switchgear, Frame #4	SG1-1004
1000	4160V Switchgear, Frame #5	SG1-1005
1000	4160V Switchgear, Frame #6	SG1-1006
1000	4160V Switchgear, Frame #7	SG1-1007
1000	4160V Switchgear, Frame #8	SG1-1008
1000	4160V Switchgear, Frame #9	SG1-1009
1000	4160V Switchgear, Pt Compartment	SG1-1PT1
1000	12 MVA, Transformer 115KV/4.16KV (by Gulf Power)	T-1000-1
1000	1500 KVA, Transformer 4.16KV/480	T-1000-2
1000	1500 KVA, Transformer 4.16KV/480	T-1000-3
1000	1500 KVA, Transformer 4.16KV/480	T-1000-4
1000	1500 KVA, Transformer 4.16KV/480	T-1000-5
1000	112.5 KVA, Lighting Transformer 480/277/120	T-1000-6
1000	225 KVA, Misc Transformer 480/120/208	T-1000-7
1000	225 KVA, Heat Tracing 8 HVAC Transformer 480/208/120	T-1000-8
1000	Variable Frequency Drive Controller	VFC-1001
1000	Variable Frequency Drive Controller	VFC-1002
1000	Variable Frequency Drive Controller	VFC-1003
1000	Variable Frequency Drive Controller	VFC-1004
1000	Variable Frequency Drive Controller	VFC-1005
1000	Variable Frequency Drive Controller	VFC-1006

APPENDIX A

EQUIPMENT LIST

PLANT CRIST SCR PROJECT
MAJOR EQUIPMENT LIST
(9/17/90)

REACTOR TRAIN DESIGNATION

Reactor Train	Reactor Size	Unit	Dust Loading	Catalyst Supplier	Catalyst
~~A~~	~~Large~~	~~5~~	~~High~~	~~W.R. Grace~~	~~HC-V205/TiO2 (Noxeram)~~
B	Large	5	High	Nippon Shokubi	HC-V205/TiO2/SiO2
C	Large	5	High	Siemens	Plate-V205/TiO2
D	Small	5	High	Hitachi Zosen	Plate-V205/TiO2
E	Small	5	High	W.R. Grace	HC-V205/TiO2/SiO2 (Synox)
F	Small	5	High	Norton	HC-Zeolite w/V205
G	Small	5	High	Engelhard	HC-Coated V205/TiO2
H	Small	5	High	Haldor Topsoe*	Plate-V205/TiO2
J	Small	5	Low	Engelhard	HC-Coated V205/TiO2

* Pending negotiations.

AREA DESIGNATION

AREA	DESCRIPTION
100	Flue Gas Extraction Scoop to Flue Gas Distribution Header
200	Flue Gas Distribution Header to Reactor Inlet
300	Ammonia Storage to Reactors
400	SCR Reactors
500	SCR Reactor Outlet to Cyclones
600	Cyclones to Host Boiler Duct
700	Pilot-Plant Air Compressor Station
800	Extractive Gas Sampling System
900	Control Room
1000	Utility Systems

MAJOR EQUIPMENT

Area	Description	Equipment No.
100	Host boiler duct extraction scoop	ES-101
100	Reactor train A flue gas takeoff	ES-102A
100	Reactor train B flue gas takeoff	ES-102B
100	Reactor train C flue gas takeoff	ES-102C
100	Reactor train D flue gas takeoff	ES-102D
~~100~~	~~Reactor train E flue gas takeoff~~	~~ES-102E~~
100	Reactor train F flue gas takeoff	ES-102F
100	Reactor train G flue gas takeoff	ES-102G
100	Reactor train H flue gas takeoff	ES-102H
100	Reactor train J flue gas takeoff	ES-102J
100	Main extraction line flow control damper	FCD-101
100	Economizer bypass flow control damper	FCD-102
200	Reactor train A isolation damper	DMP-201A
200	Reactor train B isolation damper	DMP-201B
200	Reactor train C isolation damper	DMP-201C
200	Reactor train D isolation damper	DMP-201D
200	Reactor train E isolation damper	DMP-201E
200	Reactor train F isolation damper	DMP-201F
200	Reactor train G isolation damper	DMP-201G
200	Reactor train H isolation damper	DMP-201H
200	Reactor train J isolation damper	DMP-201J
200	Reactor train A flue gas heater	HTR-201A
200	Reactor train B flue gas heater	HTR-201B
200	Reactor train C flue gas heater	HTR-201C
200	Reactor train D flue gas heater	HTR-201D
200	Reactor train E flue gas heater	HTR-201E
200	Reactor train F flue gas heater	HTR-201F
200	Reactor train G flue gas heater	HTR-201G
200	Reactor train H flue gas heater	HTR-201H
200	Reactor train J flue gas heater	HTR-201J
200	Reactor train A venturi	FE-201A
200	Reactor train B venturi	FE-201B
200	Reactor train C venturi	FE-201C
200	Reactor train D venturi	FE-201D
200	Reactor train E venturi	FE-201E
200	Reactor train F venturi	FE-201F
200	Reactor train G venturi	FE-201G
200	Reactor train H venturi	FE-201H
200	Reactor train J venturi	FE-201J
200	Reactor train A air purge damper	DMP-202A
200	Reactor train B air purge damper	DMP-202B
200	Reactor train C air purge damper	DMP-202C
200	Reactor train D air purge damper	DMP-202D
200	Reactor train E air purge damper	DMP-202E
200	Reactor train F air purge damper	DMP-202F
200	Reactor train G air purge damper	DMP-202G
200	Reactor train H air purge damper	DMP-202H
200	Reactor train J air purge damper	DMP-202J
200	Reactor train A inlet damper	DMP-203A

200	Reactor train B inlet damper	DMP-203B
200	Reactor train C inlet damper	DMP-203C
200	Reactor train A inlet bypass damper	DMP-204A
200	Reactor train B inlet bypass damper	DMP-204B
200	Reactor train C inlet bypass damper	DMP-204C
300	Ammonia storage tank	TNK-301
300	Ammonia storage tank heater/vaporizer	HTR-301
300	Ammonia accumulator tank	TNK-302
300	Reactor train A ammonia flow control valve	FCV-301A
300	Reactor train B ammonia flow control valve	FCV-301B
300	Reactor train C ammonia flow control valve	FCV-301C
300	Reactor train D ammonia flow control valve	FCV-301D
300	Reactor train E ammonia flow control valve	FCV-301E
300	Reactor train F ammonia flow control valve	FCV-301F
300	Reactor train G ammonia flow control valve	FCV-301G
300	Reactor train H ammonia flow control valve	FCV-301H
300	Reactor train J ammonia flow control valve	FCV-301J
300	Ammonia dilution air filter	FIL-301
300	Ammonia dilution air fan	F-301
300	Ammonia dilution air fan motor	MXR-301
300	Reactor train A air/ammonia mixer	MXR-301A
300	Reactor train B air/ammonia mixer	MXR-301B
300	Reactor train C air/ammonia mixer	MXR-301C
300	Reactor train D air/ammonia mixer	MXR-301D
300	Reactor train E air/ammonia mixer	MXR-301E
300	Reactor train F air/ammonia mixer	MXR-301F
300	Reactor train G air/ammonia mixer	MXR-301G
300	Reactor train H air/ammonia mixer	MXR-301H
300	Reactor train J air/ammonia mixer	MXR-301J
300	Reactor train A air/ammonia injection grid	AIG-301A
300	Reactor train B air/ammonia injection grid	AIG-301B
300	Reactor train C air/ammonia injection grid	AIG-301C
300	Reactor train D air/ammonia injection grid	AIG-301D
300	Reactor train E air/ammonia injection grid	AIG-301E
300	Reactor train F air/ammonia injection grid	AIG-301F
300	Reactor train G air/ammonia injection grid	AIG-301G
300	Reactor train H air/ammonia injection grid	AIG-301H
300	Reactor train J air/ammonia injection grid	AIG-301J
300	Ammonia dilution air electric heater	HTR-302
300	Reactor train A dilution air damper	DMP-301A
300	Reactor train B dilution air damper	DMP-301B
300	Reactor train C dilution air damper	DMP-301C
300	Reactor train D dilution air damper	DMP-301D
300	Reactor train E dilution air damper	DMP-301E
300	Reactor train F dilution air damper	DMP-301F
300	Reactor train G dilution air damper	DMP-301G
300	Reactor train H dilution air damper	DMP-301H
300	Reactor train J dilution air damper	DMP-301J
400	SCR reactor A	RXR-401A
400	SCR reactor B	RXR-401B
400	SCR reactor C	RXR-401C
400	SCR reactor D	RXR-401D

400	SCR reactor E	RXR-401E
400	SCR reactor F	RXR-401F
400	SCR reactor G	RXR-401G
400	SCR reactor H	RXR-401H
400	SCR reactor J	RXR-401J
400	Reactor A typical dummy layer (flow straightener)	DL-401A
400	Reactor B typical dummy layer (flow straightener)	DL-401B
400	Reactor C typical dummy layer (flow straightener)	DL-401C
400	~~Reactor D typical dummy layer (flow straightener)~~	~~DL-401D~~
400	~~Reactor E typical dummy layer (flow straightener)~~	~~DL-401E~~
400	Reactor F typical dummy layer (flow straightener)	DL-401F
400	Reactor G typical dummy layer (flow straightener)	DL-401G
400	Reactor H typical dummy layer (flow straightener)	DL-401H
400	Reactor J typical dummy layer (flow straightener)	DL-401J
400	Reactor A first layer catalyst basket	CB-401A
400	Reactor B first layer catalyst basket	CB-401B
400	Reactor C first layer catalyst basket	CB-401C
400	Reactor D first layer catalyst basket	CB-401D
400	Reactor E first layer catalyst basket	CB-401E
400	Reactor F first layer catalyst basket	CB-401F
400	Reactor G first layer catalyst basket	CB-401G
400	Reactor H first layer catalyst basket	CB-401H
400	Reactor J first layer catalyst basket	CB-401J
400	Reactor A second layer catalyst basket	CB-402A
400	Reactor B second layer catalyst basket	CB-402B
400	Reactor C second layer catalyst basket	CB-402C
400	Reactor D second layer catalyst basket	CB-402D
400	Reactor E second layer catalyst basket	CB-402E
400	Reactor F second layer catalyst basket	CB-402F
400	Reactor G second layer catalyst basket	CB-402G
400	Reactor H second layer catalyst basket	CB-402H
400	Reactor J second layer catalyst basket	CB-402J
400	Reactor A third layer catalyst basket	CB-403A
400	Reactor B third layer catalyst basket	CB-403B
400	Reactor C third layer catalyst basket	CB-403C
400	Reactor D third layer catalyst basket	CB-403D
400	Reactor E third layer catalyst basket	CB-403E
400	Reactor F third layer catalyst basket	CB-403F
400	Reactor G third layer catalyst basket	CB-403G
400	Reactor H third layer catalyst basket	CB-403H
400	Reactor J third layer catalyst basket	CB-403J
400	Reactor A fourth layer catalyst basket	CB-404A
400	Reactor B fourth layer catalyst basket	CB-404B
400	Reactor C fourth layer catalyst basket	CB-404C
400	Reactor D fourth layer catalyst basket	CB-404D
400	Reactor E fourth layer catalyst basket	CB-404E
400	Reactor F fourth layer catalyst basket	CB-404F
400	Reactor G fourth layer catalyst basket	CB-404G
400	Reactor H fourth layer catalyst basket	CB-404H
400	Reactor J fourth layer catalyst basket	CB-404J
500	Reactor train A air preheater (APH)	APH-501A
500	Reactor train B air preheater (APH)	APH-501B
500	Reactor train C air preheater (APH)	APH-501C

