Urban Wood-Based Bio-Energy Systems in Seattle

Award Number: EE00000435

Seattle Steam Company

Seattle, WA

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1. Executive Summary:

Seattle Steam Company provides thermal energy service (steam) to the majority of buildings and facilities in downtown Seattle, including major hospitals (Swedish and Virginia Mason) and The Northwest (Level I) Regional Trauma Center. Seattle Steam has been heating downtown businesses for 117 years, with an average length of service to its customers of 40 years.

In 2008 and 2009 Seattle Steam developed a biomass-fueled renewable energy (bio-energy) system to replace one of its gas-fired boilers that will reduce greenhouse gases, pollutants and the amount of waste sent to landfills.

This work in this sub-project included several distinct tasks associated with the biomass project development as follows:

a. **Engineering and Architecture:** Engineering focused on development of system control strategies, development of manuals for start up and commissioning.

b. **Training:** The project developer will train its current operating staff to operate equipment and facilities.

c. **Flue Gas Clean-Up Equipment Concept Design:** The concept development of acid gas emissions control system strategies associated with the supply wood to the project.

d. **Fuel Supply Management Plan:** Development of plans and specifications for the supply of wood. It will include potential fuel sampling analysis and development of contracts for delivery and management of fuel suppliers and handlers.

e. **Integrated Fuel Management System Development:** Seattle Steam requires a biomass Fuel Management System to track and manage the delivery, testing, processing and invoicing of delivered fuel. This application will be web-based and accessed from a password-protected URL, restricting data access and privileges by user-level.

Each task was successfully completed and the desired results were achieved.

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2. PROJECT OBJECTIVES

Seattle Steam Company provides thermal energy service (steam) to the majority of buildings and facilities in downtown Seattle, including major hospitals (Swedish and Virginia Mason) and The Northwest (Level I) Regional Trauma Center. Seattle Steam has been heating downtown businesses for 117 years, with an average length of service to its customers of 40 years.

A 25MW_{th} wood-fueled combustion system was installed to generate more than 55% of the total thermal energy needs of Seattle Steam, or approximately 130 GWh of energy production using a renewable fuel source.

As a subset of this overall project the DOE Project included:

- The completion of development of documentation for commissioning and start up.
- The concept design of the custom Acid Gas Clean-Up System which is designed to match the actual wood contracted for the plant resulting in very low acid gas emissions consistent with the location of the facility.
- Development for the plans and specifications for delivery of wood to the plant
- The provision of a novel, internet based, fully integrated, fuel management system designed to manage the collection, sorting, treating, transport, storage and blending of the biomass feedstock to achieve specific emissions targets.

3. DETAILED RESULTS:

3.1. **Engineering and Architecture:**

Engineering focused on development of system control strategies, development of manuals for start up and commissioning. These documents were completed in thirteen volumes as follows:

FD-01 Wood Fuel Receiving System

FD-02 Wood Fuel Processing System

FD-03 Wood Fuel Storage System

FD-04 Wood Conveying System

FD-05 Combustion Control System

FD-06 Combustor Sand System

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FD-07 Combustor Pre-Heat System

FD-08 Boiler and Economizer Sootblower System

FD-09 Baghouse Particulate Removal System

FD-10 SNCR NO_x Reduction System

FD-11 Ash Collection and Handling System

FD-12 Ash Transfer System

FD-13 Limestone Injection System

The descriptions are included in Appendix A.

3.2. **Training:**

Implementation of a biomass boiler system required the retraining of a complete operating work force. To do this successfully a training manual was developed and a training program implemented. The training manual allowed staff to train both at work and at home. The training manual developed covered the following topics and in included in its entirety in Appendix B.

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Process Management

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3.3. **Acid Gas Clean-Up Concept and Equipment Design Standards:**

The concept development of acid gas emissions control system strategies associated with the quality of the wood supply to the project is developed to ensure that the maximum available control technology (MACT) was correctly implemented in this biomass facility. The location of this facility, in downtown Seattle, imposed many control requirements, some regulatory and some by the project's need to be a "good neighbor" to existing, nearby properties.

The flue gas from the boiler has certain quantities of HCl and S02. The amounts of those components depend on fuel characteristics and combustion parameters. The purpose of the BACT spray absorber system is to reduce HCl and S02 from the flue gas prior to discharge to the atmosphere.

S02 and HCl are reduced by reacting with a solution of caustic soda. The amount of caustic required for neutralization depends on the amount of gaseous components in the flue gas. Caustic usage will reduce depending on the amount of boiler blow down water which has inherent alkalinity introduced into the blend tank.

Control philosophy requires a known constant pH that is always maintained in the blend tank by adding 50% caustic. The heart of the system is a spray dryer absorber (SDA). The spray dryer is a co-current tower. Incoming hot gas is sprayed with dilute solution of caustic and sodium hydroxide using dual atomizing nozzles. Atomizing nozzles produce a fine mist of droplets. The contact between fine mist and air results in the adiabatic cooling of the hot flue gas. A chemical reaction between caustic and gaseous components results in removal of pollutants.

Control of the outlet temperature from the SDA is critical to maintain required acid control efficiency and also to keep the baghouse which is located down stream of SDA above the dew point.

In summary the process control philosophy is based on pH on the blend tank and outlet temperature of SDA. A detailed description of the process is included in Appendix C

3.4. **Fuel Supply Management Plan:**

The following Fuel Supply Management Plan was developed along with the Fuel Management Wood Supply Monitoring Plan in Appendix D

3.4.1. **General**

3.4.1.1.1. The intent of the Seattle Steam Biomass Boiler Project (Project) is to procure its woody biomass fuel requirements from as many as

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four (4) primary suppliers with firm obligations to provide and to accept.

3.4.1.1.2. Expected terms of obligation would be one (1) to ten (10) years.

3.4.1.1.3. Expectations are that the Project would be a very steady consumer of fuel day-to-day with largely fixed deliveries from each supplier. To accommodate contingencies, fuel requirements for each supplier would be communicated daily by the Project. Saturday and Sunday needs would be addressed on the immediately preceding Friday. Procedural provisions for last-minute revisions would also be made.

3.4.1.1.4. The Project's goal is to have signed Memorandums of Understanding with its fuel suppliers by years-end 2008 and to have final contracts executed by the end of January 2009.

3.4.2. Fuel Pricing

3.4.2.1.1. Two-tiered pricing:

3.4.2.1.2. Fixed component addresses investment made for dedicated processing, storage, and loading of Project fuel by supplier.

3.4.2.2. Variable component addresses incremental production, storage, and loading costs and profit would be indexed and adjusted quarterly to a suitable third-party regionally-based industry woody biomass fuel report.

3.4.2.3. Fixed ceiling and floor values for total fuel price over term of purchase contract.

3.4.2.4. Fuel transactions would be based on the taking of load weights at point-of-origin. The taking of weights on suitable scales would be obligation of and at the expense of supplier.

3.4.2.5. Fuel purchase and passing of ownership would be fob point-of-origin; loaded

3.4.2.6. It would be supplier's obligation to load fuel as needed; 24 hours per day, 7 days per week.

3.4.2.7. Incentive pricing available for meeting "target" fuel specifications.

3.4.2.8. Fuel payments to supplier would be made monthly, payable within 15-days.

3.4.3. Specifications

3.4.3.1. "Woody biomass fuel" for the purposes of procurement would be that fuel complying with the requirements of the "Working Fuel Procurement Specification" dated November 25, 2008.

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3.4.3.2. A Quality Assurance Plan will be required of each supplier as a condition of transaction. Plan would ensure proper fuel is provided; contaminants minimized, and proscribed materials excluded. Plan is subject to prior approval by Project and to periodic monitoring/audit over the course of contract.

3.4.3.3. Monetary penalties for non-compliant fuel up to and including load-by-load rejection under extreme circumstances.

3.4.3.4. Each load would be sampled and evaluated for fuel moisture content by Project upon delivery.

3.4.4. Quantity/Delivery Terms

3.4.4.1. The Project requires 270 "green" tons (175 bone dry tons approximately) of woody biomass fuel per day, 7 days per week, 355(+) days per year; about 98,000 green tons annually.

3.4.4.2. Transportation of fuel would be provided and paid for by the Project.

3.4.4.3. Each supplier would be contracted for a fixed daily amount with agreed-upon maximum and minimums.

3.5. Integrated Fuel Management System Development:

Seattle Steam requires a biomass Fuel Management System to track and manage the delivery, testing, processing and invoicing of delivered fuel. This application will be web-based and accessed from a password-protected URL, restricting data access and privileges by user-level.

4. CONCLUSION:

All project goals have been met. A key component of this project was to demonstrate and commercialize the technical conditions necessary to process urban wood waste into a useful form, transport it through a dense urban setting, store and handle it within the urban core of a large city, and blend it to meet environmental requirements to achieve specific emissions targets for Chlorine, Sulphur, NOx and ammonia slip (NH3).

The information within this report demonstrates all of those technologies employed to meet these goals. The body of knowledge thus created is available within this report.

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Appendix A

Engineering and Architecture:

Biomass Boiler control strategies for start up and commissioning.

FD-01 Wood Fuel Receiving System

FD-02 Wood Fuel Processing System

FD-03 Wood Fuel Storage System

FD-04 Wood Conveying System

FD-05 Combustion Control System

FD-06 Combustor Sand System

FD-07 Combustor Pre-Heat System

FD-08 Boiler and Economizer Soot Blower System

FD-09 Baghouse Particulate Removal System

FD-10 SNCR NO_x Reduction System

FD-11 Ash Collection and Handling System

FD-12 Ash Transfer System

FD-13 Limestone Injection System

FD-01: WOOD FUEL MANAGEMENT SYSTEM

Section 1: General Description - The purpose of Biomass Fuel Management is to manage all aspects of biomass fuel acquisition, transport, storage, quality control, utilization, value assessment, and associated routine business transactions for the Seattle Steam Company (SSC) Biomass Boiler Project. More specifically, in approximate process order:

a. Monitor and manage multiple biomass fuel supply contacts and one fuel transportation contract, procurement documents including invoice preparation and insurance certifications.

b. Monitor and manage quality control program compliance and performance of multiple individual biomass fuel suppliers both at the respective facilities of origin and at delivery.

c. Upon loading of fuel at suppliers' Facility of Origin (FOF), supplier-arranged transport of fuel from FOF to the Fuel Staging Facility (FSF).

d. Fuel receiving, in-processing, storing, management, and loading out of fuel at the FSF, owned and operated for SSC by a contract operator.

e. Fuel transport and delivery to the Biomass Boiler Project's Fuel Receiving Facility (FRF) in Seattle on Western Avenue and its management and utilization therein.

The Fuel Management System (FMS) supports and accomplishes key elements of overall fuel management. The FMS would be an on-line interface-based solutions package to track fuel transactions, both physical and business, generating fuel management and inventory reports, directly applicable permitting/regulatory compliance documents, invoicing, and direct inputs to SSC accounting systems. The FMS comprises multiple elements; specifically:

- fuel transaction tracking, by truck load and fuel units-of-measure; from delivery and purchase through consumption
- FSF management and operations
- FRF management and operations
- fuel quality and value assessments
- financial management/invoicing

- data communications, collection/uploading, management, and security
- reporting; management, financial, regulatory, and general

Section 2: Fuel Supply Contract Administration

a. Biomass fuel procurement requirements to support SSC operations are anticipated to require multiple supply.

b. Accomplishment of these requirements is expected to be largely administrative in nature and expected to include:

- Contract term, renewal, price adjustments, and price openers.
- Minimum insurance coverage requirements and certifications.
- Contract revisions, amendments, and notifications.
- Creation and maintenance of contract files and key dates.

c. Aspects of this may be purpose-designed into the FMS

Section 3: Fuel Quality Assurance/Control Programs, Plans, and Administration

a. SSC air quality and operating permitting requires each biomass fuel supplier prepare and have in place a fuel quality assurance program.

b. SSC requires of each biomass fuel supplier a written quality assurance plan detailing practices, methods, and controls by which each program is to be accomplished.

c. Each plan and its on-going administration and effectiveness is subject to SSC approval, as a condition of its fuel procurement contracts.

d. The accomplishment of this requirement is expected to be administrative in nature, specifically:

- current supplier plans, with evidence of SSC review and approval, are kept on file by SSC
- expiration dates, periodic plan review and update cycles, on-site inspections, and other requirements would reside in a suitable scheduling program or purpose-designed into the FMS

Section 4: FSF Operations – Fuel Staging

a. Hours of Operation – Jointly established by SSC & FSF contract operator to:

- accommodate varying fuel production and operational requirements of suppliers
- minimize impacts of regional traffic congestion on fuel transportation
- minimize interference with nightly fuel load-out and transportation
- Monitor testing and certification of weight scales

b. Delivery, Scale-In

- primary communications between driver, FSF, and scale are by CB radio or other mutually agreeable method; secondary method by cell-phone
- upon arrival at FSF, fuel delivery truck proceeds to specified scale facility
- driver aligns truck with scale deck, exits truck cab
- driver (1) slides account card on scale console; (2) manually enters account codes and info; or (3) checks in with scale attendant, if present. Needed information includes: supplier code/account, supplier facility of origin, truck ID*, trailer ID*, and driver name/code*
- driver re-enters truck cab; releases parking brake, and positions truck on scale deck; when scale-out read is secured, drives off scale deck
- digital transaction record of load created in scale system or directly within FMS' interface with scale
- Weigh scale management system/FMS creates and prints (1) a hardcopy Sample Ticket, taken by driver; minimum data presented on ticket includes supplier account, date-time-stamp (dts), and unique load tracking number (LTN, both written and bar-code) (LTN can be a combination of DTS, supplier code and daily load count).

  * Supplier and/or transporter-provided names, ID numbers, and/or codes.

c. Delivery, Off-Load

- primary communications between driver and FSF by CB radio or other mutually agreeable method; secondary method by cell-phone
- driver proceeds from scale to FSF queue; in exceptional circumstances, the FSF yard operator may visually inspect load prior to off-loading; provision for the safe performance of such inspections will be provided in or near the FSF
- driver proceeds to next available off-loading slot on receiving apron or as directed by FSF yard operator, sets parking brake, and exits truck cab; truck engine remains running
- driver obtains a sample bag (1-gallon capacity, heavy-duty, "zip-lock" style) from provided dispenser
- driver releases trailer doors, initiates fuel off-load; hand-collects representative (at least six separate handfuls) sample from fuel; inserts hardcopy sample ticket in bag, seals it, and places sample bag in provided sample bin
- As practicable, FSF yard operator will periodically observe from a distance the taking of sample by driver to insure sample is representative and properly collected
- As practicable, FSF yard operator will perform a walk-by visual inspection of off-loaded fuel for evidence of low quality, excess contamination, prohibited materials, or other exceptional conditions; photograph, collect further samples, question driver, etc. as appropriate; immediately report adverse evidence to designated SSC contact by cell-phone or other mutually agreeable method
- driver visually confirms all fuel clear of trailer; closes and latches trailer doors, enters truck cab, and departs FSF
- the authority to reject delivery of off-specification fuel loads, and its decision criteria, is jointly developed and administered by SSC and FSF contract operator with ultimate authority retained by SSC
- if load is rejected as being off-specification or other reason, that load is immediately reloaded by FSF contractor operator in the trailer in which it arrived or, as arranged with supplier, left on apron for later reload

d. Delivery, Scale-Out

- primary communications between driver, FSF, and scale is by CB radio or other mutually agreeable method; secondary method by cell-phone
- emptied fuel delivery truck proceeds from FSF receiving apron to scale facility

- driver aligns truck with scale deck, sets parking brake, and exits truck cab; truck engine remains running
- driver (1) slides account card on scale console; (2) manually enters account codes and info; or (3) checks in with scale attendant, if present; selects from a "pending loads" list
- driver re-enters truck cab; releases parking brake, and positions truck on scale deck; when scale-out read is secured, drives off scale deck
- digital record of load is completed in scale system
- Weigh scale management system creates and prints (3) hardcopy Delivery Tickets, taken by driver; minimum data on ticket includes supplier account, date-time-stamp (dts), and LTN; driver places1st hardcopy ticket in provided receptacle at scale and keeps 2nd and 3rd hardcopies for supplier and/or transporter use
- FSF yard operator collects accumulated hardcopy tickets daily from scale facility receptacle; hardcopy tickets are forwarded to SSC in a pouch along with fuel samples
- digital transaction records are uploaded/transferred daily from scale management system to the FMS

e. Delivery, Logistics

- FSF yard operator pushes off-loaded fuel from the receiving apron up into one of several piles, segregated by moisture content, quality, source or other criterion; specific practices here will be developed as experience in operating both the FSF and the SSC biomass boiler is gained and would continue to evolve as fuel supply and fuel use circumstances develop

f. On-Site Fuel Supply – It is expected that biomass fuels are to be processed on or near the FSF as a separate and distinct business undertaking by the FSF contract operator and that some, or all, of that fuel would be intended for use by SSC. Fuel processed on-site will not be physically commingled in the course of staging or load-out with fuels originating from <u>any</u> SSC off-site supplier(s).

Section 5: FSF Operations – Fuel Load Out/Transport

a. Hours of Operation – Jointly established by SSC & CGC to:

- Accommodate fuel delivery requirements of Fuel Receiving Facility (FRF) reliably and safely much as described in Section 4.

b. Load Out, Scale-In

- primary communications between driver, FSF, and scale is by CB radio or other mutually agreeable method; secondary method by cell-phone
- upon arrival to FSF, fuel transport truck proceeds to specified scale facility
- driver aligns truck with scale deck, sets parking brake, and exits truck cab
- driver (1) slides account card on scale console; (2) manually enters account codes and info; or (3) checks in with scale attendant, if present. Information includes: transporter code/account, truck ID*, trailer ID*, and driver name/code*
- driver re-enters truck cab; releases parking brake, and positions truck on scale deck; when scale-out read is secured, drives off scale deck
- digital record of load created in scale system with unique LTN
- driver proceeds to FSF loading queue

c. Loading

- primary communications between driver and FSF by CB radio or other mutually agreeable method; secondary method by cell-phone
- when directed by FSF yard operator, driver proceeds to loading apron
- FSF yard operator loads truck trailer with appropriate amounts of fuel by use of extended-height front-end loader, taking from different fuel staging piles to achieve a desired blend

d. Scale-Out

- primary communications between driver, FSF, and scale by CB radio or other mutually agreeable method; secondary method by cell-phone

- fuel delivery truck proceeds from FSF loading apron to scale facility
- aligns truck with scale deck, driver exits truck cab; truck engine remains running
- driver (1) slides account card on scale console; (2) manually enters account codes and info; or (3) checks in with scale attendant, if present; selects from a "pending loads" list
- driver re-enters truck cab; drives on to scale deck; when scale-out read is secured, drives off scale deck
- digital record of load is completed in weigh scale system
- Weigh scale system creates and prints (3) hardcopy Fuel Tickets, taken by driver; minimum data on ticket includes date-time-stamp (dts); destination code; scale-in, scale-out, gross, tare, and net weights; and LTN; driver places1st hardcopy ticket in provided receptacle and keeps 2nd and 3rd hardcopies.
- FSF yard operator collects accumulated hardcopy tickets daily from scale facility receptacle; hardcopy tickets are forwarded to SSC in a pouch along with fuel samples and paper work for the fuel received at the FSF the same day.
- digital transaction records are uploaded/transferred daily from scale management system to the FMS
- first load of "day" only; the bin of accumulated samples and a pouch of hardcopy scale tickets from fuel deliveries and load-outs will be loaded into the truck cab for transport to the FRF

Section 6: Fuel Receiving Facility Operations

a. FRF – General

- the FRF is allowed to accept fuel 8:00pm through 6:00am daily per its operating permits; the first load may not enter the FRF until after 8:00pm and the last must exit the FRF prior to 6:00am
- 30 minutes have been allocated for each truck to enter the FRF, unload fuel and depart FRF.
- SSC Operations will provide a plant mounted streaming video of the external (door) view to the control room.
- a hard-wired intercom is provided between the driver unloading station and SSC operations to ensure positive contact can be made at any time during the unloading process; supplementing radio or cell phone communication methods

- Man height mounted, hard-wired carbon monoxide and/or hydrocarbon sensors detect excess truck exhaust accumulation in the FRF and will alarm with lights and sound.
- Truck arrival: Driver opens door, lights come on and two center exhaust fans start. Fans-on indication is provided and override is provided to SSC operations
- Building internal pressure is monitored; low pressure (TBD) indication will start remaining roof fans to provide air into the garage.
- the FRF truck bay is equipped with visual and audible fire alarms and warning lights to notify drivers and other persons in the FRF of emergency conditions so that emergency walk-exits may be utilized
- during fuel in-processing, SSC operations collects fuel samples from drivers for moisture content testing; at least daily intervals.
- three (?) video circuits are provided for SSC operations to monitor the FRF and fuel delivery operations; (1) the FRF exterior, viewed from across Western and generally south (available online) provided by SSC; (2) the FRF truck deck interior, viewed from high on the north wall (close to Union) viewing the truck, floor area on drivers-side, and both entry and exit doors reporting to SSC control room; and (3) the receiving hopper, mounted high on the back wall of the hopper and viewing the open end of a dumping truck; this last view is made available to the driver at the unloading station;

b. FRF Entry

- first load only; 10-minutes out, driver contacts SSC operations by phone to notify of imminent arrival; SSC operations ensures FRF access is clear (by video monitor) and enabled (operator override of timer off), fuel receiving system is clear and operable, and FRF truck deck is clear (by video monitor)
- truck approaches FRF on Western Avenue north-bound
- as truck nears FRF, driver actuates a handheld remote opening FRF entry door; SSC operations has a opening override control to ensure entry door is open when truck arrives
- truck turns directly into FRF entry without pausing

- as truck passes through, two (minimum) optical sensors set at approximately 6-inch and 84-inch heights above floor level detect when truck and trailer are clear of the entry opening and initiates entry door closure; interruption of either or both sensors during the close will reverse the door motion; local wall-mounted controls and SSC operations remotes would reset and close doors as needed

c. Unloading at FRF

- SSC operations monitors unloading activities in the FRF truck deck by video, positioned to view both entry and exit doors and the positioned truck; camera mount should be high on the FRF north wall, drivers-side, forward of truck
- driver aligns truck and trailer and backs up to receiving hopper; painted lines and physical guide rails on truck deck floor assist in proper alignment; a backstop prevents trailer from traveling too far into receiving hoper
- a bumper contact or proximity sensor on the backstop actuates a visual signal mounted on wall to the side of the receiving hopper, viewable from drivers-side rear-view mirror, to indicate positive contact has been made with the backstop and the trailer is properly positioned
- driver sets parking brake and exits truck cab
- a wall-mounted control panel (near truck cab), allows driver to (1) use separate bar code reader adjacent to control panel. THe bar code device shall enable the control panel functions.
- driver unlatches trailer doors from drivers-side of trailer.
- at control panel, driver is presented with a green “button” to initiate unloading; “green” is contingent SSC operations override off:
- when actuated by driver, the “green” button signals plant control to start up fuel receiving (FD 02)
- driver places 2nd hardcopy ticket in provided receptacle; first load only, driver places sample bags from FSF in provided bin; SSC operations collects accumulated tickets and samples daily
- driver monitors progress of unloading via video monitor showing the trailer interior as viewed from high on the back wall of the receiving hopper

- Upon completion of unloading driver re-enters truck cab, starts engine, releases parking brake, and drives forward about six feet
- driver resets parking brake, exits cab, and closes and latches trailer doors; sweep up any fuel that's been spilled with a broom and shovel, provided; dump fuel into receiving hopper; stow broom and shovel on provided rack

d. FRF Exit

- open exit door using local control at unloading station
- re-enter truck cab, release parking brake, and drive out FRF exit door into northbound lanes of Western Avenue.
- as truck passes through exit doorway, two (minimum) optical sensors set at approximately 6-inch and 84-inch heights above floor level detect when truck and trailer are clear of the entry opening and initiates exit door closure; interruption of either or both sensors during the close will reverse the door motion; local wall-mounted controls and SSC operations remotes would reset and close doors as needed

Section 7: Ash Transfer and Load-Out

a. The Biomass Boiler Project is expected to generate approximately 14 tons (dry weight) of wood ash daily

- ash will be collected and stored in a sealed silo located in the FRF above the fuel receiving hopper
- ash will be augured from the silo base, water added to control dust and placed into a truck container for transport from the FRF (FD 12)

b. Ash Load-Out

- ash trucks will approach and enter the FRF similar to that described for fuel delivery trucks, including making contact with and obtaining clearance confirmation from SSC operations
- driver will align truck container under ash load-out spout utilizing painted reference lines on FRF truck deck floor, set parking, brake, shut down engine, and exit truck cab
- driver will make truck container ready to receive ash as needed (remove tarps, align entry points, engage fugitive dust control devices, etc.)

- when ready, driver will utilize local controls to activate ash unloading systems and transfer ash from silo to truck container
- when transfer is complete, driver will secure ash unloading systems and ready truck for over-the-road
- driver will open FRF exit door using local controls, re-enter truck cab, start engine, release parking brake, and drive out into northbound lanes of Western Avenue.

Section 8: FMS Requirements

a. General – The FMS is an integrated hosted software solution, built around a relational database, and web-based operator interface. This custom application is being developed by G H Michaels Associates (Evanston, Illinois) on the UtilityStudio.com platform. User access to data and application privileges are controlled through secure login at www.utilitystudio.com. FMS will be modular, encompassing the following major functions:

1. Supplier Management
2. Fuel Deliveries Tracking to Staging and Receiving/Operations
3. Fuel Quality Assurance Testing
4. Supplier Invoice Generation
5. Fuel Management Reporting
6. FMS User Administration

b. Units - The fundamental unit of fuel management is the as-received-ton (ART)

c. Supplier Management: System Inputs

- Supplier Name and address; Supplier Code (administratively assigned; 3-place alpha-numeric or code from Accounts Payable: TBD)
- Processing facility name and address (if different)
- Mileage from plant to SSC FSF
- Facility Average Fuel Moisture Content
- Contact name and contact information

- Contract date and term
- Pricing: Fuel Price; Monthly Capacity Fee; Low Moisture Fuel Price Reduction; High Moisture Fuel Price Reduction; Off-Spec Fuel Price Reduction; (System will capture and track all periodic changes to fuel charges).

d. Deliveries Tracking: System Inputs

- Supplier Code
- Delivery Date/Time (system generated)
- Lot Tracking Number (system generated; LTN-S in Staging; LTN-R in Receiving); 12-place numeric format of yymmdd-hr-min-xx ("xx" is daily sequential number); examples: 090324-33, 131124-07, etc.; LTN's are assigned to both incoming and outgoing truck loads
- Gross Weight (Loaded Truck Weight; in pounds (lbs.); ranging 5,000-110,000 lbs)
- Tare Weight (Empty Truck Weight; in pounds (lbs.); ranging 5,000-110,000 lbs)
- Net Weight (system generated; units in As-Received-Tons)
- Truck ID; Trailer ID; Driver ID; (all 8-place alphanumeric format to be confirmed)

e. Quality Assurance and Moisture Content Testing: System Inputs

- Sample ID# (system generated)
- Sample Type (Delivered or As-Burned)
- Supplier; LTN #; Date Pulled
- Test Date
- Tester ID
- Pan ID #
- Green Weight
- Dry Weight
- Pan Weight
- Moisture Content % (system generated per calculation)
- Outside lab testing - results of full chemical analysis

f. FMS User Administration: System Inputs

- User Login Name
- User Password
- First Name; Last Name
- Organization; Title
- Contact Info: Email Address; Phone Number
- User-Type (function drives level of access to FMS data and features)
- User Auth Level

g. Invoice Management: System Outputs

- Supplier Name; Supplier Code/ID
- Billing Month and Year
- Invoice Number
- Invoice Date; Due Date
- Current Invoice Total; Total Due
- Total Fuel Delivered for billing period (ART)
- Invoice Charges: Fuel Charge ; Monthly Capacity Fee; Misc Charges; Credits; Taxes
- Invoice Adjustments; Reason

h. Management Reporting: System Outputs

Note: Data will be presented in pre-formatted reports/tables, graphs, and export (Excel, CSV, PDF, XML) format. Reports will offer selection logic to allow reporting by Supplier and Date Range.

- Fuel Management Cost Report: Cost and ART for reporting period (daily, weekly, monthly, annual)
- Daily Fuel Deliveries and Inventory Report (between user-specified dates)
- Moisture and Material Analysis Summary Report

i. Other System Outputs

- Fuel Delivery Ticket: Generated and printed at Staging - 3 hardcopies: Date/Time; LTN; Supplier; Facility of Origin (if multiple); Truck ID; Trailer ID; Driver ID; Net Weight (calculated); Note: Bar coding of tickets will be evaluated after initial system development.

- Quality Assurance Sample Ticket: Generated at Staging during delivery (Supplier sample) or from blended lots (for As-Burned samples): 1 hardcopy; Date/Time; Sample ID; Sample Type; Supplier; LTN; Note: printed on water-resistant card stock for inserting into fuel sample bags; Bar coding of tickets will be evaluated after initial system development.

- Delivery Transactions captured for invoice generation and reporting.

- Estimated Supplier Invoices (described above)

- Input to SSC accounting systems: To Be Determined

j. System Security

All system access for all system users is through the secure web site www.utilitystudio.com. User login will drive access to system data, features and functions. These levels will be defined during development.

- System Administrator: Access to all data, features and functions; Has username/password access to all general user level access; Edit record detail; Edit supplier profiles; Financial system input; Username/password tables and other administrative/system management.

- General User: Access based on function and responsibility; Access to data will be defined; Read/Edit/Delete privileges will be defined for all screens and reports.

- History of data and transactions will be maintained; Edits will be tracked with user id and date/time.

- System-wide record and application backup occurs daily; Emergency system switch-over/recovery will occur within 4 hours. Length of system data storage for presentation and archiving will be determined during development.

k. System Communications

FMS is hosted on UtilityStudio.com, a contracted application service from G H Michaels Associates, LLC. User system requirements: Microsoft/Windows-based computer with browser Internet Explorer (version 6 or higher).

