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**NORIT AMERICAS INC. MOBILE TEST SILO DOSING SYSTEM**

<i><b>SYSTEM FEATURE</b></i>	<i><b>BENEFIT</b></i>
<i>PAC System Design from Worlds Largest PAC producer</i>	<ul style="list-style-type: none"><li>• Experienced Team and Custom Design ensures reliability</li><li>• The best system from the people who know PAC the best</li></ul>
<i>Automatic feed of PAC</i>	<ul style="list-style-type: none"><li>• Easy start-up</li><li>• Totally hands off operation which is <u>monitored</u> by the operator</li><li>• Accurate PAC feedrate</li><li>• No operator handling or exposure to carbon dust</li></ul>
<i>Prefabricated Components</i>	<ul style="list-style-type: none"><li>• Fast Erection &amp; Startup</li><li>• Minimized plant interruption.</li></ul>
<i>Totally contained system</i>	<ul style="list-style-type: none"><li>• <u>NO carbon mess</u></li><li>• Enhanced Reliability</li><li>• Improved safety from cleaner work place</li></ul>



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## **I. INTRODUCTION**

NORIT Americas Inc. proposes to design and supply one reliable dosing/injection system that will receive, store and feed bulk Powdered Activated Carbon (PAC) into flue gas at various coal-fired power plants. The system will be designed to facilitate moving from plant to plant using a double-drop dolly trailer and a minimum of equipment disassembly.

## **II. DESCRIPTION OF THE SYSTEM**

The NORIT bulk silo storage and feed system will receive bulk PAC in 40,000-pound batches, delivered by tanker truck. The PAC is unloaded pneumatically into a dry welded steel storage silo where a combination of specially designed air fluidization valves and nozzles, located in the conical discharge section of the silo, pulse compressed air into the bulk of the PAC, promoting mass flow out of the flanged discharge connections. NORIT takes advantage of the natural tendency of fine powders to flow with liquid-like properties when fluidized by a gas, normally air, to move the PAC within the system. By separating the individual PAC particles with a gas, the normal resistance to bulk flow is greatly reduced and the PAC can easily be moved from the silo into the metering equipment.

Fluidized PAC is fed from the silo by a rotary valve into a volumetric feed hopper where it is temporarily stored until conveyed by the feeder screw into the drop tube. The amount of PAC discharged from feeder is directly proportional to the speed of the feeder screw and an adjustable speed drive motor allows a wide range of PAC delivery rates from the screw. PAC is fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle produces a negative pressure in the eductor inlet, which helps draw PAC and air into the mixing zone directly downstream of the mouth. From the eductor, the PAC is transported through the piping system to the injection nozzle in flue gas ductwork.

A programmable logic controller (PLC), with input from remote sensors, controls the sequences of events throughout the system and also provides alarms and interlocks to annunciate problems and protect the system. The system is configured to feed a constant pounds per hour of PAC or to follow an analog signal provided by the customers equipment. During normal operation, operator attention is not required, as the system operates automatically once the mode of operation and the feed rates have been selected.



The equipment/system proposed will require a dry compressed air supply, a 480 VAC power supply, computer control interface via Allen Bradley DH+ and injection piping interfaces. All system components will be located under or attached to the silo and on the storage silo top deck. The footprint of the PAC storage silo will be 10 feet in diameter and will require an adjoining area for spotting a pneumatic road tanker for PAC filling.

### III. SCOPE OF WORK

NORIT Americas Inc. proposes to provide the following management, design, equipment, delivery and installation support for installation by others (Note: Option for installation by NORIT will follow):

#### A. MANAGEMENT, DESIGN & SUPPORT

##### 1. Project Management

NORIT will provide the services of a Project Manager to oversee the complete project including the following activities:

- a. System design.
- b. Project scheduling.
- c. Project submittals.
- d. Coordination between the Purchaser and NORIT for system details.
- e. Equipment Procurement.
- f. Supervision of fabrication shop for sub-assemblies.
- g. Technical support during equipment installation.
- h. System start-up.
- i. Development of the system O&M Manuals.