500	Reactor train A APH bypass heat exchanger	HX-501A
500	Reactor train B APH bypass heat exchanger	HX-501B
500	Reactor train C APH bypass heat exchanger	HX-501C
500	Reactor train A APH inlet isolation damper	DMP-501A
500	Reactor train B APH inlet isolation damper	DMP-501B
500	Reactor train C APH inlet isolation damper	DMP-501C
500	Reactor train A APH bypass isolation damper	DMP-502A
500	Reactor train B APH bypass isolation damper	DMP-502B
500	Reactor train C APH bypass isolation damper	DMP-502C
500	Reactor train A APH outlet isolation damper	DMP-503A
500	Reactor train B APH outlet isolation damper	DMP-503B
500	Reactor train C APH outlet isolation damper	DMP-503C
500	Reactor train A air preheater (APH) motor	MTR-501A
500	Reactor train B air preheater (APH) motor	MTR-501B
500	APH hot air fan	F-502
500	APH hot air fan motor	MTR-502
500	Perforated plate/oriface	FE-501
500	Reactor train A APH air inlet damper	DMP-504A
500	Reactor train B APH air inlet damper	DMP-504B
500	Reactor train C APH air inlet damper	DMP-504C
500	Reactor train A bypass outlet damper	DMP-505A
500	Reactor train B bypass outlet damper	DMP-505B
500	Reactor train C bypass outlet damper	DMP-505C
600	Reactor train A cyclone	CYC-601A
600	Reactor train B cyclone	CYC-601B
600	Reactor train C cyclone	CYC-601C
600	Reactor train D cyclone	CYC-601D
600	Reactor train E cyclone	CYC-601E
600	Reactor train F cyclone	CYC-601F
600	Reactor train G cyclone	CYC-601G
600	Reactor train H cyclone	CYC-601H
600	Reactor train D flow control damper	FCD-601D
600	Reactor train E flow control damper	FCD-601E
600	Reactor train F flow control damper	FCD-601F
600	Reactor train G flow control damper	FCD-601G
600	Reactor train H flow control damper	FCD-601H
600	Reactor train J flow control damper	FCD-601J
600	Reactor train A ID fan	F-601A
600	Reactor train B ID fan	F-601B
600	Reactor train C ID fan	F-601C
600	ID fan for reactor trains D, E & F	F-602
600	ID fan for reactor trains G, H & J	F-603
600	Fan motor for F-601A	MTR-601A
600	Fan motor for F-601B	MTR-601B
600	Fan motor for F-601C	MTR-601C
600	Fan motor for F-602	MTR-602
600	Fan motor for F-603	MTR-603
600	Reactor train A isolation damper	DMP-601A
600	Reactor train B isolation damper	DMP-601B
600	Reactor train C isolation damper	DMP-601C
600	Reactor trains D, E & F isolation damper	DMP-602
600	Reactor trains G, H & J isolation damper	DMP-603

700	Air Filter	FIL-701
700	Air Dryer	DRY-701
700	Air Compressor	COM-701
700	Compressed Air Surge Cylinders	TNK-701
700	Pressure Regulator	PR-701
700	Pressure Relief Valve	PRV-701
700	Instrument Air Filter	FIL-702
700	Instrument Air Dryer	DRY-702
700	Instrument Air Pressure Regulator	PR-702
800	Analyzer Bank No. 1	AB-801
800	Analyzer Bank No. 2	AB-802
800	Analyzer Bank No. 3	AB-803
800	Analyzer Bank No. 4	AB-804
800	Bypass flow control valve for AB-801	FCV-801
800	Bypass flow control valve for AB-802	FCV-802
800	Bypass flow control valve for AB-803	FCV-803
800	Bypass flow control valve for AB-804	FCV-804
800	Gas sampling valve for point 801	GSV-801
800	Gas sampling valve for point 802	GSV-802
800	Gas sampling valve for point 803	GSV-803
800	Gas sampling valve for point 804	GSV-804
800	Gas sampling valve for point 805	GSV-805
800	Gas sampling valve for point 806	GSV-806
800	Gas sampling valve for point 807	GSV-807
800	Gas sampling valve for point 808	GSV-808
800	Gas sampling valve for point 809	GSV-809
800	Gas sampling valve for point 810	GSV-810
800	Gas sampling valve for point 811	GSV-811
800	Gas sampling valve for point 812	GSV-811
800	Gas sampling valve for point 813	GSV-811
800	Gas sampling valve for point 814	GSV-811
800	Gas sampling valve for point 815	GSV-811
800	Gas sampling valve for point 816	GSV-811
800	Gas sampling valve for point 817	GSV-811
800	Gas sampling valve for point 818	GSV-811
800	Gas sampling valve for point 819	GSV-811
800	Gas sampling valve for point 820	GSV-811
800	Gas sampling valve for point 821	GSV-811
800	Gas sampling valve for point 822	GSV-811
800	Gas sampling valve for point 823	GSV-811
800	Gas sampling valve for point 824	GSV-811
800	Gas sampling valve for point 825	GSV-811
800	Gas sampling valve for point 826	GSV-811
800	Gas sampling valve for point 827	GSV-811
800	Gas sampling valve for point 828	GSV-811
800	Gas sampling valve for point 829	GSV-829
800	Gas sampling valve for point 830	GSV-830
800	Gas sampling valve for point 831	GSV-831
800	Gas sampling valve for point 832	GSV-832
800	Gas sampling valve for point 833	GSV-833
800	Gas sampling valve for point 834	GSV-834
800	Gas sampling valve for point 835	GSV-835
800	Gas sampling valve for point 836	GSV-836

800	Gas sampling valve for point 837	GSV-837
800	Gas sampling valve for point 838	GSV-838
800	Gas sampling valve for point 839	GSV-839
800	Gas sampling valve for point 840	GSV-840
800	Sample conditioner for AB-801	SC-801
800	Sample conditioner for AB-802	SC-802
800	Sample conditioner for AB-803	SC-803
800	Sample conditioner for AB-804	SC-804
800	Sample probe for point 801	SP-801
800	Sample probe for point 802	SP-802
800	Sample probe for point 803	SP-803
800	Sample probe for point 804	SP-804
800	Sample probe for point 805	SP-805
800	Sample probe for point 806	SP-806
800	Sample probe for point 807	SP-807
800	Sample probe for point 808	SP-808
800	Sample probe for point 809	SP-809
800	Sample probe for point 810	SP-810
800	Sample probe for point 811	SP-811
800	Sample probe for point 812	SP-812
800	Sample probe for point 813	SP-813
800	Sample probe for point 814	SP-814
800	Sample probe for point 815	SP-815
800	Sample probe for point 816	SP-816
800	Sample probe for point 817	SP-817
800	Sample probe for point 818	SP-818
800	Sample probe for point 819	SP-819
800	Sample probe for point 820	SP-820
800	Sample probe for point 821	SP-821
800	Sample probe for point 822	SP-822
800	Sample probe for point 823	SP-823
800	Sample probe for point 824	SP-824
800	Sample probe for point 825	SP-825
800	Sample probe for point 826	SP-826
800	Sample probe for point 827	SP-827
800	Sample probe for point 828	SP-828
800	Sample probe for point 829	SP-829
800	Sample probe for point 830	SP-830
800	Sample probe for point 831	SP-831
800	Sample probe for point 832	SP-832
800	Sample probe for point 833	SP-833
800	Sample probe for point 834	SP-834
800	Sample probe for point 835	SP-835
800	Sample probe for point 836	SP-836
800	Sample probe for point 837	SP-837
800	Sample probe for point 838	SP-838
800	Sample probe for point 839	SP-839
800	Sample probe for point 840	SP-840
800	Sample probe for point 841	SP-841
800	NH_3 or SO_3 trap for AB-803	TR-801
800	NH_3 or SO_3 trap for AB-804	TR-802
800	Vacuum pump for AB-801	VP-801
800	Vacuum pump for AB-802	VP-802
800	Vacuum pump for AB-803	VP-803

800	Vacuum pump for AB-804	VP-804
900	None	
1000	480V Lighting Panel	LTG-1001
1000	480V Motor Control Center A, Frame #1	MC2-10A1
1000	480V Motor Control Center A, Frame #2	MC2-10A2
1000	480V Motor Control Center A, Frame #3	MC2-10A3
1000	480V Motor Control Center A, Frame #4	MC2-10A4
1000	480V Motor Control Center A, Frame #5	MC2-10A5
1000	480V Motor Control Center B, Frame #1	MC2-10B1
1000	480V Motor Control Center B, Frame #2	MC2-10B2
1000	480V Motor Control Center B, Frame #3	MC2-10B3
1000	480V Motor Control Center B, Frame #4	MC2-10B4
1000	480V Motor Control Center B, Frame #5	MC2-10B5
1000	480V Motor Control Center C, Frame #1	MC2-10C1
1000	480V Motor Control Center C, Frame #2	MC2-10C2
1000	480V Motor Control Center C, Frame #3	MC2-10C3
1000	480V Motor Control Center C, Frame #4	MC2-10C4
1000	480V Motor Control Center C, Frame #5	MC2-10C5
1000	480V Motor Control Center D, Frame #1	MC2-10D1
1000	480V Motor Control Center D, Frame #2	MC2-10D2
1000	480V Motor Control Center D, Frame #3	MC2-10D3
1000	480V Motor Control Center D, Frame #4	MC2-10D4
1000	480V Motor Control Center D, Frame #5	MC2-10D5
1000	480V Motor Control Center D, Frame #6	MC2-10D6
1000	4160V Switchgear, Frame #1	SG1-1001
1000	4160V Switchgear, Frame #2	SG1-1002
1000	4160V Switchgear, Frame #3	SG1-1003
1000	4160V Switchgear, Frame #4	SG1-1004
1000	4160V Switchgear, Frame #5	SG1-1005
1000	4160V Switchgear, Frame #6	SG1-1006
1000	4160V Switchgear, Frame #7	SG1-1007
1000	4160V Switchgear, Frame #8	SG1-1008
1000	4160V Switchgear, Frame #9	SG1-1009
1000	4160V Switchgear, Pt Compartment	SG1-1PT1
1000	12 MVA, Transformer 115KV/4.16KV (by Gulf Power)	T-1000-1
1000	1500 KVA, Transformer 4.16KV/480	T-1000-2
1000	1500 KVA, Transformer 4.16KV/480	T-1000-3
1000	1500 KVA, Transformer 4.16KV/480	T-1000-4
1000	1500 KVA, Transformer 4.16KV/480	T-1000-5
1000	112.5 KVA, Lighting Transformer 480/277/120	T-1000-6
1000	225 KVA, Misc Transformer 480/120/208	T-1000-7
1000	225 KVA, Heat Tracing 8 HVAC Transformer 480/208/120	T-1000-8
1000	Variable Frequency Drive Controller	VFC-1001
1000	Variable Frequency Drive Controller	VFC-1002
1000	Variable Frequency Drive Controller	VFC-1003
1000	Variable Frequency Drive Controller	VFC-1004
1000	Variable Frequency Drive Controller	VFC-1005
1000	Variable Frequency Drive Controller	VFC-1006