Section 9: Moisture Testing

a. General

- utilize ASTM E 871 "Standard Method for Moisture Analysis of Particulate Wood Fuels" as guideline
- performed as daily routine by SSC operators and/or lab/water quality technician, per approved written SSC procedure
- requires precision scale, bar code reader, system access terminal, approximately (50) pre-weighed shallow pans with barcode labels, and precision oven
- testing performance and records are subject to audit and observation by fuel suppliers

b. Discussion

- each sample should be approximately 1 gallon in volume and be representative of the delivered load' composition, contaminants (if any), and MC
- scale weights (green, dry, and empty pan) can be measured in grams, pounds, ounces, etc. so long as all weights are taken in same units of measure
- the "green weight" of the sample is obtained by weighing the loaded pan before drying
- the oven temperature and cycle duration is set to uniformly evaporate moisture from all fuel, irrespective of particle size, of the sample without driving off volatiles from the wood itself

- the “dry weight” of the sample is obtained by weighing the loaded pan after drying
- minimize ambient air exposure of loaded sample pans once dried as air-borne moisture can be re-absorbed and skew results
- wood moisture is expressed as a percent “wet” or percent “dry”; for biomass fuels, the “wet” basis is the more regionally common format
- FMS calculates “wet” basis fuel sample MC by:

$$\%MC = \frac{(\text{green weight} - \text{dry weight})}{(\text{green weight} - \text{pan weight})} \times 100\%$$

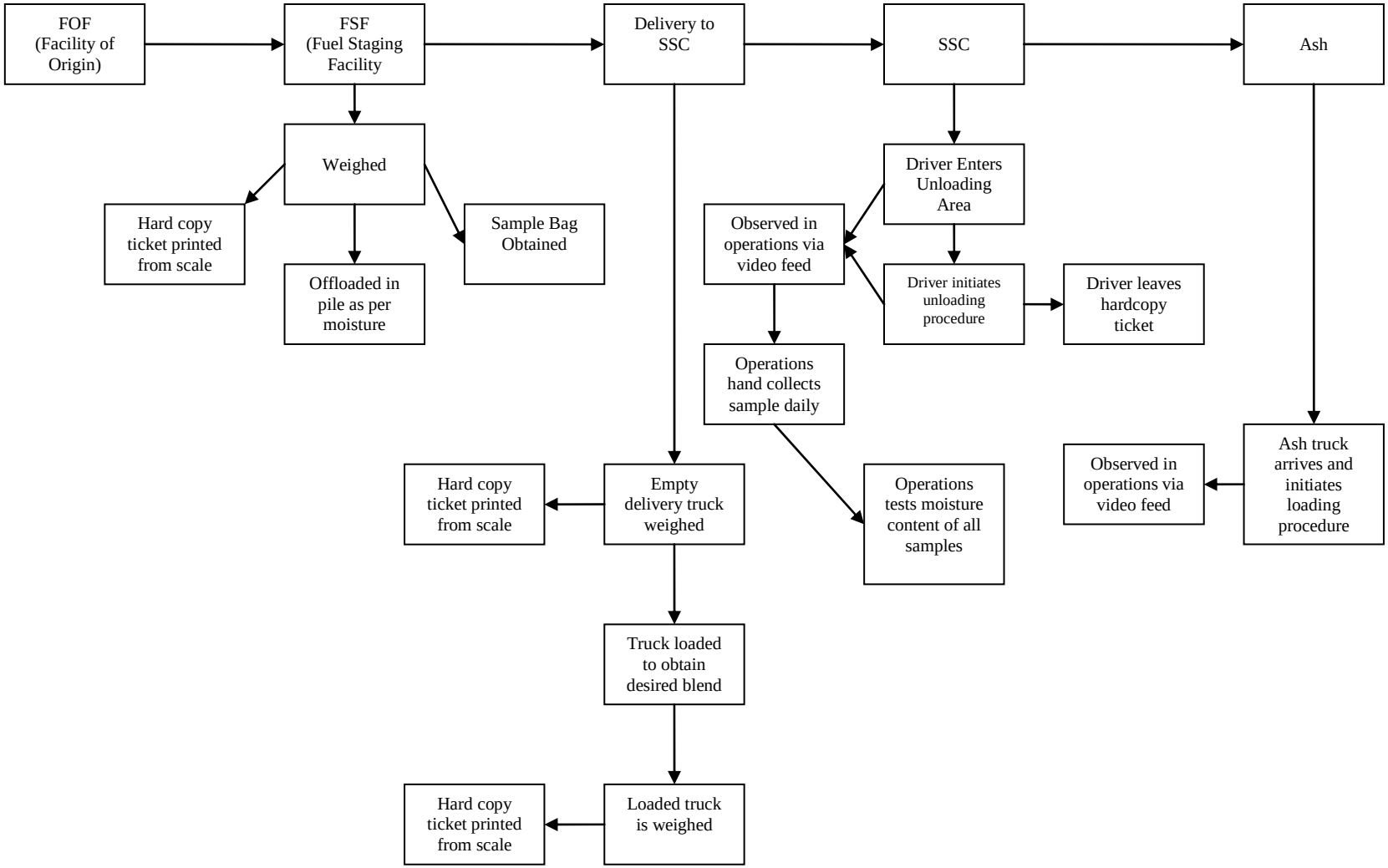
c. Procedure

- retrieve bin with fuel sample bags and ticket pouch daily from FRF
- remove hardcopy tickets from pouch; forward to SSC admin
- open each sample bag, dump contents in pan, discard emptied bag
- inspect sample for unusual materials or evidence of contamination; notify SSC fuel manager as appropriate
- scan both sample ticket and pan barcodes; discard sample ticket; weigh and record loaded pan; green weight
- place loaded pan in sample oven
- repeat until all samples are in-processed
- close sample over and start drying cycle; typically 105°C for 14 hours
- when sample oven cycle is complete and pans cooled enough to touch, remove each pan and scan pan barcode; empty pan weight is retrieved from system based on its barcode
- weigh and record loaded pan; dry weight
- discard fuel in sample bin; retain unusual samples for SSC fuel manager if requested
- repeat until all samples are out-processed

- review for questionable or exceptional MC results
- upload moisture test results to FMS
- return bin to FRF and dump its contents in the receiving hopper
- place empty hardcopy ticket pouch in bin; set it out to collect next round of sample bags

d. Periodic Quality Assurance/Control Requirements

- check sample oven temperature and timer against standard
- calibrate/certify sample scale against standard
- recheck empty pan weights; update FMS pan-weight table as needed
- SSC plant and/or fuel manager observe and spot-check operator/technician performance in MC testing
- create and send out “split” fuel samples to outside lab MC testing
- document and retain QA/QC results


FOF (Facility of Origin)
FSF (Fuel Staging Facility
Delivery to SSC
SSC
Ash
Weighed
Hard copy ticket printed from scale
Sample Bag Obtained
Offloaded in pile as per moisture
Driver Enters Unloading Area
Observed in operations via video feed
Driver initiates unloading procedure
Driver leaves hardcopy ticket
Operations hand collects sample daily
Operations tests moisture content of all samples
Ash truck arrives and initiates loading procedure
Observed in operations via video feed
Hard copy ticket printed from scale
Empty delivery truck weighed
Truck loaded to obtain desired blend
Hard copy ticket printed from scale
Loaded truck is weighed

PRECISION ENERGY SERVICES INC.

FD-02: WOOD RECEIVING AND PROCESSING SYSTEM

Section 1: General Description:

The fuel handling system consists of three subsystems: the wood fuel receiving and processing system, the wood fuel storage system, and the wood conveying system. This functional description describes the wood fuel receiving and processing system. The system begins where incoming trucks off-load wood fuel into a receiving bin. The fuel is then conveyed from the bin via a vibrating conveyor to a second vibrating conveyor that separates the over-sized material from acceptable sized fuel. The over-sized material is reduced in size by a small hammer mill. The ground material from the hammer mill is discharged to an inclined belt conveyor which returns the material to the second vibrating conveyor for resizing. The second vibrating conveyor deposits acceptable sized material into a bucket elevator which raises the fuel to the top of the fuel storage silo. The bucket elevator deposits the fuel into the fuel silo infeed screw conveyor which transfers the fuel to the fuel storage silo.

Section 2: Principal Elements

P&ID 700-002, sheets 1 and 2 provide a schematic representation of all the equipment components associated with the fuel receiving and processing system. Major components for this system consist of the following:

a. Fuel Receiving Bin 12-001:
The fuel receiving bin has a capacity of 2,500 cubic feet of fuel. The bottom of this bin is comprised of a Keith Walking Floor (KWF) that moves the fuel to the bin discharge conveyor. This floor is operated by a KWF hydraulic power unit (HPU) 12-001-06.

b. Fuel Bin Discharge Conveyor 12-006:
This is a vibrating conveyor with a capacity of 50 tons per hour.

c. Inclined Screen/Scalping Conveyor 12-007:
This is a vibrating conveyor with an oversize material screening section. The screen will separate the fuel into 2 classifications: material over 3” and material 3” or less in size.

d. Wood Hog Oversized Fuel Grinder 12-010:
The wood hog or hammer mill reduces the size of fuel that is over 3” in size.

e. Inclined Slider Belt Conveyor 12-009:
The slider belt conveyor transfers processed material from the outfeed of the wood hog back to the infeed section of the inclined screen/scalping conveyor.

f. Fuel Handling Bucket Elevator Conveyor 12-012:
The bucket elevator receives wood fuel from the outfeed of the inclined scalping conveyor and lifts it to the infeed of the fuel storage silo infeed conveyor.

g. Fuel Storage Silo Conveyor 12-014
This is a screw type conveyor that transfers wood fuel from the bucket elevator to the fuel storage silo.

h. Dust Collection System 12-050:
The dust collection system employs a network of ducting with a number of intakes located at various points in the fuel building basement where fugitive dust is produced during fuel handling operations. A fan draws air from the ducting and exhausts to a baghouse where dust particles are removed. Clean air from the baghouse is returned to the basement. The dust particles removed by the baghouse are collected in a hopper and periodically discharged to the fuel receiving bin.

Section 3: Modes of Control

The main function of the wood fuel receiving and processing system is to transfer wood fuel being delivered by truck to the wood fuel storage silo. The DCS shall provide the controls to enable remote startup and shutdown of the wood fuel receiving and processing equipment. The subsections that follow describe the controls to be provided and the various operating modes in more detail:

a. Receiving Processing Controller (FC-1230)
The DCS shall provide a sequencing controller that regulates the operation of all of the equipment in the fuel receiving and processing system, FC-1230. This controller shall start and stop the wood fuel receiving and processing system equipment as described in sections 3.e and 3.f.

b. Fuel Receiving Bin Controller (FC-1232)
The DCS shall provide a sequencing controller, FC-1232 that regulates the fuel receiving bin. This controller shall operate the fuel receiving bin as follows:

1 - Forward Mode
When FC-1230 requests the fuel receiving bin to begin operation, FC-1232 shall energize SV-1232 and then start the fuel receiving bin hydraulic power unit pump 12-001, by energizing the pump's motor, 12-001-01. This will cause the walking floor in the bin to move in the forward direction.

2 - Reverse Mode
If during operation in the forward mode, the contacts shut for fuel receiving bin level detector, LSHR-1230, FC-1232 shall energize SVR-1232 This will cause the direction of the walking floor to reverse and move wood fuel toward the rear of the fuel receiving bin. As soon as the contacts for LSHR-1230 open, FC-1232 shall

de-energize SVR-1232 which will cause the walking floor to move in the forward direction.

3 - Fuel Receiving Bin Stop
If during receiving bin operation the contacts for LSH-1230 shut, FC-1232 shall stop the fuel receiving bin hydraulic pump, de-energize SV-1232, and initiate a high bin level alarm.

c. System Start Switch (HS-1230A)
The DCS shall be programmed to receive a discrete input from a local push button switch, HS-1230A which will cause FC-1230 to initiate a startup of the fuel receiving and processing system.

d. Control Room Override Switch (HS-1230C)
The DCS shall provide a control room operator override switch HS-1230C which when in the override position shall prevent a truck driver from initiating a startup sequence.

e. Startup
Startup of the wood fuel receiving and processing shall be initiated when a fuel truck driver presses the system start switch, HS-1230A. Once this switch is depressed, FC-1230 shall initiate the following sequence:

i. De-energize System Stop Lights
De-energize the red system stop light, OI-1230E located in the control box that houses HS-1230A and OI-1230F displayed in the control room.

ii. Energize System Start Lights
Energize yellow system start light, OI-1230A located in the control box that houses HS-1230A and OI-1230C displayed in the control room. This will provide an indication to the wood fuel truck driver and control room operator that the control system has acknowledged the request to start and is in the process of energizing the wood fuel receiving and processing equipment.

iii. Energize Baghouse Cleaning System Controller:
Energize the baghouse cleaning system controller, DPC-1265 by shutting power supply switch, JS-1265 which will provide 120VAC power to the controller.

iv. Activate Dust Collection System
Start the collection system fan; 12-049 using HS-1265 to energize motor 12-049-01.

v. Start Fuel Silo Infeed Conveyor
Start the fuel silo infeed screw conveyor 12-014 using HS-1242 to energize motor 12-014-01.

vi. Start Bucket Elevator
Start the bucket elevator, 12-012 using HS-1241 to energize motor 12-012-01.

vii. Start Wood Hog
Start the oversize wood fuel hog, 12-010 using HS-1239 to energize motor 12-010-01.

viii. Start Inclined Slider Belt Conveyor
Start the inclined slider belt conveyor, 12-009 using HS-1240 to energize motor 12-009-01.

ix. Start Inclined Screen/Scalping Conveyor
Start the inclined screen/scalping conveyor, 12-007 using HS-1238 to energize motor 12-007-01.

x. Start Fuel Bin Discharge Conveyor
Start the receiving bin discharge conveyor, 12-006 using HS-1237 to energize motor, 12-006-01.

xi. Start Receiving Bin Spike Roll
Start the receiving bin spike roll, 12-005 using HS-1234 to energize motor 12-005-01.

xii. Start Receiving Bin Walking Floor
Start the receiving bin walking floor by sending a start signal to FC-1232.

xiii. Energize System Ready Light
After FC-1232 energizes SV-1232, FC-1230 shall de-energize OI-1230A and OI-1230C. FC-1230 shall then energize green system in operation lights OI-1230B located in the control box that houses HS-1230A, and OI-1230D displayed in the control room. These lights will provide an indication to the wood fuel truck driver and control room operator that the wood fuel receiving and processing system is operating.

xiv. The truck driver may then commence unloading his truck to the receiving bin. The truck driver should Monitor the camera for the receiving bin and be prepared to press the e-stop and stop his truck conveyor if the bin overfills or he notices piling or spillage.

f. Shut Down Mode
Shutdown of the wood fuel receiving and processing system shall occur when the receiving bin level sensor LSL-1230 no longer detects fuel in the bin. FC-1230 shall initiate a sequential shutdown if the contacts for LSL-1230 remain shut for more than 2 minutes as follows:

i. De-energize System Ready Light
As soon as FC-1230 initiates a stop sequence the system ready lights OI-1230B and 1230D shall be de-energized.

ii. Energize System Stop Light, Flashing
After FC-1230 de-energizes the system ready lights, the controller shall energize system stop lights OI-1230E and OI-1230F in a flashing mode at a 1 second interval to provide local and remote

indications that signify the wood fuel receiving and processing system is shutting down.

iii. **Stop Receiving Bin Walking Floor**
Stop the receiving bin walking floor by sending a stop signal to FC-1232.

iv. **Stop Receiving Bin Spike Roll**
Stop the receiving bin spike roll, 12-005 by de-energizing motor 12-005-01.

v. **Stop Fuel Bin Discharge Conveyor**
After stopping the receiving bin spike roll continue operating the remaining wood fuel receiving and processing equipment for 5 minutes then Stop the fuel bin discharge conveyor, 12-006 by de-energizing motor, 12-006-01.

vi. **Stop Inclined Screen/Scalping Conveyor**
Stop the inclined screen/scalping conveyor, 12-007 by de-energizing motor 12-007-01.

vii. **Stop Wood Hog**
Stop the wood hog, 12-010 by de-energizing motor 12-010-01.

viii. **Stop Inclined Slider Belt Conveyor**
Stop the inclined slider belt conveyor, 12-009 by de-energizing motor 12-009-01.

ix. **Stop Bucket Elevator**
Stop the fuel handling bucket elevator, 12-012 by de-energizing motor 12-012-01.

x. **Stop Fuel Silo Infeed Conveyor**
Stop the fuel silo infeed screw conveyor 12-014 by de-energizing motor 12-014-01.

xi. **Stop Dust Collection System**
Stop the collection system fan, 12-049 fifteen minutes after the shutdown was initiated by de-energizing motor 12-049-01.

xii. **De-energize Baghouse Cleaning System Controller**
De-energize the baghouse cleaning system controller, DPC-1265 after fan 12-049 is stopped by opening power supply switch, JS-1265 which will remove 120VAC power to the controller.

xiii. **Energize System Stop Light, Steady**
After FC-1230 opens the power supply switch, JS-1265 for the baghouse cleaning system controller, FC-1230 shall switch the output to the system stop lights, OI-1230E and OI-1230F to change their indications from a flashing mode to steady mode.

g. Emergency Stop

During wood fuel unloading the driver shall monitor the receiving bin via a monitor which is connected to a video camera that is aimed at the receiving bin. In the event of any abnormal condition requiring an immediate shutdown of the system, the driver shall press the emergency stop push button, HS-1230B. This push button will be located in the same control box that houses HS-1230A & HS-1230B. When an emergency stop is initiated the DCS shall stop all wood receiving and processing equipment, de-energize the system ready lights and energize the system stop lights in the steady mode.

h. High Fuel Storage Silo Level Emergency Stop

If a high level condition in the fuel storage silo occurs during fuel unloading operations as indicated by the shutting of the contacts for LSHH-1246, the DCS shall stop all wood receiving and processing equipment, de-energize the system ready lights and energize the system stop lights in the steady mode.

Section 4: Safety Interlocks

a. General

For all conveying equipment: In the event of a loss of running signal, fault alarm, or the activation of the equipments low speed switch all upstream equipment shall stop immediately. A normal shutdown will be initiated to stop the remaining downstream equipment. The stop lights will flash rapidly at ½ second interval to inform the truck driver and the control room operator there is a problem. All motor starters shall alarm on overload fault.

b. Switch ZSC-1230

If the Fuel Receiving Bin Hopper's door switch ZSC-1230 contacts are open, no motors shall start or if they open during operation and an emergency stop shall be initiated.

c. Switch ZSC-1263

If the baghouse discharge airlock door switch ZSC-1263 contacts are open, the air lock's drive motor shall be prevented from starting or if they open during operation the drive motor shall be stopped and an alarm shall be initiated.

d. Switch ZSC-1266A thru C

If any of the contacts for switches ZSC-1266A thru C are open, it shall not be possible to operate dust collection fan, 12-049; the baghouse cleaning blower, 12-051; and the baghouse discharge airlock, 12-058. This equipment shall be shutdown if any of these contacts open during operation of the wood fuel receiving and processing system and an alarm shall be initiated.

e. Switch LSHH-1246

If the fuel silo's high level switch LSHH-1246 contacts shut indicating a full fuel storage silo while the wood fuel receiving and processing system is operating an emergency shutdown shall be initiated as described in section 3.g.

Section 5: Monitoring

The DCS shall provide graphics display of the wood fuel receiving and processing system and data logging as described in the sections that follow:

a. Indications Displayed

The DCS shall provide a graphics overview display for the control room operator that depicts the wood fuel receiving and processing system fuel receiving bin with walking floor, walking floor hydraulic power unit with hydraulic pump, discharge conveyor, inclined screen/scalping conveyor, wood hog, inclined slider belt conveyor, bucket elevator, fuel silo infeed screw conveyor, fuel storage silo, dust collection fan and related ductwork, baghouse, baghouse cleaning blower, and baghouse discharge airlock. The display shall include the remote override switch, HS-1230C and the display shall provide the following indications:

i. Fuel receiving bin hydraulic pump motor run status: auxiliary contacts for MY-1231.

ii. Fuel receiving bin spike roll run status: auxiliary contacts for MY-1234.

iii. Fuel receiving bin discharge conveyor run status: auxiliary contacts for MY-1237.

iv. Inclined screen/scalping conveyor run status: auxiliary contacts for MY-1238.

v. Wood hog run status: auxiliary contacts for MY-1239.

vi. Inclined slider belt conveyor run status: auxiliary contacts for MY-1240.

vii. Bucket elevator run status: auxiliary contacts for MY-1241.

viii. Fuel silo infeed conveyor run status: auxiliary contacts for MY-1242.

ix. Dust collection fan run status: auxiliary contacts for MY-1265.

x. Baghouse bag cleaning blower run status: auxiliary contacts for MY-1264.

xi. Baghouse discharge airlock run status: auxiliary contacts for MY-1263.

xii. Baghouse differential pressure as indicated by DPT-1265.

xiii. Wood receiving system ready, OI-1230D

xiv. Wood receiving system starting OI-1230C

xv. Wood receiving stopped, OI-1230F

b. Data Logging
Runtime hours for each piece of rotating machine and conveyor in the wood fuel receiving and processing system shall be recorded for maintenance purposes.

Section 6: Alarms

The DCS shall provide the following alarms for the wood fuel receiving and processing system during wood firing operations:

a. Fuel storage silo high as indicated the shutting of the contacts for LSHH-1246.

b. An alarm shall be generated for each piece of equipment that has stopped moving as indicated by the shutting of contacts on the following switches:

i. SSL-1234 – Receiving Bin Spike Roll 12-005

ii. SSL-1237 - Fuel Bin Discharge Conveyor 12-006

iii. SSL-1238- Inclined Screen/Scalping Conveyor 12-007

iv. SSL-1239 – Wood Hog Oversized Fuel Grinder 12-010

v. SSL-1240 – Inclined Slider Belt Conveyor 12-009

vi. SSL-1241 – Fuel Handling Bucket Elevator 12-012

vii. SSL-1242 – Fuel Silo Infeed Screw Conveyor 12-014

viii. SSL-1263 – Baghouse Discharge Airlock

ix. SSL-1264- Baghouse cleaning blower 12-051.

c. An alarm shall be generated for each electric motor driven piece of equipment commanded to run if its electric motor stops as indicated by the opening of the motor's run status contacts for the following motors:

i. Fuel receiving bin hydraulic pump motor run status: auxiliary contacts for MY-1231.

ii. Fuel receiving bin spike roll run status: auxiliary contacts for MY-1234.

iii. Fuel receiving bin discharge conveyor run status: auxiliary contacts for MY-1237.

iv. Inclined screen/scalping conveyor run status: auxiliary contacts for MY-1238.

v. Wood hog run status: auxiliary contacts for MY-1239.

vi. Inclined slider belt conveyor run status: auxiliary contacts for MY-1240.

vii. Bucket elevator run status: auxiliary contacts for MY-1241.

viii. Fuel silo in feed conveyor run status: auxiliary contacts for MY-1242.

ix. Dust collection fan run status: auxiliary contacts for MY-1265.

x. Baghouse bag cleaning blower run status: auxiliary contacts for MY-1264.

xi. Baghouse discharge airlock run status: auxiliary contacts for MY-1263.

d. An alarm shall be generated for each electric motor driven piece of equipment with motor starters or variable speed drive with fault indication contacts that develop faults when commanded to run as indicated by the following contact closures:

i. YA-1239 – Wood hog motor starter fault.

ii. YA-1241 – Fuel transfer bucket elevator variable speed drive fault.

iii. YA-1265 – Dust collector fan motor starter fault.

e. Fuel receiving bin fuel level high as indicated by the shutting of the contacts for LSH-1230.

f. Low oil level in hydraulic power unit oil reservoir as indicated by the shutting of contacts for LSL-1231.

g. High oil temperature in hydraulic power unit oil reservoir as indicated by the shutting of the contacts for TSH-1231.

h. Fuel receiving bin door open as indicated open contacts for ZSC-1230.

i. Baghouse hopper discharge airlock door open as indicated by open contacts for ZSC-1263.

j. Baghouse explosion doors open as indicated by open contacts for ZSC-1266A through ZSC-1266C.

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
HSA	1231	Receiving Bin Hyd Pump Auto	DI	
HSA	1234	Receiving Bin Spike Roll Drive Auto	DI	
HSA	1237	Fuel Bin Discharge Conveyor Auto	DI	
HSA	1238	Scalping Conveyor Auto	DI	
HSA	1239	Oversized Wood Grinder Auto	DI	
HSA	1240	Inclined Slider Belt Conveyor Auto	DI	
HSA	1241	Fuel Transfer Bucket Elevator Auto	DI	
HSA	1242	Infeed Screw Conveyor Auto	DI	
HS	1230A	Fuel Receiving System Start	DI	
HS	1230B	Fuel Receiving System Stop	DI	
PBES	1230	Fuel Receiving System Estop	DI	
OI	1230E	Fuel Receiving System Local Stop Light	DO	
OI	1230A	Fuel Receiving System Local Start Light	DO	

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
OI	1230B	Fuel Receiving System Control Local in Operation Light	DO	
LSH	1230	Fuel Receiving Bin Discharge Level High	DI	
LSHR	1230	Fuel Receiving Bin Level Reverse Limit	DI	
LSL	1230	Fuel Receiving Bin Discharge Level Low	DI	
ZSC	1230	Fuel Receiving Bin Access Door	DI	
LSL	1231	Receiving Bin Hyd Reservoir Oil Low	DI	
TSH	1231	Receiving Bin Hyd Reservoir Temperature High	DI	
SV	1232	Receiving Bin Walking Floor Run Sol	DO	
SVR	1232	Receiving Bin Walking Floor Reverse Sol	DO	
SSL	1234	Receiving Bin Spike Roll Drive Zero Speed	DI	
SSL	1237	Fuel Bin Discharge Conveyor Zero Speed	DI	
SSL	1238	Scalping Conveyor Zero Speed	DI	
SSL	1239	Oversized Fuel Grinder Zero Speed	DI	
SSL	1240	Inclined Slider Belt Conveyor Speed Zero Speed	DI	
SSL	1241	Fuel Handling Bucket Elevator Zero Speed	DI	
SSL	1242	Infeed Screw Conveyor Zero Speed	DI	
YA	1231	Receiving Bin Hyd Pump Fault	DI	
YA	1239	Oversized Wood Grinder Fault	DI	
YA	1241	Fuel Transfer Bucket Elevator Fault	DI	
YA	1265	Dust Collection Fan Fault	DI	
SSL	1263	Dust Collection Discharge Airlock Zero Speed	DI	
JS	1265	Switch Power to Baghouse Cleaning DPC-1265	DO	
ZSC	1263	Dust Collection Access Door Closed	DI	
ZSC	1266	Dust Collection Explosion Doors Closed	DI	
HS	1231	Receiving Bin Hyd Pump Start	DI	
MY	1231	Receiving Bin Hyd Pump Run	DI	
MY	1234	Receiving Bin Spike Roll Drive Run	DI	
MY	1237	Fuel Bin Discharge Conveyor Run	DI	
MY	1238	Scalping Conveyor Running	DI	
MY	1239	Oversized Wood Grinder Run	DI	
MY	1240	Inclined Slider Belt Conveyor Run	DI	
MY	1241	Fuel Transfer Bucket Elevator Run	DI	
MY	1242	Infeed Screw Conveyor Run	DI	
MY	1263	Dust Collection Discharge Airlock Run	DI	
MY	1264	Dust Collection Bag Cleaning Run	DI	
MY	1265	Dust Collection Fan Run	DI	
PDS	1265	Dust Collection Baghouse Diff Pressure High	DI	
TSH	1231	Receiving Bin Hyd Reservoir Temperature High	DI	

PRECISION ENERGY SERVICES INC.

FD-03: WOOD FUEL STORAGE SYSTEM

Section 1: General Description:

The fuel handling system consists of three subsystems: the wood fuel receiving system and processing system, the wood fuel storage system, and the wood conveying system. This functional description describes the wood fuel storage system. The wood fuel storage system consists primarily of a large above ground tank for the storage and dispensing of wood fuel to the wood conveying system that delivers wood fuel to the No. 1 Boiler.

Section 2: Principal Elements

P&ID 700-002 Sheet 2 shows all of the equipment and instruments that are part of the fuel handling system. The equipment components associated with wood storage system are as follows:

a. Fuel Storage Silo:

All wood fuel for the No. 1 Boiler is stored in a metal silo (12-030**)** which has a capacity of nearly 38,000 cubic feet.

b. Fuel Storage Silo Unloader:

The fuel storage silo unloader is located at the bottom of the silo and serves to discharge wood fuel from the silo. It consists of a main drive auger (12-031-01) and two advancing drive units (12-031-02 and 12-031-03) which cause the main drive to revolve around the base of the storage silo.

c. Discharge Auger:

The discharge auger, 12-032 is a reversing screw that receives fuel from the silo unloader and transports it to the Metering Bins 12-036 & 12-037 which are part of the wood conveying system. It rotates in one direction to fill Metering Bin 12-036 and the opposite direction to fill Metering Bin 12-037.

Section 3: Modes of Control

The main function of the wood fuel storage system is to store and transfer wood fuel from the storage silo to the fuel metering bins. The DCS shall provide the controls to enable automatic operation of the discharge auger and the fuel storage silo unloader. The subsections that follow describe the controls to be provided and the various operating modes in more detail:

a. Fuel Bin Selector Switch

The DCS shall provide a 3 position fuel bin selector switch, HS-1254. When position 1 is selected the output from fuel feed controller FC-1254 shall go to the variable speed drive for fuel Metering Bin No. 1, SC-1211. In position 3 the output shall go to the variable speed drive for fuel Metering Bin No. 2, SC-1221. When both (position 2) is selected the

output from FC-1254 shall be divided by 2 and sent to the variable speed drives for both fuel metering bins. In addition, when both metering bins are selected for operation an output signal to indicate both metering bins are operating shall be provided to the fuel delivery controller, FC-1245.

b. Control Loops

The DCS shall employ several control loops to regulate the flow of wood fuel to the wood conveying system Metering Bins:

i. Metering Bin Level Controllers:
The DCS shall provide a level controller for each fuel metering bin which when placed in automatic operating mode shall send requests for fuel to the wood fuel storage system. LC-1211 shall maintain the fuel level in fuel Metering Bin No. 1. During automatic operation a discrete input from LSL-1211 to LC-1211 shall cause the controller to send a request for fuel signal to fuel delivery controller FC-1245. When the bin is full a discrete input from LSH-1211 shall cause LC-1211 to terminate its request for fuel signal to FC-1245.
LC-1221 shall maintain fuel level in fuel Metering Bin No. 2. This controller will employ level switches LSL-1221 and LSH-1221 to determine when to start and stop fuel delivery requests to FC-1245.

ii. Fuel Delivery Controller
The fuel delivery controller, FC-1245 will receive control signals from the fuel bin level controllers LC-1211 and LC-1221. Upon receipt of a request for fuel signal, FC-1245 will start the fuel storage system discharge auger, silo unloader main drive auger, and silo unloader advancing drives in a timed sequence. When a request for fuel signal ends, FC-1245 will initiate a timed shutdown sequence of the fuel delivery equipment

c. Operating Modes

During normal wood firing operations wood fuel storage system must be capable of automatically delivering fuel to the wood conveying system metering bins for two possible modes of operation: single bin operation or operation with both metering bins running. The subsections that follow describe the manner in which FC-1245 will coordinate the starting and stopping of the discharge auger and the silo unloader.

i. Single Bin Operation Startup and Shutdown
During single bin operation one of the fuel metering bins will be designated by the control room operator to supply fuel to the wood conveying system with the bin selector switch, HS-1254. The control room operator will then place the fuel delivery controller, FC-1245 in automatic mode. The controller will then respond automatically to a fuel request by the bin's level controller and start the fuel storage system discharge auger, silo unloader main drive auger, and silo unloader advancing drives in a timed sequence as follows:

1 - With a call for fuel from a bin level controller, FC-1245 will send a start signal to the Discharge Auger variable speed drive, SC-1245. The incoming signal from the bin level controller shall be used by FC-1245 to determine the required rotation for the Discharge Auger and the output signal from FC-1245 to SC-1245 shall cause the auger to rotate in the correct direction. SC-1245 shall be programmed to run the Discharge Auger motor at 60 hertz at all times.

2 - After confirmation of Discharge Auger rotation, FC-1245 shall start the Silo Unloader Main Auger by sending a start signal to SC-1244. If the Discharge Auger feed chute high level switch LSH-1244 contacts are shut, FC-1245 shall send a speed setting signal of 50% to SC-1244. If or when the contacts for LSH-1244 open, FC-1245 shall increase the speed setting signal to 100%.

3 - Ten seconds after FC-1245 sends a start signal to start the Silo Unloader Main Auger, FC-1245 shall provide a start signal to the Silo Unloader Advancing Drives provided the contacts of LSH-1244 are not shut. If the contacts for this level switch are shut, the Advancing Drives shall not be started until the contacts open.

Note: At any time during fuel unloading operations, if the contacts for LSH-1244 shut, the Silo Unloader Main Auger speed shall be reduced to 50% and the Advancing Drives shall be stopped. When the contacts reopen the Main Auger speed shall be increased to 100%. Then after ten seconds the Advancing Drives shall be restarted.

4 - If the contacts for LSHH-1244 shut, the Silo Unloader Main Auger shall be stopped. During fuel unloading operations if the contacts for this switch re-open, the Silo Main Auger shall be re-started with an initial speed setting of 50%.