##### 2. Design

NORIT will provide the following design documents and drawings:

- a. General arrangement drawings.
- b. Piping Instrumentation Diagram.
- c. Mechanical Design/Layout Drawings.
- d. Electrical Schematics.
- e. Point to point wiring diagrams.
- f. Interconnect Diagram & Conduit Routing



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- g. Allen Bradley PLC Ladder Logic Diagrams.
  - i. I/O List.
  - j. Equipment List.
  - k. Motor data sheets.
  - l. Foundation Loadings provided by the Silo Manufacturer.

3. Submittal

NORIT will provide four (4) copies of the following drawings and information, as a minimum, to the Purchaser for approval prior to purchase of equipment.

- a. Written Description of System Operation.
- b. Project Schedule.
- c. System P&ID's.
- d. System General Arrangement Drawings.
- e. System Plan Drawings.
- f. Electrical Schematic Drawings.
- g. Control Panel Layout Drawings.
- h. PLC Ladder Logic.
- i. Equipment Cut Sheets.

4. O&M Manuals

NORIT will provide four (4) copies of the O&M manuals prior to installation of the equipment and will provide as-built drawings upon completion of the project. The O&M Manuals will contain, as a minimum, the following information:

- a. Written Description of System Operation.
- b. System P&ID's.
- c. System General Arrangement Drawings.
- d. System Plan Drawings.
- e. Electrical Wiring Diagrams.
- f. Control Panel Layout Drawings.
- g. PLC Ladder Logic.
- h. Equipment Operation & Installation Manuals.



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i. Silo Design Drawings & Foundation Loading Calculations.

5. Installation Services

NORIT Americas will provide the services of the Project Manager for a period of one (1) week to assist with the installation of the equipment. Additional days on-site at the request of the purchaser for installation will be billed at the standard rate of \$850 per day plus living and travel expenses.

6. Start-Up and Training Services

NORIT Americas will provide the services of the Project Manager for a period of one (1) week for start-up and operator training on the system. Additional days on-site at the request of the purchaser after successful start-up will be billed at the standard rate of \$850 per day plus living and travel expenses.

B. CIVIL/STRUCTURAL

1. Storage Silo Foundation

NORIT will provide the storage silo design loads to allow the Purchaser to design and install a suitable foundation for the PAC storage silo.

2. Equipment Support Structure

The PAC feed equipment, blower, associated piping and instruments will be mounted on support skids fabricated from 3" A 500 square tubing with base plates for anchoring. The support skid steel surfaces will be blasted per SSPC SP6 commercial blast to obtain a 1.5 mil average profile, prime coated with Sherwin Williams Dura-Plate 235 Epoxy Primer (4.0-8.0 Mils DFT) and finish coated with Sherwin Williams Acrolon 218 HS Acrylic Polyurethane (3.0 mils DFT) in "Safety" blue.

The PAC feed equipment skids and the Power and Control Panel will be mounted on a platform fabricated from A-36 structural steel and plate attached at the base of the storage silo.

C. MECHANICAL EQUIPMENT

1. Storage Silo

A welded carbon steel silo with support legs will be provided to receive and store the bulk PAC. The silo will be 10 feet in diameter with a working capacity of approximately 2,500 cubic



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feet. The silo deck will be sloped ten (10) degrees for drainage. The silo will be fabricated with a single cone bottom with a 60-degree minimum slope. The discharge cone will be fitted with a short section of 8" nominal pipe and an 8" flange.

The silo will be designed to meet the most stringent of the following conditions:

- a. Per the Uniform Building Code, latest edition.
- b. Wind loads based on a velocity of 100 mph.
- c. Seismic zone 2B per UBC 1997.
- d. A weight of 35 pounds per cubic foot for the material contained within the silo.
- e. Transportation, handling and erection loads.
- f. To support a 300 pound person walking on any point, in addition to the dead load weight of all equipment and appendages.
- g. A live load of 50 psf on the roof area and 100 psf on walking surfaces.