APPENDIX B

INSTRUMENTATION SCHEDULE

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
D201A	REACTOR TRAIN A ISOLATION DAMPER	DO	1
D201B	REACTOR TRAIN B ISOLATION DAMPER	DO	1
D201C	REACTOR TRAIN C ISOLATION DAMPER	DO	1
D201D	REACTOR TRAIN D ISOLATION DAMPER	DO	1
D201E	REACTOR TRAIN E ISOLATION DAMPER	DO	1
D201F	REACTOR TRAIN F ISOLATION DAMPER	DO	1
D201G	REACTOR TRAIN G ISOLATION DAMPER	DO	1
D201H	REACTOR TRAIN H ISOLATION DAMPER	DO	1
D201J	REACTOR TRAIN J ISOLATION DAMPER	DO	1
D401A	REACTOR A INLET ISOLATION DAMPER	DO	1
D401B	REACTOR B INLET ISOLATION DAMPER	DO	1
D401C	REACTOR C INLET ISOLATION DAMPER	DO	1
D402A	REACTOR A BYPASS ISOLATION DAMPER	DO	1
D402B	REACTOR B BYPASS ISOLATION DAMPER	DO	1
D402C	REACTOR C BYPASS ISOLATION DAMPER	DO	1
D501A	REACTOR A APH INLET ISOLATION DAMPR	DO	1
D501B	REACTOR B APH INLET ISOLATION DAMPR	DO	1
D501C	REACTOR C APH INLET ISOLATION DAMPR	DO	1
D502A	REACTOR A APH BYPASS ISOLATION DMPR	DO	1
D502B	REACTOR B APH BYPASS ISOLATION DMPR	DO	1
D502C	REACTOR C APH BYPASS ISOLATION DMPR	DO	1
D503A	REACTOR A APH OUTLET ISOLATION DMPR	DO	1
D503B	REACTOR B APH OUTLET ISOLATION DMPR	DO	1
D503C	REACTOR C APH OUTLET ISOLATION DMPR	DO	1
DCSWGR1	SWITCHGEAR FRAME 1 CLOSE	DO	1
DCSWGR2	SWITCHGEAR FRAME 2 CLOSE	DO	1
DCSWGR3	SWITCHGEAR FRAME 3 CLOSE	DO	1
DCSWGR4	SWITCHGEAR FRAME 4 CLOSE	DO	1
DOA501A	RUN APH 501A	DO	1
DOA501B	RUN APH 501B	DO	1
DOAB1000	RUN ASH BLOWER	DO	1
DOAC1000	RUN AIR COMPRESSOR AC-1000	DO	1
DOF301A	RUN INJECTION AIR BLOWER F-301A	DO	1
DOF301B	RUN INJECTION AIR BLOWER F-301B	DO	1
DOF301C	RUN INJECTION AIR BLOWER F-301C	DO	1
DOF301D	RUN INJECTION AIR BLOWER F-301D	DO	1
DOF301E	RUN INJECTION AIR BLOWER F-301E	DO	1
DOF301F	RUN INJECTION AIR BLOWER F-301F	DO	1
DOF301G	RUN INJECTION AIR BLOWER F-301G	DO	1
DOF301H	RUN INJECTION AIR BLOWER F-301H	DO	1
DOF301J	RUN INJECTION AIR BLOWER F-301J	DO	1
DOF501	RUN FAN F-501	DO	1
DOF601A	RUN FAN F-601A	DO	1
DOF601B	RUN FAN F-601B	DO	1
DOF601C	RUN FAN F-601C	DO	1
DOF602	RUN FAN F-602	DO	1
DOF603	RUN FAN F-603	DO	1
DOH300	AMMONIA HEATER H-300	DO	1
DOH301	AMMONIA HEATER H-301	DO	1
DOP1000	RUN SERVICE WATER PUMP 1000	DO	1