5 - The system also requires a verification of fuel flow by sensors FS-1245A or FS-1245B which are in discharge chutes 12-034 & 12-035. If after 30 seconds from the starting of the Silo Unloader Advancing Drives, there is no indication of fuel flow in either chute, the equipment shall be stopped.

6 - When the high level sensor contacts in the pre-selected metering bin (LSH-1211 or LSH-1221) shut, the system shall be shutdown and remain in a standby status until the selected metering bin's low level sensor (LSL1211 or LSL1221) opens at which time another start sequence shall be initiated by FC-1245.The shutdown sequence during single metering bin operation shall be as follows:

- As soon as the request for fuel from the metering bin to FC-1245 is terminated, the controller shall stop the Silo Unloader Advancing Drives and Main Auger.
- FC-1245 shall continue the operation of the Discharge Auger for 30 seconds and then stop the auger.

ii. Two Bin Operation Startup and Shutdown

Two bin operation will be similar to single bin operation. The control room operator will select this mode of operation by placing the bin selector switch, HS-1254 in the both position. After making this selection the operator will place the fuel delivery controller, FC-1245 in automatic mode. FC-1245 will then respond automatically to fuel requests[1] by either metering bin's level controller and start the fuel storage system discharge auger, silo unloader main drive auger, and silo unloader advancing drives in a timed sequence as described in section 3.c.i with the following modifications to the control sequence:

1 - FC-1245 shall continue filling the first metering bin to request fuel until it fills the bin as indicated by the bin's high level switch (LSH-1211 or LSH-1221). It shall then stop the Silo Unloader Advancing Drives and Main Drive and Discharge Auger as described in section 3.c.ii.6. After the shutdown is complete if the other fuel bin has requested fuel, FC-1245 shall restart the above equipment as described in sections 3.c.i.1 to 3.c.i.3 and fill the bin.

2 - If FC-1245 is in the process of filling a bin that has requested fuel and the other metering bin's low-low level switch contacts (LSLL-1211 or LSLL-1221) open, FC-1245 shall immediately stop filling the bin currently receiving fuel by stopping the Silo Unloader Advancing Drives and Main Drive and Discharge Auger as described in section 3.c.ii.6. As soon as this equipment has been stopped, FC-1245 shall restart the equipment in accordance with the procedure described in section 3.c.i.1 to 3.c.i.3 and fill the bin that tripped its low-low level switch.

3 - Shutdown during two bin operation is the same as that for single bin operation which is described in section 3.c.ii.6.

[1] In the event both metering bin fuel level Lo-Lo switch contacts are shut, metering bin no. 1 shall be filled first.

Section 4: Safety Interlocks

For all conveying equipment: In the event of a loss of running signal, fault alarm, or the activation of an equipment low speed switch all upstream equipment shall stop immediately. A normal shutdown will be initiated to stop the remaining downstream equipment. The DCS shall establish the following interlocks when operating the Silo Unloader Advancing Drives and Main Drive and Discharge Auger:

a. Operation of the Silo Unloader Main Drive shall not be possible until the Discharge Auger is operating as indicated by the shutting of the auxiliary contacts for MY-1245.

b. Operation of the Silo Unloader Advancing Drive shall not be possible until the Silo Unloader Main Drive and discharge auger are operating as indicated by the shutting of the auxiliary contacts for MY-1244 and MY-1245 respectively.

c. A high-high level alarm (LSHH-1244) in the Silo Unloader Discharge chute shall initiate an immediate shutdown of the Silo Unloader Advancing Drives and Main Drive and Discharge Auger as described in sections 3.c.i.3 and 3.c.i.4.

Section 5: Monitoring

A graphical display for the control room work stations that depicts the principal elements of the wood fuel storage system and wood fuel conveying system as depicted on sheet 2 of P&ID 700-002 shall be created and display the information described in the next subsection.

a. Indications Displayed

i. A continuous level indication of the Fuel Storage Silo 12-030 should be displayed with data coming from the continuous Level Transmitter LT-1246.

ii. Operating frequency in hertz for the VFD powering the Silo Unloader Main Drive 12-031-01.

iii. Contact status of level indicators LSHH-1244 and LSH-1244.

iv. Operating frequency in hertz for the VFD powering the Discharge Auger Drive 12-032-01.

v. The direction of rotation of Discharge Auger 12-032, i.e. bin 1 or 2.

vi. Contact status of flow switches FS-1245A & FS-1245B

vii. The run status for the motors associated with the Silo Unloader Advancing Drives and Main Drive and Discharge Auger as indicated by the auxiliary contacts for MY-1247, MY1248, MY-1249, MY-1244, and MY1245 respectively.

b. Data Logging

i. All of the runtime hours should be documented for generating maintenance and inspection reports.

ii. The number of reversing cycles over a given period of time of the Discharge Auger 12-032 shall be recorded.

iii. The rate of fuel consumption (FI-1246) vs. time based on a correlation between fuel storage silo level (LT-1246) and silo volume shall be recorded.

Section 6: Alarms

Alarms for the following conditions shall be generated by the DCS:

a. Fuel storage silo level low as indicated by LAL-1246.

b. Fuel storage silo low-low as indicated by LALL-1246.

c. Discharge Auger not turning as indicated by the shutting of the contacts for SSL-1245.

d. No Fuel Movement in Discharge Auger Chute as indicated by the contacts for one of the flow switches, FS-1245A or FS-1245B not being shut 15 seconds after the Silo Unloader Advancing Drives have been started.

e. An alarm shall be generated for each electric motor driven piece of equipment commanded to run if its electric motor stops as indicated by the opening of the motor's run status contacts for the following motors:

i. Reclaim Auger Main Drive motor status: auxiliary contacts for MY-1244.

ii. Discharge Auger drive motor status: auxiliary contacts for MY-1245.

iii. Advancing Drive No. 1 motor status: auxiliary contacts for MY-1248.

iv. Advancing Drive No. 2 motor status: auxiliary contacts for MY1247.

v. Reclaim Auger Main Drive cooling fan motor status: auxiliary contacts for MY-1249.

vi. Advancing Drive No. 1 cooling fan motor status: auxiliary contacts for MY-1251.

vii. Advancing Drive No. 2 cooling fan motor status: auxiliary contacts for MY-1252.

f. An alarm shall be generated for each electric motor driven piece of equipment with motor starters or variable speed drive with fault indication contacts that develop faults when commanded to run as indicated by the following contact closures:

i. YA-1244 – Reclaim Auger Main Drive motor fault.

ii. YA-1245 – Discharge Auger motor fault.

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I/O TABLE WOOD FUEL STORAGE

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
HSA	1244	Reclaim Auger Auto	DI	
MY	1244	Reclaim Auger Run	DI	
YA	1244	Reclaim Auger Fault	DI	
HS	1244	Reclaim Auger Forward	DO	
HSR	1244	Reclaim Auger Reverse	DO	
SC	1244	Reclaim Auger Speed Reference	AI	
ST	1244	Reclaim Auger Speed Feedback	AO	
HSA	1245	Discharge Auger Auto	DI	
MY	1245	Discharge Auger Run	DI	
YA	1245	Discharge Auger Fault	DI	
HS	1245	Discharge Auger Forward	DO	
HSR	1245	Discharge Auger Reverse	DO	
SC	1245	Discharge Auger Speed Reference	AI	
ST	1245	Discharge Auger Speed Feedback	AO	
HSA	1247	Advancing Drive 2 Auto	DI	
MY	1247	Advancing Drive 2 Run	DI	
HS	1247	Advancing Drive 2 Start	DO	
HSA	1248	Advancing Drive 1 Auto	DI	
MY	1248	Advancing Drive 1 Run	DI	
HS	1248	Advancing Drive 1 Start	DO	
HSA	1249	Reclaim Auger Cooling Fan Auto	DI	
MY	1249	Reclaim Auger Cooling Fan Run	DI	
HS	1249	Reclaim Auger Cooling Fan Start	DO	
MY	1250	Discharge Auger Cooling Fan Run	DI	
MY	1251	Advancing Drive 2 Cooling Fan Run	DI	
MY	1252	Advancing Drive 1 Cooling Fan Run	DI	
LSH	1244	Reclaim Auger Chute High	DI	
LSHH	1244	Reclaim Auger Chute High High	DI	
SSL	1244	Reclaim Auger Zero Speed	DI	
TSH	1244	Reclaim Auger Motor Temp High	DI	
UA	1244A	Reclaim Auger Chute High System OK	DI	
UA	1244B	Reclaim Auger Chute High High System OK	DI	
SSL	1245	Discharge Auger Zero Speed	DI	
TSH	1245	Discharge Auger Motor Temp High	DI	
ZS	1245A	Discharge Auger Chute 1 Blockage	DI	
ZS	1245B	Discharge Auger Chute 2 Blockage	DI	
LSHH	1246	Fuel Silo Level High High	DI	
UA	1246	Fuel Silo Level High High System OK	DI	
LSL	1246	Fuel Silo Level Low	DI	
LSLL	1246	Fuel Silo Level Low Low	DI	
LT	1246	Fuel Silo Level	AI	
TSH	1247	Advancing Drive 1 Motor Temp High	DI	
TSH	1248	Advancing Drive 2 Motor Temp High	DI	
LSH	1221	Fuel Metering Bin #2 Level High	DI	
LSL	1221	Fuel Metering Bin #2 Level Low	DI	

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
LSLL	1221	Fuel Metering Bin #2 Level Low Low	DI	
SSL	1221	Fuel Metering Bin #2 Discharge Screw Zero Speed	DI	
ZSC	1221	Fuel Metering Bin #2 Door Closed	DI	
SSL	1222	Blowline Feeder #2 Rotary Valve Zero Speed	DI	
ZSC	1222	Outfeed Chute #2 Door Closed	DI	
LSH	1211	Fuel Metering Bin #1 Level High	DI	
LSL	1211	Fuel Metering Bin #1 Level Low	DI	
LSLL	1211	Fuel Metering Bin #1 Level Low Low	DI	
SSL	1211	Fuel Metering Bin #1 Discharge Screw Zero Speed	DI	
ZSC	1211	Fuel Metering Bin #1 Door Closed	DI	
SSL	1212	Blowline Feeder #1 Rotary Valve Zero Speed	DI	
ZSC	1212	Outfeed Chute #1 Door Closed	DI	
ST	1211	Fuel Metering Bin #1 Discharge Screw Speed Feedback	AI	
SC	1211	Fuel Metering Bin #1 Discharge Screw Speed Reference	AO	
ST	1225	Fuel Metering Bin #2 Discharge Screw Speed Feedback	AI	
SC	1226	Fuel Metering Bin #2 Discharge Screw Speed Reference	AO	
FS	1245A	Reclaim Auger Chute12-034 Flow	DI	
FS	1245B	Reclaim Auger Chute 12-035 Flow	DI	

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FD-04: WOOD CONVEYING SYSTEM

Section 1: General Description:

The fuel handling system consists of three subsystems: the wood fuel receiving system and processing system, the wood fuel storage system, and the wood conveying system. This functional description describes the wood fuel conveying system. This system supplies wood fuel to the No.1 Boiler Fluidized Bed Combustor (FBC) via high pressure pneumatic blow lines. These blow lines have fuel metered to them by multiple rotating screws feeding from small volume metal bins.

Section 2: Principal Elements

P&ID 700-002, sheet 2 & 700-003 provides a schematic representation of all the equipment components associated with the wood conveying system. Major components for this system consist of the following:

b. Metering Bins 12-036 (12-037):
There are two metering bins which store small amounts of fuel for the wood conveying system.

c. Metering Bin Screws:
Each metering bin is equipped with a set of augers which are driven by electric motors which receive their power from variable speed drives, 12-036-01 and 12-037-01. The speed of the drives shall be manipulated by the DCS to control the rate of fuel flow to the FBC.

d. Rotary Feeder Valve 12-043 (12-044)
Each of the metering bin screws discharge wood fuel to an electric motor driven rotary valve which isolates the metering bin from the high pressure pneumatic line that conveys wood fuel line to the FBC.

e. Boiler Fuel Supply Blower 12-041 (12-042)
There are two pneumatic blow lines which carry fuel to the FBC. Each blow line is equipped with a blower that provides 3100 ACFM of air to the line at a pressure of 3.1 psig.

Section 3: Modes of Control

The main function of the wood fuel conveying system is to deliver wood fuel to the FBC. The DCS shall provide the controls to enable remote startup and shutdown of the wood conveying equipment. The DCS shall also provide the controls to allow automatic speed control of the fuel bin metering bin screws. The subsections that follow describe the controls to be provided and the various operating modes in more detail.

a. Fuel Bin Selector Switch (HS-1254)
The DCS shall provide a 3 position fuel bin selector switch, HS-1254 (see FD-03). As described in FD-03 when position 1 is selected the output from fuel feed controller FC-1254 shall go to the variable speed drive for fuel Metering Bin No. 1, SC-1211. In position 3 the output shall go to the

variable speed drive for fuel Metering Bin No. 2, SC-1221. When both (position 2) is selected the output from FC-1254 shall be divided by 2 and sent to the variable speed drives for both fuel metering bins.

b. Solid Fuel Start/Stop Switch (HS-1255)

The DCS shall provide a solid fuel start/stop switch, HS-1255. This switch shall receive an input from the metering bin selector switch, HS-1254 to indicate which metering bin or bins are to be operated. Placing HS-1255 in the start position will initiate a startup sequence of the wood fuel conveying equipment. The output from HS-1255 shall also go to the wood firing burner management system (BMS) to indicate wood firing operations are being initiated.

c. Fuel Pulse Switch (HS-1256)

In order to facilitate the startup of the FBC, the DCS shall provide a soft fuel pulse switch which when depressed by the control room operator shall cause the fuel feed controller, FC-1254 to produce a 50% output for 1 minute. Note in order for fuel pulses to be generated, FC-1254 must be in manual control mode.

d. Fuel Feed Controller (FC-1254)

The DCS shall provide a fuel feed controller, FC-1254 to regulate the speed of the metering bin screws. The output from FC-1254 shall go to the metering bin screw variable speed drives as determined by the fuel bin selector switch, HS-1254 as described in section 3.a. Initially during startup, FC-1254 will receive requests for fuel from the fuel pulse switch, HS-1256. During steady state operations, FC-1254 will receive fuel feed requests from the steam plant's plant master controller or the steam flow master controller, FC-1253. During abnormal conditions FC-1254 may receive fuel flow requests from TIC-0114 or TIC-0115 (see FD-05A).

e. Startup

Startup of the wood fuel conveying shall be initiated by placing HS-1255 in the start position. The DCS shall then initiate the following sequence (note the sequence described assumes Metering Bin No. 1 was selected with HS-1254; similar would be required if Metering Bin No. 2 or both bins were to be operated):

i. Open the fuel target box isolation valve, FV-0162.

ii. When the limit switch, ZSO-0162 indicates FV-0162 is open; start fuel blower 12-041.

iii. Ten seconds after the fuel blower motor auxiliary contacts for MY-1213 shut, start Blow-line Feeder No. 1 (12-043).

iv. After starting the blow line feeder and after establishing stable combustion in the fluid bed combustor (see FD-05A), the control room operator will manually start metering bin screw 12-036-01 and manually control fuel flow with FC-1254 until the boiler steaming rate is high enough to support automatic operation.

f. Normal Operation

During normal operation, the fuel feed controller, FC-1254 will regulate the flow of fuel from the metering bin to the blow-line feeder and to the blow-line.

g. Abnormal Operating Conditions

The following subsections describe abnormal operating conditions for the wood conveying system and the corrective action to be taken by the DCS should any of these conditions occur.

i. High Blow-line Pressure

Each fuel blow-line is equipped with two pressure switches: PSH-1213, PSHH-1213, PSH-1223, and PSHH-1223. The contacts on PSH-1213 and PSH-1223 are set to shut when the air pressure in the blow-line reaches 3.5 psig. If the contacts on one of these switches shut while their blow-line is in service, the DCS shall stop the corresponding metering bin screw feeder and rotary feeder in that order. If the pressure switch does not reset in 10 seconds, the DCS shall stop the associated blower and initiate an alarm indicating a failure of that fuel feed system. Should the high pressure condition clear within the 10 second period, the blower and associated rotary feeder should be started in that order. If at any time the air pressure in a wood conveying system blow-line as indicated by either PSHH-1213 or PSHH-1223 reaches 4 psig, the DCS shall immediately stop the blow-line system's blower, metering bin screw feeder, and rotary feeder. If both fuel delivery systems are operating and a high pressure condition requires a shutdown, the remaining fuel delivery system shall continue to operate.

ii. Rotary Feeder Zero Speed

Each rotary feeder is equipped with a zero speed switch, SSL-1212 and SSL-1222. If during wood fuel conveying operations the contacts for a zero speed switch monitoring an operating rotary feeder open, the DCS shall immediately stop the associated metering bin screw and initiate and alarm that indicates a zero speed condition with the rotary feeder. If both fuel delivery systems are operating and a rotary feeder zero speed condition requires a shutdown, the remaining fuel delivery system shall continue to operate.

h. Shutdown

Shutdown of the wood conveying system shall be initiated by placing HS-1255 in the stop position. When the control operator places the switch in the stop position, the DCS shall initiate the following sequence:

i. Stop the metering bin screw(s).

ii. Stop the rotary feeder(s).

iii. After the rotary feeder(s) is stopped, run the fuel supply blower(s) for 10 seconds and then stop the blower(s).

iv. Shut the fuel target box isolation valve(s).

Section 4: Safety Interlocks

The following interlocks shall be provided:

a. General

In the event of a loss of running signal, fault alarm, or the activation of the equipment's low speed switch all upstream equipment shall stop immediately. A normal shutdown will be initiated to stop the remaining downstream equipment. Any motor starter overload fault shall generate an alarm.

b. Metering Bin Screws

The DCS shall not permit starting or operation of the metering bin screws if the zero speed switches for the rotary feeders indicate the feeders are not operating or if the auxiliary contacts for the fuel supply blower motors indicate the blowers are not operating or if the fuel target box isolation valves are shut as follows:

i. Metering Bin 12-036

If any of the following contacts are open, the DCS shall not allow operation of the screw feeder for Metering No. 1: SSL-1212, auxiliary contacts for MY-1213, and ZSO-0162.

ii. Metering Bin 12-037

If any of the following contacts are open, the DCS shall not allow operation of the screw feeder for Metering No. 2: SSL-1222, auxiliary contacts for MY-1223, and ZSO-0163.

c. Fuel Supply Blowers

The DCS shall not permit starting or operation of a fuel supply blower if the fuel target box valve for the blower's blow line is shut as follows:

i. Fuel Supply Blower 12-041

Operation of this blower shall not be permitted if contacts for ZS0-0162 are open.

ii. Fuel Supply Blower 12-042

Operation of this blower shall not be permitted if contacts for ZSO-0163 are open.

Section 5: Monitoring

The DCS shall provide graphics display of the wood fuel conveying system and data logging as described in the sections that follow:

a. Indications Displayed

The DCS shall provide a graphics overview display for the control room operator that depicts the wood conveying system fuel metering bins, blow-line feeders, fuel supply blowers, blow-lines, fuel target box isolation valves, and FBC. The display shall include the Mode Selector Switch, HS-1253, the Steam Flow Master controller, FC-1253, the Wood Fuel Flow Controller, FC-1254; the Bin Selector Switch, HS-1254; and the Solid Fuel Start/Stop Switch, HS-1255. The display shall provide the following indications:

i. Metering bin screw feeder run status: auxiliary contacts for MY-1223 and MY-1221.

ii. Rotary feeder run status: auxiliary contacts for MY-1212 & MY-1222

iii. Fuel supply blower run status: auxiliary contacts for MY-1213 and MY-1223.

iv. Fuel target box isolation valve position status: ZSO-0162 and ZSO-0163.

b. Data Logging

Data logging shall consist of keeping track of the runtime hours for each of the fuel metering systems.

Section 6: Alarms

The DCS shall provide the following alarms for the wood fuel conveying system during wood firing operations as indicated when HS-1255 is in the start position:

a. Metering Bin Low as indicated by the shutting of contacts for LSLL-1211 or LSLL-1221.

b. Metering Bin Screws failure as indicated the shutting of contacts for SSL-1211 or SSL-1221.

c. Rotary Feeder Valve Door Switch open as indicated by the opening of the contacts for ZSC-1212 or ZSC-1222.

d. Blow Line Temperature high as indicated by the shutting of the contacts for TSH-1213 or TSH-1223.

e. High Blow Line Pressure high as indicated by the shutting of the contacts for PSHH-1213 & PSHH-1223.

f. An alarm shall be generated for each electric motor driven piece of equipment commanded to run if its electric motor stops as indicated by the opening of the motor's run status contacts for the following motors:

i. Fuel Metering Bin No. 1 Discharge Screw motor run status: Auxiliary contacts for MY-1211

ii. Blowline Feeder No. 1 Rotary Valve motor run status: Auxiliary contacts for MY-1212.

iii. Boiler Fuel Supply Blower No. 1 motor run status: Auxiliary contacts for MY-1213.

iv. Fuel Metering Bin No. 2 Discharge Screw motor run status: Auxiliary contacts for MY-1221

v. Blowline Feeder No. 2 Rotary Valve motor run status: Auxiliary contacts for MY-1222.

vi. Boiler Fuel Supply Blower No. 2 motor run status: Auxiliary contacts for MY-1223.

g. An alarm shall be generated for each electric motor driven piece of equipment with motor starters or variable speed drive with fault indication contacts that develop faults when commanded to run as indicated by the following contact closures:

i. YA-1211 – Fuel Metering Bin No. 1 Discharge Screw motor starter fault.

ii. YA-1212 – Blowline Feeder No. 1 Rotary Valve motor starter fault.

iii. YA-1213 – Boiler Fuel Supply Blower No. 1 motor starter fault.

iv. YA-1221 – Fuel Metering Bin No. 2 Discharge Screw motor starter fault.

v. YA-1222 – Blowline Feeder No. 2 Rotary Valve motor starter fault.

vi. YA-1223 – Boiler Fuel Supply Blower No. 2 motor starter fault.

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
ZSO	0162	No. 1 Metering Bin Target Slide Gate Opened	DI	
FQY	0162	No. 1 Metering Bin Target Slide Gate Sol	DO	
FQY	0163	No. 2 Metering Bin Target Slide Gate	DO	
ZSO	0163	No. 2 Metering Bin Target Slide Gate Opened	DI	
MY	1211	Fuel Metering Bin No. 1 Discharge Screw Run	DI	
MY	1212	Blowline Feeder No.1 Rotary Valve Run	DI	
MY	1213	Boiler Fuel Supply Blower No. 1 Run	DI	
MY	1221	Fuel Metering Bin No. 2 Discharge Screw Run	DI	
MY	1222	Blowline Feeder No. 2 Rotary Valve Run	DI	
MY	1223	Boiler Fuel Supply Blower No. 2 Run	DI	
YA	1211	Fuel Metering Bin No. 1 Discharge Screw motor starter fault	DI	
YA	1212	Blowline Feeder No. 1 Rotary Valve motor starter fault	DI	
YA	1222	Boiler Fuel Supply Blower No. 1 motor starter fault	DI	
YA	1221	Fuel Metering Bin No. 2 Discharge Screw motor starter fault	DI	
YA	1222	Blowline Feeder No. 2 Rotary Valve motor starter fault	DI	
YA	1223	Blowline Feeder No. 2 Rotary Valve motor starter fault	DI	
PSH	1213	Blow Line Feeder No. 1 Pressure High	DI	
PSHH	1213	Blow Line Feeder No. 1 Pressure High High	DI	
TSH	1213	Blow Line Feeder No. 1 Temperature High	DI	
LSH	1221	Fuel Metering Bin No. 2 Level High	DI	
LSL	1221	Fuel Metering Bin No. 2 Level Low	DI	
LSLL	1221	Fuel Metering Bin No. 2 Level Low Low	DI	
SSL	1221	Fuel Metering Bin No. 2 Discharge Screw Zero Speed	DI	
ZSC	1221	Fuel Metering Bin No. 2 Door Closed	DI	
SSL	1222	Blowline Feeder No. 2 Rotary Valve Zero Speed	DI	
PSH	1223	Blow Line Feeder No. 2 Pressure High	DI	
PSHH	1223	Blow Line Feeder No. 2 Pressure High High	DI	
TSH	1223	Blow Line Feeder No. 2 Temperature High	DI	
SSL	1212	Blowline Feeder No. 1 Rotary Valve Zero Speed	DI	
SSL	1222	Blowline Feeder No. 2 Rotary Valve Zero Speed	DI	
LSLL	1211	Fuel Metering Bin No. 1 Level Low Low	DI	
LSLL	1221	Fuel Metering Bin No. 2 Level Low Low	DI	
SSL	1211	Fuel Metering Bin No. 1 Discharge Screw Zero Speed	DI	
ZSC	1212	Outfeed Chute No. 1 Door Closed	DI	
ZSC	1222	Outfeed Chute No. 2 Door Closed	DI	

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FD-05A: Combustion Control System (Wood Firing)

Section 1: General Description:

The distributed control system (DCS) shall provide the control features necessary to allow the starting and stopping of the fluidized bed combustor (FBC) from a control room work station and provide for the continuous control of the FBC as follows:

a. Regulate the flow of wood fuel into the FBC in response to steam production demand requests from steam plant's master controller. Alternatively allow the control room operator to select a desired steam production rate in which wood fuel would be varied as required to maintain a desired steam production rate.

b. Maintain the required airflow to the bottom of the FBC sand bed to keep it in a bubbling state while the FBC is operating.

c. Insure during wood firing operation that temperature in the FBC's sand bed does not fall below 900F.

d. Regulate the flow of overfire air into the FBC to maintain the gas temperature in the FBC vapor space at 1750F.

e. Regulate the speed of the induced draft (ID) fan to maintain a negative pressure in the furnace (-.1 inches H_2O).

f. Regulate the speed of the forced draft fan (FD) to maintain a constant air delivery pressure to the dampers that regulate airflow to the FBC sand bed and FBC vapor space.

Section 2: Principal Elements

The primary components manipulated by the combustion control system during wood firing operations are shown on P & IDs 700-002, 700-003, and 700-008. The following is a brief description of the elements:

a. Forced Draft Fan (01-001)

The forced draft fan provides fluidizing and overfire air to the FBC. The output of the fan is controlled by a variable frequency drive. Also included is a damper upstream of the fan, FCV-0114, which is shut when the fan is started. There are two control dampers downstream of the fan:

i. FCV-0111 – Shuts during sand bed pre-heat operation and is modulated during wood firing operations to maintain the airflow required to keep the sand bed in a fluidizing state.

ii. FCV-0113 – Regulates the flow of overfire air into the FBC during wood firing operations.

b. Induced Draft Fan (01-039)

The induced draft fan maintains a negative pressure in the boiler furnace of -.1 inches H_2O and discharges combustion product gases to the stack. Included in the fan inlet ductwork is a damper, FCV-0132 which is shut during fan startup. The fan motor receives its power from a variable speed drive which receives speed setting signals from the combustion control system.

c. Fuel Metering Bins (12-036 & 12-037)

The fuel metering bins, located below the silo discharge auger, are equipped with augers that deliver fuel to the pneumatic fuel conveying system which carries fuel to the FBC. Normally one metering bin will be operated to supply fuel to the fluid bed FBC. Fuel feed rate is varied by regulating the speed of the metering bin auger which is equipped with a variable speed drive.

d. Burner Management System

A separate burner management system is used to provide combustion safety features to protect the boiler and FBC from emergency situations that could lead to serious damage. This system is described in further detail in FD-15.

Section 3: Modes of Control

This section describes the control loops that will be employed to maintain control of the fluid bed FBC during wood firing operations. Also included will be a narrative that describes the sequence followed during a normal startup and shutdown.

a. Control Loops

The DCS will employ a number of control loops to maintain control of the combustion process in the fluid bed FBC as follows:

i. Plant Master or Steam Flow Control

When the boiler output reaches 40,000 lbs/hr the control room operator via a control system boiler mode selector may choose to have the unit operate in response to demand signals from the plant master controller or choose a mode where the control room operator can select a desired steam output rate in which case the DCS will manipulate fuel flow with a steam flow controller, FC-1246 (P&ID 700-002, sht. 2) to maintain the desired steaming rate.

ii. Vapor Temperature Control

When the FBC is operating the DCS will employ a vapor space temperature controller, TIC-0113.This controller will regulate the flow of over fire air in the space above the FBC's bubbling bed (vapor space) in order to hold the temperature in this zone at 1,750F. TIC-0113 will manipulate FCV-0113 to either increase or decrease the flow of overfire air into the vapor space. Two thermocouples will measure vapor space temperatures. Their outputs will be transmitted to TIC-0113 via TE-0105 and TE-0106. TIC-0113 will select the higher of these two signals for control purposes. If the temperature difference between TE-106 and TE-105 is greater that 200F an alarm shall be generated.

iii. Vapor Temperature Override

In the event that FBC vapor space temperature reaches 1850°F, while the boiler is operating in plant master or steam flow control mode, the DCS will automatically override either of these modes and transfer control of the fuel feeder to a second vapor space temperature controller, TIC-0114, which will decrease fuel flow until the vapor space temperature reaches 1,600F. Upon reaching this temperature the DCS shall automatically transfer control of the fuel feeder back to the master or steam flow controllers.

iv. Sand Bed Temperature Override

Should a situation develop while operating in either plant master control mode or steam flow control mode where the average sand bed temperature as measured by TE-0101, TE-0102, TE-0103, and TE-0104 falls below 900F the DCS shall automatically transfer control of the fuel feeder to a bed temperature controller, TIC-0115. This controller shall then increase fuel flow until average bed temperature reaches 1,200F. Upon reaching this temperature the DCS shall then transfer control of the fuel feeder to the plant master or steam flow controllers.

v. FBC Sand Bed Airflow Control

In order to insure that proper fluidizing conditions are maintained in the sand bed, the DCS shall vary the position of airflow damper FCV-0111 with a flow controller, FIC-0111. This controller will manipulate the damper's position in order to maintain the required flow to maintain the FBC sand bed in a fluidizing state.[1]

[1] The set point for FIC-0111 shall be the flow difference (FE-0109 minus FE-0113) determined during FBC commissioning tests that results in a sand bed differential pressure of 13 inches H_2O as measured by PDT-0111.

vi. Forced Draft Fan Discharge Pressure

The speed of the FD fan will be regulated by a controller, PIC-0114, which will adjust the speed of the fan to maintain a constant air supply pressure to the sand bed and over fire air dampers of 45 inches H_2O.

vii. Furnace Draft

Whenever the boiler is operating the ID fan shall be operated by the DCS to maintain minus .1 inches of H_2O in the furnace as indicated by PT-0132A. The DCS shall vary the output of a PID controller, PIC-0133 which adjusts the control speed of the ID fan's variable speed drive, SC-0133, in order to maintain furnace draft of minus .1 inches of H_2O.

b. Normal Startup

A normal startup of the FBC is accomplished with the boiler's auxiliary burner firing the boiler with natural gas at a steam generation rate of 40,000 lbs/hr. The DCS will enable plant operators to start the FBC primarily from the control room which will be carried out in the following sequence:

i. Prepare the fuel handling system for automatic operation:

Verify that the wood storage system is prepared and ready for automatic operation. Functional description FD-03 describes the wood storage system. Verify that the wood conveying system is ready for operation. FD-04 describes the wood conveying system.

As part of preparations for wood firing verify that the wood fuel feed rate controller FC-1254 is in manual control mode with its output set at zero percent. A 3 position selector switch, HS-1247 as described in FD-03 allows the control room operator to designate which fuel metering bin(s) provide fuel to the wood conveying system. When bin 1 position is selected the output from FC-1254 shall go to the variable speed drive for fuel metering bin no. 1, SC-1211. When the both position is selected the output from FC-1254 shall be divide by 2 and sent to the variable speed drives for both fuel metering bins. Finally when the bin 2 position is selected the output shall go to the variable speed drive for fuel metering bin no. 2, SC-1221.