The silo will be equipped with a 4" nominal, schedule 40 fill line, with a 12" radius elbow, which enters the silo tangentially, reducing dusting and lowering the demand on the silo vent filter. The fill line will be supported by brackets attached to the silo shell and will be equipped with a 4" male camlok fitting & cap located approximately 4½' above grade for the truck hose connection.

The silo roof deck will be equipped with a cartridge type vent filter for cleaning the conveying air from the delivery tankers, a 24" pressure and vacuum relieving manway, and a hoisting system to lift bulk bags from ground level to the roof for unloading into the storage tank. The hoisting system design capacity shall be 2,000 pounds. The hoisting system will have bolted connections to facilitate removal for shipping.

The silo will be equipped with three (3) each 1½" half couplings located in the sidewall for three (3) point level switches that monitor PAC level.

The silo outlet cone will be equipped with sixteen (16) each 2" half coupling with fluidizing nozzles. The discharge pipe on the bottom of the outlet cone will also contain one each 2" and one each 1" half couplings with fluidizing nozzles. The silo discharge



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cone will also be equipped with a poke-hole connection to rod out the piping section to the rotary valve.

The silo will be primed with a polyamide epoxy primer over a commercial SSPC SP-6 blast on the exterior surfaces and inside the skirt. The exterior will be coated with an acrylic enamel topcoat of a color chosen from the manufacturer's standard color chart. The silo top deck and the equipment platform will be painted with a Ferrox non-skid coating.

A galvanized carbon steel OSHA approved ladder with integral safety cage and intermediate landing will be provided for access to the silo top deck, which will be enclosed with handrail and toe plate. The handrail will be aluminum pipe supported from galvanized carbon steel angle posts with galvanized steel toe-board.

Electrical Equipment installed under, on the side and on top of the silo will be suitable for use in Class II Division 2 Group F Environments.

## 2. Silo Vent Filter

A self-contained cartridge-type bin vent filter will be provided and mounted on top the PAC storage silo. The dust collector will be oriented to allow easy operator access of the filter elements for routine maintenance. The dust collector will be designed to provide a 1.3:1 air-to-surface ratio based on 600 acfm of air volume from the truck-mounted blower. The filter unit will be a TORIT TBV-2 bin vent with TORIT Ultra-Web NL filter cartridges. Two spare filter cartridges are also included.

The filter elements will be cleaned by a reverse pulse air jet type cleaning system which will require approximately 7½ scfm of compressed air at 100 psig when operating. The vent filter timer board, which actuates the solenoid valves, will be located within a NEMA 4X enclosure mounted on the filter house. The unit will be primed and finish painted safety blue and will be flange mounted on the storage silo roof.

A Dwyer Series 1950 differential pressure switch and a Dwyer Series 2000 Magnahelic differential pressure indicator will be provided to monitor the pressure drop across the filter bags. An Off/Hand selector switch will be provided to control the filter bag cleaning cycle. The time between air pulses and the duration of the pulses are adjustable.



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The particulate matter concentration in the effluent gas of the dust collector will not exceed an average of 0.02 grains per actual cubic foot. The guarantee is based on particles two microns and larger in diameter and on the equipment being properly installed and maintained according to the manufacturers instructions.

3. Manual Knifegate Valve

The silo discharge cone will be equipped with an 8" DeZurik manual knifegate valve to isolate the PAC storage silo from the feed system below. The valve shall be actuated manually using the supplied chain-drive actuator. All wetted parts will be of stainless steel construction.

4. Rotary Valve

The silo discharge cone will be equipped with an 8" Rotolok Industries HD8 (OAE) rotary valve to control the flow of fluidized PAC from the silo into the volumetric feeder hopper. The valve will be constructed of cast iron with 8" ANSI flanged inlet and outlet connections and a closed rotor with a minimum of six pockets. The valve will feature externally mounted bearings to separate the product from the bearings. The rotary valve will turn at approximately 10 revolutions per minute, providing a theoretical maximum PAC feed rate of 110 cubic feet per hour to the volumetric feeder hopper. The unit will be located between the knifegate valve and the expansion joint. The rotary valve will be driven by a 1/2 hp 480/3/60 single speed TEFC motor. The motor will be coupled to a gearbox that drives the valve rotor through a chain and sprocket arrangement encased inside an OSHA approved guard.