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TAG NUMBER	DESCRIPTION	IO TYPE	QTY
DTSWGR1	SWITCHGEAR FRAME 1 TRIP	DO	1
DTSWGR2	SWITCHGEAR FRAME 2 TRIP	DO	1
DTSWGR3	SWITCHGEAR FRAME 3 TRIP	DO	1
DTSWGR4	SWITCHGEAR FRAME 4 TRIP	DO	1
DV601A	CYCLONE A DISCH VALVE	DO	1
DV601B	CYCLONE B DISCH VALVE	DO	1
DV601C	CYCLONE C DISCH VALVE	DO	1
DV601D	CYCLONE D DISCH VALVE	DO	1
DV601E	CYCLONE E DISCH VALVE	DO	1
DV601F	CYCLONE F DISCH VALVE	DO	1
DV601G	CYCLONE G DISCH VALVE	DO	1
DV601H	CYCLONE H DISCH VALVE	DO	1
FCD101	ECONOMIZER OUTLET DAMPER	AO	1
FCD505A	APH 501A AIR INLET FLOW CONTROL	AO	1
FCD505B	APH 501B AIR INLET FLOW CONTROL	AO	1
FCD505C	APH 501C AIR INLET FLOW CONTROL	AO	1
FCV300	FLOW CNTRL VLV NH3 ACCUM TANK	AO	1
FCV301A	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301B	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301C	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301D	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301E	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301F	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301G	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301H	FLOW CNTRL VLV NH3 DELIV	AO	1
FCV301J	FLOW CNTRL VLV NH3 DELIV	AO	1
FE201A	STREAM 2 FLOW ELEMENT	--	1
FE201B	STREAM 3 FLOW ELEMENT	--	1
FE201C	STREAM 4 FLOW ELEMENT	--	1
FE201D	STREAM 5 FLOW ELEMENT	--	1
FE201E	STREAM 6 FLOW ELEMENT	--	1
FE201F	STREAM 7 FLOW ELEMENT	--	1
FE201G	STREAM 8 FLOW ELEMENT	--	1
FE201H	STREAM 9 FLOW ELEMENT	--	1
FE201J	STREAM 10 FLOW ELEMENT	--	1
FE300A	FLOW ELEMENT NH3 DELIVERY	--	1
FE300B	FLOW ELEMENT NH3 DELIVERY	--	1
FE300C	FLOW ELEMENT NH3 DELIVERY	--	1
FE300D	FLOW ELEMENT NH3 DELIVERY	--	1
FE300E	FLOW ELEMENT NH3 DELIVERY	--	1
FE300F	FLOW ELEMENT NH3 DELIVERY	--	1
FE300G	FLOW ELEMENT NH3 DELIVERY	--	1
FE300H	FLOW ELEMENT NH3 DELIVERY	--	1
FE300J	FLOW ELEMENT NH3 DELIVERY	--	1
FE301A	FLOW ELEMENT FOR FAN F-301A	--	1
FE301B	FLOW ELEMENT FOR FAN F-301B	--	1
FE301C	FLOW ELEMENT FOR FAN F-301C	--	1
FE301D	FLOW ELEMENT FOR FAN F-301D	--	1
FE301E	FLOW ELEMENT FOR FAN F-301E	--	1
FE301F	FLOW ELEMENT FOR FAN F-301F	--	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
FE301G	FLOW ELEMENT FOR FAN F-301G	--	1
FE301H	FLOW ELEMENT FOR FAN F-301H	--	1
FE301J	FLOW ELEMENT FOR FAN F-301J	--	1
~~FE501A~~	~~HX-501A FLOW ELEMENT-WATER~~	~~--~~	~~1~~
FE501B	HX-501B FLOW ELEMENT-WATER	--	1
FE501C	HX-501C FLOW ELEMENT-WATER	--	1
FE601	HX-601 FLOW ELEMENT-WATER	--	1
FE602	HX-602 FLOW ELEMENT-WATER	--	1
FI1001	STEAM FLOW TO PILOT PLANT	AO	1
FI201	SUM OF STREAM GAS FLOWS	AO	1
FI501	SUM OF APH AIR INLET FLOW	AO	1
FI502	SUM OF APH AIR OUTLET FLOW	AO	1
FS300	FLOW SWITCH IN NH3 VENT PIPING	DI	1
FT001	UNIT 5 LIGHTER OIL FLOW	AI	1
FT1001	STEAM FLOW TO PILOT PLANT	AI	1
FT201A	STREAM 2 FLOW TRANSMITTER	AI	1
FT201B	STREAM 3 FLOW TRANSMITTER	AI	1
FT201C	STREAM 4 FLOW TRANSMITTER	AI	1
FT201D	STREAM 5 FLOW TRANSMITTER	AI	1
FT201E	STREAM 6 FLOW TRANSMITTER	AI	1
FT201F	STREAM 7 FLOW TRANSMITTER	AI	1
FT201G	STREAM 8 FLOW TRANSMITTER	AI	1
FT201H	STREAM 9 FLOW TRANSMITTER	AI	1
FT201J	STREAM 10 FLOW TRANSMITTER	AI	1
FT300A1	FLOW TRANS NH3 DELIVERY	AI	1
FT300A2	TRAIN A FLOW TRANS NH3 DELIVERY	AI	1
FT300B1	FLOW TRANS NH3 DELIVERY	AI	1
FT300B2	TRAIN B FLOW TRANS NH3 DELIVERY	AI	1
FT300C1	FLOW TRANS NH3 DELIVERY	AI	1
FT300C2	TRAIN C FLOW TRANS NH3 DELIVERY	AI	1
FT300D1	FLOW TRANS NH3 DELIVERY	AI	1
FT300D2	TRAIN D FLOW TRANS NH3 DELIVERY	AI	1
FT300E1	FLOW TRANS NH3 DELIVERY	AI	1
FT300E2	TRAIN E FLOW TRANS NH3 DELIVERY	AI	1
FT300F1	FLOW TRANS NH3 DELIVERY	AI	1
FT300F2	TRAIN F FLOW TRANS NH3 DELIVERY	AI	1
FT300G1	FLOW TRANS NH3 DELIVERY	AI	1
FT300G2	TRAIN G FLOW TRANS NH3 DELIVERY	AI	1
FT300H1	FLOW TRANS NH3 DELIVERY	AI	1
FT300H2	TRAIN H FLOW TRANS NH3 DELIVERY	AI	1
FT300J1	FLOW TRANS NH3 DELIVERY	AI	1
FT300J2	TRAIN J FLOW TRANS NH3 DELIVERY	AI	1
FT301A	FLOW TRANSMITTER FOR FAN F-301A	AI	1
FT301B	FLOW TRANSMITTER FOR FAN F-301B	AI	1
FT301C	FLOW TRANSMITTER FOR FAN F-301C	AI	1
FT301D	FLOW TRANSMITTER FOR FAN F-301D	AI	1
FT301E	FLOW TRANSMITTER FOR FAN F-301E	AI	1
FT301F	FLOW TRANSMITTER FOR FAN F-301F	AI	1
FT301G	FLOW TRANSMITTER FOR FAN F-301G	AI	1
FT301H	FLOW TRANSMITTER FOR FAN F-301H	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
FT301J	FLOW SWITCH FOR FAN F-301J	DI	1
FT501A	HX-501A FLOW TRANSMITTER--WATER	AI	1
FT501B	HX-501B FLOW TRANSMITTER--WATER	AI	1
FT501C	HX-501C FLOW TRANSMITTER--WATER	AI	1
FT502A	APH 501A AIR INLET FLOW	AI	1
FT502B	APH 501B AIR INLET FLOW	AI	1
FT502C	APH 501C AIR INLET FLOW	AI	1
FT503A	APH 501A AIR OUTLET FLOW	AI	1
FT503B	APH 501B AIR OUTLET FLOW	AI	1
FT503C	APH 501C AIR OUTLET FLOW	AI	1
IP300	I TO P POSITIONER, FCV300	AO	1
IP301A1	I TO P POSITIONER, FCV301A1	AO	1
IP301A2	I TO P POSITIONER, FCV301A2	AO	1
IP301B1	I TO P POSITIONER, FCV301B1	AO	1
IP301B2	I TO P POSITIONER, FCV301B2	AO	1
IP301C1	I TO P POSITIONER, FCV301C1	AO	1
IP301C2	I TO P POSITIONER, FCV301C2	AO	1
IP301D1	I TO P POSITIONER, FCV301D1	AO	1
IP301D2	I TO P POSITIONER, FCV301D2	AO	1
IP301E1	I TO P POSITIONER, FCV301E1	AO	1
IP301E2	I TO P POSITIONER, FCV301E2	AO	1
IP301F1	I TO P POSITIONER, FCV301F1	AO	1
IP301F2	I TO P POSITIONER, FCV301F2	AO	1
IP301G1	I TO P POSITIONER, FCV301G1	AO	1
IP301G2	I TO P POSITIONER, FCV301G2	AO	1
IP301H1	I TO P POSITIONER, FCV301H1	AO	1
IP301H2	I TO P POSITIONER, FCV301H2	AO	1
IP301J1	I TO P POSITIONER, FCV301J1	AO	1
IP301J2	I TO P POSITIONER, FCV301J2	AO	1
IP302A	I TO P POSITIONER, FCV302A	AO	1
IP302B	I TO P POSITIONER, FCV302B	AO	1
IP302C	I TO P POSITIONER, FCV302C	AO	1
IP302D	I TO P POSITIONER, FCV302D	AO	1
IP302E	I TO P POSITIONER, FCV302E	AO	1
IP302F	I TO P POSITIONER, FCV302F	AO	1
IP302G	I TO P POSITIONER, FCV302G	AO	1
IP302H	I TO P POSITIONER, FCV302H	AO	1
IP302J	I TO P POSITIONER, FCV302J	AO	1
JI100	PILOT PLANT STATION SERVICE	AO	1
JT100	PILOT PLANT WATT TRANSDUCER	AI	1
LI300	LEVEL IND ANDYDROUS NH3 STOR TNK 1	--	1
LI301	LEVEL IND ANDYDROUS NH3 STOR TNK 2	--	1
PI300	PRESS IND ANDYDROUS NH3 STOR TNK 1	--	1
PI300A	STREAM 13 PRESS INDICATOR	--	1
PI300B	STREAM 16 PRESS INDICATOR	--	1
PI300C	STREAM 19 PRESS INDICATOR	--	1
PI300D	STREAM 22 PRESS INDICATOR	--	1
PI300E	STREAM 25 PRESS INDICATOR	--	1
PI300F	STREAM 28 PRESS INDICATOR	--	1
PI300G	STREAM 31 PRESS INDICATOR	--	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
PI300H	STREAM 34 PRESS INDICATOR	--	1
PI300J	STREAM 37 PRESS INDICATOR	--	1
PI301	PRESS IND, ANDYDROUS NH3 STOR TNK 2	--	1
PI302	PRESS IND, NH3 ACCUM TANK	--	1
PS1000	SOOTBLOWER STEAM SUPPLY AVAILABLE	DI	1
PS300	PRESS SW ANHYDROUS NH3 STOR TNK 1	DI	1
PS301	PRESS SW ANHYDROUS NH3 STOR TNK 2	DI	1
PSV300A	SAFE VLV ANHYDROUS NH3 STOR TNK 1	DI	1
PSV300B	SAFE VLV ANHYDROUS NH3 STOR TNK 1	DI	1
PSV301A	SAFE VLV ANHYDROUS NH3 STOR TNK 2	DI	1
PSV301B	SAFE VLV ANHYDROUS NH3 STOR TNK 2	DI	1
PT201A	STREAM 2 PRESSURE	AI	1
PT201B	STREAM 3 PRESSURE	AI	1
PT201C	STREAM 4 PRESSURE	AI	1
PT201D	STREAM 5 PRESSURE	AI	1
PT201E	STREAM 6 PRESSURE	AI	1
PT201F	STREAM 7 PRESSURE	AI	1
PT201G	STREAM 8 PRESSURE	AI	1
PT201H	STREAM 9 PRESSURE	AI	1
PT201J	STREAM 10 PRESSURE	AI	1
PT300A	STREAM 11 PRESSURE	AI	1
PT300B	STREAM 14 PRESSURE	AI	1
PT300C	STREAM 17 PRESSURE	AI	1
PT300D	STREAM 20 PRESSURE	AI	1
PT300E	STREAM 23 PRESSURE	AI	1
PT300F	STREAM 26 PRESSURE	AI	1
PT300G	STREAM 29 PRESSURE	AI	1
PT300H	STREAM 32 PRESSURE	AI	1
PT300J	STREAM 35 PRESSURE	AI	1
PT302A	PRESS TRANS, NH3 ACCUM TANK	AI	1
PT302B	PRESS TRANS, NH3 ACCUM TANK	AI	1
PT401A	INLET TO BED 1 DIFF PRESS	AI	1
PT401B	INLET TO BED 1 DIFF PRESS	AI	1
PT401C	INLET TO BED 1 DIFF PRESS	AI	1
PT401D	INLET TO BED 1 DIFF PRESS	AI	1
PT401E	INLET TO BED 1 DIFF PRESS	AI	1
PT401F	INLET TO BED 1 DIFF PRESS	AI	1
PT401G	INLET TO BED 1 DIFF PRESS	AI	1
PT401H	INLET TO BED 1 DIFF PRESS	AI	1
PT401J	INLET TO BED 1 DIFF PRESS	AI	1
PT402A	TRAIN A BED 1 DIFF PRESS	AI	1
PT402B	TRAIN B BED 1 DIFF PRESS	AI	1
PT402C	TRAIN C BED 1 DIFF PRESS	AI	1
PT402D	TRAIN D BED 1 DIFF PRESS	AI	1
PT402E	TRAIN E BED 1 DIFF PRESS	AI	1
PT402F	TRAIN F BED 1 DIFF PRESS	AI	1
PT402G	TRAIN G BED 1 DIFF PRESS	AI	1
PT402H	TRAIN H BED 1 DIFF PRESS	AI	1
PT402J	TRAIN J BED 1 DIFF PRESS	AI	1
PT403A	TRAIN A BED 2 DIFF PRESS	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
PT403B	TRAIN B BED 2 DIFF PRESS	AI	1
PT403C	TRAIN C BED 2 DIFF PRESS	AI	1
PT403D	TRAIN D BED 2 DIFF PRESS	AI	1
PT403E	TRAIN E BED 2 DIFF PRESS	AI	1
PT403F	TRAIN F BED 2 DIFF PRESS	AI	1
PT403G	TRAIN G BED 2 DIFF PRESS	AI	1
PT403H	TRAIN H BED 2 DIFF PRESS	AI	1
PT403J	TRAIN J BED 2 DIFF PRESS	AI	1
PT404A	TRAIN A BED 3 DIFF PRESS	AI	1
PT404B	TRAIN B BED 3 DIFF PRESS	AI	1
PT404C	TRAIN C BED 3 DIFF PRESS	AI	1
PT404D	TRAIN D BED 3 DIFF PRESS	AI	1
PT404E	TRAIN E BED 3 DIFF PRESS	AI	1
PT404F	TRAIN F BED 3 DIFF PRESS	AI	1
PT404G	TRAIN G BED 3 DIFF PRESS	AI	1
PT404H	TRAIN H BED 3 DIFF PRESS	AI	1
PT404J	TRAIN J BED 3 DIFF PRESS	AI	1
PT405A	TRAIN A INLET TO OUTLET DIFF PRESS	AI	1
PT405B	TRAIN B INLET TO OUTLET DIFF PRESS	AI	1
PT405C	TRAIN C INLET TO OUTLET DIFF PRESS	AI	1
PT405D	TRAIN D INLET TO OUTLET DIFF PRESS	AI	1
PT405E	TRAIN E INLET TO OUTLET DIFF PRESS	AI	1
PT405F	TRAIN F INLET TO OUTLET DIFF PRESS	AI	1
PT405G	TRAIN G INLET TO OUTLET DIFF PRESS	AI	1
PT405H	TRAIN H INLET TO OUTLET DIFF PRESS	AI	1
PT405J	TRAIN J INLET TO OUTLET DIFF PRESS	AI	1
PT501A	APH-501A AIR TO GAS DIFF-INLET	AI	1
PT501B	APH-501B AIR TO GAS DIFF-INLET	AI	1
PT502A	HX-501A INLET TO OUTLET DIFF	AI	1
PT502B	HX-501B INLET TO OUTLET DIFF	AI	1
PT502C	HX-501C INLET TO OUTLET DIFF	AI	1
PT503A	APH-501A INLET TO OUTLET DIFF	AI	1
PT503B	APH-501B INLET TO OUTLET DIFF	AI	1
PT503C	APH-501C INLET TO OUTLET DIFF	AI	1
PT505A	APH 501A AIR IN/AIR OUT DIFF PRESS	AI	1
PT505B	APH 501B AIR IN/AIR OUT DIFF PRESS	AI	1
PT601A	CYCLONE CL-601A INL TO OUTL DIFF	AI	1
PT601B	CYCLONE CL-601B INL TO OUTL DIFF	AI	1
PT601C	CYCLONE CL-601C INL TO OUTL DIFF	AI	1
PT601D	CYCLONE CL-601D INL TO OUTL DIFF	AI	1
PT601E	CYCLONE CL-601E INL TO OUTL DIFF	AI	1
PT601F	CYCLONE CL-601F INL TO OUTL DIFF	AI	1
PT601G	CYCLONE CL-601G INL TO OUTL DIFF	AI	1
PT601H	CYCLONE CL-601H INL TO OUTL DIFF	AI	1
PT602	CYCLONE CL-601E OUTLET PRESSURE	AI	1
PT603	CYCLONE CL-601H OUTLET PRESSURE	AI	1
SBM401A	TRAIN A BED 1 SOOTBLOWER MOTOR	DO	1
SBM401B	TRAIN B BED 1 SOOTBLOWER MOTOR	DO	1
SBM401C	TRAIN C BED 1 SOOTBLOWER MOTOR	DO	1
SBM402A	TRAIN A BED 2 SOOTBLOWER MOTOR	DO	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