Normally the boiler will be operated with one fuel metering bin in operation. For the normal startup procedure described by this functional description, place HS-1247 in the bin 1 position. Then place both metering bin level controllers LC-1211 and LD-1221 in auto. Finally, verify that the steam flow master controller TIC-1245 is set to operate in manual mode.

ii. Shut the following dampers:

1 - Place differential pressure controller PDIC-0111 in manual and shut the fluidizing air damper FCV-0111.

2 - Place temperature controller TIC-0114 in manual and shut the over fire air damper FCV-0113.

ii. Start the forced draft fan:

Place pressure controller PIC-0114 in manual and start FD Fan 01-001. Note the DCS shall close FCV-0114 before allowing the fan's motor to be energized. When the FD fan motor variable speed drive output reaches 30Hz the DCS shall open FCV-0114. As soon as the fan has started, manually increase the fan's speed with PIC-0114 until the indicated pressure on PIC-0114 is 45 inches H_20. Place PIC-0114 in automatic.

iii. Pre-heat the sand bed:

FD-07 provides a functional description of the sand bed pre-heat system. Prior to starting the pre-heater, verify that pre-heater temperature controller TIC-0119 is in manual and that the fuel control valve TCV-0119 is in its light off position. Start the pre-heater (see FD-07). As soon as the pre-heat system burner management system releases control of the pre-heater's fuel control valve to the DCS, the control system using TIC-0119 shall raise the temperature of the air leaving the pre-heater as measured by TE-0119 to 350F over a period 30 minutes. Upon reaching this temperature the control system shall manipulate TIC-0119 to establish a heat up rate of 100F per hour until the air temperature leaving the pre-heater is 800F. At this point the control system shall place TIC-0119 in an automatic mode with a set point of 800F. Monitor the sand bed temperature as indicated by TI-0101, TI-0102, TI-0103, and TI-0104. When all reach 650F or higher wood fuel can be introduced to the FBC.

iv. Lineup baghouse for wood firing operations:

As soon as the air temperature leaving the pre-heater reaches 700F the DCS shall open baghouse flow control valves FCV-0165B, FCV-0166B, FCV-0167B, and FCV-0168B and then shut baghouse bypass valve FCV-0164.

v. Ash handling system start:

When the air temperature leaving the pre-heater reaches 750F the DCS shall start the ash handling and collection system ash blowers. FD-11 provides a functional description of this system.

vi. Vapor space temperature controller in auto

When the air temperature leaving the pre-heater reaches 800F the DCS shall place the vapor space temperature controller, TIC-0113, in automatic.

vii. Place start stop switch, HS-1255 in start position

As soon as the vapor space temperature controller has been transferred to automatic control mode; place the solid fuel start/stop switch, HS-1255 (see FD-04) in the start position. As described in FD-04 this will initiate the following sequence:

1 - Fuel target box isolation valve, FV-0162 will be opened.

2 - When the limit switch, ZSO-0162 indicates FV-0162 is open; the fuel blower 12-041 will be started.

3 - Ten seconds after the fuel blower motor auxiliary contacts for MY-1213 shut, Blow-line Feeder No. 1 (12-043) will be started.

viii. Initiate wood fuel delivery to the FBC

When sand temperature indicators TI-0101, TI-0102, TI-0103, and TI-0104 are all showing a temperature above 650F, wood fuel may be introduced to the FBC as follows:

1 - Using flow controller FIC-0111 manually open the fluidizing air damper FCV-0111 until the differential pressure indicated by PDI-0111 is 8 inches H_2O.

2 - Verify that fuel flow controller FC-1254 is in manual mode with the manipulated variable output set at 50%. Depress the fuel pulse switch, HS-1256 (see FD-04) momentarily. This shall cause the FC-1254 to send a 50% signal for 60 seconds to the variable speed drive, SC-1211 for fuel metering bin no. 1. Allow 1-3 minutes to elapse before initiating another pulse. Closely monitor lower vapor space temperature indicator, TI-0108. A rapidly rising temperature from this indicator will confirm that wood fuel is burning on the sand bed. Continue this cycle until TI-0101, TI-0102, TI-0103, and TI-0104 are showing bed temperatures between 1300F-1500F.

3 - Adjust differential flow controller FIC-0111 manually until the indicated flow is within 5% of the controller's set point (see Section 3.a.v) then place FIC-0111 in automatic.

4 - Stop the pre-heat burner.

5 - Monitor FBC vapor space temperature indicators TI-0105 and TI-0106. Restart the metering bin no. 1 drive motor by depressing HS-1211 and using FC-1254 manually increase fuel flow such that the rate of temperature increase in the vapor space rises by no more than 100F per hour.

6 - When FBC vapor temperature reaches 1,750F, TIC-0113 will begin to manipulate the over fire air damper FCV-0113 to maintain vapor space temperature at 1,750F.

7 - Open wood fuel target box isolation valve FV-0163. Start wood fuel conveying system blower 12-042. Note: the second fuel conveying system will remain in a standby status ready for the control room operator to place in service if the selected fuel delivery system fails.

8 - Continue to manually increase wood fuel flow with FC-1254 until the steam production rate for the boiler reaches 65,000 lbs/hr. Upon reaching this steaming rate, manually reduce the gas flow to the auxiliary burner while manually increasing wood fuel flow maintaining the steaming rate as close as possible to 65,000 lbs/hr.

9 - When fuel flow to the auxiliary burner reaches the minimum firing rate, stop the burner.

10 - Manually adjust the wood fuel flow rate to establish a steam production rate of 40,000 lbs/hr - 45,000 lbs/hr.

11 - Start the SNCR system and place urea flow controller FIC-0192 in automatic. Functional description FD-10 provides a description of the SNCR system.

12 - Start the limestone injection system and place the controller that regulates the flow of limestone into the FBC, FC-0201 in automatic control mode. FD-13 provides a description of the limestone injection system.

13 - Place the combustion sand control system in automatic operation mode. Functional description FD-06 provides a description of the combustion sand system.

14 - Determine the desired mode of boiler operations and place the boiler mode selector switch in the preferred mode, i.e. plant master mode or steam flow master mode.

15 - If plant master mode is selected, adjust fuel flow until the boiler's steam production rate matches the plant master demand signal and place FC-1254 in automatic control mode.

16 - If steam flow master mode is selected, adjust fuel flow with FC-1254 until the boiler's steaming rate reaches the flow setting required by the steam flow master controller, FC-1254. Then place both controllers in automatic control mode.

b. Normal Operation

Normal operation of the FBC will be limited to a steam production rate of no less than 40,000 lbs/hr. The boiler will operate in either plant master control mode or steam flow control mode.

c. Shut Down

A normal shut down of the FBC is managed from the control room. Plant operators using controls provided by the DCS will stop the FBC and its related auxiliaries as follows

i. Reduce the steam production rate to 40,000 lbs/hr

Complete the steps necessary to reduce the boiler steam production rate to 40,000 lbs/hr as follows:

1 - Place fuel flow controller FC-1254 in manual mode. If the steam flow master, FIC-1245, was regulating fuel flow to the boiler, switch the controller to manual control mode.

2 - Gradually reduce fuel flow to the FBC using FIC-1247 until the steam rate reaches 40,000 lbs/hr.

3 - Stop automatic operation of the sand system.

4 - Stop the limestone injection system.

5 - Stop the SNCR system.

6 - Stop the standby wood fuel supply blower and its associated blow line feeder and shut the fuel target box isolation valve in the fuel feed line.

ii. Stop the flow of wood fuel and cool down FBC

Complete the following steps to stop fuel flow to the FBC and cool down the unit:

1 - Stop the operating fuel bin drive motor and associated blow line feeder to stop fuel flow to the FBC. Allow the wood fuel supply blower to operate for an additional 5 minutes.

2 - Shut the fuel target box isolation valve in the fuel feed line and stop the wood fuel supply blower and auger.

3 - Continue the operation of forced draft fan 01-001 until the sand bed temperature reaches 100-150F as indicated by TI-0101, TI-0102, TI-0103, and TI-0104

4 - Place controllers PIC-0114, FIC-0111, and TIC-0113 in manual operating mode and stop FD Fan 01-001.

5 - Continue operation of the ash collection system for ten minutes after the forced draft fan has been stopped then stop the system.

6 - Place the steam drum level controller, LIC-0147, in manual operating mode and shut one of its manually operated isolation valves.

7 - Open baghouse bypass valve FCV-0164 and shut baghouse flow control valves FCV-0165B, FCV-0166B, FCV-0167B, and FCV-0168B.

8 - Place the furnace draft pressure controller, PIC-0133, in manual control mode and stop the induced draft fan 01-039.

Section 4: Safety Interlocks

A burner management system (BMS) provides independent safety protection for the FBC. The BMS is described in detail in FD-15. Additional interlocks to be provided by the DCS for the FBC are as follows:

a. Forced Draft Fan Inlet Damper
Forced draft fan 01-001 may not be started unless its inlet damper FCV-0114 is shut as indicated by ZSC-0114.

b. Induced Draft Fan Inlet Damper
Induced draft fan 01-039 many not be started unless its inlet damper FCV-0132 is shut as indicated by ZSC-0132.

c. Fuel Target Box Isolation Valves
Fuel target box isolation valves may not be opened if baghouse flow control valves FCV-0165B, FCV-0166B, FCV-0167B, and FCV-0168B are not open and baghouse bypass valve FCV-0164 is not shut as indicated by their respective limit switches, ZSO-0165A, ZSO-0166A, ZS0-0167A, ZS0-0168A, and ZSC-0164.

Section 5: Monitoring

The DCS shall provide graphics display of the wood fuel combustion system and data logging as described in the sections that follow:

a. Indications Displayed
The DCS shall provide a graphics overview display for the control room operator that depicts the boiler, FBC, pre-heater, auxiliary burner and fan, forced draft fan and interconnecting ductwork between the fan, pre-heater, and FBC. The display shall show the control dampers that regulate over fire airflow and fluidizing airflow. It shall show the vibrating conveyor, 01-007-01 and the knife gate valve, FCV-0127 that opens and closes to allow sand to flow from the FBC to the vibrating conveyor. The display shall provide the following indications:

i. Forced draft fan run status as indicated by the auxiliary contacts for MY-0114.

ii. Forced draft fan speed in Hz. As indicated by SI-0114.

iii. Forced draft fan discharge pressure as indicated by PIC-0114.

iv. Pre-heat burner on/off status as indicated by the BMS for the burner.

v. Fluidizing sand temperature as indicated by TI-0101, TI-0102, TI-0103, and TI-0104.

vi. Sand temperature as indicated by TI-0126.

vii. Sand outlet temperature to vibrating conveyor as indicated by TI-0127.

viii. FBC lower vapor space temperature as indicated by TI-0108.

ix. FBC upper vapor space temperature as indicated by TI-105 and TI-106.

x. FBC air manifold to fluidizing nozzle differential pressure as indicated by PDIC-0111.

xi. FBC air manifold to FBC freeboard zone differential pressure as indicated by PDI-0110.

xii. FBC freeboard zone pressure as indicated by PI-0132.

xiii. FBC freeboard zone pressure as indicated by PI-0133.

xiv. Vapor space temperature as indicated by TI-0105.

xv. Vapor space temperature as indicated by TI-0106.

xvi. Vibrating screen conveyor run status as indicated by MY-0127.

xvii. Pre-heater air temperature as indicated by TI-0119.

xviii. Forced draft fan fixed bearing temperature as indicated by TI -0116A.

xix. Forced draft fan fixed bearing temperature as indicated by TI -0116B.

xx. Forced draft fan floating bearing temperature as indicated by TI-0115.

xxi. Induced draft fan fixed bearing temperature as indicated by TI -0134A.

xxii. Induced draft fan fixed bearing temperature as indicated by TI -0134B.

xxiii. Induced draft fan floating bearing temperature as indicated by TI -0133.

xxiv. Boiler steaming rate as indicated by FI-0145.

xxv. Boiler feed water flow as indicated by FI-0146

xxvi. Boiler steam drum water level as indicated by LI-0147.

xxvii. Boiler furnace pressure as indicated by PI-0133.

xxviii. Boiler steam drum pressure as indicated by PI-0150.

b. Data Logging

Data logging and trending shall be provided for the following:

i. Steam drum level (LI-0147) vs. time.

ii. Steam flow (FI-0145) vs. time.

iii. Boiler feed water flow (FI-0146) vs. time.

iv. Boiler steam drum pressure (PI-0150) vs. time.

v. Pre-heater air temperature (TI-0119) vs. time.

vi. FBC vapor space temperatures vs. time as indicated by TI-0105 and TI-0106.

vii. FBC lower vapor space temperature vs. time as indicated by TI-0108.

viii. FBC fluidizing sand temperatures vs. time as indicated by TI-0101, TI-0102, TI-0103, and TI-0104.

ix. FBC sand temperature (TI-0126) vs. time.

x. FBC sand to vibrating conveyor temperature (TI-0127) vs. time.

xi. FBC air manifold to fluidizing nozzle differential pressure (PDIC-0111) vs. time.

xii. FBC air manifold to freeboard zone differential pressure (PDI-0110) vs. time.

xiii. FBC freeboard zone pressure vs. time as indicated by PI-0132 and PI-0133.

xiv. Forced draft fan discharge pressure (PIC-0114) vs. time.

xv. Forced draft fan fixed bearing temperature as indicated by TE-0116A vs. time.

xvi. Forced draft fan fixed bearing temperature as indicated by TE-0116B vs. time.

xvii. Forced draft fan floating bearing temperature as indicated by TI-0115 vs. time.

xviii. Induced draft fan fixed bearing temperature as indicated by TE-0134A vs. time.

xix. Induced draft fan fixed bearing temperature as indicated by TE-0134B vs. time.

xx. Induced draft fan floating bearing temperature as indicated by TE-0133 vs. time.

Section 5: Alarms

The DCS shall provide the following alarms:

a. Vapor space temperature high as indicated by TAHH-0107.

b. High vapor space temperature transmitter differential as indicated by TS-0120.

c. FBC air manifold temperature high as indicated by TS-0120.

d. FBC sand temperature high as indicated by TAH-0126.

e. Sand temperature to vibrating conveyor temperature high as indicated by TAH-0127.

f. Forced draft fan fixed bearing temperature high as indicated by TAH-0116A.

g. Forced draft fan fixed bearing temperature high as indicated by TAH-0116B.

h. Forced draft fan floating bearing temperature high as indicated by TAH-0115.

i. Induced draft fan fixed bearing temperature high as indicated by TAH-0134A.

j. Induced draft fan fixed bearing temperature high as indicated by TAH-0134B.

k. Induced draft fan floating bearing temperature high as indicated by TAH-0133.

l. Steam drum level low as indicated by LSL-0149.

m. Steam drum level high as indicated by LSH-0149.

n. Steam drum high pressure trip as indicated by PSHH-0150.

o. Steam drum low level trip as indicated by LSLL-0147 or LSLL-0149.

p. Master fuel trip by BMS.

I/O TABLE

TAG NO.		DESCRPITION	DELTA-V I/O TYPE	I/O ADDRESS
TT	0101	Temperature NW Active Bed	AI	
TT	0102	Temperature SE Active Bed	AI	
TT	0103	Temperature NE Active Bed	AI	
TT	0104	Temperature Center Active Bed	AI	
TE	0105	Temperature Upper Vapor #1	AI	
TE	0106	Temperature Upper Vapor #2	AI	
TSHH	0107	W.F.Combustor Upper Vapor HI HI Temperature	DI	
TE	0108	Temperature Lower Vapor	AI	
FT	0109	Total Combustion Air Flow	AI	
PDT	0110	W.F. Combustor Bed Diff Pressure	AI	
PT	0110	W.F. Combustor Bed Pressure	AI	
PDT	0111	Pressure Diff. Underfire/Fluidizing Air Nozzle	AI	
EZ	0111	Underfire/Fluidizing Air Actuator Command	AO	
ZSC	0111	Underfire/Fluidizing Air Actuator Closed	DI	
ZSO	0111	Underfire/Fluidizing Air Actuator Opened	DI	
ZT	0111	Underfire/Fluidizing Air Actuator Position	AI	
FT	0113	Flow Lower Overfire Air Flow	AI	
EZ	0113	Lower Overfire Air Actuator Command	AO	

ZT	0113	Lower Overfire Air Actuator Position	AI	
PT	0114	Pressure FD Fan Discharge	AI	
EZ	0114	FD Fan Inlet Air Damper Command	AO	
MY	0114	FD Fan Running	DI	
SC	0114	FD Fan Speed Reference	AO	
ST	0114	FD Fan Speed Feedback	AI	
ZSC	0114	FD Fan Inlet Air Damper Closed	DI	
ZSO	0114	FD Fan Inlet Air Damper Opened	DI	
ZT	0114	FD Fan Inlet Air Damper Position	AI	
PT	0114	Pressure FD Fan Discharge	AI	
TE	0115	Temperature FD Fan Floating Bearing	AI	
TE	0116A	Temperature FD Fan Fixed Bearing A	AI	
TE	0116B	Temperature FD Fan Fixed Bearing B	AI	
PDSL	0118	Preheater Low Diff Pressure Switch	DI	
EZ	0119	Preheater Main Gas Actuator	AO	
ZT	0119	Preheater Main Gas Actuator Position	AI	
ZSO	0119	Preheater Main Gas Actuator Opened	DI	
ZSC	0119	Preheater Main Gas Actuator Closed	DI	
TT	0119	Air Preheator Temperature	AI	
TS	0120	Temperature Preheater Plenum	DI	
HSA	0122	Preheater BMS Auto Mode	DI	
MFT	0122	Preheater Gas Fuel MFT	DI	
SA	0122	Preheater Purge	DI	
SB	0122	Preheater Lightoff	DI	
SC	0122	Preheater Modulate	DI	
YPM	0122	Preheater BMS Run Permissive	DO	
TE	0126	Temperature W.F. Combustor Upper Cone	AI	
TE	0127	Temperature Sand Outlet	AI	
MY	0127	Vibrating Tramp Removal Screen Conveyor Run	DO	
TE	0134A	Temperature ID Fan Fixed Bearing A	AI	
TE	0134B	Temperature ID Fan Fixed Bearing	AI	
TE	133	Temperature ID Fan Float Bearing A	AI	
PT	0132	Pressure W.F. Combustor Vessel	48	
PT	0133	Pressure W.F. Combustor Vessel	48	
FT	0145	Boiler Steam Rate	AI	
FT	0146	Boiler Feed Water Flow	AI	
LI	0149	Level Steam Drum	AI	
LSH	0149	Level Steam Drum	DI	
LSL	0149	Level Steam Drum	DI	
LSLL	0149	Boiler Feedwater Low Low Level	DI	
PSHH	0150	Pressure Steam Drum	DI	
PT	0150	Pressure Steam Drum	DI	
JS	0160	BMS Power Supply Ok	DI	
YS	0160	Metering Bin Target Slide Gate Interlock	DO	
YA	0160	BMS Alarm	DI	

PRECISION ENERGY SERVICES INC.

FD-06: COMBUSTION SAND SYSTEM

Section 1: General Description:

The primary purpose of this system is the intermittent removal of sand from the fluidized bed FBC (FBC). This is necessary due to the possibility of rocks or other foreign material entering the FBC with the fuel. Periodically removing a small amount of sand from the FBC will allow tramp material to slowly migrate to the bottom of the FBC where it can be removed. This system is also designed to allow for the filling and emptying of all sand from the FBC to allow for maintenance.

Section 2: Principal Elements

A schematic representation of the combustion sand system can be found on P&ID's 700-003 and 700-009. Primary system components are as follows:

a. Tramp Removal and Vibratory Conveyor, 01-007:
Classifies and removes oversize material that has entered the FBC with the fuel during operation of the FBC. When service the conveyor will remove approximately 6,000 lbs/hr of sand.

b. Bucket Elevator, 01-008:
Transfers sand removed from the FBC sand bed to an elevation where it may be returned to the FBC or the sand storage bunker. When in service the bucket elevator has a capacity of 28,000 lbs/hr.

c. Storage Bunker, 01-009
Provides storage for the initial charge of sand or for interim storage of sand when the FBC is shut down for service. The bunker has a storage capacity of 1,750 ft^3 (approximately 85 tons)

Section 3: Modes of Control

The subsections that follow describe various modes of operation that will be handled by the plant DCS. Note, all time settings mentioned in the sections that follow shall be adjustable from the graphics display described in section 4.a.

a. Start-up

i. The DCS shall provide a selector switch, HS-0132 that allows the control room operator to place the sand system diverter valve FV-0131 in either the bunker position or FBC position. When the divert position is selected, sand entering FV-0131 will be discharged to the sand storage bunker. When the FBC position is selected, sand entering FV-0131 will be discharged to the FBC.

The sand bunker will require a first fill of sand. This operation will be supervised locally with assistance from a control room operator. This procedure will involve transferring a bulk delivery of sand to a hopper and chute that leads to one of the bucket elevator inlet ports.

The bucket elevator will be energized from the control room and will convey sand to the to the diverter valve, FV-0131. The control room operator will place the FV-0131 selector switch in the bunker position during this operation. Note: the DCS will energize FQY-0131 to place FV-0131 in the bunker position. Sand entering FV-0131 will then be discharged to the line leading to the sand storage bunker. Bunker high level indicator LSH-0128 will be monitored from control room to prevent over filling of the bin.

ii. Once sand is in the bunker, a sand bed can be established in the FBC. This operation will again be supervised locally with assistance from a control room operator. In order to transfer sand to the FBC, the control room operator will need to place the selector switch, HS-0132 in the FBC position. The DCS will de-energize FQY-0131 when this position is selected. Once the bucket elevator is operating, HV-0128 will be partially opened to allow sand in the bunker to flow by gravity to the bucket elevator in a controlled manner. The transfer of sand to the FBC will continue until the correct bed level is obtained. Once this activity is completed, HV-0128 will be shut and the bucket elevator will be stopped.

b. Normal Operation (Automatic Mode)

In order to remove rocks and other tramp material that may have entered the FBC with the fuel, it will be necessary to periodically operate the bucket elevator, the vibratory conveyor, and FCV-0127. The DCS shall provide a mode selector switch, HS-0133 that allows the operator to run this equipment in an automatic mode or manual mode. During automatic operation a DCS controller, FC-0131 shall operate this equipment for 15 minutes every 8 hours as follows:

i. Start the bucket elevator, 01-008.
ii. Start the vibratory conveyor, 01-007.
iii. Cycle FCV-0127 every 60 seconds by energizing FQY-0127 and de-energizing as soon as the contacts for ZSO-0127 shut.
iv. At the end of the 15 minute period stop cycling FCV-0127, allow the vibratory conveyor to continue running for 2 minutes then stop the conveyor. Allow the bucket elevator to run for 4 additional minutes after stopping the vibratory conveyor; then stop the elevator.

c. Normal Operation (Manual Mode)

When HS-0133 is placed in the manual position the DCS shall operate the sand system equipment as follows:

i. Start the bucket elevator, 01-008.

ii. Start the vibratory conveyor, 01-007.

iii. Cycle FCV-0127 every 60 seconds by energizing FQY-0127 and de-energizing FQY-0127 as soon as the contacts for ZSO-0127 shut.

d. Emergency Shut Down

A thermocouple, TE-0127 (see P&ID 700-003) is installed just above FCV-0127. If the temperature measured by this thermocouple is greater than 300F and the sand system is being operated, an emergency shut down shall be initiated by the DCS as follows:

i. Stop cycling FCV-0127.

ii. Allow the vibratory conveyor to fun for 2 minutes then stop.

iii. Allow the bucket elevator to run for 4 additional minutes after stopping the vibratory conveyor; then stop the elevator.

e. Normal Shut Down

System shutdown shall be initiated from the control room by placing the system mode selector switch in manual. If the system is shutdown during a run cycle, the DCS shall perform a sequenced shutdown as described in section 3.d.

f. FBC Maintenance

At least once per year it will be necessary to remove the sand in the FBC in order to inspect the FBC's fluidizing nozzles and air manifolds. This will require transferring sand from the FBC to the sand storage bunker. This activity will be carried out as follows:

i. The transfer of sand from the FBC to the sand storage bunker will be supervised locally by plant maintenance personnel with assistance from a control room operator. In order to transfer sand to the sand storage bunker, the control room operator will need to place the selector switch for FCV-0131 in the bunker position. After receiving a request from plant maintenance staff, the control room operator will place the sand system mode selector switch in the unload position. The DCS will then initiate the following sequence and continue running the system until the mode selector switch is returned to the manual position:

1 - Start the bucket elevator, 01-008.
2 - Start the vibratory conveyor, 01-007.
3 - Cycle FCV-0127 every 60 seconds by energizing FQY-0127 and de-energizing FQY-0127 as soon as the contacts for ZSO-0127 shut.

g. Safety Interlocks
The following interlocks shall be imposed:

i. Transfer of sand to the storage bunker shall be blocked if the contacts for the bunker high level switch, LS-0128 are shut.

ii. Operation of the FBC lower cone valve, FCV-0127 requires the operation of the vibrating screen conveyer as indicated when the conveyor's motor starter auxiliary contacts for MY-0127 are shut.

iii. The vibratory conveyor 01-007 shall not operate unless the bucket elevator, 01-008 is running as indicated by the contacts of SSL-0131 being shut.

Section 4: Monitoring

a. Indications Displayed
A graphic display shall be created that depicts the FBC, the bucket elevator, the vibratory conveyor, FV-0131, FCV-0127, and the sand storage bunker. The status for all drive motors and control valves shall be included in the display as well as the temperature of the sand leaving the FBC as measured by TE-0127.

b. Data Logging
Normal operating sequence start and stop functions shall be logged.

Section 5: Alarms

The following alarms when detected during operation of the sand system shall be initiated by the DCS[1]:

a. High level in sand bin as indicated by LSH-0125.

b. FCV-0127 open for more than 5 seconds as indicated by ZSO-0127.

c. Bucket elevator motor failure as indicated by the opening of the motor starter auxiliary contacts for MY-0131.

d. Bucket elevator motor starter fault as indicated by YA-0131.

e. Vibrating conveyor motor failure as indicated by the opening of the motor starter auxiliary contacts for MY-0127.

f. Vibrating conveyor not operating as indicated by SSL-0127.

g. Diverter valve, FV-0131 not in normal operating position as indicated by contacts for ZSO-0131 being open.

h. FBC sand bed differential pressure high as indicated by PDAH-0110.

i. FBC sand bed differential pressure low as indicated by PDAL-0110.

[1] Alarms for c, d, e, and f shall only be active when the combustion sand system is in an automatic mode of operation.

j. FBC sand to vibrating conveyor sand temperature high as indicated by TAH-0127.

I/O TABLE SAND SYSTEM

TAG NO.		DESCRIPTION	I/O TYPE	I/O Address
MY	0127	Vibrating Tramp Removal Screen Conveyor Run	DI	
HS	0127	Vibrating Tramp Removal Screen Conveyor Start	DO	
SSL	0127	Vibrating Screen Conveyor Zero Speed	DI	
MY	0127	Vibrating Tramp Removal Screen Conveyor Run	DI	
ZSC	0127	W.F. Combustor Lower Cone Slide Gate Close	DI	
ZSO	0127	W.F. Combustor Lower Cone Slide Gate Open	DI	
FQY	0127	W.F. Combustor Lower Cone Slide Gate Sol	DO	
LSL	0128	Sand Storage Silo Low Level	DI	
LSH	0128	Sand Storage Silo High Level	DI	
SSL	0131	Sand Bucket #1 Elevator Zero Speed	DI	
ZSC	0131	Sand Bucket #1 Elevator Diverter Gate Close	DI	
ZSO	0131	Sand Bucket #1 Elevator Diverter Gate Open	DI	
SSL	0131	Sand Bucket #1 Elevator Zero Speed	DI	
FQY	0131	Sand Bucket #1 Elevator Diverter Gate Sol	DO	
TE	0126	Temperature W.F. Combustor Upper Cone	AI	
TE	0127	Temperature W.F. Combustor Lower Cone	AI	
PDT	0110	W.F. Combustor Bed Diff Pressure	AI	
PT	0110	W.F. Combustor Bed Pressure	AI	
PDAH	0110	W.F. Combustor Bed Pressure High Alarm	DI	
PDAL	0110	W.F. Combustor Bed Pressure Low Alarm	DI	
ZSO	0130	Sand Bucket #1 Elevator Slide Gate Open	DI	
FQY	0130	Sand Bucket #1 Elevator Slide Gate Sol	DO	
HS	0131	Sand Bucket #1 Elevator Forward	DO	
ST	0131	Sand Bucket #1 Elevator Reference	AI	
MY	0131	Sand Bucket #1 Elevator Run	DI	
YA	0131	Sand Bucket #1 Elevator Fault	DI	

PRECISION ENERGY SERVICES INC.

FD-07: COMBUSTOR PRE-HEAT SYSTEM

Section 1: General Description

The combustor pre-heater burner system is a natural gas fired burner mounted in the ductwork that supplies fluidizing air to the combustor sand bed. This system is operated prior to and during a cold Combustor start-up pre-heat the fluidizing air for the fluidized bed combustor (FBC) sand bed.

Section 2: Principal Elements

The system components are shown on P&ID 700-003 and consist of the following:

a. Pre-heat Burner 01-003.

b. Natural gas piping and valves that control the flow of gas to the burner.

c. A Burner Management System (BMS).

d. Instrumentation to monitor temperature, pressure and positions of various valves in the system.

Section 3: Modes of Control

a. Start-up Mode:

i. Verify power is available at the preheater BMS panel located near the burner.

ii. Verify that natural gas is available at the preheater gas train and open the manual isolation valves at the inlet main gas and pilot gas fuel trains.

iii. The DCS shall provide a pre-heat burner start switch, HS-0160. When all of the start limits for the pre-heat burner BMS have been satisfied, the BMS will provide a discrete input to he DCS indicating the burner is ready to start. Once the start permissive is received from the BMS, the control operator may depress start switch, HS-0160 and the BMS will commence the burner start sequence.

iv. Start limits for the BMS are as follows

1. MY-0114 auxiliary contacts shut – FD Fan running
2. ZSO-0114 contacts shut – FD inlet damper open
3. ZSC-0121 contacts shut – Pre-heater gas shutoff valve no.1 shut.
4. ZSC-0122 contacts shut – Pre-heater gas shutoff valve no. 2 shut.
5. PDSL-0118 contacts shut ($\geq$ 5" H_2O) – Proof of airflow.
6. LSLL- 0149 contacts shut - Boiler drum level not low.

7. HSHH- 0150 contacts open – Steam drum pressure not high.
8. PT-0133 contacts open - Furnace Pressure not high.

v. Once HS-0160 has been placed in the run position, the BMS will verify that all the start limits are satisfied and the Master Fuel Trip Relay (MFT) is closed. Upon verification the BMS will provide a discrete input signal to the DCS requesting an air purge of the FBC. The DCS in response will generate an output to the FD Fan variable speed drive, SC-0114 causing the fan to operate at 50 Hz and at the same time open fluidizing air damper FCV-0111 and shut over fire air damper FCV-0113.

The DCS shall provide discrete input signals to the BMS to indicate that the FD fan has reached purge airflow as measured by FE-0109 and that FCV-0111 is closed via ZSC-0113 and FCV-0113 is closed (via ZSC- 0111) are in the purge position. The BMS will then start a purge timer set for 5 minutes. At the completion of the purge cycle, the BMS shall provide an input to the DCS indicating the purge is complete. The DCS shall then place the FD fan in the light off flow condition by reducing the output from SC-0114 to 30 Hz. The DCS shall shut FCV-111. As soon as FCV-0111 is shut as indicated by position switch contacts ZSC-0111, the DCS shall provide a discrete input signal to the BMS that light off flow conditions are met.