5. Volumetric Feeder

An Acrison model BDF-1.5-K/2 auger type volumetric feeder, designed to deliver between approximately 50 and 1000 pounds per hour of PAC, will be provided to meter the PAC from the feeder hopper into the drop tube. All wetted surfaces of the feeders and the supply hopper will be fabricated from stainless steel.

The feeder will be driven by a 1 hp variable speed TEFC DC motor and controlled by a Contrex M-Drive microprocessor controller located in the door of the main control panel. The digital speed controller will allow a turndown ratio of approximately 20:1, providing a wide range of dosing levels. The



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feeder controller will be programmed to allow feeding of the carbon at a constant rate in pounds per hour or to follow a 4-20 mA analog signal from a remote location.

6. Drop Tube

A removable, 304 stainless steel drop tube will be installed between the volumetric feeder outlet and the inlet to the eductor.

7. Blower Package

One (1) blower will be provided for the feeder and will be mounted below the feeder skid. The blower will be a Siemens regenerative type blower driven by a 460/3/60 TEFC variable speed motor capable of operating from 2200 to 5000 rpm. The drive motor will be direct coupled to the blower.

The blower will be mounted below the feeder support frame and/or attached to the structural equipment platform below the storage silo. The blower will have an inlet filter, an inlet silencer and a discharge pressure gauge.

The blower will provide sufficient volume and pressure to maintain the minimum velocity to keep the PAC in suspension for a distance up to a maximum of 300 feet with an elevation change of 120 feet.

The sound level will not exceed 85 dBA at 3 feet from a single blower operating alone.

A pressure switch will be used to monitor the blower discharge pressure for both high and low pressure.

8. Eductor

A 2" carbon steel eductor will be installed at the outlet from the drop tube to convey the PAC/air mixture to the injection point. Two sets of eductors are included in the system package. One set is for feed rates of 500 #/hr and below. The other is for feed rates between 500 and 1000 #/hr.

9. Piping

Motive air piping from the blower to the eductor will be 304 stainless steel pipes with screwed fittings.

The Purchaser will supply PAC transfer piping or hoses from the eductors to the injection nozzles. Transfer piping or hoses shall be 2" for PAC feeds up to 500 #/hr and will be 2½" for PAC feeds



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between 500 and 1000 #/hr.

Compressed air piping from the Plant to the fluidizing air headers and to the silo vent filter will be ASTM B-88 Type K hard drawn copper pipe with solder joint fittings

Air fluidization tubing between the air fluidization solenoid valves and the air fluidization nozzles will be poly tubing with compression type fittings.

10. Air Fluidization Nozzles

Air fluidization nozzles will be placed in strategic locations on the silo discharge cones in the silo under-skirt area. The type and placement of fluidizing nozzles acts to promote reliable mass flow of the PAC from the silo.

D. POWER DISTRIBUTION

1. The PAC system 480 volt power distribution devices shall be contained within the power control panel, including main disconnect breaker, motor circuit breakers, motor starters, power blocks, terminal blocks, breakers and fuses. However, the control power transformer may be mounted external to the power distribution panel if desired, but must be mounted in the immediate vicinity of the panel.
2. A main disconnect breaker will be provided in the power panel which will be utilized to protect and to de-energize the complete PAC system electrical system.
3. A motor circuit protector, a NEMA starter and solid state overload protection will be provided for each 480 volt AC motor.
4. A 480-volt AC single phase (3-phase if required) to 120 volt AC single phase (3-phase 208/120 if required) transformer will provide 120-volt AC power for control and equipment.
5. 480 volt AC power will be distributed to the various devices in the power panel via a power distribution block.
6. A single breaker (3 pole 208/120 or single pole 120) will be provided for isolation and protection of the control power system. Individual single-phase breakers will be provided as required for distribution of 120 volt AC power.

E. CONTROL PANEL

1. The PAC system PLC, PLC power-supply, manual control



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devices, feeder speed controllers, control relays, lights, terminal blocks, switches and the silo controls will be contained within the control panel. All system equipment can be controlled manually from the main control panel. The Power Panel and Control panel may be combined into a single panel with individual doors for Power and Control.