SBM402B	TRAIN B BED 2 SOOTBLOWER MOTOR	DO	1
SBM402C	TRAIN C BED 2 SOOTBLOWER MOTOR	DO	1
SBM403A	TRAIN A BED 3 SOOTBLOWER MOTOR	DO	1
SBM403B	TRAIN B BED 3 SOOTBLOWER MOTOR	DO	1
SBM403C	TRAIN C BED 3 SOOTBLOWER MOTOR	DO	1
SBM404A	TRAIN A BED 4 SOOTBLOWER MOTOR	DO	1
SBM404B	TRAIN B BED 4 SOOTBLOWER MOTOR	DO	1
SBM404C	TRAIN C BED 4 SOOTBLOWER MOTOR	DO	1
SQA501A	APH 501A INPUT SPEED SIGNAL	AO	1
SQA501B	APH 501B INPUT SPEED SIGNAL	AO	1
SQF601A	FAN F-601A INPUT SPEED SIGNAL	AO	1
SQF601B	FAN F-601B INPUT SPEED SIGNAL	AO	1
SQF601C	FAN F-601C INPUT SPEED SIGNAL	AO	1
SQF602	FAN F-602 INPUT SPEED SIGNAL	AO	1
SQF603	FAN F-603 INPUT SPEED SIGNAL	AO	1
STA501A	APH 501A SPEED	AI	1
STA501B	APH 501B SPEED	AI	1
STF601A	FAN F-601A SPEED	AI	1
STF601B	FAN F-601B SPEED	AI	1
STF601C	FAN F-601C SPEED	AI	1
STF602	FAN F-602 SPEED	AI	1
STF603	FAN F-603 SPEED	AI	1
SV1000	OPEN STEAM VALVE FOR SOOTBLOWER	DO	1
SV201A	V201A VENTURI TAP BLOWBACK	DO	1
SV201B	V201B VENTURI TAP BLOWBACK	DO	1
SV201C	V201C VENTURI TAP BLOWBACK	DO	1
SV201D	V201D VENTURI TAP BLOWBACK	DO	1
SV201E	V201E VENTURI TAP BLOWBACK	DO	1
SV201F	V201F VENTURI TAP BLOWBACK	DO	1
SV201G	V201G VENTURI TAP BLOWBACK	DO	1
SV201H	V201H VENTURI TAP BLOWBACK	DO	1
SV201J	V201J VENTURI TAP BLOWBACK	DO	1
SV300	SOLENOID OPERATED VLV FV300	DO	1
SV300A	SOLENOID OPERATED VLV FV300A	DO	1
SV300B	SOLENOID OPERATED VLV FV300B	DO	1
SV300C	SOLENOID OPERATED VLV FV300C	DO	1
SV300D	SOLENOID OPERATED VLV FV300D	DO	1
SV300E	SOLENOID OPERATED VLV FV300E	DO	1
SV300F	SOLENOID OPERATED VLV FV300F	DO	1
SV300G	SOLENOID OPERATED VLV FV300G	DO	1
SV300H	SOLENOID OPERATED VLV FV300H	DO	1
SV300J	SOLENOID OPERATED VLV FV300J	DO	1
SV301	SOLENOID OPERATED VLV FV301	DO	1
SV401A	TRAIN A BED 1 SOOTBLOWER VALVE	DO	1
SV401B	TRAIN B BED 1 SOOTBLOWER VALVE	DO	1
SV401C	TRAIN C BED 1 SOOTBLOWER VALVE	DO	1
SV402A	TRAIN A BED 2 SOOTBLOWER VALVE	DO	1
SV402B	TRAIN B BED 2 SOOTBLOWER VALVE	DO	1
SV402C	TRAIN C BED 2 SOOTBLOWER VALVE	DO	1
SV403A	TRAIN A BED 3 SOOTBLOWER VALVE	DO	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
SV403B	TRAIN B BED 3 SOOTBLOWER VALVE	DO	1
SV403C	TRAIN C BED 3 SOOTBLOWER VALVE	DO	1
SV404A	TRAIN A BED 4 SOOTBLOWER VALVE	DO	1
SV404B	TRAIN B BED 4 SOOTBLOWER VALVE	DO	1
SV404C	TRAIN C BED 4 SOOTBLOWER VALVE	DO	1
SV501A1	APH A SOOTBLOWER #1	DO	1
SV501A2	APH A SOOTBLOWER #2	DO	1
SV501B1	APH B SOOTBLOWER #1	DO	1
SV501B2	APH B SOOTBLOWER #2	DO	1
SV501C1	AIR PIPE SOOTBLOWER # 1	DO	1
SV501C10	AIR PIPE SOOTBLOWER #10	DO	1
SV501C2	AIR PIPE SOOTBLOWER # 2	DO	1
SV501C3	AIR PIPE SOOTBLOWER # 3	DO	1
SV501C4	AIR PIPE SOOTBLOWER # 4	DO	1
SV501C5	AIR PIPE SOOTBLOWER # 5	DO	1
SV501C6	AIR PIPE SOOTBLOWER # 6	DO	1
SV501C7	AIR PIPE SOOTBLOWER # 7	DO	1
SV501C8	AIR PIPE SOOTBLOWER # 8	DO	1
SV501C9	AIR PIPE SOOTBLOWER # 9	DO	1
TCV501A	HX-501A CONTROL VALVE FOR WATER	AO	1
TCV501B	HX-501B CONTROL VALVE FOR WATER	AO	1
TCV501C	HX-501C CONTROL VALVE FOR WATER	AO	1
TCV602	HX-602 CONTROL VALVE FOR WATER	AO	1
TE101	STREAM 1 TEMPERATURE	AI	1
TE201A	STREAM 2 TEMPERATURE	AI	1
TE201B	STREAM 3 TEMPERATURE	AI	1
TE201C	STREAM 4 TEMPERATURE	AI	1
TE201D	STREAM 5 TEMPERATURE	AI	1
TE201E	STREAM 6 TEMPERATURE	AI	1
TE201F	STREAM 7 TEMPERATURE	AI	1
TE201G	STREAM 8 TEMPERATURE	AI	1
TE201H	STREAM 9 TEMPERATURE	AI	1
TE201J	STREAM 10 TEMPERATURE	AI	1
TE300A	STREAM 11 TEMPERATURE	AI	1
TE300B	STREAM 14 TEMPERATURE	AI	1
TE300C	STREAM 17 TEMPERATURE	AI	1
TE300D	STREAM 20 TEMPERATURE	AI	1
TE300E	STREAM 23 TEMPERATURE	AI	1
TE300F	STREAM 26 TEMPERATURE	AI	1
TE300G	STREAM 29 TEMPERATURE	AI	1
TE300H	STREAM 32 TEMPERATURE	AI	1
TE300J	STREAM 35 TEMPERATURE	AI	1
TE301A	STREAM 13 TEMPERATURE	AI	1
TE301B	STREAM 16 TEMPERATURE	AI	1
TE301C	STREAM 19 TEMPERATURE	AI	1
TE301D	STREAM 22 TEMPERATURE	AI	1
TE301E	STREAM 25 TEMPERATURE	AI	1
TE301F	STREAM 28 TEMPERATURE	AI	1
TE301G	STREAM 31 TEMPERATURE	AI	1
TE301H	STREAM 34 TEMPERATURE	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
TE301J	STREAM 37 TEMPERATURE	AI	1
TE401A	TRAIN A REACTOR INLET TEMPERATURE	AI	1
TE401B	TRAIN B REACTOR INLET TEMPERATURE	AI	1
TE401C	TRAIN C REACTOR INLET TEMPERATURE	AI	1
TE401D	TRAIN D REACTOR INLET TEMPERATURE	AI	1
TE401E	TRAIN E REACTOR INLET TEMPERATURE	AI	1
TE401F	TRAIN F REACTOR INLET TEMPERATURE	AI	1
TE401G	TRAIN G REACTOR INLET TEMPERATURE	AI	1
TE401H	TRAIN H REACTOR INLET TEMPERATURE	AI	1
TE401J	TRAIN J REACTOR INLET TEMPERATURE	AI	1
TE402A	TRAIN A REACTOR BED 1 TEMPERATURE	AI	1
TE402B	TRAIN B REACTOR BED 1 TEMPERATURE	AI	1
TE402C	TRAIN C REACTOR BED 1 TEMPERATURE	AI	1
TE402D	TRAIN D REACTOR BED 1 TEMPERATURE	AI	1
TE402E	TRAIN E REACTOR BED 1 TEMPERATURE	AI	1
TE402F	TRAIN F REACTOR BED 1 TEMPERATURE	AI	1
TE402G	TRAIN G REACTOR BED 1 TEMPERATURE	AI	1
TE402H	TRAIN H REACTOR BED 1 TEMPERATURE	AI	1
TE402J	TRAIN J REACTOR BED 1 TEMPERATURE	AI	1
TE403A	TRAIN A REACTOR BED 2 TEMPERATURE	AI	1
TE403B	TRAIN B REACTOR BED 2 TEMPERATURE	AI	1
TE403C	TRAIN C REACTOR BED 2 TEMPERATURE	AI	1
TE403D	TRAIN D REACTOR BED 2 TEMPERATURE	AI	1
TE403E	TRAIN E REACTOR BED 2 TEMPERATURE	AI	1
TE403F	TRAIN F REACTOR BED 2 TEMPERATURE	AI	1
TE403G	TRAIN G REACTOR BED 2 TEMPERATURE	AI	1
TE403H	TRAIN H REACTOR BED 2 TEMPERATURE	AI	1
TE403J	TRAIN J REACTOR BED 2 TEMPERATURE	AI	1
TE404A	TRAIN A REACTOR BED 3 TEMPERATURE	AI	1
TE404B	TRAIN B REACTOR BED 3 TEMPERATURE	AI	1
TE404C	TRAIN C REACTOR BED 3 TEMPERATURE	AI	1
TE404D	TRAIN D REACTOR BED 3 TEMPERATURE	AI	1
TE404E	TRAIN E REACTOR BED 3 TEMPERATURE	AI	1
TE404F	TRAIN F REACTOR BED 3 TEMPERATURE	AI	1
TE404G	TRAIN G REACTOR BED 3 TEMPERATURE	AI	1
TE404H	TRAIN H REACTOR BED 3 TEMPERATURE	AI	1
TE404J	TRAIN J REACTOR BED 3 TEMPERATURE	AI	1
TE405A	TRAIN A REACTOR OUTLET TEMPERATURE	AI	1
TE405B	TRAIN B REACTOR OUTLET TEMPERATURE	AI	1
TE405C	TRAIN C REACTOR OUTLET TEMPERATURE	AI	1
TE405D	TRAIN D REACTOR OUTLET TEMPERATURE	AI	1
TE405E	TRAIN E REACTOR OUTLET TEMPERATURE	AI	1
TE405F	TRAIN F REACTOR OUTLET TEMPERATURE	AI	1
TE405G	TRAIN G REACTOR BED 3 TEMPERATURE	AI	1
TE405H	TRAIN H REACTOR BED 3 TEMPERATURE	AI	1
TE405J	TRAIN J REACTOR BED 3 TEMPERATURE	AI	1
TE501A	APH-501A INLET TEMPERATURE	AI	1
TE501B	APH-501B INLET TEMPERATURE	AI	1
TE501C	APH-501C INLET TEMPERATURE	AI	1
TE502A	HX-501A INLET TEMPERATURE-GAS	AI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
TE502B	HX-501B INLET TEMPERATURE-GAS	AI	1
TE502C	HX-501C INLET TEMPERATURE-GAS	AI	1
TE503A	HX-501A OUTLET TEMPERATURE-WATER	AI	1
TE503B	HX-501B OUTLET TEMPERATURE-WATER	AI	1
TE503C	HX-501C OUTLET TEMPERATURE-WATER	AI	1
TE504A	HX-501A INLET TEMPERATURE-WATER	AI	1
TE504B	HX-501B INLET TEMPERATURE-WATER	AI	1
TE504C	HX-501C INLET TEMPERATURE-WATER	AI	1
TE505	FAN F-501 INBOARD BEARING TEMP	AI	1
TE506	FAN F-501 OUTBOARD BEARING TEMP	AI	1
TE507A	APH 501A AIR INLET TEMPERATURE	AI	1
TE507B	APH 501B AIR INLET TEMPERATURE	AI	1
TE507C	APH 501C AIR INLET TEMPERATURE	AI	1
TE508A	APH 501A AIR OUTLET TEMPERATURE	AI	1
TE508B	APH 501B AIR OUTLET TEMPERATURE	AI	1
TE508C	APH 501C AIR OUTLET TEMPERATURE	AI	1
TE601	CYCLONE CL-601E OUTLET TEMP-GAS	AI	1
TE601A	CYCLONE CL-601A INLET TEMP	AI	1
TE601B	CYCLONE CL-601B INLET TEMP	AI	1
TE601C	CYCLONE CL-601C INLET TEMP	AI	1
TE602	CYCLONE CL-601H OUTLET TEMP-GAS	AI	1
TE602A	FAN F-601A INBOARD BEARING TEMP	AI	1
TE602B	FAN F-601B INBOARD BEARING TEMP	AI	1
TE602C	FAN F-601C INBOARD BEARING TEMP	AI	1
TE603A	FAN F-601A OUTBOARD BEARING TEMP	AI	1
TE603B	FAN F-601B OUTBOARD BEARING TEMP	AI	1
TE603C	FAN F-601C OUTBOARD BEARING TEMP	AI	1
TE605	FAN F-602 INBOARD BEARING TEMP	AI	1
TE606	FAN F-602 OUTBOARD BEARING TEMP	AI	1
TE609	FAN F-603 INBOARD BEARING TEMP	AI	1
TE610	FAN F-603 OUTBOARD BEARING TEMP	AI	1
TI101	STREAM 1 TEMPERATURE	AO	1
TI300	TEMP INDICATOR NH3 ACCUM TANK	--	1
TI501	SUM OF APH AIR INLET TEMP	AO	1
TI502	SUM OF APH AIR OUTLET TEMP	AO	1
TI503	SUM OF APH GAS OUTLET TEMP	AO	1
TS300	TEMP SW NH3 VAPORIZER TANK 1	DI	1
TS301	TEMP SW NH3 VAPORIZER TANK 2	DI	1
TS302	TEMP SW NH3 ACCUM TANK	DI	1
XS10002	TRANSFORMER 1000-2 MISC. ALARM	DI	1
XS10003	TRANSFORMER 1000-3 MISC. ALARM	DI	1
XS10004	TRANSFORMER 1000-4 MISC. ALARM	DI	1
XS10005	TRANSFORMER 1000-5 MISC. ALARM	DI	1
XS501	FAN F-501 RUNNING	DI	1
XSA501A1	APH 501A STATUS 1	DI	1
XSA501A2	APH 501A STATUS 2	DI	1
XSA501B1	APH 501B STATUS 1	DI	1
XSA501B2	APH 501B STATUS 2	DI	1
XSAC1000	AIR COMPRESSOR AC-1000 RUNNING	DI	1
XSF601A1	FAN F-601A STATUS 1	DI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
XSF601A2	FAN F-601A STATUS 2	DI	1
XSF601B1	FAN F-601B STATUS 1	DI	1
XSF601B2	FAN F-601B STATUS 2	DI	1
XSF601C1	FAN F-601C STATUS 1	DI	1
XSF601C2	FAN F-601C STATUS 2	DI	1
XSF6021	FAN F-602 STATUS 1	DI	1
XSF6022	FAN F-602 STATUS 2	DI	1
XSF6031	FAN F-603 STATUS 1	DI	1
XSF6032	FAN F-603 STATUS 2	DI	1
XSP1000	SERVICE WATER PUMP 1000 RUNNING	DI	1
XSSWGR1	SWITCHGEAR 1 TRIP	DI	1
XSSWGR2	SWITCHGEAR 2 TRIP	DI	1
XSSWGR3	SWITCHGEAR 3 TRIP	DI	1
XSSWGR4	SWITCHGEAR 4 TRIP	DI	1
XSSWGR5	SWITCHGEAR 5 TRIP	DI	1
XXH201A	REACTOR TRAIN A FLUE GAS HEATER	AO	1
XXH201B	REACTOR TRAIN B FLUE GAS HEATER	AO	1
XXH201C	REACTOR TRAIN C FLUE GAS HEATER	AO	1
XXH201D	REACTOR TRAIN D FLUE GAS HEATER	AO	1
XXH201E	REACTOR TRAIN E FLUE GAS HEATER	AO	1
XXH201F	REACTOR TRAIN F FLUE GAS HEATER	AO	1
XXH201G	REACTOR TRAIN G FLUE GAS HEATER	AO	1
XXH201H	REACTOR TRAIN H FLUE GAS HEATER	AO	1
XXH201J	REACTOR TRAIN J FLUE GAS HEATER	AO	1
YI802	O2 ANALYZER	AO	1
YI803	CO ANALYZER	AO	1
YI804	CO2 ANALYZER	AO	1
ZS201A	ISOLATION DAMPER D-201A CLOSED	DI	1
ZS201B	ISOLATION DAMPER D-201B CLOSED	DI	1
ZS201C	ISOLATION DAMPER D-201C CLOSED	DI	1
ZS201D	ISOLATION DAMPER D-201D CLOSED	DI	1
ZS201E	ISOLATION DAMPER D-201E CLOSED	DI	1
ZS201F	ISOLATION DAMPER D-201F CLOSED	DI	1
ZS201G	ISOLATION DAMPER D-201G CLOSED	DI	1
ZS201H	ISOLATION DAMPER D-201H CLOSED	DI	1
ZS201J	ISOLATION DAMPER D-201J CLOSED	DI	1
ZS300	NH3 TANK 1 DISCH VALVE CLOSED	DI	1
ZS300A	NH3 TRAIN A SHUTOFF VALVE CLOSED	DI	1
ZS300B	NH3 TRAIN B SHUTOFF VALVE CLOSED	DI	1
ZS300C	NH3 TRAIN C SHUTOFF VALVE CLOSED	DI	1
ZS300D	NH3 TRAIN D SHUTOFF VALVE CLOSED	DI	1
ZS300E	NH3 TRAIN E SHUTOFF VALVE CLOSED	DI	1
ZS300F	NH3 TRAIN F SHUTOFF VALVE CLOSED	DI	1
ZS300G	NH3 TRAIN G SHUTOFF VALVE CLOSED	DI	1
ZS300H	NH3 TRAIN H SHUTOFF VALVE CLOSED	DI	1
ZS300J	NH3 TRAIN J SHUTOFF VALVE CLOSED	DI	1
ZS301	NH3 TANK 2 DISCH VALVE CLOSED	DI	1
ZS401A	ISOLATION DAMPER D-401A CLOSED	DI	1
ZS401B	ISOLATION DAMPER D-401B CLOSED	DI	1
ZS401C	ISOLATION DAMPER D-401C CLOSED	DI	1