Once the startup flow signal is received at the BMS, the light off sequence commences. The pilot gas valve BSV-0125 opens and the igniter is energized. When the flame rod signal BT-0123 is received at the BMS, the main fuel valves BSV-0121 & BSV-0122 are opened. Following the 10 second hold, BSV-0125 closes and the main gas valve remains open with the flame rod monitoring the burner flame.

When ignition is successful & the light on the BMS panel indicates main flame, visually verify a flame is present by looking through the preheater burner viewing port.

Once flame is varied stable on main flame, the BMS will provide a discrete input signal to the DCS that allows the DCS to manipulate the pre-heat burner temperature control valve, TCV-0119.

NOTE: If the ignition attempt is not successful, the **flame failure** light will turn on, determine the cause of the failure, and reset the flame failure lockout reset button on the BMS panel before making another attempt. Start over by depressing the preheat start button to again purge system.

b. Burner Normal shutdown

When the operation of the pre-heat burner is no longer required, the control room operator will place HS-0160 in the stop position. The BMS will then conduct a normal burner shutdown by shutting gas safety valve BSV- 0121 and BSV-0122.

c. Safety shutdown

If during the operation of the burner, a safety interlock is lost, a Master Fuel Trip signal will be generated. The BMS will immediately remove power from the main and pilot train BSV valves. This action will stop the flow of natural gas to the burner. Whenever this occurs the BMS panel shall provide a MFT indication and provide a discrete input signal to the DCS indicating that the BMS has initiated a Master Fuel Trip.

Restoration from a master fuel condition will require the following:

1. Clearing the condition that caused the trip.
2. Initiating a burner re-start command from the DCS.
3. Completion of a burner /combustor purge

Section 4: Monitoring

a. Indications Displayed

The DCS shall provide a graphic representation of the pre-heat burner system as described in FD-05A.

d. Data Logging

Data logging for the pre-heat burner shall be as required in FD-05A.

Section 5: Alarms

The following lists the pre-heat burner trips and alarms:

Pre-Heat Burner/Trip Alarms

Alarm Description	Trip Value	Detection Device	Response	Corrective Action	Re-Set Response
No flame igniter	No signal after 10 sec.	Flame Rod	MFT-BMS	re-start sequence	purge complete
Low gas pressure	≤5" H2O	PSL-0122	MFT-BMS	re-start sequence	purge complete
High gas pressure	≥100" H2O	PSH-0122	MFT-BMS	re-start sequence	purge complete
Loss of atomizing air	≤5" H2O	PDSL-0118	MFT-BMS	re-start sequence	purge complete
No main flame		Flame Rod	MFT-BMS	re-start sequence	purge complete
Loss of BMS power	80 VAC	BMS	MFT	re-start sequence	purge complete
Loss of fan flow	less than purge flow	FT-0109/	MFT-BMS	re-start sequence	purge complete
Master Fuel Trip	Loss of Prerequisites	BMS	MFT-BMS	re-start sequence	purge complete

I/O TABLE COMBUSTION PRE-HEAT SYSTEM

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
TE	0101	TEMPERATURE NW ACTIVE BED	AI	
TT	0101	TEMPERATURE NW ACTIVE BED	AO	
TE	0102	TEMPERATURE SE ACTIVE BED	AI	
TT	0102	TEMPERATURE SE ACTIVE BED	AO	
TE	0103	TEMPERATURE NE ACTIVE BED	AI	
TT	0103	TEMPERATURE NE ACTIVE BED	AO	
TE	0104	TEMPERATURE CENTER ACTIVE BED	AI	
TT	0104	TEMPERATURE CENTER ACTIVE BED	AO	
PDT	0111	PRESSURE DIFF. UNDERFIRE/FLUIDIZING AIR NOZZLE	AI	
MY	0114	FD FAN RUN	DI	
ZSC	0114	FD FAN INLET AIR DAMPER CLOSE	DI	
ZSO	0114	FD FAN INLET AIR DAMPER OPEN	DI	
PDSL	0118	PREHEATER LOW DIFF. PRESSURE SWITCH	DI	
TE	0119	AIR PREHEATER TEMPERATURE	AI	
TT	0119	AIR PREHEATER TEMPERATURE	AO	
ZSC	0119A	PREHEATER MAIN GAS LOW FIRE	DI	
BSV	0121	PREHEATER GAS SAFETY SHUT-OFF VALVE #1	DO	
ZSC	0121	PREHEATER GAS SAFETY SHUT-OFF VALVE #1 CLOSED	DI	
BSV	0122	PREHEATER GAS SAFETY SHUT-OFF VALVE #2	DO	
HS	0122	LOCAL GAS PREHEATER MFT RESET PB	DI	
HSA	0122	PREHEATER BMS AUTO MODE	DO	
PSH	0122	PREHEATER MAIN GAS PRESSURE - HI	DI	
PSL	0122	PREHEATER MAIN GAS PRESSURE - LOW	DI	
MFT	0122	PREHEATER GAS FUEL MFT	DO	
SA	0122	PREHEATER PURGE	DO	
SB	0122	PREHEATER LIGHTOFF	DO	
SC	0122	PREHEATER MODULATE	DO	
YPM	0122	PREHEATER BMS RUN PERMISSIVE	DI	
ZSC	0122	PREHEATER GAS SAFETY SHUT-OFF VALVE #2 CLOSE	DI	
BT	0123	PREHEATER FLAME ROD TRANSMITTER	AI	
BX	0123	PREHEATER FLAME IGNITOR	DO	
BSV	0125	PREHEATER PILOT GAS SHUT-OFF VALVE	DO	
ZSC	0125	PREHEATER PILOT GAS SHUT-OFF VALVE CLOSED	DI	
ZSC	0132	ID FAN INLET AIR DAMPER CLOSED	DI	
ZSO	0132	ID FAN INLET AIR DAMPER OPENED	DI	
MY	0133	ID FAN RUN	DI	
LSLL	0147	BOILER FEEDWATER LOW LOW LEVEL	DI	
LSLL	0149	BOILER FEEDWATER LOW LOW LEVEL	DI	
PSHH	0150	PRESSURE STEAM DRUM HIGH HIGH	DI	
BST	0160	BMS TOGGLE	DO	
CST	0160	CONTROL SYSTEM TOGGLE	DI	
JS	0160	BMS POWER SUPPLY OK	DO	
MFT	0160	W.F. COMBUSTOR MFT	DO	

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I/O TABLE COMBUSTION PRE-HEAT SYSTEM

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
YS	0160	BMS ESTOP ENABLED	DO	
YPM	0160	W.F.COMBUSTOR BMS RUN PERMISSIVE	DI	
ZSC	0162	NO. 1 METERING BIN TARGET SLIDE GATE CLOSED	DI	
ZSC	0163	NO. 2 METERING BIN TARGET SLIDE GATE CLOSED	DI	
PSH	0182A	FURNACE PRESSURE	DI	
HES	0160	OPERATOR MFT TRIP PB	DI	
HS	0160	LOCAL WOOD MFT RESET PB	DI	
SFT	122	SOLID FUEL TRIP	DI/DO	
PB	0122A	OPERATOR MFT TRIP	DI	
PB	0122B	OPERATOR SFT TRIP	DI	

Note: Consult with Emerson for analog output source approval for TT signals.

Indicates this is not on Emerson FSS System I/O from May 5, 2009 In Cab1 I/O

Indicates not on BMS Cabinet I/O added by Emerson

Indicates device is not required for Emerson implementation using thermocouple input card

Indicates item is in Cabinet 1 IO and will be communicated to FSS by Emerson data link

Changes to PB 0122 for Emerson FSS implementation Solid Fuel Trip.

FD-08: BOILER & ECONOMIZER SOOTBLOWER SYSTEM

Section 1: General Description:

The No. 1 Boiler and the primary and secondary economizers utilize soot blowers on the flue gas side of the heat transfer tubes to remove a mixture of soot an ash that can adhere to and foul the tubes. All soot blowers are fixed rotary type units. The soot blower manufacturer is Diamond Power International and the model being supplied to the project is their Model G9B unit. Each blower when operated rotates and blows steam in a pre-determined arc controlled by an actuating cam. Soot blowing steam is delivered to the soot blowing system by a 3 inch line connected to the No. 1 boiler's steam drum. Each blower is equipped with an element (pipe) that has nozzles welded to its sidewalls that are spaced to blow steam between each bank of tubes. There are eight motorized soot blowing units on the boiler, two motorized units on the primary economizer and two manual units located on the secondary economizer.

Section 2: Principal Elements

The soot blower system is shown on PES P&ID's 700-005 & 700-007. Figure 1 below shows the main elements of the G9B soot blower.

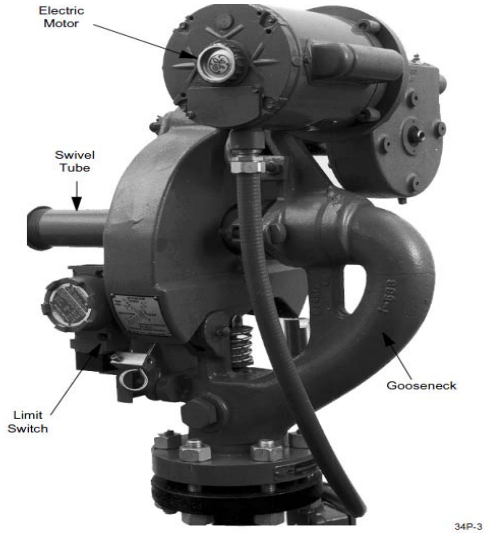

Figure 1: Diamond Power G9B Motor Actuated Soot Blower

Section 3: Modes of Control

The plant DCS shall provide a sequencing controller, FC-0137 to operate the eight soot blowers on the boiler in a sequence. The DCS shall provide the control room operator with the ability to manually set the time when an automatic cleaning cycle will start. Various operating modes to be provided are described in more detail in the subsections that follow:

a. Normal Operating Mode

This operating mode occurs when the control room operator places the sootblower sequencing controller, FC-0137 in its automatic mode. FC-0137 shall operate the soot blowers in the following order:

a. SB-0141
b. SB-0143
c. SB-0142
d. SB-0144
e. SB-0137
f. SB-0139
g. SB-0138
h. SB-0140

b. Individual Soot Blower Operation

The DCS shall provide the operator with the capability to operate any soot blower from a control room work station. A graphic display of the soot blowing system shall be created and individual soft push buttons shall be provided to enable single soot blower operation. The DCS shall be programmed such that FC-0137 must be place in manual mode in order to operate soot blowers individually.

c. Shut Down Mode

Normally the soot blowers will be in a standby mode when they are not operating. There are no specific shutdown sequences to be performed by the DCS with respect to operation of the soot blowers.

Section 4: Safety Interlocks

During normal cleaning sequence the next soot blower in the cycle may not start until the previous soot blower's limit switch contacts shut. For example, SB-0143 may not start until contacts ZS-0141 are shut.

Section 5: Monitoring

A graphic display of the soot blower system will show the boiler and primary economizer and each soot blower that is part of the system.

a. Indications Displayed

i. The operator's display shall show the current status of each soot blower when a normal sequence has started as follows.

- **Active –** The word "**Active**" shall be illuminated above the soot blower that is currently undergoing a blowing revolution.

- **Standby** – The word "**Standby**" shall be illuminated above the next soot blower to be activated.

b. Data Logging
The time and date of each normal soot blowing sequence shall be recorded.

Section 6: Alarms

The following alarms shall be generated during the following operations:

a. Activated Soot Blower
Any soot blower performing a blowing revolution when not initiated by the DCS or control room operator.

b. Soot Blower Cycle Incomplete
Each soot blower is equipped with a limit switch that provides an indication of when it has completed a cycle. If after 30 seconds during a soot blowing cleaning sequence, a soot blower fails to complete its cycle and an alarm shall be generated indicating which soot blower has failed to complete its cycle. In addition the cleaning sequence shall be terminated.

I/O TABLE BOILER & ECONOMIZER SOOTBLOWER SYSTEM

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
SB	0135	Primary Economizer Soot Blower #9 Valve	DO	
ZS	0135	Primary Economizer Soot Blower #9 Position	DI	
SB	0136	Primary Economizer Soot Blower #10 Valve	DO	
ZS	0136	Primary Economizer Soot Blower #10 Position	DI	
SB	0137	No.1 Boiler Soot Blower #1 Valve	DO	
ZS	0137	No.1 Boiler Soot Blower #1 Home	DI	
SB	0138	No.1 Boiler Soot Blower #3 Valve	DO	
ZS	0138	No.1 Boiler Soot Blower #3 Home	DI	
SB	0139	No.1 Boiler Soot Blower #2 Valve	DO	
ZS	0139	No.1 Boiler Soot Blower #2 Home	DI	
SB	0140	No.1 Boiler Soot Blower #4 Valve	DO	
ZS	0140	No.1 Boiler Soot Blower #4 Home	DI	
SB	0141	No.1 Boiler Soot Blower #5 Valve	DO	
ZS	0141	No.1 Boiler Soot Blower #5 Home	DI	
SB	0142	No.1 Boiler Soot Blower #7 Valve	DO	
ZS	0142	No.1 Boiler Soot Blower #7 Home	DI	
SB	0143	No.1 Boiler Soot Blower #6 Valve	DO	
ZS	0143	No.1 Boiler Soot Blower #6 Home	DI	
SB	0144	No.1 Boiler Soot Blower #8 Valve	DO	
ZS	0144	No.1 Boiler Soot Blower #8 Home	DI	
TE	0148A	Economizer Gas In Temperature	AI	
TE	0148B	Economizer Gas Out Temperature	AI	

FD-09: BAGHOUSE PARTICULATE REMOVAL SYSTEM

Section 1: General Description

The No. 1 Boiler employs a pulsejet baghouse to remove fly ash from the boiler's flue gas before it is discharged to the atmosphere. The baghouse consists of 4 individual modules. Pulsejet baghouses are designed with internal frame structures, called cages, to allow the collection of particulate on the outside surface of bags that are pulled over the outside of the cages. During operation a dust cake forms on the surface of the bags. The dust cake is periodically removed by a jet of compressed air directed into the bag. This air blast causes the bag to expand suddenly. The bag expansion dislodges the dust on the bag surface enabling it to slide along the outside of the bag and drop into an ash collection hopper located directly below the cage and bag assembly. The baghouse contains 4 separate modules. Each module has 240 bags grouped in 16 rows with 15 bags in each row. The bag diameter is 6 inches. Bag length is 192 inches.

Section 2: Principal Elements

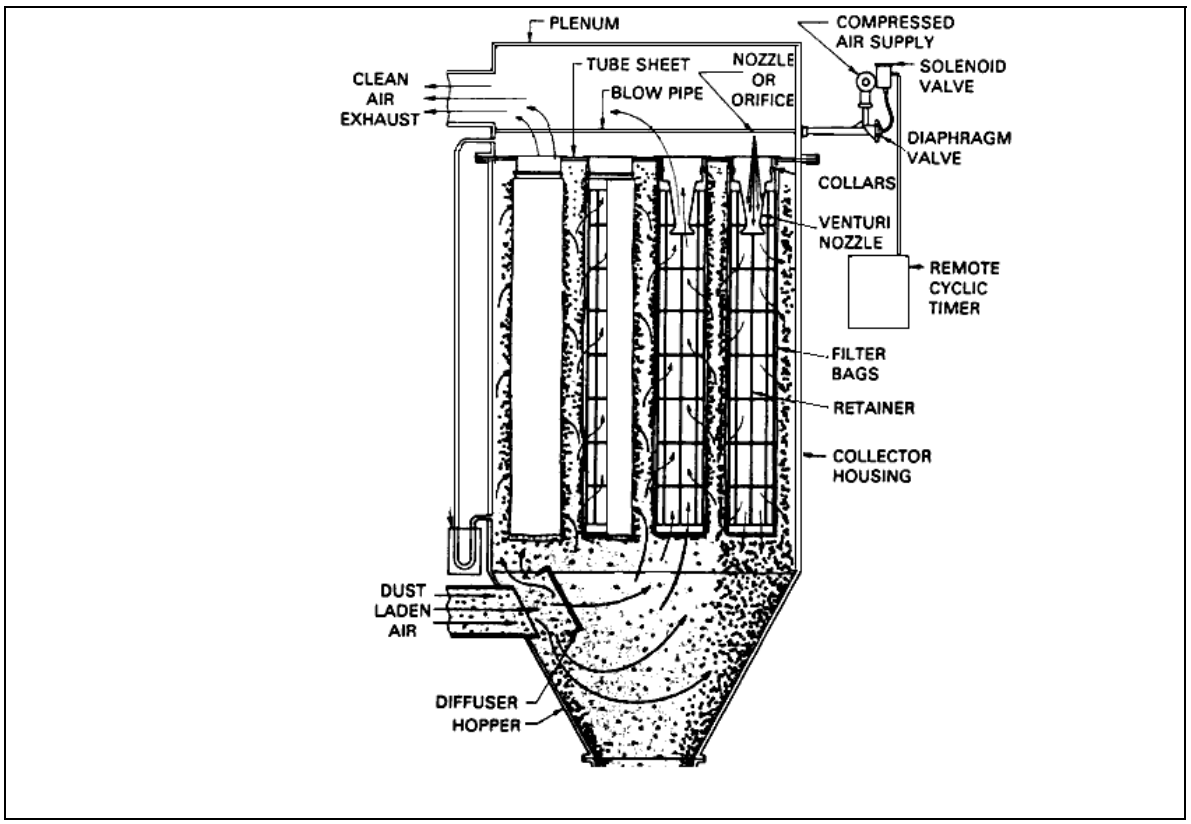

Figure1: Typical Baghouse Construction

During online operation dust laden flue gas enters at the bottom of the module, approaching the surface of the bags, passing through the bags to a plenum, and then leaving the unit.

All baghouse modules are cleaned periodically in order to maintain an acceptable pressure drop through the baghouse. Each module is equipped with a standalone Dwyer Series DCT1000 timer controller. During a cleaning cycle a timer controller for a module will be activated. The controller, when signaled by the boiler's control system, energizes in a timed sequence each solenoid valve that provides pilot air to open a larger diaphragm valve which admits air into a blow pipe. The blow pipe has a nozzle directly over each bag in the row it is cleaning. Alternate rows are cleaned until all rows have received an air pulse. P&ID, 20267-700-008, is a schematic representation of the baghouse and related ductwork. The drawing also shows all of the instrumentation, control valves, hand operated valves, etc. associated with the system.

Section 3: Modes of Control

The No. 1 Boiler may be fired with wood, natural gas, or No. 2 diesel. During gas or diesel firing the baghouse is to be bypassed as particulate is not produced when firing gas and the combustion products produced during oil firing are harmful to the baghouse bags. Bypassing is accomplished by opening valve FCV-0164 and shutting the module isolation valves FCV-0165B, FCV-0166B, FCV-0167B, FCV-0168B, HV-0165A, HV-0166A, HV-0167A, and HV-0168A. At all times during wood firing operations the flue gas produced by the boiler must pass through the baghouse. This is accomplished by opening the module isolation valves FCV-0165B, FCV-0166B, FCV-0167B, FCV-0168B, HV-0165A, HV-0166A, HV-0167A, and HV-0168A and shutting valve FCV-0164. Each baghouse module has three possible modes of operation: Normal Mode, Online Cleaning Mode, Offline Cleaning Mode, and offline mode. Each of these modes is described in the subsections that follow.

a. Normal Operating Mode:

When a module is operating in the normal operating mode its flue gas inlet and outlet valves are open (FCV-0165B, HV-0165A typ.) and the unit is removing particulate from the flue gas.

b. Online Cleaning Mode

An online cleaning sequence is to be automatically initiated by a DCS controller, PDIC-0164 when the differential pressure between the baghouse flue gas inlet and outlet manifolds reaches 4 inches H_2O as measured by PDT-0164. When the sequence begins the boiler control system will clean each module sequentially until the differential pressure falls below 2 inches H_2O. The control system starts a cleaning sequence by signaling the module's standalone controller with a contact closure. The contacts remain closed for a predetermined amount of time which is

to be adjustable from a DCS SCADA screen. This time will be that which allows the controller to pulse each row in a baghouse module three times. Once the sequence is completed if the differential remains above 2 inches H_2O the boiler control system shall start a cleaning sequence with the next module. When the differential pressure reaches the desired level the boiler control system shall start the next cleaning sequence with the module following the last one to be cleaned during a previous sequence. The boiler control system shall alert the control room operator when an online cleaning sequence is initiated.

c. Offline Cleaning Mode

When burning wood each module is to be cleaned offline once per day. The DCS shall provide a controller, PDC-0164 for this purpose. It shall be possible through a SCADA screen interface for a control room operator to select the time of day when offline cleaning is to be accomplished. Offline cleaning involves shutting a module's discharge isolation valve (FCV-0165B, FCV-0166B, FCV-0167B, or FCV-1068B) and having the boiler control system signal the module's standalone controller to start a cleaning sequence.

d. Offline Mode

A baghouse module will be considered to be offline if the module's discharge isolation valve is shut and the module isnot being cleaned.

Section 4: Safety Interlocks

The actuator, FQY-0164, which operates the bypass valve FCV-0164 shall be interlocked with FCV-0165B, FCV-0166B, FCV-0167B, and FCV-1068B such that it will shut FCV-0164 if any of these valves are opened.

Section 5: Monitoring

The following subsections list the display and data logging requirements for the baghouse particulate removal system:

a. Indications Displayed

The boiler control system shall provide a graphic display that depicts each baghouse module and the flue gas inlet and outlet manifolds. The status of each baghouse module shall be shown indicating whether a module is online, in an online cleaning mode, in an offline cleaning mode, or offline. The status of the module isolation valves, the position of the bypass valve, the differential pressure across each module, and the differential pressure between the inlet and outlet manifold shall be displayed.

b. Data Logging

For historical purposes the boiler control system shall record the output of PDT-0164 vs. time during those periods when the boiler is firing wood. The control system shall also record by module the time of each online cleaning, each offline cleaning, and the time and duration each module was taken offline.

Section 6: Alarms

The following alarms shall be initiated during the following operations:

a. Gas and oil firing:

- Bypass valve FCV-0164 open limit switch ZS0-164 contacts not shut.
- Baghouse module isolation valves limit switches ZSC-165A, ZSC-166A, ZSC-167A, ZSC-167A, ZSC-165B, ZSC-166B, ZSC-167B, and ZSC-167B contacts not shut.
- ID Fan motor fault as indicated by YA-0133

b. Wood firing:

- Bypass valve FCV-0164 shut limit switch ZSC-0164 contacts not shut.
- Baghouse module isolation valve limit switches ZSO-165A, ZSO-166A, ZSO-167A, ZSO-167A, ZSO-165B, ZSO-166B, ZSO-167B, and ZSO-167B contacts not shut.
- High flue gas baghouse inlet temperature (TT-0148B) above 400F.
- High differential pressure between baghouse flue gas inlet and outlet manifolds (DPT-0164) above (5 inches H_2O).
- High baghouse module differential pressure as indicated by DPAH-0165, DPAH-0166, DPAH-0167, and DPAH-0168 (5 inches H_2O).
- High ash level baghouse module 1 ash hopper as indicated by LAH-0165.
- High ash level baghouse module 2 ash hopper as indicated by LAH -0166.
- High ash level baghouse module 3 ash hopper as indicated by LAH -0167.
- High ash level baghouse module 4 ash hopper as indicated by LAH -0168.
- ID Fan motor fault as indicated by YA-0133

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I/O TABLE BAGHOUSE & ID FAN

TAG NO.		DESCRIPTION	DELTA - V I/O TYPE	I/O ADDRESS
PDT	0164	Baghouse Diff Pressure Transmitter	AI	
FQY	0164	Baghouse Bypass Control Valve	DO	
ZSC	0164	Baghouse Bypass Control Valve Closed	DI	
ZSO	0164	Baghouse Bypass Control Valve Open	DI	
YA	0165	Baghouse Module #1 High Diff Press	DI	
LSH	0165	Baghouse Module #1 Level	DI	
PDT	0165	Baghouse Module #1 Diff Pressure	AI	
TE	0165	Baghouse Module #1 Ash Pot Temperature	AI	
ZSC	0165A	Baghouse Module #1 Inlet Damper Closed	DI	
ZSO	0165A	Baghouse Module #1 Inlet Damper Open	DI	
FCV	0165B	Baghouse Module #1 Outlet Valve	DO	
ZSC	0165B	Baghouse Module #1 Outlet Valve Closed	DI	
ZSO	0165B	Baghouse Module #1 Outlet Valve Open	DI	
YA	0166	Baghouse Module #2 High Diff Press	DI	
LSH	0166	Baghouse Module #2 Level	DI	
PDT	0166	Baghouse Module #2 Diff Pressure	AI	
TE	0166	Baghouse Module #2 Ash Pot Temperature	AI	
ZSC	0166A	Baghouse Module #2 Inlet Damper Closed	DI	
ZSO	0166A	Baghouse Module #2 Inlet Damper Open	DI	
FCV	0166B	Baghouse Module #2 Outlet Valve	DO	
ZSC	0166B	Baghouse Module #2 Outlet Valve Closed	DI	
ZSO	0166B	Baghouse Module #2 Outlet Valve Open	DI	
YA	0167	Baghouse Module #3 High Diff Press	DI	
LSH	0167	Baghouse Module #3 Level	DI	
PDT	0167	Baghouse Module #3 Diff Pressure	AI	
TE	0167	Baghouse Module #3 Ash Pot Temperature	AI	
ZSC	0167A	Baghouse Module #3 Inlet Damper Closed	DI	
ZSO	0167A	Baghouse Module #3 Inlet Damper Open	DI	
FCV	0167B	Baghouse Module #3 Outlet Valve	DO	
ZSC	0167B	Baghouse Module #3 Outlet Valve Closed	DI	
ZSO	0167B	Baghouse Module #3 Outlet Valve Open	DI	
YA	0168	Baghouse Module #4 High Diff Press	DI	
LSH	0168	Baghouse Module #4 Level	DI	
PDT	0168	Baghouse Module #4 Diff Pressure	AI	

I/O TABLE BAGHOUSE & ID FAN

TAG NO.		DESCRIPTION	DELTA - V I/O TYPE	I/O ADDRESS
TE	0168	Baghouse Module #4 Ash Pot Temperature	AI	
ZSC	0168A	Baghouse Module #4 Inlet Damper Closed	DI	
ZSO	0168A	Baghouse Module #4 Inlet Damper Open	DI	
FCV	0168B	Baghouse Module #4 Outlet Valve	DO	
ZSC	0168B	Baghouse Module #4 Outlet Valve Closed	DI	
ZSO	0168B	Baghouse Module #4 Outlet Valve Open	DI	
EZ	0132	ID Fan Inlet Air Damper Command	AO	
ZSC	0132	ID Fan Inlet Air Damper Closed	DI	
ZSO	0132	ID Fan Inlet Air Damper Open	DI	
ZT	0132	ID Fan Inlet Air Damper Position	AI	
SC	0133	ID Fan Speed Reference	AO	
ST	0133	ID Fan Speed Feedback	AI	
TE	0133	Temperature ID Fan Floating Bearing	AI	
HS	0133	ID Fan Start	DO	
HAS	0133	ID Fan Auto	DI	
YA	0133	ID fan Motor Fault	DI	
TE	0134A	Temperature ID Fan Fixed Bearing A	AI	
TE	0134B	Temperature ID Fan Fixed Bearing B	AI	

FD-10: SNCR NO_x REDUCTION SYSTEM

Section 1: General Description

The purpose of the SNCR NO_x reduction system is to deliver a measured amount of urea into the fluid bed combustor to control NO_x emissions. This is done with the use of High Energy Reagent Technology (HERT). The Seattle Steam HERT system combines urea with water and injects this mixture into the boiler furnace through a set of six nozzles located around the periphery of the combustor. Compressed air is also supplied to each injection nozzle to evaporate the urea mixture and propel the vapor into the combustor. As the urea vapor mixes with the high temperature gases in the furnace, the urea breaks down and forms ammonia. Ammonia then combines with NO_x compounds present in the combustion products converting these compounds to stable N_2 and water vapor. The DCS shall provide the controls necessary to operate the SNCR NO_x reduction system.

Section 2: Principal Elements

P&ID 700-011 shows a schematic representation of all of the equipment associated with the SNCR NO_x Reduction System. The primary elements are as follows:

a. Liquid urea storage tank 01-023:
Has a capacity of 2,600 gallons of diluted urea.

b. Urea pump/control skid 01-123A:
Contains all pumps and control valving necessary to control pressurized urea solution for delivery to injection nozzles.

c. Six urea injector nozzles, 01-130 thru 01-135:
Positioned on the combustor at strategic locations.

Section 3: Modes of Control

a. Start-up Mode

i. Prior to start up; verify that the indicated level in the urea storage tank as indicated by LI-0191 is greater than 500 gallons.

ii. Verify that the urea manual pressure regulator globe valve is open and set for the desired urea recirculation loop pressure.

iii. Verify that all manually operated valves downstream of the static mixer are open.

iv. The system will be activated by an operator initiated discrete input signal (HS-0192) from the control room work station. After the initiate signal, the DCS will start the following sequence in the order listed:

1 - Motor operated FCV-0194 will be shut.

2 - When ZSC-0194 confirms FCV-0194 is shut, the control system will start pump 01-126.

3 - Once the water pump 01-126 operation is confirmed by the motor's variable speed drive SC-0194 run status auxiliary contact MY-0194, controller PIC-0195B will be activated. PIC-0195B will vary the speed of pump 01-126 to maintain the pressure downstream of the static mixer at 80 psig.

4 - After water pump 01-126 has been started and pressure downstream of the static mixer as measured by PT-0195B has reached 80 psig, the DCS will open FCV-0195B.

5 - When FCV-0195B is fully open as indicated by ZSO-0195B, a signal from the control system will start the urea pump (01-127-01) and provide a minimum speed signal of 30 H_z to the pump's variable speed drive, SC-0195. A pressure signal from PT-0195A and closure of SC-0195 run status contact MY-0195 will confirm that the pump is operating.

b. Normal Operating Mode – Injector Start

i. The urea pump, 01-127, will be operated at 30 H_z until the boiler steaming rate reaches 40,000 lbs/hr.

ii. Urea flow will be regulated by a urea flow controller, FIC-0192 which will manipulate flow control valve, FCV-0195A. FIC-0192 will receive a steam flow signal from FT-0145.This flow signal will be used by the controller to determine a urea flow set point from a table that establishes the required urea flow as a function of steam flow. Initial table values shall be as follows:

1 - Urea flow rate set to 4 gph for a 40,000 lbs/hr steaming rate.

2 - Urea flow rate set to 10 gph at for an 80,000 lbs steaming rate.

3 - Final values will be determined during system commissioning.

iii. As the boiler load changes, FCV-0195A will open or close accordingly to maintain the desired flow rate. The operator shall be able to adjust the flow rate with a multiplier bias of +/- 10%.

iv. Urea pump 01-127 speed will be varied by a PIC-0195A, which will vary the pumps speed to maintain a constant urea pump discharge pressure of 90 psig.

c. Shut Down Mode

Flow regulation of urea to the combustor will stop under two conditions: 1) If the boiler steam flow drops below 40,000 lbs/hr, or 2) The control room operator initiates a system stop. In either case the following will occur:

i. Controlled Shut Down

1 - The DCS shall stop the urea pump motor, 01-127.

2 - The DCS shall shut FCV-0195B.

3 - As soon as feedback from the position switch ZSC-0195B indicates FCV-0195B is closed, urea flow control valve FCV-0195A shall be opened to 100%

4 - The DCS shall then open motorized purge valve, FCV-0194.