2. Control wiring philosophy will meet the following requirements:
  - a. The control wiring philosophy will be such that all field control devices utilize normally closed contacts during normal operating condition.
  - b. A contact opening or an open circuit will result in an alarm condition for the specific device.
  - c. Loss of power to a control device will result in an alarm condition.

F. PANEL FEATURES

The power panel and control panel will be provided with the following items and/or features:

1. Panels will be constructed of 304 stainless steel and rated NEMA 4X.
2. The main control panel will contain a fluorescent work light and 15 amp 120 Volt GFI convenience receptacle.
3. Terminal blocks will be provided for termination of all "field run" cables.
4. All PLC inputs and outputs will be wired to fused terminal blocks equal to Allen Bradley 1492-H6.
5. Terminal blocks for voltage of 120 volts and less will be equal to Allen Bradley 1492-W10 unless specified otherwise.
6. All control features that are visible on the front of the control panels will have Lamacoid nameplates, which are white with black letters.
7. All wiring will be installed in Panduit or similar wireways and separate into categories (i.e., 480 volt power, 120 volt control, etc.) to the extent practical. AC or DC power wiring will not run in any raceway with any type instrument wiring. Wiring will be protected across panel hinges. All terminal strips for all wiring terminations will be numbered.



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8. Wiring will be stranded copper, 600 volt, THHN or MTW insulated, extra flexible type. As a minimum wire size will be #12 AWG for all power wiring, #16 AWG for all control wiring and #18 AWG twisted shielded pair for analog signal conductors. Wiring will be color coded as follows:
    - a. Ground wiring will be green.
    - b. 120 volt ac and 480 volt ac wiring will be black.
    - c. Neutral wiring will be white.
    - d. 120 volt ac control wiring will be red.
    - e. 24 volt dc control wiring will be brown positive and orange negative.
    - f. 90 volt dc power wiring will be blue.
  9. Wiring at all terminals within panels, junction boxes, and field devices will be numbered with shrink fit, machine printed labels.

**G. ELECTRICAL COMPONENTS**

1. 480 Volt Circuit Breakers: Molded case, thermal magnetic, minimum interrupting capacity of 10,000 amperes symmetrical at 480 volts AC. Acceptable manufacturers are Allen Bradley, General Electric, Siemens, Square D, or Cutler-Hammer.
2. Motor Circuit Protectors: 480 volt AC, three (3) phase, NEMA rated, motor circuit protectors for all 480 volt motors. Acceptable manufacturers are Square D or Cutler-Hammer (Westinghouse).
3. Starters: 480 volt AC, three-phase, NEMA rated, with solid state overcurrent protection in each phase. Acceptable manufacturers are Allen-Bradley, Square D, General Electric, or Cutler-Hammer.
4. Power Distribution Blocks: Allen Bradley 1492-PD, Square D type LB or IIsco type PDB.
5. 120 Volt Circuit Breakers: Allen Bradley 1492-CB,
6. Control Relays: Allen Bradley type HA, Potter Brumfield type KRP or Square D type KP.
7. E-Stop Button: 30.5 mm, heavy duty, NEMA 4X rated; contacts rated 10 amps continuous, 6 amps break at 120 VAC, equal to Allen-Bradley Type 800H.
8. Indicating Lights: 30.5 mm, heavy duty, NEMA 4X rated, 6 volt transformer type, equal to Allen-Bradley Type 800H.



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9. Raceway: Galvanized rigid steel conduit, 3/4" minimum nominal diameter.

H. CONTROL COMPONENTS.

1. Programmable Logic Controller

A single PLC will be provided to control and monitor the PAC systems. A minimum of 10 percent spare memory capacity, a minimum of 10 percent spare I/O points, and interposing relays for external status/control signals will be provided. Complete software documentation including a ladder logic diagram printout with a complete set of comments and a narrative description of the sequence of operation will be provided. The PLC will be a Model SLC 5/04 as manufactured by Allen-Bradley. The PLC rack will also include a 16-point analog input card.