TAG NUMBER	DESCRIPTION	IO TYPE	QTY
ZS402A	ISOLATION DAMPER D-402A CLOSED	DI	1
ZS402B	ISOLATION DAMPER D-402B CLOSED	DI	1
ZS402C	ISOLATION DAMPER D-402C CLOSED	DI	1
ZS501A	ISOLATION DAMPER D-501A CLOSED	DI	1
ZS501B	ISOLATION DAMPER D-501B CLOSED	DI	1
ZS501C	ISOLATION DAMPER D-501C CLOSED	DI	1
ZS502A	ISOLATION DAMPER D-502A CLOSED	DI	1
ZS502B	ISOLATION DAMPER D-502B CLOSED	DI	1
ZS502C	ISOLATION DAMPER D-502C CLOSED	DI	1
ZS503A	ISOLATION DAMPER D-503A CLOSED	DI	1
ZS503B	ISOLATION DAMPER D-503B CLOSED	DI	1
ZS503C	ISOLATION DAMPER D-503C CLOSED	DI	1
ZS601A	ISOLATION DAMPER D-601A CLOSED	DI	1
ZS601B	ISOLATION DAMPER D-601B CLOSED	DI	1
ZS601C	ISOLATION DAMPER D-601C CLOSED	DI	1
ZT101	ECONOMIZER OUT DMPR POSITION	AI	1
ZT504	FAN F501 INLET DMPR POSITION	AI	1
ZT505A	APH 501A AIR INLET DMPR POSITION	AI	1
ZT505B	APH 501B AIR INLET DMPR POSITION	AI	1
ZT505C	APH 501C AIR INLET DMPR POSITION	AI	1
ZT601D	REACTOR TRAIN D FLOW DMPR POSITION	AI	1
ZT601E	REACTOR TRAIN E FLOW DMPR POSITION	AI	1
ZT601F	REACTOR TRAIN F FLOW DMPR POSITION	AI	1
ZT601G	REACTOR TRAIN G FLOW DMPR POSITION	AI	1
ZT601H	REACTOR TRAIN H FLOW DMPR POSITION	AI	1
ZT601J	REACTOR TRAIN J FLOW DMPR POSITION	AI	1
ZZ101	ECONOMIZER OUT DMPR POSITIONER	AO	1
ZZ504	FAN F501 INLET DMPR POSITIONER	AO	1
ZZ505A	APH 501A AIR INLET DMPR POSITIONER	AO	1
ZZ505B	APH 501B AIR INLET DMPR POSITIONER	AO	1
ZZ505C	APH 501C AIR INLET DMPR POSITIONER	AO	1
ZZ601D	REACTOR TRAIN D FLOW CNTRL DAMPER	AO	1
ZZ601E	REACTOR TRAIN E FLOW CNTRL DAMPER	AO	1
ZZ601F	REACTOR TRAIN F FLOW CNTRL DAMPER	AO	1
ZZ601G	REACTOR TRAIN G FLOW CNTRL DAMPER	AO	1
ZZ601H	REACTOR TRAIN H FLOW CNTRL DAMPER	AO	1
ZZ601J	REACTOR TRAIN J FLOW CNTRL DAMPER	AO	1
*** Total ***			
			587