5 - When feedback from the flow control valve switch, ZSO-0194, confirms the valve is open a 5 minute purge cycle shall be initiated by the DCS to flush out the lines and injector nozzles.

6 - Once the flush is complete the control system shall stop the water pump (01-0126).

ii. Emergency Shut Down

The control system shall provide an emergency stop feature that allows the control room operator to initiate an emergency stop of the system. When initiated the urea pump, 01-127, and water pump, 01-126, will immediately shut down. Prior to a restart of the system, the startup mode conditions must once again be met.

Section 4: Safety Interlocks

The SNCR NO_x Reduction System shall not operate or shutdown if either of the following conditions exist:

a. Liquid level in the urea storage tank as measure by LT-0191 is less than 100 gallons.

b. Compressed air delivery pressure to the SNCR NO_x Reduction system as measured by the PT-0195 is less than 15 psig.

Section 5: Monitoring

a. Indications Displayed

The following indications should be displayed on a boiler control system graphic display for the SNCR NO_x Reduction System:

i. Urea Storage Tank fluid level, LI-0191

ii. Urea pump drive speed control setting, SC-0195

iii. Discharge pressure to injector nozzles, PI-0195B

iv. Water purge valve open/close condition, ZYO-0194 or ZYC-0194

v. Urea flow control valve open/close condition, ZYO-0195B or ZYC-0195B

vi. Urea discharge pressure indication reading from PIC-0195A

vii. Urea flow rate from FT-0192

b. Data Logging

Data logging should include the following:

i. Hours of injector start operation

ii. Urea consumption

Section 6: Alarms

The following alarms shall be displayed by the boiler control system and if not cleared within 30 seconds of detection should cause a normal shut down of the system:

a. Urea tank low level, LAL-0191 (less than 100 gallons).

b. Low compressed air pressure PAL-0195 (less than 15 psi).

c. Reagent Supply Pressure to injector nozzles lower than 80 psi (PAL-0195B).

d. Boiler steaming rate below 35,000 lbs/hr of rated capacity.

e. Urea pressure below minimum set point as indicated by PAL-0195A

f. Urea motorized flow control valve not in controlled position, either not open or not closed when signaled to do so, as indicated by ZSO-0195B or ZSC-0195B.

g. Purge motorized flow control valve not in controlled position, either not open or not closed when signaled to do so, as indicated by ZSO-0194 or ZSC-0194.

I/O TABLE SNCR NOx REDUCTION SYSTEM

TAG NO.		DESCRIPTION	DELTA –V I/O TYPE	I/O ADDRESS
LT	0191	Urea Storage Tank Level	AI	
FT	0192	Primary Urea Flow	AI	
TE	0193	Urea Storage Tank Temperature	AI	
FVC	0194	Water Pump Flush Valve Closed Command	DO	
FVO	0194	Water Pump Flush Valve Open Command	DO	
HS	0194	Water Pump Start	DO	
PIC	0194	Water Pump Speed Reference	AO	
MY	0194	Water Pump Running	DI	
SI	0194	Water Pump Speed	AI	
ZSC	0194	Water Pump Flush Valve Closed	DI	
ZSO	0194	Water Pump Flush Valve Open	DI	
FCV	0195B	Urea Pump Discharge Valve Closed Command	DO	
HS	0195B	Urea Pump Discharge Valve Open Command	DO	
ZSC	0195B	Urea Pump Discharge Valve Closed	DI	
ZSO	0195B	Urea Pump Discharge Valve Open	DI	
HS	0195	Urea Pump Start	DO	
PIC	0195A	Urea Pump Speed Reference	AO	
MY	0195	Urea Pump At Speed	DI	
PT	0195B	Urea Mixture Pressure Transmitter	AI	
PT	0195A	Urea Pump Discharge Pressure	AI	
PAL	0195	Compressed Air Low Pressure Alarm	DI	
PAL	0195A	Urea Low Pressure Alarm	DI	
SI	0195	Urea Pump Speed	AI	

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FD-11: ASH COLLECTION & HANDLING SYSTEM

Section 1: General Description:

The Ash Handling System is a positive displacement type system that employs eductors that create vacuum conditions at selected ash collection points to bring ash into transport pipes which carry ash to a silo where it is stored. The benefit of the positive displacement system is that when properly maintained there will be no ash contamination to surrounding areas and it is easy to maintain.

Section 2: Principal Elements

P&ID 700-012 and P&ID 700-004 provide a schematic representation of all the equipment associated with the ash system.

The primary components of the ash collection system are:

a. Ash Blowers

Two ash blowers, 01-047 and 01-050, provide fresh air and motive force to move collected ash to the ash silo. The blowers run continuously during wood fired boiler operation.

b. Boiler Ash Screws

Two ash screws convey ash that drops out in the boiler's secondary flue gas tube bank to a chute that leads to a collection point.

c. Ash Pots with Eductors

Ash pots with eductors serve as the actual pickup points for the ash handling system. The ash pots are refractory lined cylindrical vessels with an eductor assembly mounted to the side of the vessel. Ash enters the top of the vessel during operation. Blowers provide approximately 200 acfm of air at 3-5 psig to each ash pot's eductor assembly. The air flowing through the eductor creates a vacuum which draws ash from the ash pot. As soon as the ash enters the eductor it is entrained in the eductor's air steam, accelerated, and discharged to the ash transport piping.

d. Ash Transport Pipes and Fittings

Transport pipes move the ash from the ash pots to the ash silo for storage. Piping will be schedule 80 carbon steel. The fittings used in the transport system are a special wear resistant type fitting designed specifically for transport of ash.

e. Ash Collection Silo

The ash collection silo stores ash produced during wood firing operations until it can be unloaded and moved for disposal.

The Ash Silo Bag Filter

The air that transports ash to the ash silo must be released to the atmosphere at the top of the silo. Before it can be discharged it must be filtered. The silo is equipped with a small baghouse which removes fine particulate from the air that is being discharged. The baghouse has a self contained pulse jet cleaning system that periodically operates to remove dust that accumulates on the outer surface of the bags.

Section 3: Modes of Control

The DCS shall provide the controls to make it possible for remote startup and shutdown of the ash collection and handling system. The subsections that follow describe the controls to provided and the various operating modes in more detail:

a. Ash System Start/Stop Switch

A start/stop switch, HS-0170 shall be provided that when activated or de-activated from a control room workstation causes the ash system equipment to start or stop. This includes the ash blower drive motors, 01-047-01 & 01-050-01, the ash silo bin vent filter controller power switch
JS-0174, the bin vent filter regen-blower motor, and the Boiler Ash Screw Controller, FC-0158.

b. Boiler Ash Screw Controller

The DCS shall provide a controller, FC-0158 which controls the ash screw augers that remove fly ash collected on the sides of the boiler. The ash screw augers are to be operated intermittently. The DCS shall be configured so that a control room operator may set the frequency of operation of FC-158 from a work station display.

c. Start-up Mode

Startup will be initiated by activating ash system equipment with HS-0170. The following actions shall take place during a startup of the ash handling system:

i. The ash system blower drives 01-047-01 and 01-050-01 will be the started first. The blowers need to be operating before wood fuel combustion begins in order to keep the ash pots clear. The plant DCS shall also provide soft push buttons for the ash blowers designated as follows: HS-0168 for blower 01-050 and HS-0169 for blower 01-040. These two push buttons will make it possible for control room operators to start and stop the blowers from the control room.

ii. The boiler ash screw drives 01-014-01 and 01-015-01 are to be started after blowers 01-047-01 and 01-050-01 are operating. This will prevent plugging of the boiler ash pot eductor 01-048. The plant DCS shall also provide soft push buttons for the ash screw drives designated as HS-0158 for drive 01-014-01 and HS-0159 for drive 01-015-01.

d. Normal Operating Mode

During normal operation the ash system equipment will operate as follows:

i. The ash blower drives 01-047-01 and 01-050-01 will operate continuously to move ash from the ash pot assemblies to the ash storage silo 01-053.

ii. The boiler ash screw drives 01-014-01 and 01-015-01 are to be operated on an intermittent timer with the time increment adjustable by the operator from a plant DCS work station display. This will allow changing the ash screw operation frequency to keep the ash troughs clear but avoid the need to run them continuously.

iii. During normal operation the ash bin vent filter 01-054 pulse cleaning system will be operated continuously.

e. Shut Down Mode

i. Controlled Shut Down

A controlled shut down will be initiated from a control room workstation by deactivating the system with HS-0170 and carried out as follows:

1 - The ash system should be allowed to run for at least ten minutes after stopping wood firing operations in the boiler. During this period the boiler ash screws 01-014-01 and 01-015-01 should be stopped in order to allow the ash system to purge all ash from the transport lines.

2 - After the boiler has been shut down for ten minutes as described above, the ash blower drives 01-047-01 and 01-050-01 can be shut down by the control room operator.

ii. Emergency Shut Down

During normal ash system operations emergency action shall be taken as described below if any of the following events occur:

1 - Ash screw drives 01-014-01 and 01-015-01 should be stopped any time an ash blower trips.

2 - Ash screw drives 01-014-01 and -0-015-01 should be stopped if the contacts for LSH-0177B shut.

3 - If either of the ash blower drives 01-047-01 or 01-050-01 trips, the other should be immediately shut down to prevent blowback in the other line.

4 - If there is a fault with the ash bin vent filter 01-054, the ash system can be allowed to run as long as there is not an obviously broken bag. However, if maintenance is to be performed it will be necessary to suspend boiler wood firing operations and stop the ash system blowers.

Section 4: Safety Interlocks

The following interlocks shall be provided:

a. Ash blowers 01-048 and 01-050 must be operating before boiler ash screw drives 01-014-01 and 01-015-01 can be started.

b. Pressure switch PS-0168 and PS-0169 contacts must be open before ash blowers 01-048 and 01-050 can be started.

c. The DCS shall prevent automatic operation of the ash bin vent filter 01-054 cleaning system until ash blowers 01-048 and 01-050 are operating.

Section 5: Monitoring

A DCS graphic display depicting the ash system blowers, transport piping, ash pickup points, and boiler ash discharge screw conveyors shall be created.

a. Indications Displayed

i. Ash bin vent filter regenerative blower operating as indicated when run status contacts, MY-0168 are shut.

ii. Ash bin vent filter in cleaning mode to be indicated when the DCS produces an output signal for JS-0174.

iii. Ash blowers 01-048 and 01-050 operating as indicated when the run status contacts MY-0168 and MY-0169 are shut.

iv. Boiler ash screws 01-014 and 01-015 operating as indicated when the run status contacts MY-0158 and MY-0159 are shut.

b. Data Logging

The DCS shall provide a historical record for the following:

i. Ash bin vent filter cleaning frequency versus time.

Section 6: Alarms

The DCS shall provide the following alarms:

a. Pressure switch PS-0168 or PS-0169 contacts closed.

b. Ash blower 01-048 or 01-050 tripped during ash system operation.

c. Boiler ash screws 01-014 or 01-015 tripped during ash system operation.

d. Ash bin level high, LAH-0177B.

e. Ash bin level low, LAL-0177A.

f. Ash bin cone bottom level low, LAL-0177C.

I/O TABLE ASH COLLECTION & HANDLING

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
HSA	0169	Boiler Ash System Blower Auto	DI	
MS	0169	Boiler Ash System Blower Start	DO	
MY	0169	Boiler Ash System Blower Run	DI	
YA	0169	Boiler Ash System Blower Fault	DI	
HSA	0158	Boiler Ash Augur #1 Auto	DO	
MS	0158	Boiler Ash Augur #1 Start	DO	
MY	0158	Boiler Ash Augur #1 Run	DI	
HSA	0159	Boiler Ash Augur #2 Auto	DI	
MS	0159	Boiler Ash Augur #2 Start	DO	
MY	0159	Boiler Ash Augur #2 Run	DI	
SSL	0158	Boiler Ash Augur #1 Zero Speed	DI	
SSL	0159	Boiler Ash Augur #2 Zero Speed	DI	
HSA	0168	Baghouse Ash System Blower Auto	DI	
MS	0168	Baghouse Ash System Blower Start	DO	
MY	0168	Baghouse Ash System Blower Run	DI	
YA	0168	Baghouse Ash System Blower Fault	DI	
PS	0168	Baghouse Ash System Blower Pressure	DI	
PSL	0173	Ash Pug Mill Water Pressure Low	DI	
FQY	0173	Ash Pug Mill Water Isolation Valve	DO	
FQY	0175	Ash Bin Pneumatic Vibrator Air Sol	DO	
FQY	0176	Ash Bin Pneumatic Slide Gate Sol	DO	
SSL	0177	Ash Bin Discharge Screw Feeder Zero Speed	DI	
LT	0177	Ash Bin Level	AI	
LSL	0177A	Ash Bin Low Level	DI	
LSH	0177B	Ash Bin High Level	DI	
LSLL	0177C	Ash Bin Low Low Level	DI	
HSA	0156	Ash Bin Rotary Valve Auto	DI	
MY	0156	Ash Bin Rotary Valve Run	DI	
MS	0156	Ash Bin Rotary Valve Start	DO	
SSL	0156	Ash Bin Rotary Zero Speed	DI	
HSA	0173	Ash Pug Mill Auto	DI	
MY	0173	Ash Pug Mill Run	DI	
MS	0173	Ash Pug Mill Start	DO	
SSL	0173	Ash Plug Mill Drive Zero Speed	DI	
HSA	0177	Ash Bin Discharge Screw Feeder Auto	DI	
MY	0177	Ash Bin Discharge Screw Feeder Run	DI	
MS	0177	Ash Bin Discharge Screw Feeder Start	DO	
HSA	0178	Ash Bin Regen. Blower Auto	DI	
MY	0178	Ash Bin Regen. Blower Start	DO	
MS	0178	Ash Bin Regen. Blower Run	DI	
PS	0169	Boiler Ash System Blower Pressure	DI	

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FD-12: Ash Transfer System

Section 1: General Description:

The ash unloading system is located in the fuel handling building. It is designed to take ash accumulated in the ash storage silo and move it into disposal trucks. This system has been designed to unload the ash in a rapid manner in order to minimize the time a truck must remain in the building.

Section 2: Principal Elements

P&ID 700-012 sheet 2 provides a schematic representation of all the equipment associated with the ash unloading system.

The primary components of the ash unloading system are:

a. Ash Silo

Stores ash generated by the wood fired boiler system for later disposal. The silo contains approximately 1570 cubic feet.

b. Manual Gate Valve

The manual gate valve, HV-0176, is used to isolate the silo from the ash unloading equipment so the equipment can be maintained and tested without having to handle ash when there is ash present in the silo.

c. Pneumatic Knife Gate Valve

The pneumatic knife gate, FV-0176, keeps ash from exiting the silo into the rotary feeder until the equipment has gone through the proper startup sequence.

d. Rotary Valve

The rotary valve, 01-056, meters ash from the silo into the pug mug in a steady manner. This prevents the ash conditioner from being flooded with ash which could cause it to plug.

e. Ash Conditioner (Pug Mill)

The ash conditioner, 01-058, mixes ash with a metered amount of water to wet the ash to prevent excessive dust from exiting the system when transferring ash to a truck.

f. Discharge Screw Conveyor

The discharge screw conveyor, 01-057, moves ash from the ash conditioner to the unloading snorkel for delivery the ash to trucks of ash storage containers.

g. Unloading Snorkel

The unloading snorkel, 01-059, allows ash to flow from the discharge screw conveyor to the truck or ash container without generating excessive dust during the unloading process.

Section 3: Modes of Control

After the ash unloading snorkel is deployed as described below the plant DCS shall employ a sequence controller, FC-0180 to carry out the sequences related to the transfer of ash as described in the following subsections:

a. Start-up

The following actions shall take place during a startup and normal operation of the ash handling system:

i. Visually verify that the manual slide gate HV-0176 is in the open position. If not, open the valve.

ii. Lower unloading snorkel 01-059 into place on the truck or container. This snorkel has spring loaded return to off switches that prevent it from being raised or lowered unless an individual is holding the raise or lower switch.

Once the snorkel has been lowered into place the driver or operator in the building will initiate a DCS controlled ash unloading sequence by depressing a local start push button, HS-0180A.

iii. When the unloading start button has been pressed, the ash discharge screw conveyor 01-057 will be started by the DCS.

iv. When the ash discharge screw motor starter auxiliary contacts for MY-0177 have been shut for 15 seconds the ash conditioner 01-058 will be started by the DCS.

v. When the ash conditioner motor starter auxiliary contacts for MY-0173 have been shut for 15 seconds ash silo rotary valve 01-056 will be started by the DCS.

vi. When the ash silo rotary valve motor starter auxiliary contacts for MY-0156 have been shut for 15 seconds the DCS shall open pneumatic ash slide gate by energizing solenoid FQY-0176.

vii. Once FQY-0176 has been engaged for 10 seconds, FQY-0177 can be energized to start providing fluidizing air to the silo cone aeration devices. At this point the DCS should start cycling the bin vibration elements VE-1075A and VE-0175B for 15 seconds every two minutes by energizing and de-energizing FQY-0175.

viii. Once the ash silo rotary valve motor starter auxiliary contacts for MY-0156 have been open for 35 seconds, solenoid FQY-0173 should be energized and water will be allowed into the ash conditioner to start wetting ash for unloading.

b. Shut Down

i. Controlled Shut Down

A signal to stop the system will be initiated by depressing a local stop push button, HS-0180B. The DCS shall initiate the following sequence:

1 - De-energize both the bed aeration and silo vibration elements FQY-0175 and FQY-0177.

2 - De-energize the pneumatic knife gate solenoid FQY-0176 which will cause the knife gate to close.

3 - De-energize FQY-0173 to stop the flow of water to the ash conditioner.

4 - Once FQY-0176 has been de-energized for 25 seconds, rotary valve 01-056 shall be stopped.

5 - Once rotary valve 01-056 has been stopped for 25 seconds, the ash conditioner 01-058 shall be stopped.

6 - Once ash conditioner 01-058 has been stopped for 40 seconds the ash discharge screw conveyor 01-057 shall be stopped.

ii. Emergency Shut Down

The DCS shall initiate emergency shut down action as described if any of the following events occur:

1 - If the low-low level switch LAL-0177A is activated, the DCS should follow the controlled shut down sequence as described above.

2 - If the SSL-0173 contacts close indicating a zero speed alarm, the following items should be immediately stopped or de-energized:

- Solenoid FQY-0175 for silo vibration elements
- Solenoid FQY-0177 for bed aeration
- Solenoid FQY-0176 for the pneumatic slide gate
- Ash Bin Rotary Valve 01-056
- Solenoid FQY-0173 for ash conditioner water supply
- Ash Conditioner 01-058
- Ash Discharge Screw 01-057

3 - If the SSL-0177 contacts close indicating a zero speed alarm, the following items should be immediately stopped or de-energized:

- Solenoid FQY-0175 for silo vibration elements
- Solenoid FQY-0177 for bed aeration

- Solenoid FQY-0176 for the pneumatic slide gate
- Ash Bin Rotary Valve 01-056
- Solenoid FQY-0173 for ash conditioner water supply.
- Ash Conditioner 01-058
- Ash Discharge Screw 01-057

Section 4: Safety Interlocks

The following interlocks shall be provided:

a. If LSLL-0177C is shut, then the ash unloading system should not operate.

b. If the snorkel 01-059 is fully retracted as indicated by ZSC-0179 the ash unloading system should not operate.

Section 5: Monitoring

A DCS graphic display depicting the ash unloading system should be displayed including the following:

a. Indications Displayed

i. Ash Silo level, LI-0177

ii. Silo Vibration Elements VE-0175A & VE-0175B operating.

iii. Silo Aerators operating, FQY-0177 energized.

iv. Pneumatic Slide Gate FV-0176 open, ZSO-0176.

v. Rotary Valve 01-056 operating, MY-0156.

vi. Ash Conditioner 01-058 operating, MY-0173.

vii. Ash Conditioner Water Flow activated, FQY-0173 energized.

viii. Ash Unloading Screw 01-057, operating, MY-0177.

ix. Ash Snorkel 01-059 fully retracted, ZSC-0179.

x. Ash Snorkel 01-059 control power off, OI-0179D.

xi. Ash Snorkel 01-059 control power on, OI-0179C.

xii. Ash transfer equipment running, OI-0180A.

xiii. Ash transfer equipment stopped, OI-0180B.

b. Data Logging

The DCS shall provide a historical record for the following:

i. Ash silo unloading time

Section 6: Alarms

The DCS shall provide the following alarms:

a. Ash conditioner zero speed switch SSL-0173 shut while in normal operation, SAL-0173.

b. Ash unloading screw zero speed switch SSL-0177 shut while in normal operation, SAL-0177.

c. Ash conditioner water pressure level low, PAL-0173.

d. Ash silo high level, LAH-0177B.

e. Ash Silo High level, LAH-01778.

f. Ash Silo Low Level, LAH-0177A.

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I/O TABLE ASH TRANSFER SYSTEM

TAG NO.		DESCRIPTION	I/O TYPE	I/O Address
HSA	0156	Ash Bin Rotary Valve Auto	DI	
MS	0156	Ash Bin Rotary Valve Start	DO	
MY	0156	Ash Bin Rotary Valve Run	DI	
SSL	0156	Ash Bin Rotary Zero Speed	DI	
FQY	0175	Ash Bin Pneumatic Vibrator Air Sol	DO	
VE-0175A	0175	Ash Bin Vibration Element	DI	
VE-0175B	0175	Ash Bin Vibration Element	DI	
FQY	0176	Ash Bin Pneumatic Slide Gate Sol	DO	
ZSO	0176	Ash Bin Pneumatic Slide Gate Open	DI	
ZYC	0176	Ash Bin Pneumatic Slide Gate Closed	DI	
HAS	0173	Ash Pug Mill Auto	DI	
MS	0173	Ash Pug Mill Start	DO	
MY	0173	Ash Pug Mill Run	DI	
FQY	0173	Ash Pug Mill Water Isolation Valve	DO	
PSL	0173	Ash Pug Mill Water Pressure Low	DI	
SSL	0173	Ash Conditioner Drive Zero Speed	DI	
HSA	0177	Ash Bin Discharge Screw Feeder Auto	DI	
LSH	0177B	Ash Bin High Level	DI	
LSL	0177A	Ash Bin Low Level	DI	
LSLL	0177C	Ash Bin Low Low Level	DI	
LT	0177	Ash Bin Level	AI	
SSL	0177	Ash Bin Discharge Screw Feeder Zero Speed	DI	
HAS	0177	Ash Bin Discharge Screw Feeder Auto	DI	
MS	0177	Ash Bin Discharge Screw Feeder Start	DO	
MY	0177	Ash Bin Discharge Screw Feeder Run	DI	
FQY	0177	Ash Bin Fluidized Air Sol.	DO	
HSA	0178	Ash Bin Regen Blower Auto	DI	
MS	0178	Ash Bin Regen Blower Run	DI	
MY	0178	Ash Bin Regen Blower Start	DO	
HAS	0179	Ash Snorkel Auto	DI	
HS	0179	Ash Snorkel Fully Up/Down Switch	DI	
MS	0179	Ash Snorkel Fully Up/Down	DI	
ZYC	0179	Ash Snorkel Fully Retracted	DI	
HS	0180A	Ash Transfer System Start	DI	
HS	0180B	Ash transfer System Stop	DI	
FQY	0177	Ash Bin Fluidizing Air Sol	DO	

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FD-13: LIMESTONE INJECTION SYSTEM

Section 1: General Description

The purpose of the limestone injection system is to inject granulated limestone into the fluid bed combustor to limit SO_2 emissions and to reduce the potential for bed fouling. This system will be operated on a continuous basis any time the combustor is firing solid fuel. The limestone feed rate will be determined as a function of steam flow.

Section 2: Principal Elements

P&ID 700-013 provides a schematic representation of all the equipment components associated with the limestone injection system

a. Limestone Silo:
The silo, located on top of the fuel oil storage tank, stores bulk limestone for the fluidized bed combustion system. The Silo has a capacity of approximately 360 cubic feet and will receive bulk limestone deliveries of granulated screened limestone.

b. Silo Filter:
The silo filter, located on top of the silo, filters out fine particulate in the airstream leaving the silo during short loading periods when limestone is transferred pneumatically from a delivery truck to the silo.

c. Limestone Metering Screw 01-051 & Variable Frequency Drive 01-051-01
The limestone metering screw controls how much limestone is blown into the combustor when operating.

d. Limestone blower 01-052, Eductor & Piping
The limestone blower provides transport air to the pipe that carries limestone to the combustor.

Section 3: Modes of Control

a. Start-up Mode

i. Prior to start; visually verify the product level in limestone storage bin. There is an inspection port at the top of the ladder on the limestone bin. There is no automatic level detection device for the bin.

ii. The system will be activated by an operator initiated discrete input signal from the control room workstation after fuel feed to the combustor commences.

1 - The control system will verify operation of blower 01-052 by checking the motor run status contacts for MY-0202 are shut**.** In the event the blower is not running, start the blower before initiating the auto start sequence for the lime injection system.

2 - Once the contacts are verified as closed shut, the limestone feeder 01-051-01 will be started and the feed rate set in accordance with the steam flow rate.

b. Normal Operating Mode

i. During normal operation the silo will keep the feed hopper for the limestone feeder full. The DCS shall provide a controller, FC-0201 which will regulate the speed of the limestone feeder drive 01-051-01 in order to meter limestone into the delivery eductor. The output speed setting signal of FC-0201 shall be a function of boiler steaming rate. The relationship between limestone feed rate and steam flow shall be linear with initial values as follows:

1 - Steam flow = 40,000 lbs/hr, limestone feeder speed = 30Hz.
2 - Steam flow = 85,000 lbs/hr, limestone feeder speed = 50Hz.
3 - Final values will be determined during the plant commissioning phase.

ii. As the boiler steaming rate changes, FC-0201 will vary the speed signal to SC-0201 which controls the limestone feeder drive to maintain the desired limestone injection rate. The control system shall provide the capability to bias the set point for FC-0201 +/- 10%.

c. Shut Down Mode

Limestone feed will be taken offline any time the combustion boiler steam production rate drops below 50%.

i. Controlled Shut Down

1 - The shutdown sequence is to take the feeder drive 01-051-01 offline first then shut down the blower 01-052. If the limestone feed is being taken offline without taking the combustor offline, the blower 01-052 should be left running as it provides sealing air to the sand system.

ii. Emergency Shut Down

1 - The control system shall initiate an emergency shutdown of the limestone system if the pressure switch PS-0202 detects a pressure above 5psig in the eductor piping.

2 - If an emergency shutdown condition exists, the control system shall stop the limestone metering screw 01-051 and blower 01-052..

Section 4: Safety Interlocks

a. ID Fan drive 01-039-01 must be operating in automatic for blower motor 01-052-01 to start.

b. Fuel feeders 12-036-01 or 12-037-01 must be operating to feed limestone.

c. Pressure switch PS-0201 contacts must be open for blower motor 01-052-01 to start.

d. Limestone blower 01-052 must be operating before limestone meter screw variable frequency drive 01-051-01 may be started.

Section 5: Monitoring

a. Indications Displayed

i. Feeder in operation and feed rate in lb/hr as indicated by FI-0201.

ii. Eductor blower operating as indicated by MY-0202.

b. Data Logging

i. Limestone feed rate versus time during wood firing operations.

Section 6: Alarms

a. Limestone injection system pressure high as indicated by PAH-0202.

b. Feeder motor 01-051-01 tripped during limestone feed operations.

c. Limestone blower 01-052 not operating during limestone feed operations.

I/O TABLE LIMESTONE INJECTION SYSTEM

TAG NO.		DESCRIPTION	DELTA-V I/O TYPE	I/O ADDRESS
HS	0201	Limestone Injection Start	DO	
MY	0201	Limestone Injection Running	DI	
FC	0201	Limestone Injection Speed Command	AO	
HS	0202	Limestone Blower Start	DO	
MY	0202	Limestone Blower Running	DI	
PS	0202	Limestone Blower High Pressure Alarm	DI	
FI	0201	Limestone Flow	AI	

Sustainably Reliable

Appendix B

Combustion Controls Training Manual

No. 1 Boiler Combustion Controls Training

Seattle Steam Company

Seattle, WA

End Customer: Seattle Steam Company
End Customer Reference Number:

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1 INTRODUCTION

The purpose of this Training Document is to facilitate Operator and Maintenance training for the SmartProcess® BOILER combustion control strategies developed for the No.1 Boiler project. Phase 1 of this project provided the auxiliary fuel firing controls. Phase 2 of this project provided the wood combustion controls.

The following provides an abbreviated description of No.1 Boiler.

Boiler Manufacturer	Energy Products of Idaho, relocated from Brevard, NC
Boiler Type	Bubbling Fluidized Bed
Maximum Continuous Rating	85 mpph
Outlet steam pressure	150 psig saturated

The following acronyms/abbreviations are used in this document:

Aux	Auxiliary
BTU	British Thermal Unit
FA	Fluidizing Air
FD	Forced Draft
ID	Induced Draft
In WC	Inch of Water Column
MFT	Master Fuel Trip
mpph	Thousand (m) Pounds per Hour
OFA	Overfire Air
PID	Proportional, Integral, and Derivative
psig	Pounds per Square Inch Gauge
VFD	Variable Frequency Drive

2 SmartProcess® BOILER CONTROLS

SmartProcess BOILER controls are divided into the following functional groupings:

- Aux fuel firing controls
- Wood firing controls
- Wood combustion air controls
- Furnace pressure controls
- Miscellaneous information

2.1 Aux Fuel Firing Controls

The existing aux fuel firing rate control strategies that were provided in Phase 1 of this project are modified to incorporate firing rate constraints.

2.1.1 Aux Fuel Firing Strategies

Auxiliary ("Aux") Fuel is used on No. 1 boiler to warm up the boiler prior to firing wood waste. Aux fuel can also be used to when wood waste is unavailable or to supplement the wood fuel during reduced availability. Boiler No. 1 can fire two types of aux fuels – natural gas or oil – but only one can be fired at a time.

There are two different strategies that can be used to control No.1 Boiler's aux fuel firing rate. These are:

- Manual (Boiler Master)
- Total steam flow master

If the Boiler Master is in manual - the operator adjusts the jackshaft directly as long as the boiler continues to operate within certain constraints. (See below).

There is a rate limiter applied to the jackshaft signal so that demand changes are ramped to the new value.

The Aux Fuel Boiler Master for No. 1 boiler does not have automatic mode. Automatic mode is used when a boiler received a signal from a plant master. No. 1 boiler does not participate in the aux fuel plant master strategy.

If Steam Flow is selected as the aux fuel firing strategy - the jackshaft position will be automatically adjusted in order to maintain a total steam flow from boiler No. 1.

2.1.2 Aux Fuel Firing Rate Constraints

The aux fuel firing demand from the selected master is constrained to keep from exceeding boiler limitations. These constraints are active even with the boiler master in manual. Constraints that can reduce the aux fuel firing demand are:

- Boiler steam flow high
- Drum pressure high
- Furnace pressure controller output high

The boiler **steam flow high constraint** will limit the aux fuel demand when the total steam flow on the boiler reaches 80 mpph if wood is also being fired in the boiler. If the boiler is firing aux fuel only, the constraint will become active at 85 mpph.

The **drum pressure high constraint** will limit the aux fuel demand when the drum pressure on the boiler reaches 170 psig if wood is also being fired in the boiler. If the boiler is firing aux fuel only, the constraint will become active at 175 psig.

The **furnace pressure controller output high constraint** will limit the aux fuel demand when the ID fan speed reference reaches 90% if wood is also being fired in the boiler. If the boiler is firing aux fuel only, the constraint will become active at 95%.

The condition that is constraining the aux fuel firing rate demand is indicated to the operator, but the constraint controls themselves are not accessible to the operator.