2. Feeder Speed Controller

The screw drive for the volumetric feeder will be controlled by a digital microprocessor controller providing finite local adjustment of the PAC feeding rate over a range of 50 to 1000 pounds per hour. Based on the position of the system operation selector switch, the controller will follow a constant feed rate or a 4-20 ma signal provided by the Purchaser. The feeder microprocessor controller will be a Contrex M-Drive.

3. Fluidizing Solenoid Valves

Solenoid valves will be brass body, soft-seated, with 120V AC solenoid coil. Solenoid operators will be molded coil in NEMA 9 explosion proof enclosure. Maximum operating pressure differential capability will be 100 psig. Solenoid valves will not require a minimum pressure to either open or close. Valves will be two-way, energize-to-open. Valves will be ASCO Red Hat or approved equal.

4. Point Level Switches

Two (2) Bindicator point level switches will be provided to control the volumetric feeder hopper fill cycles and to provide storage silo level indication on the main control panel. The units are of the tuning fork type and have local indicating LED lights to indicate when the switch is energized and the state of the switch. The units mount through 1½" half couplings and are easily removable for servicing. The units will be Bindicator Pulse Point oscillating tuning fork type, of stainless steel construction.



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5. Pressure Switches

The silo vent filter differential pressure switch will be a Dwyer series 1620. The compressed air pressure switch will be Ashcroft B series or Allen Bradley Bulletin 836. Pressure switches will also be used to monitor and control the eductor inlet pressure and motive air pressure from the blower.

6. Variable Frequency Drives

To accommodate the wide feed range required for the silo, the blowers will have to operate at several different capacities. To achieve this, the blowers will be variable speed. Speed control will be accomplished using an Allen Bradley PowerFlex 70 AC Drive.

I. MONITORING DEVICES.

1. Differential Pressure Switch

The differential pressure across the silo vent filter will be displayed continuously at the vent filter by a Dwyer Magnahelic Series 2000 differential pressure indicator.

2. Pressure Indicators

Pressure indicators will be Bourdon tube type with solid front, phenolic plastic case and 4-1/2 inch dial. Indicators will be equal to or greater than Ashcroft Duragauge Style 1279.

- a. Amber - Silo Filter DP High – Stop Fill.

J. CONTROL FEATURES

1. The following control features will be available from the Panelview or control panel:

- a. Emergency Stop for the Feed System
- b. Control for each Blower
- c. Control for each Feeder
- d. Control for the Rotary Valve
- e. On/Off control for the Vent Filter on the silo.

K. CONTROLS AND INDICATORS

1. The following controls and indicators will be located on the control panel:

- a. A Contrex M-Drive speed controller for each Feeder



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- b. A PanelView Operator Interface.

#### IV. SYSTEM OPERATION

The PAC dosing system will consist of three (3) independent control loops: (1) silo level monitoring and filling; (2) feeder hopper level monitoring and filling and (3) PAC feed/injection.

##### A. SILO LEVEL MONITORING AND FILLING.

1. The PAC level in the silo will be monitored continuously by an acoustic level detector. The level signal will be provided to the PLC and to the PanelView on the control panel.
2. The PAC level in the storage silo will also be monitored at two points by "tuning fork" type level switches. When ample volume exists in the silo to accept a complete truck-load of PAC (~40,000 pounds), the silo low point level switch will be uncovered by the PAC. The contact opening will activate the SILO LEVEL LOW - OK TO FILL indicator on the PanelView. The silo low point level switch will not stop operation of the PAC feed system, which will operate independently of the PAC level in the silo.
3. The PAC storage silo will be filled by pneumatic road tankers, which will employ a trailer mounted blower to pneumatically transfer the PAC from the tanker into the silo. When the PAC level covers the silo high point level switch, the switch will activate the SILO LEVEL HIGH - STOP FILL alarm and indicator on the PanelView.
4. During silo filling, the air that is utilized to pneumatically convey the PAC into the silo will be discharged to the atmosphere through the "bag" type silo vent filter. The bags will be sequentially cleaned by pulses of air flowing in the reverse direction through the bags on a preset timed basis (HAND). Filter operation will be designated as HAND or OFF via the PanelView. In the HAND mode, the dust collector will sequentially pulse the bags with cleaning air on a preset time interval continuously as long as the HO screen indicates HAND mode. If the vent filter bags are not being cleaned properly, the vent filter differential pressure switch will initiate an alarm on the PanelView to stop filling.