APPENDIX C

VALVE SCHEDULE

(Later)

APPENDIX D

DYNAGEN'S DISCUSSION OF AMMONIA CONCENTRATION AND ANHYDROUS AMMONIA MATERIAL SAFETY DATA SHEET

FIGURE 1 AMMONIA INJECTION IN A STRAIGHT PIPE (2'ϕ)

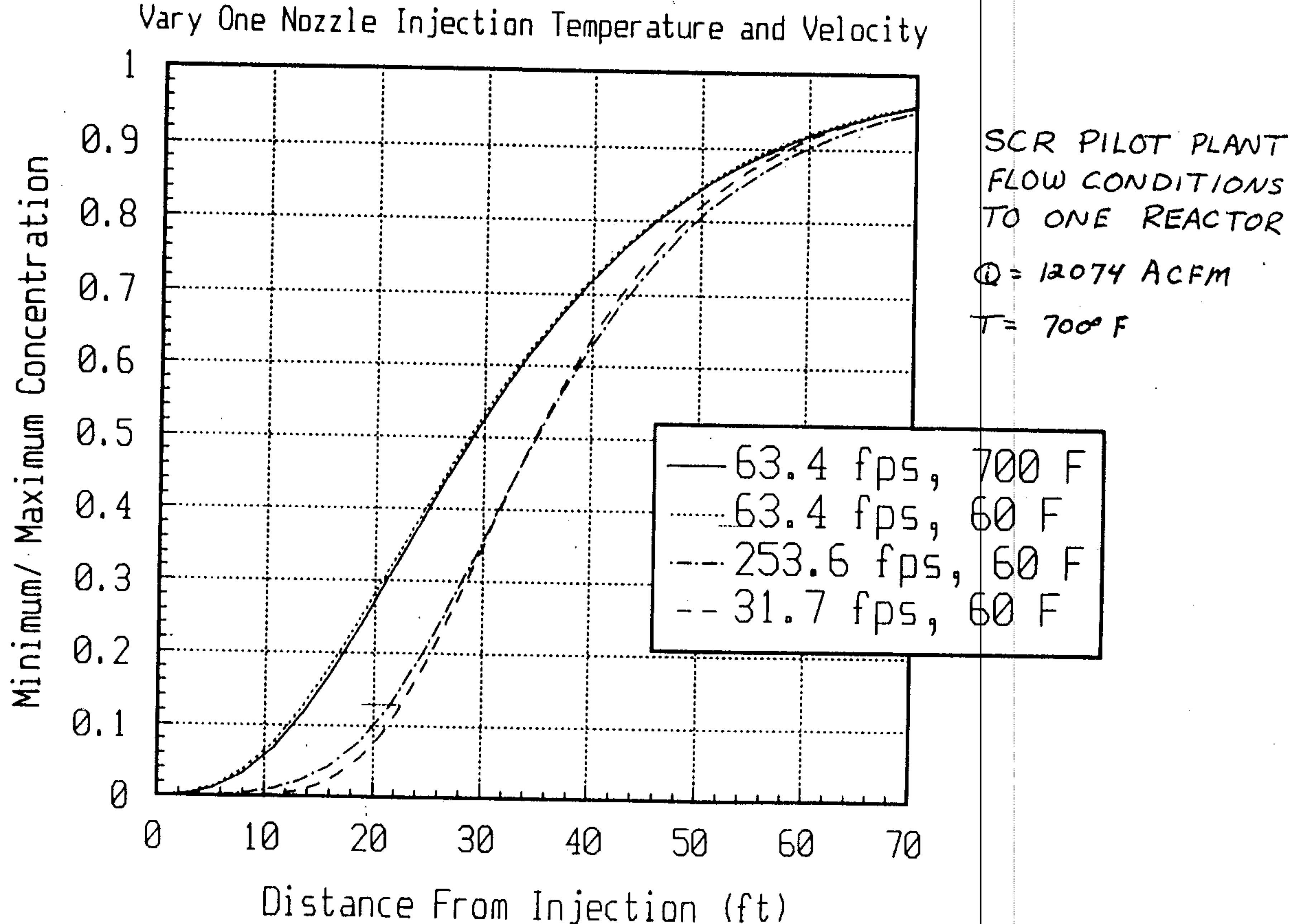
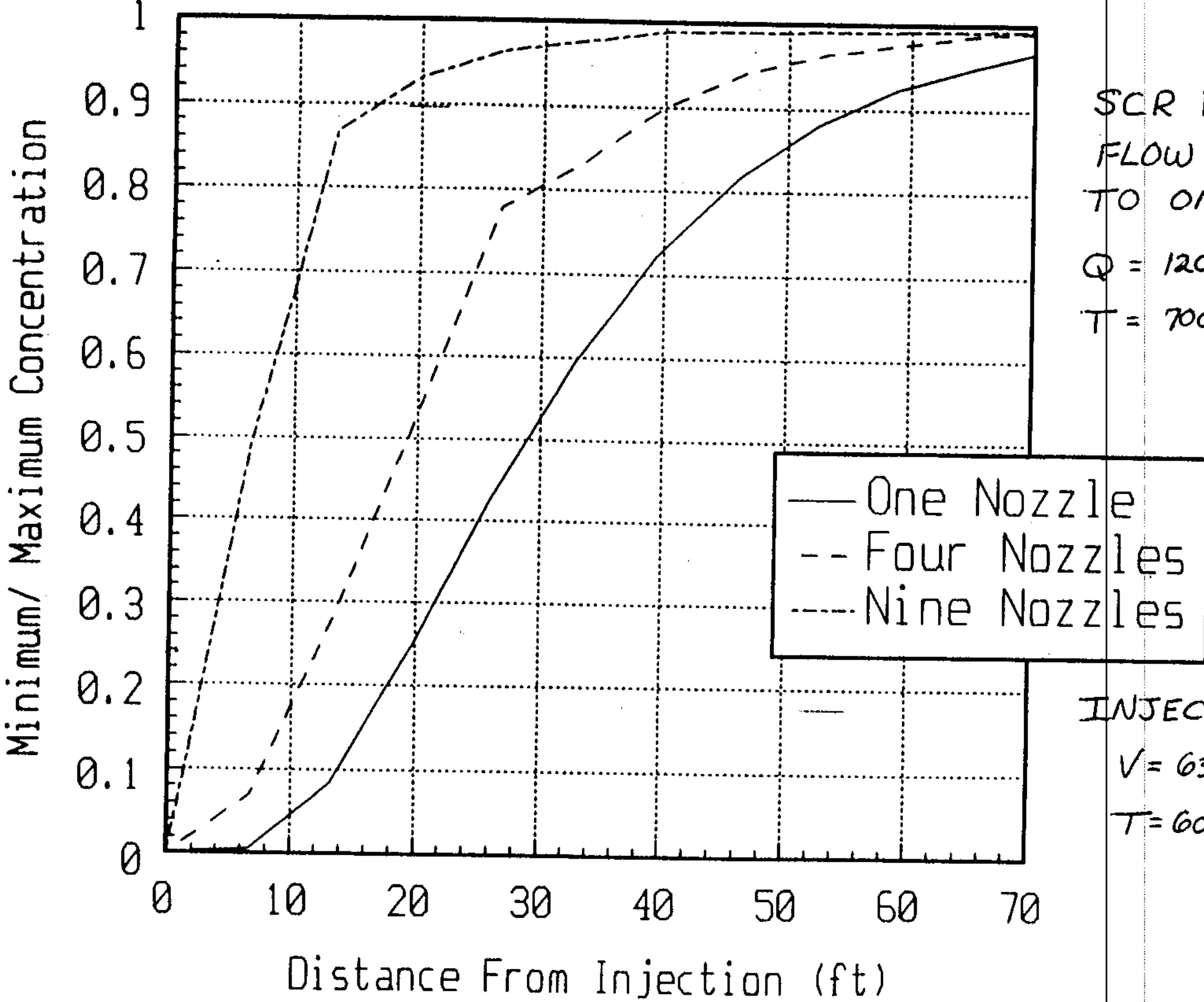


FIGURE 2 AMMONIA INJECTION IN A STRAIGHT PIPE (2'ϕ)

One, Four, Nine Nozzles



SCR PILOT PLANT FLOW CONDITIONS TO ONE REACTOR

Q = 12074 ACFM

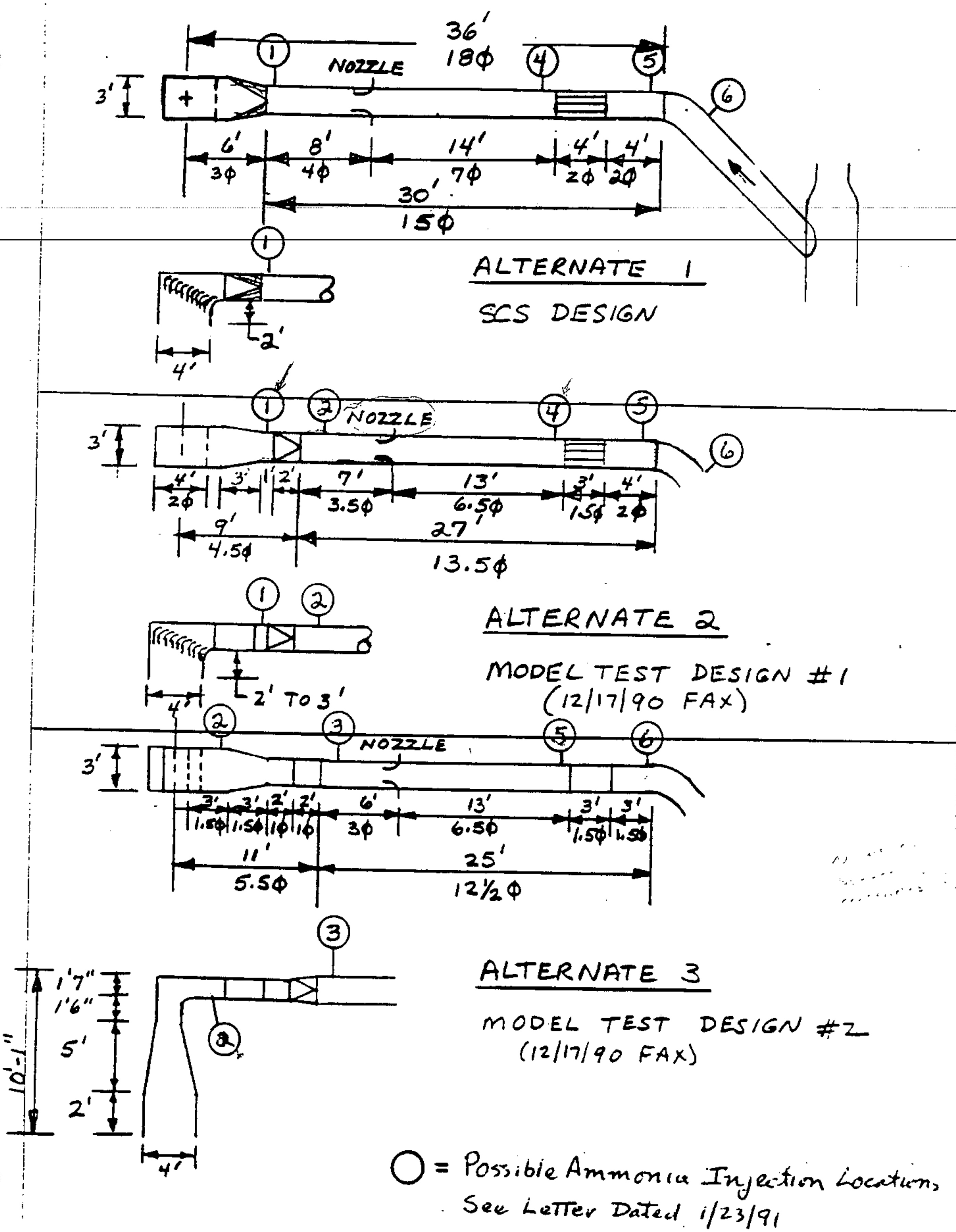
T = 700 °F

INJECTION CONDITION

V = 63.4 fps

T = 60 °F

FIGURE 2A – ALTERNATE REACTOR INLET DUCT ARRANGEMENTS



MATERIAL SAFETY DATA SHEET

ANHYDROUS AMMONIA

Northeastern

NATIONAL

BOWER BB BRAND

DISTRIBUTORS:

NATIONAL AMMONIA COMPANY
BOWER AMMONIA & CHEMICAL COMPANY
NORTHEASTERN AMMONIA COMPANY, INC.
AL WELLS, INC.

TACONY & VANKIRK STS., PHILADELPHIA, PA 19135

CORPORATE EMERGENCY TELEPHONE NUMBER: 215-535-7530 CHEMTREC (CMA) 800-424-9300

DESCRIPTION

CHEMICAL NAME: Ammonia, anhydrous
SYNONYMS: Ammonia, liquefied
CHEMICAL FAMILY: Ammonia
COMPOSITION: 99+% ammonia

CAS REGISTRY NO.: 7664-41-7
FORMULA: NH_3
MOL. WT.: 17.03

STATEMENT OF HEALTH HAZARD

HAZARD DESCRIPTION: Irritant and corrosive to skin, eye, respiratory tract and mucous membranes. May cause severe burns, eye and lung injuries. Skin and respiratory related diseases aggravated by exposure.
Not recognized by OSHA as a carcinogen.
Not listed in the National Toxicology Program annual report.
Not listed as a carcinogen by the International Agency for Research on Cancer.

EXPOSURE LIMITS: Vapor - 50 ppm, 35 mg/m^3 PEL (OSHA)
25 ppm, 18 mg/m^3 TLV (ACGIH)

EMERGENCY TREATMENT

EFFECTS OF OVEREXPOSURE: Eye: lachrymation, edema, blindness. Moist skin: irritation, corrosive burns, blister formation. Contact of liquid with skin freezes the tissue, then produces a caustic burn. Inhalation: heavy, acute exposure may result in severe irritation of the respiratory tract, glottal edema, bronchospasm, pulmonary edema, respiratory arrest. Chronic effects: bronchitis. Extreme exposure (5000 ppm) can cause immediate death from spasm, inflammation or edema of larynx.