2.2 Wood Firing Controls

2.2.1 Wood Firing Rate Strategies

There are two different strategies that can be used to control No.1 Boiler's wood firing rate. These are:

- Wood plant master
- Wood steam flow master

Which strategy to use is operator selectable. When the operator requests a particular firing strategy, the target mode of all the necessary controllers for that strategy will be pulsed to the required mode. The following **regulatory and**

trim controllers will be pulsed to the specified mode when the wood firing rate strategy is changed (provided that the controller's mode logic permits it):

- Fluidizing air flow controller to cascade
- OFA flow controller to cascade
- Bed temperature controller to automatic
- Oxygen trim controller to cascade
- FD fan discharge pressure controller to automatic
- No.1 wood feeder controller to cascade
- No.2 wood feeder controller to cascade
- Wood flow controller to cascade
- Selected wood firing rate controller to automatic/cascade

Switching between firing strategies will be entirely bump-less and balance-less for the operator. Each of the firing rate strategies is described in the following sections.

2.2.1.1 Wood Plant Master

The wood plant master controller is a PID algorithm whose process variable is the same as the existing aux fuel plant master (header pressure) and whose output is the wood firing rate demand. This controller has manual, automatic, and cascade modes.

NOTE: The concept of having one plant master for aux fuel and having another plant master for wood fuel is what Emerson calls **"dual masters"**. This accomplishes two things:

- Wood firing is maximized due to the wood plant master having a slightly higher setpoint than the aux fuel plant master and
- the two plant masters can be tuned correctly for the dynamic responses of the particular fuel that it controls.

NOTE: the aux fuel plant master was provided in the original DeltaV controls upgrade for No.2 boiler. This existing plant master provides aux fuel (either oil or gas) demand signals to the individual boiler masters for each of the boilers that are online, except No.1 boiler, even if it is firing aux fuel. No. 1 boiler fires aux fuel in either manual or steam flow mode, it does not have a header pressure mode.

If the Wood Plant Master is in manual – the operator adjusts the wood firing demand directly.

If the Wood Plant Master is in auto – the operator sets the header pressure setpoint and the controller will adjust the wood firing demand in order to maintain that setpoint. **Caution!** Never use the same exact setpoint as the Aux Plant Master! It is best to keep it slightly higher, that is why we have cascade mode…..

If the Wood Plant Master is in cascade – the setpoint will be biased from the Aux Plant Master by + or – 10 psig. A positive bias means the Wood Plant Master Setpoint is higher than the Aux Plant Master setpoint and the controls will try to burn as much wood as possible in an effort to get the setpoint higher than the "normal" setpoint.

NOTE: A positive bias will maximize wood burning (typically a good thing). A negative bias will minimize wood burning (typically a not so good thing).

The Wood Plant Master output will track the Wood Steam Flow Master output (mode = LO) whenever steam flow is selected as a firing strategy.

The Wood Plant Master will initialize (mode = IMAN) if header pressure is selected as a firing strategy but the regulatory controls are not all in their proper mode.

2.2.1.2 Wood Steam Flow Master

The wood steam flow controller is a PID algorithm whose process variable is the calculated wood steam flow and whose output is the wood firing rate demand. This controller has manual and automatic modes.

What is "wood steam"? Wood Steam is equal to the total steam flow (from the meter) less the steam produced from oil or gas. The latter is calculated based upon the know heating value of auxiliary fuel. If the boiler is not burning aux fuel then wood steam = total steam.

If the Wood Steam Flow Master is in manual – The operator is adjusting the wood firing demand directly.

If the Wood Steam Flow Master is in auto – The operator sets the wood steam flow setpoint and the controller will adjust the wood firing demand in order to maintain that setpoint. **Caution!** Never use a setpoint that is higher than the Aux Steam Flow Master! (unless it is not being used….) It is best to keep it exactly the same which is why we have cascade mode

If the Wood Steam Flow Master is in cascade – the setpoint will equal the Aux Fuel Steam Flow Master. Since the Aux Fuel Steam Flow Master is trying to control TOTAL steam, setting both steam flow masters to the same setpoint

will drive the wood demand to maximum (good) and the aux demand to minimum (also good.)

The Wood Steam Flow Master output will track the Wood Plant Master output (mode = LO) whenever header pressure is selected as a firing strategy.

The Wood Steam Flow Master will initialize (mode = IMAN) if steam flow is selected as a firing strategy but the regulatory controls are not all in their proper mode.

2.2.2 Wood Firing Rate Constraints

The wood firing rate demand from the selected firing rate strategy (see section 2.2.1) is constrained to keep from exceeding boiler limitations. Constraints that can reduce the wood firing rate demand are:

- Boiler steam flow high
- Drum pressure high
- Fluidizing air flow controller output high *(this constraint is disabled)*
- OFA flow controller output high
- Furnace pressure controller output high
- Combustor vapor temperature high

The **boiler steam flow high constraint** controller will limit the wood firing demand if the total steam flow reaches 85 mpph.

The **drum pressure high constraint** controller will limit the wood firing demand if the drum pressure reaches 175 psig.

[The fluidizing air flow controller output high constraint will limit the wood firing demand if the fluidizing air flow controller output reaches 95%. ***NOTE:*** *This constraint was inactivated during testing and may be deleted if it is not used during start up.]*

The **OFA flow controller output high constraint** will limit the wood firing demand if the OFA flow controller output reaches 95%.

The **furnace pressure controller output high constraint** will limit the wood firing demand if the ID fan speed reference reaches 95%.

The **combustor vapor temperature high constraint** will limit the wood firing demand if either of the combustion vapor temperature signals reaches 1850 °F.

The condition that is constraining the wood firing rate demand is indicated to the operator, but the operator cannot access the constraint controls.

The above wood firing rate demand is further constrained by a rate limiter so that the wood firing rate demand does not change quicker than the boiler is capable of responding.

2.2.3 Wood Firing Demand Cross Limit

This rate limited wood firing rate demand is used directly by the wood combustion air controls (see section 2.3.1). However, it is cross-limited (low selected) with the calculated wood firing rate that is allowed based upon the actual air flow before going to the wood flow controller (see section 2.2.5).

The total air flow is measured at the FD fan before being split between overfire air (OFA) and fluidizing air (FA). The total air flow is used to back calculate the amount of wood energy that the air is theoretically able to combust based upon the typical BTU value in the wood fuel delivered by the feeder[s].

The wood crass limits are designed to make sure there is enough air in the boiler to combust the wood demand. The wood demand will be limited until the air flow catches up with the boiler demand on a load increase. (Air will always lead fuel on demand increases and lag the fuel on demand decreases)

2.2.4 Relative BTU Control

The relative BTU controller is a PID algorithm whose process variable is the relative BTU of wood fuel as calculated by a consumed air model. The output of the relative BTU controller is a trim signal applied to the cross-limited wood firing rate demand that is used by the wood flow controller (see section 2.2.5). The output of this controller is ranged 85 to 115 %. This controller has no operator access and is always in auto mode unless it is forced to manual.

Interlocks - The relative BTU controller is forced to manual mode when:

- The aux fuel combustion air fan is running (MY0151)
- The fluegas oxygen (AT0172A) is greater than X %
- The wood combustion air demand (see section 2.3.1) is less than Y mpph
- The wood flow controller (see section 2.2.5) is not in cascade mode

NOTE: The "X" and "Y" values in the above section will be determined during startup.

2.2.5 Wood Flow Control

The wood flow controller is a PID algorithm whose process variable is the sum of the two wood feeder speeds (ST1211 and ST1221) and whose output is the

demand to No.1 wood feeder control (see section 2.2.6) and No.2 wood feeder control (see section 2.2.7). This controller has automatic and cascade modes.

If the Wood Flow Control is in auto – the operator sets the total wood feed speed setpoint and the controller adjusts the speed reference for the feeder[s] in order to achieve that setpoint.

If the Wood Flow Control is in cascade - The setpoint is the product of the cross-limited wood firing rate demand (see section 2.2.3), the output of the relative BTU controller (see section 2.2.4), and the % speed to % load factor (a constant).

Interlocks – This controller:

- Is prevented from being in cascade mode if the OFA flow controller (see section 2.3.8) is not in cascade mode.

2.2.6 No.1 Wood Feeder Control

No.1 wood feeder controller is a cascade/manual station whose cascade input is the demand from the wood flow controller (see section 2.2.5) and whose output sets the speed of the No.1 wood feeder (SC1211). This controller is forced to manual mode and its output forced to minimum speed if No.1 wood feeder is not running (MY1211). The minimum speed will be used as the output low limit.

2.2.7 No.2 Wood Feeder Control

No.2 wood feeder controller is a cascade/manual station whose cascade input is the demand from the wood flow controller (see section 2.2.5) and whose output sets the speed of the No.2 wood feeder (SC1221). This controller is forced to manual mode and its output forced to minimum speed if No.2 wood feeder is not running (MY1221). The minimum speed will be used as the output low limit.

2.3 Wood Combustion Air Controls

2.3.1 Wood Combustion Air Demand

Just as the wood demand is cross limited by the air available for combustion, the air demand is also cross limited to insure a safe air/fuel ratio. The wood combustion air demand is calculated using the higher of the rate limited wood firing rate demand (see section 2.2.3) and the wood steam flow (process variable of wood steam flow master, see section 2.2.1.2), converted to % load.

The air cross limits are designed to make sure there is enough air in the boiler to combust the wood demand. The air demand will be limited until the wood flow

catches up with the boiler demand on a load decrease. (Air will always lead fuel on demand increases and lag the fuel on demand decreases)

This cross limited demand (in % load) is multiplied by the excess air target (see section 2.3.6) and the air to fuel ratio (a tuneable constant). The calculated wood combustion air demand is prevented from being less than the minimum air flow allowed.

A constant air to fuel ratio? Yes – the SmartProcess air demand calculations use an air/fuel ratio that represents the amount of air that is needed per percent boiler load of fuel fired that will result in 0% excess air. The units are MPPH air / %Load Wood.

O% Excess Air? How does that work? It doesn't work – that is why the air demand calculation also includes a target excess air factor that is based upon the O2 setpoint. If we already know we want a setpoint of 5% oxygen, we might as well demand enough air to get there. The excess air target for 5% O_2 is about 30% so a factor of 1.3 is used to calculate the air demand.

2.3.2 Fluidizing Air Demand

The fluidizing air demand is calculated as the product of the wood combustion air demand (see section 2.3.1), the fluidizing air ratio, and the bed temperature controller output (see section 2.3.3).

What is the fluidizing air ratio? Total wood air is split between OFA and FA. The ratio of FA demand to total air demand is the fluidizing air ratio. The ratio changes as the air demand increases in order to make sure there is enough FA to keep the sand bed fluid. The combustion controls include a table that relates total wood air demand to percent fluidizing air. When air demand is low, close to 90% of the air will be FA. When air demand is high, the split will be close to 50% FA and 50% OFA.

What is the percent FA operator bias? The operator has the ability to adjust the percent FA up or down if he/she feels like the FA amount needs to be increased or decreased for improved boiler operation. The operator bias is visible on the FA flow faceplate when the FA flow controller is in cascade.

The output of the table plus the operator bias is divided by 100% and then multiplied by the total wood air demand to equal the untrimmed FA air demand.

2.3.3 Bed Temperature Control

The bed temperature controller provides a trim signal to the fluidizing air demand (see section 2.3.2). The bed temperature controller is a PID algorithm whose process variable is the average of the four bed temperatures (TT0101, TT0102, TT0103, and TT0104) and whose output trims the fluidizing air demand. This controller has manual and automatic modes.

When the Bed Temperature Control is in manual – The operator adjusts the trim to the FA demand directly. The output is scaled 80% to 120%. **Caution!** Placing this controller in manual may cause the bed temperature to wander outside normal limits.

When the Bed Temperature Control is in auto – The operator sets the bed temperature setpoint and the controller adjusts the trim in order to achieve this setpoint. If the bed temperature is low, FA is increased to release additional heat from the fluidized fuel. If the bed temperature is high, FA is decreased in order to slow the heat release from the fuel.

This controller will initialize (mode = IMAN) if the FA flow controller is not in cascade mode.

2.3.4 Fluidizing Air Flow Control

The fluidizing air flow controller is a PID algorithm whose process variable is the difference between the total wood air flow (FT0109) and the OFA flow (FT0113) and whose output sets the position of the fluidizing air damper (FZ0111). This controller has manual, automatic, and cascade modes. In cascade mode, the setpoint is the fluidizing air demand (see section 2.3.2). This controller has minimum and maximum setpoint limits which keep the bed in a fluidized state.

When the FA Flow Controller is in manual – The operator adjusts the FA damper directly.

When the FA Flow Controller is in automatic – The operator sets the FA setpoint and the controller adjusts the damper to achieve that setpoint.

Caution! If this controller is in AUTO or MAN, it is the operator's responsibility to ensure proper FA flow for combustion and fluidization. The air/fuel cross limits are NOT ACTIVE unless this controller is in cascade.

When the FA Flow Controller is in cascade – The setpoint is determined by the fluidizing air demand (see section 2.3.2) and is based upon the wood demand,

the O2 setpoint, the air/fuel ratio, the FA air percent target, and the bed temperature controller output.

Interlocks – This controller:

- Is prevented from being in cascade mode if the furnace pressure controller (see section 2.4.1) is not in automatic mode.
- Is forced to manual mode when a MFT occurs.
- Ramps the output to 100 % when the ID fan stops running (MY0133).
- Ramps the output to the PURGE position when the ID fan is restarted.

2.3.5 OFA Demand

The OFA demand is calculated from the wood combustion air demand (see section 2.3.1), the fluegas oxygen trim controller output (see section 2.3.6), and the fluidizing air flow controller process variable (see section 2.3.4).

First the wood combustion air demand is multiplied by the O_2 trim controller output (divided by 100%) to result in the **total trimmed wood air demand.**

The OFA demand equals this number less whatever is already going through the FA system. **Total – FA = OFA**.

2.3.6 Oxygen Trim Control

The oxygen trim controller is a PID algorithm whose process variable is the flue gas oxygen (AT0172A) and whose output trims the combustion air demand. The trimmed value is the total air demand used to calculate the OFA demand (see section 2.3.5). This controller has manual and cascade modes. The output is limited between 85% and 115%.

If the O2 Trim Controller is in manual – The operator adjusts the air demand trim directly. This mode should be avoided.

If the O2 Trim Controller is in cascade – The setpoint is based upon the % boiler load and the controller will adjust the trim output in order to achieve this setpoint.

This control also provides the **excess air target** that is used by the wood combustion air demand calculations (see section 2.3.1). The excess air target is a curve derived from the flue gas oxygen trim controller setpoint.

2.3.7 Combustor Vapor Temperature Control

The combustor vapor temperature controller is a PID algorithm whose process variable is the highest of the two combustor vapor temperatures (TE0105 and TE0106) and whose output can override and increase the OFA damper (see section 2.3.8). This controller has automatic mode. If the OFA flow controller is in manual, this controller's output will track the OFA flow controller output, thereby defeating the override so that the operator may adjust the OFA damper as desired.

What does "override the OFA damper" mean? Both the OFA flow controller and the Combustor Vapor Temperature Control use the OFA damper to achieve setpoint. Whichever controller wants the damper open more, wins. If the combustor vapor temperature is above the override setpoint, the OFA flow will end up above setpoint in an effort to cool the vapor with additional air.

2.3.8 OFA Flow Control

The OFA flow controller is a PID algorithm whose process variable is the OFA flow (FT0113) and whose output sets the position of the OFA damper (FZ0113). This controller has manual, automatic, and cascade modes.

If the OFA Flow Controller is in manual – The operator adjusts the OFA damper directly.

If the OFA Flow Controller is in auto – The operator sets the OFA flow setpoint and the controller adjusts the damper in order to achieve the setpoint.

Caution! If this controller is in AUTO or MAN, it is the operator's responsibility to ensure proper OFA flow for combustion, percent O_2, and vapor temperature. The air/fuel cross limits are NOT ACTIVE unless this controller is in cascade.

If the OFA Flow Controller is in cascade – The setpoint is determined by the OFA demand calculation (see section 2.3.5) based upon the total trimmed air demand less the actual FA flow.

The output can be overridden by the combustor vapor temperature control (see section 2.3.7). The output will be pulsed to the actual damper output whenever this controller transitions to manual to prevent an output bump if the override is active.

Interlocks – This controller:

- Is prevented from being in cascade mode if the furnace pressure controller (see section 2.4.1) is not in automatic mode.

- Is forced to manual mode when a MFT occurs.
- Ramps the output to 100 % when the ID fan stops running (MY0133).
- Ramps the output to the PURGE position when the ID fan is restarted.

2.3.9 FD Fan Discharge Pressure Control

The FD fan discharge pressure controller is a PID algorithm whose process variable is the FD fan discharge pressure (PT0114) and whose output sets the speed reference of the FD fan (SC0114). The minimum speed will be used as the output low limit. The minimum speed is a tuneable constant to be determined during start-up.

This controller has manual and automatic modes.

If the FD Fan Discharge Pressure Control is in manual – the operator adjusts the FD fan speed reference directly.

If the FD Fan Discharge Pressure Control is in auto – the operator sets the FD fan discharge setpoint and the controller will adjust the fan speed reference to achieve this setpoint.

Interlocks – This controller:

- Is prevented from being in automatic mode if the furnace pressure controller (see section 2.4.1) is not in automatic mode.
- Is forced to manual mode when a MFT occurs.
- Is forced to manual with the output set to the minimum speed when the FD fan stops running (MY0114)

2.3.10 FD Inlet Damper Position

The FD fan inlet damper controller is a "bypass" controller whose output sets the FD fan inlet damper position (FZ0114). The damper position is displayed as the process variable. The mode is forced to cascade with a setpoint of 100% if the FD fan is running (MY0114). To obtain maximum economic benefit from the FD fan VFD, this damper must be left open during fan operation.

What is a "bypass" controller? A bypass controller does not use the PID algorithm. If the mode is either auto or cascade, the setpoint is transferred directly to the output.

2.4 Furnace Pressure Controls

2.4.1 Furnace Pressure Control

The furnace pressure controller is a PID algorithm whose process variable is the median of the three furnace pressures (PT0132, PT0132A, & PT0133) and whose output sets the sets the ID fan speed reference (SC0133). The minimum speed will be used as the output low limit. The minimum speed is a tuneable constant to be determined during start-up.

This controller has manual and automatic modes.

If the furnace pressure controller is in manual – the operator adjusts the ID fan speed reference directly.

If the furnace pressure controller is in auto – the operator sets the furnace pressure setpoint and the controller adjusts the ID fan speed reference in order to achieve that setpoint.

Interlocks – This controller:

- Is forced to manual with the output set to the minimum speed when the ID fan stops running (MY0114)

This controller has a feed forward signal that is calculated from the aux fuel heat flow, the output of the fluidizing air flow controller (see section 2.3.4), and the output of the OFA flow controller (see section 2.3.8). Directional blocking on this controller's output is utilized to prevent output decreases when the furnace pressure is above 1 in WC and prevent output increases when the furnace pressure is below -1 in WC. Direction blocking is active in both automatic and manual modes.

What is feed forward control? Feed forward control uses an external signal to directly move the output even before the results of that external signal are seen by the process. For example, changing the FA damper will have an effect on the furnace pressure, but we don't need to wait for the effect before making a change to the ID fan speed. If the FA damper moves, the furnace pressure feed forward control moves the ID fan speed by an equivalent amount in order to better maintain furnace pressure.

Why do we need directly blocking? Because the feed forward signals are based upon the outputs of other controllers, it is possible for the feed forward component of the controller output to want to move the speed reference in the wrong direction during upsets.

2.4.2 ID Inlet Damper Position

The ID fan inlet damper controller is a bypass controller whose output sets the ID fan inlet damper position (FZ0132). The damper position is displayed as the process variable. The mode is forced to cascade with a setpoint of 100% if the ID fan is running (MY0133). To obtain maximum economic benefit from the ID fan VFD, this damper must be left open during fan operation.

What is a "bypass" controller? A bypass controller does not use the PID algorithm. If the mode is either auto or cascade, the setpoint is transferred directly to the output.

2.5 Miscellaneous Information

2.5.1 Boiler Efficiencies

The boiler efficiency for each fuel (wood, natural gas, and fuel oil) is calculated by a simplified heat loss method using the economizer outlet gas temperature (TE0148B) and the flue gas oxygen (AT0172A) assuming typical fuel compositions.

2.5.2 Superficial Bed Velocity

The superficial bed velocity in ft/sec is calculated using the average bed temperature, the fluidizing air flow, a reference temperature of 530 degF, a reference air density of 0.075 lb/ft3, and a bed area of 125 sqft. This value can be used in conjunction with other boiler measurements and observations to infer whether the fluidizing air flow is sufficient for proper bed fluidization.

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Appendix C

Acid Gas Clean-Up Concept and Equipment Design Standards:

INTRODUCTION TO THE PROCESS

The flue gas from the boiler has certain quantities of Hcl and SO2. The amounts of those components depend on fuel characteristics and combustion parameters.

The purpose of the BACT spray absorber system is to reduce Hcl and SO2 from the flue gas prior to discharge to the atmosphere.

SO2 and Hcl are reduced by reacting with a solution of caustic soda. The amount of caustic required for neutralization depends on the amount of gaseous components in the flue gas. Caustic usage will reduce depending on the amount of boiler blow down water which has inherent alkalinity introduced into the blend tank.

Control philosophy requires a known constant pH that is always maintained in the blend tank by adding 50% caustic.

The heart of the system is a spray dryer absorber (SDA).

The spray dryer is a co-current tower. Incoming hot gas is sprayed with dilute solution of caustic and sodium hydroxide using dual atomizing nozzles. Atomizing nozzles produce a fine mist of droplets. The contact between fine mist and air results in the adiabataic cooling of the hot flue gas. A chemical reaction between caustic and gaseous components results in removal of pollutants.

Control of the outlet temperature from the SDA is critical to maintain required acid control efficiency and also to keep the baghouse which is located down stream of SDA above the dew point.

In summary the process control philosophy is based on pH on the blend tank and outlet temperature of SDA.

SDA Operator Manual
Seattle Steam Fluidized Bed Combustor

Operation_ The SDA uses a pH controlled concentration of scrubbing liquor to react with the gaseous acid components in the process gas stream from the fluidized bed combustor. The system uses atomizing nozzles that require a specific amount of compressed air volume and pressure to generate fine mist droplets of the scrubbing liquor which react with the process gas while quenching the process gas temperature to a specific set point.

Operating Parameters_ the following items are the operating parameters of the SDA control system:

Process Gas Inlet Temperature..... Enables the SDA at 300 Degree F
SDA Exit Gas Temperature..... PV of the SDA (Quench Temp SP)
Scrubber Liquor Flow..... CV of the SDA (Pump Speed)
pH Blend Tank..... PV of the Scrub Liquor Reagent Concentration
Reagent..... NaOH

Non Controlled Device..... NaOH Storage Level
Controlled Device..... Blend Tank Storage Level

Controlled Variables:

pH..... Controlled to SP in Blend Tank
SDA Exit Temperature..... Controlled to SP at Baghouse Inlet

Operation of NaOH Storage:

Level_ is a function of allowable refill, Not that the device used to indicate level reads higher than the indicated level on the HMI. This is a result of the Pressure Transmitter used for level detection is calibrated to the available units (Inches of water) and the density correction for the NaOH is calculated in the PLC (Program Logic Controller) to accounted for the higher density of the stored product. The HMI readout also estimates the actual gallons in storage for convenience of Caustic Inventory control and usage calculations.

NaOH Concentrations_ is a function of supply and is specified at a 50% aqueous solution.

LAHH_ a mechanical float device located in the tank to avoid the possibility of overfill of the NaOH storage tank. This device affords a remote audible alarm for the delivery operator.

LAL_ Alarm set to advise restocking of the NaOH is required.

LALL_ Alarm and Pump Cutoff Point at which the system is inoperable

LAH_ Alarm to advise overfilled tank Condition

General Operating Procedures_ the Caustic (NaOH) is supplied to the process via two tandem chemical feed pumps with variable frequency drives. On the HMI screen the active chemical feed pump is selected and it delivers caustic to the blend tank on the basis of Ph set point demand. The alternate pump is configured automatically to deliver caustic to the inlet of scrub liquor feed pump to boost the delivery of caustic to the scrubber at operator desecration. This boost is configurable from the HMI on the basis of percentage flow.

Operation of Blend Tank:

Level_ is automatically controlled on the basis of a predetermined level set point with maintains the level by replenishment of either fresh water or boiler blowdown water on the basis of availability. Boiler blowdown water is the primary source with fresh water activated when blowdown water flow is not available to maintain the required level in the blend tank. The pH is adjusted to a specified level to maintain the tank at the proper pH for SDA operation.

LAHH_ alarm of tank level at overflow condition (overflow is connected to the scrubber pit sump) which would indicate a valve failure.

LAH_ Process Alarm Indicating Full Tank

LAL_ Process Alarm Indicating tank filling, fresh water is activated as a function of time if LAH is not met in a specific period.

LALL_ Process Alarm indicating a LL condition and stopping of SDA as a result of liquor feed pump non flooded inlet condition.

SDA Operation:

Standard Operation_ of the SDA is initiated by inlet temperature to the SDA, with a predetermined set point at which time that the unit cycles between a Standby Mode to an Enabled Mode in non Maintenance Mode operation. When the SDA is enabled the system will quench the process gas to a preselected temperature set point at the inlet to the baghouse. This value is known as the approach temperature and must be set at a value to allow the operation of the baghouse above gas saturation point at the baghouse discharge.

Inlet Temperature Set Point: .....300 Degree F.

SDA Exit Temperature: .....250 Degree F.

pH Set Point .....11 pH

Blend Tank Level .....58”

Compressed Air Pressure.....120 PSIG

Compressed Air to SDA.....110 PSIG

Enabling Scrubber_ To enable the operation of the SDA compressed air need be activated by pushing the start button on the control of the associated ancillary compressor. This will allow pressure to build in the SDA compressed air receiver to a value of sufficient for SDA operation. The SDA system needs to be removed from Maintenance Mode for SDA operation.

Liquor Pump Selection_ Select the desired liquor feed pump that the system is to operate with.

Caustic Pump Selection_ Select the desired caustic feed pump the system is to operate with.

Start Up Sequence_ With pumps selected and compressed air on the system will remain in standby until sufficient process gas temperature (310 degree F.) temperature is achieved at the inlet of the SDA. The sequence of events when this is achieved is as follows.

01_ Auto Valve at Inlet to the selected Liquor Feed Pump is opened with Auto Feed of Caustic Liquor Flow to Selected Pump Inlet

02_ Auto Valve SDA Drain to sump is closed

03_ Auto Valve at discharge of the Liquor Feed Pump is opened

04_ Auto Valve Feed to SDA is closed

05_ Auto Valve (I/P) of compressed air receiver opens to 85% and stays in position until compressed air at the individual lances is at 60 PSIG

06_ Auto Valve Feed to SDA is opened.

07_ Selected Pump is started at 80% of allowable Hz setting

08_ Selected Pump drops to 20% of allowable Hz when detection of flow is at Nozzle

09_ Selected Pump goes on PID control to achieve desired SDA discharge Temperature

10_ Compressed air goes on PID Control to maintain desired set point 120 PSIG

Pump Change Sequence_ at any time the selected pump may be changed to the alternate pump or in the event of pump failure this change will occur automatically.

01_ Auto Valve at the inlet of the stand-by pump is opened.

02_ Auto Valve of the discharge on the stand-by pump is opened

03_ Stand-By pump operates at 80% of the allowable Hz for 10 seconds

04_ Failed or non selected pump stops

05_ Stand-by pump switches to PID control to maintain desired SDA Discharge Temperature

06_ Auto Valve of Failed or non selected pump discharge is closed

07_ Auto Valve of failed or no selected pump inlet is closed with Auto Feed of Caustic Liquor Feed from the failed or non selected pump

Stop Sequence_ a controlled system stop operates with the following sequence

01_ Auto Valve Fresh water Feed Valve of the selected pump is opened

02_ Auto Valve of Caustic Liquor Feed is closed

03_ Active Pump operates for 5 minutes with fresh water feed only

04_ Active Pump stops PID control and returns to 20 % of allowable Hz

05_ Auto Valve to Sump opens

06_ Pump Continues to operate for 3 minutes to flush pump cavity and stops

07_ Auto Valve Fresh Water Feed of selected pump is closed

08_ Auto Valve of selected pump discharge is closed

09_ Compressed Air to SDA closes

10_ SDA System returns to standby mode

Direct Caustic Feed_ the non –selected caustic feed pump will upon description of the operator feed 50% caustic solution to the inlet of the selected of the SDA feed pump at the set frequency, initiation will open the Direct Caustic Feed Valve and initiate the pump to the preset frequency and flow.

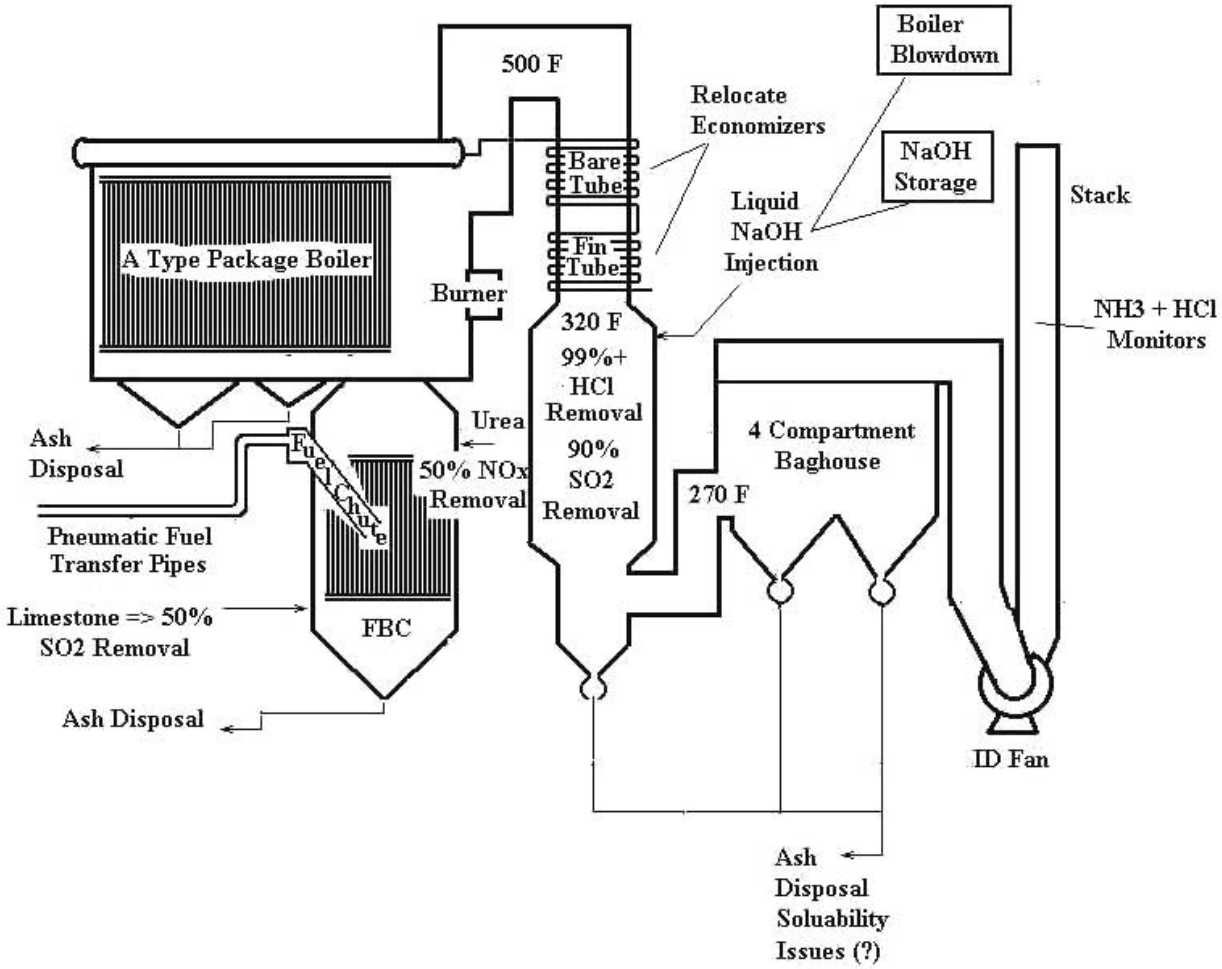

FIGURE 2

SEATTLE STEAM ACID GAS AND NH4Cl CONTROL SYSTEMS
OPTION B - NaOH SDA SYSTEM

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Appendix D

Management Wood Supply Monitoring Plan

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Biomass Supply Quality Assurance Plan

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1. MANAGEMENT

1.1. Distribution List

Copies of this QA document shall be maintained at:

- the Western Plant where Biomass is burned posted in the operation control room
- Seattle Steam Company (SSC) Main office.
- Organic Fuel Processing LLC's Fuel Staging Facility posted clearly in the weigh scale room.
- Each Biomass supplier at the supplier's site office posted clearly in the site office.