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**B. FEEDER HOPPER LEVEL MONITORING AND FILLING.**

1. Two level switches are used to monitor the PAC level in the feeder supply hopper. With the rotary valve HOA mode in the AUTO position, the high level switch will start and stop the rotary valve. When the high level switch clears, the rotary valve will start after a predetermined time delay. When the rotary valve begins to turn, PAC is fed from the silo into the feeder hopper.
2. With the Fluidizing control HOA mode is in the AUTO position, the silo fluidizing cycle will also be initiated when the rotary valve motor is started. Under certain conditions it may be advantageous to manually fluidize the silo PAC prior to placing a feeder in service. When desirable the operator may manually initiate fluidization of the PAC.
3. If the hopper low-level switch is uncovered, a feeder hopper level low alarm will be initiated and feeder operation will be terminated.
4. After the rotary valve has been started, the time required to cover the hopper high level switch is monitored and alarmed if it exceeds 5 minutes. This alarm is called the hopper fill malfunction alarm.

**C. PAC FEED**

1. Terminals for a remote contact permissive will be available if it is desirable to add a permissive, such as ID Fan operating, to limit the PAC injection operation. These terminals will be identified on the drawings.
2. A HAND/OFF/AUTO selector mode for the blower is located on the PanelView. This mode selector screen controls the blower-operating mode. When placed in HAND, the blower will start. When placed in AUTO, the operator will start the blower and motive air will be provided to the injection system. The PanelView will indicate the blower-operating status.
3. After the blower has started, the system controls will allow ten (10) seconds for motive air pressure to be established via the motive air pressure switch, otherwise the low motive air pressure alarm will be initiated and the feeder will not start until the problem is resolved and the alarm is cleared. Also, a pressure switch connected to the eductor drop tube must indicate a small negative pressure (-3" H<sup>2</sup>O) to verify that the eductor is functioning properly.



4. With the Feeder HOA mode in the AUTO position, the volumetric feeder will begin feeding PAC into the drop tube thirty (30) seconds after motive airflow and pressure have been established. With the Feeder HOA mode in the HAND position, the Feeder will operate if the drop tube indicates a small negative pressure (-3" H<sup>2</sup>O). Again, to verify that the eductor is functioning properly.
5. If a feeder high speed, low speed or speed deviation condition is detected when the PAC feeder is running, a FEEDER MALFUNCTION alarm will be initiated and the feeder will stop operation.
6. The system will inject PAC into the flue gas stream until stopped by the operator; occurring when the HOA mode is switched to OFF or the Emergency Stop button is depressed. A normal shutdown by the operator will stop the blower thirty (30) seconds after the feeder has been stopped to clear the injection piping of PAC. HOA and E-STOP shutdown will not purge the injection piping of PAC.
7. If an alarm condition has terminated the operation of the system, the alarm must be reset to restart the system.

#### D. ALARMS.

The alarm sequence will operate essentially the same for all alarms. When an alarm is initiated, the alarm condition will be displayed on the Panelview. These alarms will also be ACKNOWLEDGED on the Panelview.

1. Silo Level High (Do Not Fill): The silo level high alarm will activate on the Panelview when the silo is full and filling operations should be terminated. This alarm will not have any effect on the filling operations or normal system operation, other than to provide an alarm, and will automatically clear once the PAC level in the silo has fallen below the high point level probe.
2. Silo Level Low (OK To Fill): The silo level low alarm will activate on the Panelview when the PAC level in the storage silo has fallen below the low point level probe. The silo low-level alarm will indicate sufficient volume in the silo to receive a bulk trailer load of PAC. This alarm will not have any effect on normal system operation, other than to provide an alarm, and will automatically clear once the PAC level in the silo has covered the low point level probe.