EMERGENCY AID: Eye: Flush with copious amount of water for 15 min. Eyelids should be held open and away from eyeball to ensure thorough rinsing. SPEED AND THOROUGHNESS IN RINSING THE EYE IS MOST IMPORTANT IN PREVENTING LATENT PERMANENT INJURIES. Inhalation: move to fresh air. Administer oxygen or artificial respiration if necessary. Skin: flush affected area with copious amount of water for 15 min. Remove contaminated clothing while flushing. Do not rub affected area. Do not apply ointments to skin burns. IF SYMPTOMS PERSIST OR EXPOSURE IS SEVERE, SEEK PROMPT MEDICAL HELP.

NOTE TO PHYSICIAN: Eye injury may appear as delayed phenomenon. Pulmonary edema may follow chemical bronchitis. Supportive treatment with necessary ventilatory actions, including oxygen, may warrant consideration.

PHYSICAL DATA

BOILING PT.: -33°C (-28°F)
VAPOR PRESSURE: @ 25.7°C: 10 atm
SPECIFIC GRAVITY: 0.618

PERCENT VOLATILE: 100%

APPEARANCE AND ODOR: Colorless gas, pungent odor.

FREEZING PT.: -78°C (-108°F)
VAPOR DENSITY (Air=1): 0.6
SOLUBILITY IN WATER: 0°C: 89.9g/100cc;
100°C: 7.4g/100cc
EVAPORATION RATE (Water=1): faster than water if in liquid form

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: None

AUTOIGNITION TEMP.: 651°C (1204°F) catalyzed by iron;
850°C (1562°F) uncatalyzed

FLAMMABLE RANGE IN AIR: 16% to 25% by Volume
EXTINGUISHING MEDIA: Water spray or fog
SPECIAL FIRE-FIGHTING PROCEDURES: Must wear protective clothing and respiratory protection. See PROTECTIVE EQUIPMENT. Stop source if possible. Cool fire-exposed containers with water spray. Stay upwind and use water spray to knock down vapor and dilute. Let fire burn.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Not generally a fire hazard. If relief valves are inoperative, heat-exposed storage containers may become explosion hazards. Contact of ammonia with chemicals such as mercury, chlorine, iodine, bromine, silver oxide, or hypochlorites can form explosive compounds. Special hazard with chlorine to form chloramine gas, also a primary skin irritant and sensitizer. Combustion may form toxic nitrogen oxides.

Revision: June, 1987

APPENDIX E

EXECUTIVE SUMMARY OF SAFETY PROCEDURES

PLANT CRIST SCR PROJECT

SAFETY PROCEDURES

EXECUTIVE SUMMARY

INTRODUCTION

The Selective Catalytic Reduction (SCR) ICCT Clean Coal Project at Plant Crist introduces two new elements that require safe handling and storage methods above the safety procedures that typically take place at a power plant. These two elements are the SCR catalyst and anhydrous ammonia. The purpose of this document is to provide a set of safety procedures for handling theses items, developed by SCS in conjunction with the Gulf Power Company personnel, so that the operation of the SCR pilot plant does not compromise the safety of Plant Crist personnel.

SCR catalysts can contain several different metal oxides, vanadium pentoxide, tungsten trioxide or molybdenum trioxide as the catalytically active compound. The concentrations are typically less than 10 weight percent of the catalyst. These metal oxides are either coated on or impregnated into a catalyst substrate and then heated to form a solid catalyst element of various sizes and geometries. The catalyst substrate forms the majority of the weight of the catalyst. It is typically composed of titanium dioxide, a mixture of titanium dioxide and silicon dioxide, or aluminosilicates. These catalysts are used to catalytically react ammonia with NO_x at temperatures around 700°F, converting the NOx to nitrogen and water. Thus, ammonia is required for the conversion of NO_x.

During the operation of the SCR pilot plant, the operating staff will be required to follow all the safety procedures presently in effect at Plant Crist. Plant Crist safety personnel will provide training sessions pertaining to the Plant Crist safety procedures so that the SCR operating staff came become familiar with them. A copy of the Plant Crist safety procedures and this document will be in the SCR control room so that the safety information can be readily available to the operating personnel. A copy of this document will also be provided to the Plant Crist safety personnel. The operations of the SCR pilot plant will be subjected to periodic review by the safety personnel at Plant Crist to make sure that the pilot plant is operating in accordance to the Plant Crist guidelines.

HANDLING OF SCR CATALYST

Receiving and Storage of SCR Catalyst

The SCR catalyst will be shipped by the catalyst vendors involved in the program in modules commonly referred to as catalyst baskets. Each basket will house the appropriate number of catalyst elements that will make up a single layer inside the SCR reactors. The catalyst elements will be packed into the baskets by the catalyst vendor and the basket sealed and crated for shipment. Additional catalyst elements will also be packaged and shipped to Plant Crist to be used as replacements during catalyst sampling. The catalyst baskets and additional catalyst elements should be stored indoors to keep them dry. The catalyst baskets and elements should be properly sealed for shipment and should not pose a dust problem during handling. However, as a precautionary measure the plant personnel should wear a dust mask, gloves and safety glasses in the event that either the baskets or elements have been damaged during shipment.

Installing SCR Catalyst

Installing of the SCR catalyst will require that the catalyst baskets be uncrated and unsealed. The SCR reactors will be operated on dust-laden flue gas prior to catalyst installation and may have some accumulation of flyash on the walls of the reactor. This may be a potential dust hazard when opening the reactors to install the catalyst and will require that the operating personnel wear a dust mask, gloves and safety glasses. The catalyst baskets will be installed into the reactors using a hoist mechanism. Therefore, the operators will be required to abide by the Plant Crist safety procedures for hoisting heavy equipment. The estimated weight of a single catalyst basket for the large reactors is approximately one ton.

Sampling SCR Catalyst

The SCR catalyst will require periodic sampling to determine the deactivation rate of the catalysts. This will require physically entering the SCR reactor after it has been shutdown and cooled to ambient temperature to retrieve a catalyst element from the basket and replace it with a fresh catalyst element. The catalyst element that was sampled from the reactor will be carefully packaged and shipped to the catalyst vendors laboratories for further testing. Most catalyst vendors will be present for the sampling of their catalyst.

Entering the SCR reactor will require that the SCR operators follow the procedures for entering a duct work at Plant Crist. If an operator has to be completely inside a reactor to sample the catalyst, they will be required to tests the oxygen content inside the reactor and make provisions for adequate ventilation while inside the reactor. A dust mask, safety glasses, protective clothing (coveralls) and gloves will all be required when sampling the catalyst. The samples need to be securely sealed and packaged to prevent damage during shipment.

Spent SCR Catalyst

At the conclusion of testing of the SCR catalysts, the catalysts baskets with the catalysts and any additional catalyst elements will be sealed and crated for shipment back to the catalyst vendors for disposal. No on-site storage of spent catalyst is planned. The catalyst vendors will be requested to assist in supplying the appropriate paper work for handling and transporting the spent catalyst.

AMMONIA TECHNICAL DATA AND SAFETY REGULATIONS

Gaseous ammonia liquefies under pressure at ambient temperature. Anhydrous ammonia is usually shipped or stored as a liquid under pressure. Ammonia is a relatively stable compound and is extremely difficult to ignite. It begins to dissociate at approximately 850°F and atmospheric pressure. Ammonia gas is flammable in air in the range of 16 to 25 percent by volume. Due to the high lower limit, narrow range, and high ignition temperature, favorable conditions for ignition during normal operations are seldom seen, except for tightly enclosed areas with inadequate ventilation and a high temperature ignition source present.

Ammonia gas is irritating to the eyes, skin and mucous membranes of the nose, throat, and lungs at low concentrations. At higher concentrations, ammonia is corrosive to human tissue and possibly life threatening. The OSHA exposure short term exposure limit is 35 ppm (27 mg/m3). This is for an employee's 15 minute time-weighted average exposure which may not be exceeded at any time during a work day. At 35 ppm, ammonia is readily detectable by its pungent order which serves as its own warning.

The Department of Transportation regulation on transporting anhydrous ammonia are published in 49 CFR Chapter I. The attached Material Safety Data Sheet summarizes the hazards and precautions when handling anhydrous ammonia. Stationary storage tanks for anhydrous ammonia are regulated by the U.S. Department of Labor and must conform to the requirements of 29 CFR 1910.111. This requires that all stationary storage installations have at least two suitable gas mask and a safety shower or 50 gallon drum of water in a readily accessible location.

STORAGE AND HANDLING OF ANHYDROUS AMMONIA

The storage of anhydrous ammonia must be in tanks that are built in accordance with the ASME Boiler and Pressure Vessel Code Section VIII - Unfired Vessel and rated for 250 psig pressure. The ammonia storage tanks will be leased from the ammonia vendor and will be equipped with dual pressure relief valves. Transportation and filling of the ammonia storage tanks will be the responsibility of the ammonia vendor. All piping, tubing and fittings will be made of materials suitable for ammonia service. All piping will be tested for leaks after assembly prior to introducing ammonia. The SCR pilot plant operation personnel will periodically (monthly) inspect the ammonia storage tanks to look for signs of corrosion, damage, wear and leaks. Leak detections will be part of the maintenance program for the SCR pilot plant.

The anhydrous ammonia storage tanks and feed system to the SCR reactors will be equipped with electronic ammonia sensing devices that will alert the operating personnel when a leak has been detected. All leaks should be approached with caution. Gas-tight chemical goggles, respiratory protection, gloves, and impervious outer clothing should be worn by personnel when investigating and fixing a leak. When a leak has been detected, the first step is determine the size and location of the leak and whether it is continuous or a single release. Once a leak has been evaluated it should be repaired immediately. The vent lines for the storage tanks and purging the feed system will be plumbed into a central water tank system to help control fugitive release of ammonia.

EMERGENCY PROCEDURES

If liquid ammonia contacts the skin or eyes, the affected area should be promptly and thoroughly flushed with clean water for at least 15 minutes, with the eyes receiving the first attention. If ammonia has entered the nose or throat large quantities of water should be consume provided the afflicted person can still swallow. A physician should treat all cases of exposure to liquid ammonia.

The concentration of ammonia vapor in air can be reduced effectively by the use of adequate volumes of water applied through spray or fog nozzles in the event of an accidental release. Water should not be used directly on liquid ammonia spills. Water in the form of fog or spray should be directed at the cloud emanating from the liquid ammonia pool.

If an ammonia container is exposed to fire, water fog or spray should be used to cool it. Caution should be used if flames impinge on the vapor space of the container as violent rupture of the container is possible. The surrounding area should be evacuated to a minimum distance of 2000 feet in all directions if the fire can not be controlled and it appears that the tank may rupture.

In the event of a leak in the ammonia system, the SCR pilot plant will go through an emergency shutdown. The SCR pilot plant operating personnel will immediately notify the appropriate Plant Crist personnel of any ammonia leaks detected. All appropriate leaks will be reported to environmental protection and/or other regulatory authorities. An index will be located in the front cover of this manual with emergency telephone numbers and information for:

- Plant Crist Safety Personnel
- State and Federal Officials
- Local Fire Department
- Local Hospital Emergency Room
- DOT hazard class number
- OSHA classification number and exposure limits

This will provide a quick reference in the event of an emergency.