3. Blower Discharge Pressure High: The blower discharge pressure high alarm will be initiated on the Panelview when the blower discharge pressure switch is enabled. The alarm will immediately terminate feeder and blower operation and must be ACKNOWLEDGED on the Panelview to restart the system.
4. Silo Vent Filter DP High – Stop Fill: The differential pressure across the vent filter bags will be monitored at all times by a differential pressure switch mounted on the silo deck. If the high differential pressure switch remains in the high differential state for a period of fifteen (15) seconds, the silo vent filter DP high alarm will be initiated on the Panelview. This alarm will not effect the filling operation or normal system operation and will automatically clear when the differential pressure returns to normal.
5. Compressed Air Pressure Low – Stop Fill: A pressure switch mounted on the air receiver will monitor the air system pressure continuously. The compressed air pressure low alarm will be initiated on the Panelview when the air pressure has fallen below a pre-set pressure of 80 psig. The low air pressure alarm will automatically clear when adequate air pressure is restored.
6. Motive Air Pressure Low: The motive air pressure low alarm will be initiated on the Panelview when the motive air pressure falls below a pre-set value (approximately 10 psig). Operation of the feeder will be stopped when the alarm is initiated, however, the blower will not be stopped and the alarm will be automatically cleared when adequate air pressure is established. Feeder operation will be automatically restored when the alarm is cleared.
7. Feeder Malfunction - The M-Drive will be configured to provide a feeder malfunction alarm to the Panelview based on a minimum speed, a maximum speed and a speed error condition. The feeder malfunction alarm will immediately stop operation of the feeder. ACKNOWLEDGING the alarm on the Panelview will clear the alarm.
8. Feeder Hopper Fill Malfunction - The feeder hopper fill malfunction alarm will be initiated on the Panelview if the time to cover the hopper high level probe, after the rotary valve has been given a start signal, exceeds five (5) minutes. The feeder hopper fill malfunction alarm will not stop operation of the feeder, the rotary valve or the fluidization system. The alarm will automatically clear when the feeder high-level switch is covered



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with PAC.

9. Feeder Hopper Level Low - The feeder hopper level low alarm will be initiated on the Panelview if the feeder hopper low level probe is uncovered for more than 5 minutes. The feeder hopper level low alarm will stop operation of the feeder, the rotary valve and the fluidization system until the alarm is cleared. The alarm will automatically clear when the feeder low-level switch is covered with PAC

## V. PURCHASER'S SCOPE OF WORK

The following items are not included in this offering and shall be supplied by the Purchaser if required:

- A. FOUNDATIONS - The Purchaser shall design and install all foundations for the PAC dosing system from load data provided by the Seller. Purchaser will also provide foundation anchor bolts for the Silo.
- B. FINAL ON-SITE ERECTION AND ASSEMBLY OF EQUIPMENT - This proposal does not include final erection or assembly of the equipment.
- C. AREA LIGHTING - The Purchaser shall furnish and install area lighting.
- D. COMPRESSED AIR SUPPLY - The Purchaser shall provide dry instrument quality compressed air source capable of delivering 10 scfm at 100 psig
- E. ELECTRICAL POWER SUPPLY - The Purchaser shall provide a single electrical power feed capable of delivering 60 amps of three (3) phase, sixty (60) cycle, power at 460 volts AC to the Power Panel.
- F. INTERCONNECTING CABLE & CONDUIT - The Purchaser shall provide and install all interconnecting cable and conduit (including fittings) to connect the power and control panel to the furnished equipment.
- G. POWDERED ACTIVATED CARBON (PAC) - The Purchaser shall provide the initial and all subsequent fills of PAC.
- H. DELIVERY PIPING - The Purchaser shall provide the design and installation of the conveying piping, hoses and injection nozzles.

## VI. SPARE PARTS

The following spare parts have been included in this proposal:

- A. Bindicator point level probe.
- B. Silo fluidizing air solenoid valve.
- C. Feeder drive motor speed pick-up.
- D. Contrex M-Drive.