1.2. Organization

Primary responsibility of the content of Biomass supplied to Seattle Steam Company is provided by each supplier. SSC Plant Manager shall be responsible for the auditing of suppliers' and wood staging facility's quality assurance plans at a frequency of no less than every six months or more frequently as determined by the Plant Manager.

1.3. Problem Definition/Background

SSC is permitted by the Puget Sound Clean Air Agency to construct and operate a wood fired boiler to burn wood waste and wood derived fuel.

"Wood derived fuel" means wood pieces or particles used as a fuel for energy recovery, which contain paint, bonding agents, or creosote. Wood derived fuel does not include wood pieces or particles coated with paint that contains lead or mercury, or wood treated with other chemical preservatives such as pentachlorophenol, copper naphthanate, or copper-chrome-arsenate.

"Wood waste" means solid waste consisting of wood pieces or particles generated as a by-product or waste from the manufacturing of wood products, construction, demolition, handling and storage of raw materials, trees and stumps. This includes, but is not limited to, sawdust, chips, shavings, bark, pulp, hogged fuel, and log sort yard waste, but does not include wood pieces or particles containing paint, laminates, bonding agents or chemical preservatives such as creosote, pentachlorophenol, or copper-chrome-arsenate.

For the purposed of this document the above wood categories are collectively called Biomass.

The permit requires the establishment of a Biomass fuel monitoring plan which is designed to prevent SSC from receiving solid waste in its fuel supply.

1.4. Quality Objectives

The objective of this program is to ensure:

- that Biomass fuel suppliers to SSC implement their individual quality control programs
- That Biomass provided from each supplier is visually examined at time of delivery for Prohibited materials or Restricted materials in excess of the amounts acceptable..

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All loads received at SSC's fuel staging facility will be inspected upon delivery or arrival by the Driver and Loader Operator or Tipping Building Monitor for compliance with the following criteria:

2. Fuel Quality Requirements:

The following fuel quality requirements are established to further define acceptable and unacceptable material to provide guidance to Biomass suppliers.

2.1. Acceptable Biomass Materials for Use as Fuel Feedstock – Any Fraction, No Restrictions

Urban wood derived from clean discarded unpainted and untreated pallets, wooden crates, and lumber.

Woody Biomass materials from land-clearing or forest lands thinning activities; handled and processed to substantially exclude dirt, clay, rocks, and other entrained non-combustible materials.

Wood industry manufacturing residuals including sawdust, planer or shaper shavings, barky or clean chips, chip screen fines and overs, bark, trim blocks, edge trimmings, slabs, etc. Typical facilities of origin would include sawmills, chip mills, composting facilities and truss, wood window, or cabinet manufacturing.

Purpose-cultivated woody biomass materials harvested and processed for use as Fuel.

2.2. Acceptable Biomass Materials for Use as Fuel Feedstock –Restricted

Processed or "engineered" wood construction and fabrication products containing bonding agents/adhesives. Such products include fiberboard, oriented-strand board, plywood, "gluelam" or "microlam," particle board, and similar partially synthetic wood-based materials.

The percentage of Fuel having originated as engineered wood shall not exceed 15 percent by weight, in any Delivered load of Fuel unless specific written permission is obtained from Buyer, prior to any such delivery.

Urban wood from trimming of trees, bushes, and the like. The presence of leafy, conifer needles, or other foliage shall not exceed 5 percent by weight, in any Delivered load of Fuel unless specific written permission is obtained from Buyer, prior to any such delivery.

Certain non-toxic paints or treatments may be determined acceptable as Fuel feedstock material but on a case-by-case and prior to attempted delivery basis only. The authority to make such determination resides solely with Buyer.

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2.3. Materials Expressly Prohibited for Use as Fuel Feedstock

Yard Waste as defined in 40 CFR 60.1465

Wood treated or exposed to preservatives, chemicals, and paint. Includes that with CCA, "Sun Wood", or creosote treatment regimes, railroad ties or timbers, and painted demolition wood.

Pre-primed construction materials; "Chec" pallets.

Materials exposed to and contaminated by sea or brackish water.

Fiber residual "sludges" such as those from pulp/paper manufacturing or water treatment.

Plastics/Combustible Contaminants – Fuel is to be substantially free of plastics, laminates, and other non-woody combustible contaminants.

Employees of SSC associated with the handling of wood and employees of Organic Fuel Processors LLC shall be trained to recognize acceptable and unacceptable materials defined in Section 2.1, 2.2 and 2.3

3. Special Training/Certification

Each member of staff will be given on the job training to recognize contaminants.

4. Audit Requirements:

SSC Plant Manager is responsible for auditing the quality control plans of each supplier and the fuel staging facility. During this inspection the SSC Plant Manager shall:

- Review all suppliers' paper records for the implementation of the site quality control plan.
- Inspect the site to determine if contaminants are on the site and if so, are they adequately segregated from the acceptable wood being supplied to SSC.

Each audit will be recorded with an Inspection Report signed by the inspector and the SSC Plant Manger.

5. MEASUREMENT/DATA ACQUISITION

5.1. Sampling Methods

During each daily fuel delivery period (one day) to the Fuel Staging Facility at least one delivery from each supplier will be taken. This sample shall represent all deliveries from the supplier for that day.

5.2. Sample and Data Handling/Custody

All wood supply data shall be recorded in the Fuel Management System (FMS) Data Management System as follows:

5.2.1. FMS Requirements

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a. General – The FMS is an integrated hosted software solution, built around a relational database, and web-based operator interface. This custom application is being developed by G H Michaels Associates (Evanston, Illinois) on the UtilityStudio.com platform. User access to data and application privileges are controlled through secure login at www.utilitystudio.com. FMS will be modular, encompassing the following major functions:

1. Supplier Management
2. Fuel Deliveries Tracking to Staging and Receiving/Operations
3. Fuel Quality Assurance Testing
4. Supplier Invoice Generation
5. Fuel Management Reporting
6. FMS User Administration

b. Units - The fundamental unit of fuel management is the as-received-ton (ART)

c. Supplier Management: System Inputs

- Supplier Name and address; Supplier Code (administratively assigned; 3-place alpha-numeric or code from Accounts Payable: TBD)
- Processing facility name and address (if different)
- Mileage from plant to SSC Fuel Staging Facility (FSF)
- Facility Average Fuel Moisture Content
- Contact name and contact information
- Contract date and term, if any
- Pricing: Fuel Price; Monthly Capacity Fee; Low Moisture Fuel Price Reduction; High Moisture Fuel Price Reduction; Off-Spec Fuel Price Reduction; (System will capture and track all periodic changes to fuel charges).

d. Deliveries Tracking: System Inputs

- Supplier Code
- Delivery Date/Time (system generated)
- Lot Tracking Number (system generated; LTN-S in Staging; LTN-R in Receiving); 12-place numeric format of yymmdd-hr-min-xx ("xx" is daily sequential number); examples: 090324-33, 131124-07, etc.; LTN's are assigned to both incoming and outgoing truck loads
- Gross Weight (Loaded Truck Weight; in pounds (lbs.); ranging 5,000-110,000 lbs)
- Tare Weight (Empty Truck Weight; in pounds (lbs.); ranging 5,000-110,000 lbs)
- Net Weight (system generated; units in As-Received-Tons)
- Truck ID; Trailer ID; Driver ID; (all 8-place alphanumeric format to be confirmed)

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e. Quality Assurance and Moisture Content Testing: System Inputs

- Sample ID# (system generated)
- Sample Type (Delivered or As-Burned)
- Supplier; LTN #; Date Pulled
- Test Date
- Tester ID
- Pan ID #
- Green Weight
- Dry Weight
- Pan Weight
- Moisture Content % (system generated per calculation)
- Outside lab testing - results of full chemical analysis

f. FMS User Administration: System Inputs

- User Login Name
- User Password
- First Name; Last Name
- Organization; Title
- Contact Info: Email Address; Phone Number
- User-Type (function drives level of access to FMS data and features)
- User Auth Level

g. Invoice Management: System Outputs

- Supplier Name; Supplier Code/ID
- Billing Month and Year
- Invoice Number
- Invoice Date; Due Date
- Current Invoice Total; Total Due
- Total Fuel Delivered for billing period (ART)
- Invoice Charges: Fuel Charge ; Monthly Capacity Fee; Misc Charges; Credits; Taxes
- Invoice Adjustments; Reason

h. Management Reporting: System Outputs

Note: Data will be presented in pre-formatted reports/tables, graphs, and export (Excel, CSV, PDF, XML) format. Reports will offer selection logic to allow reporting by Supplier and Date Range.

- Fuel Management Cost Report: Cost and ART for reporting period (daily, weekly, monthly, annual)
- Daily Fuel Deliveries and Inventory Report (between user-specified dates)

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- Moisture and Material Analysis Summary Report

i. Other System Outputs

- Fuel Delivery Ticket: Generated and printed at Staging - 3 hardcopies: Date/Time; LTN; Supplier; Facility of Origin (if multiple); Truck ID; Trailer ID; Driver ID; Net Weight (calculated); Note: Bar coding of tickets will be evaluated after initial system development.
- Quality Assurance Sample Ticket: Generated at Staging during delivery (Supplier sample) or from blended lots (for As-Burned samples): 1 hardcopy; Date/Time; Sample ID; Sample Type; Supplier; LTN; Note: printed on water-resistant card stock for inserting into fuel sample bags; Bar coding of tickets will be evaluated after initial system development.
- Delivery Transactions captured for invoice generation and reporting.
- Estimated Supplier Invoices (described above)
- Input to SSC accounting systems: To Be Determined

j. System Security

All system access for all system users is through the secure web site www.utilitystudio.com. User login will drive access to system data, features and functions. These levels will be defined during development.

- System Administrator: Access to all data, features and functions; Has username/password access to all general user level access; Edit record detail; Edit supplier profiles; Financial system input; Username/password tables and other administrative/system management.
- General User: Access based on function and responsibility; Access to data will be defined; Read/Edit/Delete privileges will be defined for all screens and reports.
- History of data and transactions will be maintained; Edits will be tracked with user id and date/time.
- System-wide record and application backup occurs daily; Emergency system switch-over/recovery will occur within 4 hours. Length of system data storage for presentation and archiving will be determined during development.

Approved

President and CEO

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Exhibit A
Biomass Boiler Project Fuel Procurement Specification
For All Fuel Supply Contracts

General

1. Each supplier will be obliged to develop and execute a continuous Quality Assurance & Dangerous Material Avoidance Program, "QA Program," to assure Fuel supplied under this Agreement complies in all respects to specifications detailed in this Exhibit A.
   (a) The QA Program shall be updated and revised from time to time as circumstances warrant and is subject to review and written approval by Buyer.
   (b) A current and approved copy of Sellers' QA Program is provided as Exhibits B and C to this Agreement.
2. In practice and intent, the biomass fuel supplied for use must provide for:
   (a) Receiving, in-processing, storage, reclaim, and feeding to boiler without undue plugging or system upset.
   (b) Facilitate compliance with permitted air quality emissions constraints.
   (c) Reasonable and expected operational wear and tear rates on fuel equipment, combustor, boiler, and support systems.
3. The terms of air quality permitting for Buyer's Generating Station require that Fuel contain no more than a fixed maximum amount of chlorides and further requires fuel testing from time to time to demonstrate compliance. Accordingly, Fuel, load by load, shall contain no more than 0.15% percent chloride (Cl^-) by weight, dry basis, and Seller shall make all reasonable efforts to exclude chloride contaminated and bearing materials from Fuel.

Acceptable Biomass Materials for Use as Fuel Feedstock – Any Fraction, No Restrictions

1. Urban wood derived from clean discarded unpainted or treated pallets, wooden crates, and lumber.
2. Woody Biomass materials from land-clearing or forest lands thinning activities; handled and processed to substantially exclude dirt, clay, rocks, and other entrained non-combustible materials.
3. Wood industry manufacturing residuals.
4. Purpose-cultivated woody biomass materials harvested and processed for use as Fuel.
5. Woody Biomass materials such as tree branches or limbs, tree prunings or other woody brush type materials generated from urban sources.

Acceptable Biomass Materials for Use as Fuel Feedstock –Restricted

1. Processed or "engineered" wood construction and fabrication products containing bonding agents/adhesives. Such products include fiberboard, oriented-strand board, plywood, "gluelam" or "microlam," particle board, and similar partially synthetic wood-based materials. The percentage of Fuel having originated as engineered wood shall not exceed 15

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percent by weight, in any Delivered load of Fuel unless specific written permission is obtained from Buyer, prior to any such delivery.

2. Urban wood from trimming of trees, bushes, and the like. The presence of leafy, conifer needles, or other foliage shall not exceed 5 percent by weight, in any delivered load of Biomass unless specific written permission is obtained from Buyer, prior to any such delivery.
3. Certain non-toxic paints or treatments may be determined acceptable as Fuel feedstock material but on a case-by-case and prior to attempted delivery basis only. The authority to make such determination resides solely with Buyer.

Materials Expressly Prohibited for Use as Fuel Feedstock

1. Wood treated or exposed to preservatives, chemicals, and paint. Includes that with CCA, "Sun Wood", or creosote treatment regimes, railroad ties or timbers, and painted demolition wood.
2. Pre-primed construction materials; "Chec" pallets.
3. Materials exposed to and contaminated by sea or brackish water.
4. Fiber residual "sludges" such as those from pulp/paper manufacturing or water treatment.
5. Yard Waste: *Yard waste*[1] means grass, grass clippings, bushes, shrubs, and clippings from bushes and shrubs. They come from residential, commercial/retail, institutional, or industrial sources as part of maintaining yards or other private or public lands.
6 Plastics/Combustible Contaminants – Fuel is to be substantially free of plastics, laminates, and other non-woody combustible contaminants.

Fuel Sizing

1. Seller must process and/or screen utilizing commercially reasonable methods to ensure Fuel is less than 1 percent by weight, of particles greater than 3 inches in any dimension and that Fuel is and less than one percent by weight of particles greater than 7 inches, any dimension.
2. Seller must process and/or screen utilizing commercially reasonable methods to ensure Fuel is less than 15 percent by weight, of particles less than ¼ inches all dimensions.

Ash and Noncombustible Content

1. Total ash and noncombustible content of Fuel shall be less than 5% by weight.
2. Fuel is to be substantially free of rock, tramp metals, gravel, and dirt.

Moisture Content

1. Target Moisture Fuel shall have a moisture content of 35 percent by weight (green basis)
2. Average Moisture Fuel is the moisture content of fuel averaged over the prior year.
3. Fuel shall be within the range of 20 percent to 50 percent by weight (green basis).

[1] § 40CFR60.1465

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4. For purposes of compliance with moisture content specifications, fuel moisture shall be determined day by day as weighted average moisture of all fuel received that Day from Seller. That being said, if the tested moisture content of any individual load is above 50 percent, that load shall be deemed High Moisture Fuel.
5. In order to accommodate Seller aggregating diverse fuel sources to accomplish its obligations under this Agreement and to minimize the need for off-site blending, the "daily" moisture determinations may be made over alternative periods when mutually agreed to in advance in writing by Parties.

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Appendix E

Integrated Fuel Management System Development:

A web based biomass Fuel Management System to track and manage the delivery, testing, processing and invoicing of delivered fuel.

1.0 System Description

Seattle Steam Company required a biomass Fuel Management System, to track and manage the delivery, testing, processing and invoicing of delivered fuel. The resulting application - FMS - is an integrated hosted software solution, built around a relational database, and web-based user interface. This custom application was developed by G H Michaels Associates (Evanston, Illinois) on the UtilityStudio.com platform. User access to data and application privileges are controlled through secure login at www.utilitystudio.com. FMS is a modular software application, encompassing the following major functions:

1. Supplier Information and Contract Management
2. Fuel Deliveries Tracking to Staging and Receiving/Plant
3. Supplier Invoice Generation
4. Fuel Quality Assurance (Moisture Content and Chemical Analysis) Testing
5. Fuel Management System Reporting
6. FMS User Administration

2.0 FMS System Modules

REPORTS

The Reports module holds pre-defined summary reports of inventory, supplier invoicing and quality assurance (Moisture Content and Chemical Analysis testing) information. Selection options enable the user to view all or specific supplier and timespan information, based on user privileges. Data will be presented in pre-formatted reports/tables, graphs, and export (Excel, CSV, PDF, XML) format. Reports will offer selection logic to allow reporting by Supplier and Date Range.

Current FMS Reports:

1. Staging Deliveries
2. Plant Deliveries
3. Inventory Report
4. Supplier Invoice Report
5. Moisture Sample Results
6. Chemical Analysis Results
7. Delivery Exception Report

DATA ENTRY

The Data Entry module holds the functionality to manually enter results of internal Moisture Content testing and external Chemical analysis testing.

Current Data Entry screens include:

1. Moisture Content of Samples (for Internal MC testing)
2. Chemical Analysis - Long Form (for External Lab Monthly tests)
3. Chemical Analysis - Short Form (for External Lab Weekly tests)

ADMIN

The Admin module holds the screens for supplier information and contract (rate) management, delivery record management, supplier invoice generation and administration, SSC tax rate definition, fuel type definition, fuel source and delivery location definition, and delivery truck management.

Suppliers & Rates screen: This screen is used to add/edit/delete FMS fuel and service (transport) suppliers. Sub-screens also hold data for contract terms, and rate definition and adjustment history.

Staging Deliveries screen: This screen holds detailed lot information for all material deliveries to the Fuel Staging Facility. Automated integration with the Scale Management System updates these records twice daily. See the SMS Integration section for more information.

Plant Deliveries screen: This screen holds detailed lot information for all material deliveries from the Fuel Staging Facility to the Plant (biomass boiler). Automated integration with the Scale Management System updates these records twice daily. See the SMS Integration section for more information.

Invoice Creation Page screen: This screen is used to generate a supplier invoice. Based on stored supplier rate information and deliveries in the invoice date range, this function automatically calculates the correct invoice amount.

Invoice Admin screen: This screen holds all invoice information after an invoice in created in the Invoice Creation Page. This screen displays the invoice details for SSC administration review, adjustment and approval.

Tax Rates screen: This screen is used to set SSC tax information, used in supplier invoice generation.

Material Locations screen: This screen holds all material source locations defined in the SMS system. This includes supplier location ids, SSC internal location ids, and additional ids for material moved out of SSC operations. Automated integration with the Scale Management System updates these records twice daily.

Material Types screen: This screen holds all material type ids, defined in the SMS system. These ids include ground, unground and burner-ready material. Automated integration with the Scale Management System updates these records twice daily.

Trucks screen: This screen holds information for the supplier and SSC transport trucks that delivery fuel. Automated integration with the Scale Management System updates these records twice daily.

3.0 FMS User Access Management

FMS system access for all users is through the secure web site www.utilitystudio.com. User access to FMS is password-protected, restricting data access and privileges for features and functions, by user-level. SSC management and administrative users have access to all FMS functions and data. As well, they have editing capability to manage FMS information and data, and can add users to the FMS application. Supporting staff and external – supplier – users can view information for their function and/or organization, but cannot modify any data. See the accompanying User Access matrix for more information.

Current FMS user levels include:

1. SSC Management
2. SSC FMS System Administrator
3. SSC Fuel Manager
4. SSC QA Staff
5. SSC FMS Operations Staff
6. Fuel Supplier

FMS user access management is controlled in the Seattle Internal (Steam) application in UtilityStudio. Located in the User Admin module, this screen - Seattle Steam Web Site User Administration - is used to add users to the FMS application and define user access privileges. FMS can support an unlimited number of user levels, with different functions and data access privileges.

FMS User Administration Profile:

1. User Type: Internal, Customer, Vendor
2. User Login Name
3. Active User?
4. First Name
5. Last Name

6. Clients and Auth Levels: User Auth Level
7. User Start-Up Options: User-Type, User Start-Up Option, Associated Start-Up Page
8. User Status
9. User Password
10. Email Address
11. Phone Number
12. Comments
13. Can Access One Client Only flag

4.0 SMS Integration

The source for all FMS delivery information is a separate Scale Management System maintained at the Fuel Staging Facility. As fuel is delivered by fuel suppliers, the material is weighed and recorded in the SMS. Similarly, as lots of blended fuel are moved to the Plant (biomass boiler), this material is weighed and recorded in the SMS. The SMS system contains a network computer that pushes delivery information to UtilityStudio via automated processing. Twice daily, at 7:30 am PT and 7:30 pm PT, SMS sends delivery and FMS reference files to the UtilityStudio FTP servers. These files are immediately processed. The data records are entered in the FMS database, and the relevant screens for deliveries, suppliers, material locations, material type and trucks are automatically updated.

5.0 FMS Hosting and Maintenance

FMS is hosted on the UtilityStudio production network. All hosting, storage, maintenance and data backup procedures cover the FMS application. FMS user availability is 24/7; scheduled maintenance is performed off-hours on weekends.

As FMS is a hosted application, users do not require special equipment or software to use FMS. Users only need a Microsoft/Windows-based computer, with browser Internet Explorer (version 6 or higher).

Complete history of data and transactions is maintained. Record edits are tracked with user id and date/time.

System-wide record and application backup occurs daily; Emergency system switch-over/recovery will occur within 4 hours. Length of system data storage for presentation and archiving is unlimited and designed to SSC requirements.

Appendix

Report Field Definition

Report Name: Staging Deliveries
Report Description: Summary of all deliveries in and out of the SSC Staging Facility
Report Fields:

1. Ticket ID
2. Lot No.
3. Delivery Date/Time
4. Delivery Approved?
5. Gross Weight (Tons)
6. Tare Weight (Tons)
7. Net Weight (Tons)
8. Material Source Location
9. Material Destination
10. Supplier Invoice Number
11. Sample Taken?
12. Delivery to Other Facility?
13. Comments

Totals:
Approved Totals:
Unapproved Totals:
Sent to Non-SSC Facility:
Sorting/Querying:
Sorting by any report field.
Selection Options: All Staging Suppliers, Specific Staging Supplier, Start/End Date, Export Options.

Report Name: Plant Deliveries
Report Description: Summary of all deliveries in and out of the SSC Plant (Biomass Boiler)
Report Fields:

1. Ticket ID
2. Lot No.
3. Delivery Date/Time (Depart Staging)
4. Plant Arrival Date/Time
5. Delivery Approved?
6. Net Weight (Tons)
7. Material Source Location
8. Material Destination
9. Supplier Invoice Number
10. Sample Taken?
11. Delivery to Other Facility?
12. Comments

Totals:
Approved Totals:
Unapproved Totals:
Sent to Non-SSC Facility:
Moved Back to Staging:
Sorting/Querying:
Sorting by any report field.
Selection Options: All Plant Suppliers, Specific Plant Supplier, Start/End Date, Export Options.

Report Name: Inventory Report
Report Description: Summary of current Staging Facility inventory level.
Report Fields:

1. Delivery Date
2. No. of Deliveries In
3. No. of Deliveries Out
4. Net Weight In
5. Net Weight Out
6. Net Weight Added To Staging
7. Inventory at End of Period

Totals Since FMS Start
Sorting/Querying:
Click to drill to detail reporting levels: Year, Month, Day.
Selection Options: Export Options.
No sorting in this report.

Report Name: Invoice Report
Report Description: Summary of all approved supplier invoices.
Report Fields:

1. Supplier
2. Invoices
3. Invoice/ Delivery Date
4. Ticket ID
5. Lot No.
6. No. of Deliveries
7. Total Fuel Delivered To Staging
8. Total Fuel Delivered To Plant
9. Total Due

Grand Totals
Sorting/Querying:
Click to drill to detail reporting levels: Supplier, Invoices, Deliveries.
Selection Options: All Suppliers, Specific Supplier, Start/End Date, Export Options.
No sorting in this report.

Report Name: Moisture Sample Results
Report Description: Summary of all Moisture Content testing results.
Report Fields:

1. Sample Count
2. Mean (%)
3. Min (%)
4. Max (%)
5. Ticket ID
6. Lot No.
7. Delivery Date/Time
8. Staging Sample Moisture Content (%)
9. Test Source
10. Sample Test Date
11. Sample Notes

Totals/Avg

Sorting/Querying:
Sorting by any report field.
Selection Options: Sample Delivery Source (Staging or Plant), All Suppliers, Specific Supplier, Start/End Date, Export Options.

Report Name: Chemical Analysis Results – Monthly Tests
Report Description: Summary of all external lab comprehensive chemical analysis testing.
Report Fields:

1. Ticket ID
2. Report Date
3. Lot No.
4. Sample ID

Proximate (%): As-Received and Dry results for:

1. Moisture
2. Ash
3. Volatile
4. Fixed C
5. Sulfur
6. BTU/lb (HHV)
7. MMF BTU/lb

Proximate Totals/Avg
Ultimate (%): As-Received and Dry results for:

1. Moisture
2. Carbon
3. Hydrogen
4. Nitrogen
5. Sulfur
6. Ash
7. Oxygen
8. Chlorine

Ultimate Totals/Avg
Elemental Analysis of Ash (%):

1. SIO2
2. AL2O3
3. TIO2
4. FE2O3
5. CAO
6. MGO
7. NA2O
8. K2O
9. P2O5
10. SO3
11. CL
12. CO2

Elemental Analysis Totals/Avg
Sorting/Querying:
Sorting by any report field.
Selection Options: All Suppliers, Specific Supplier, Start/End Date, Export Options.

Report Name: Chemical Analysis Results – Weekly Tests
Report Description: Summary of all external lab abbreviated chemical analysis testing.
Report Fields:

1. Ticket ID
2. Report Date
3. Lot No.
4. Sample ID

As-Received and Dry results:

1. Ash (%)
2. Sulfur (%)
3. Chlorine (%)
4. Nitrogen (%)
5. BTU/lb (HHV)
6. Moisture (%)
7. MMF BTU/lb

As Received Totals/Avg
Dry Totals/Avg
Sorting/Querying:
Sorting by any report field.
Selection Options: All Suppliers, Specific Supplier, Start/End Date, Export Options.

Report Name: Delivery Exception Report
Report Description: Log of data import exceptions from SMS integration process.
Report Fields:

1. File Name
2. File Data Date
3. Data File Type
4. Exception Type Desc
5. Exception Note
6. Exception Handled?
7. Exception Handled Date

Sorting/Querying:
Sorting by any report field.
Selection Options: Start/End Date, Include Handled Exceptions flag, Export Options.

Data Entry Field Definition

Form Name: Moisture Content of Samples
Form Description: This form creates internal (SSC) fuel sample Moisture Content testing records.
Form Notes:
Form Fields:

1. Delivery Date (pre-filled from delivery sampled flag)
2. TicketID (pre-filled from delivery sampled flag)
3. Lot Number (pre-filled from delivery sampled flag)
4. Sample Taken? (pre-filled from delivery sampled flag)
5. Moisture Content(%)
6. Tester's Name
7. Test Date/Time
8. Sample Notes

Form Filters: Supplier-Type, Supplier, Start/End Dates, Only show records needing data entry, Show all deliveries flagged as sampled, Show all deliveries

Form Name: Chemical Analysis - Long Form
Form Description: This form creates the records of external lab testing of fuel sample chemical analysis.
Form Notes:
Form Fields:

1. TicketID
2. Lot Number
3. Report Date
4. HRI Series No
5. HRI Sample ID
6. Documents (stored lab results pdf)

Proximate (%): As-Received and Dry results for:

7. Moisture
8. Ash
9. Volatile
10. Fixed C
11. Total (calculated)
12. Sulfur
13. BTU/lb (HHV)
14. MMF BTU/lb

Ultimate (%): As-Received and Dry results for:

15. Moisture
16. Carbon
17. Hydrogen
18. Nitrogen
19. Sulfur
20. Ash
21. Oxygen
22. Total (calculated)
23. Chlorine

Elemental Analysis of Ash (%):

24. SIO2
25. AL2O3
26. TIO2
27. FE2O3
28. CAO

29. MGO
30. NA2O
31. K2O
32. P2O5
33. SO3
34. CL
35. CO2
36. Total (calculated)
37. Notes

Form Filters: Supplier-Type, Supplier, Start/End Dates

Form Name: Chemical Analysis - Short Form
Form Description: This form creates the records of external lab testing of fuel sample chemical analysis.
Form Notes:
Form Fields:

1. TicketID
2. Lot Number
3. Report Date
4. HRI Series No
5. HRI Sample ID
6. Documents (stored lab results pdf)

As-Received and Dry results:

8. Moisture (%)
9. Ash (%)
10. Sulfur (%)
11. BTU/lb (HHV)
12. MMF BTU/lb
13. Chlorine (%)
14. Nitrogen (%)
15. Notes

Form Filters: Supplier-Type, Supplier, Start/End Dates

Admin Screen Definition

Form Name: Suppliers & Rates
Form Description: This form creates a supplier profile in FMS.
Form Notes:
Form Fields:

1. Supplier Name
2. Supplier Code
3. Supplier-Type
4. Active Supplier?
5. Current Rate
6. Change Rate
7. Supplier Documents
8. Supplier Code
9. Billing Address 1
10. Billing Address 2
11. City
12. State
13. Zip

14. Website url
15. Contact first name
16. Contact last name
17. Contact title
18. Contact phone
19. Contact phone 2
20. Contact email address
21. Contract start date
22. Contract term
23. Default days for payment
24. Insurance Certification on File? (Y/N)
25. Active supplier?
26. Notes

Form Filters: Supplier
Form Sorting: Key fields in table header.

Form Name: Suppliers & Rates - Documents Sub-form
Form Description: This form is used to upload and store contract PDFs and track all contract revisions.
Form Notes:
Form Fields:

1. Supplier Name
2. Supplier Code
3. Supplier-Type
4. File Name
5. File Description
6. Current Contract Document?
7. Upload Date

Form Name: Suppliers & Rates - Change Rate Sub-form
Form Description: This form is used to define the individual contract variables and revision history.
Form Notes:
Form Fields:

1. Supplier
2. Supplier Code
3. Supplier Type
4. Rate Code
5. Effective Date
6. Fuel Rate ($/Ton)
7. Fuel Rate Applies To Bone Dry Weight?
8. Min Monthly Tons Applies?
9. Min Monthly Tons
10. $/Ton below Min Tons
11. Days to Pay
12. Approved Invoices Exist?

Form Name: Staging Deliveries
Form Description: This screen holds individual SMS delivery records for fuel deliveries in and out of the SSC Staging Facility.
Form Notes: While data entry is automated through SMS integration, system administrators can add, modify, and delete delivery records.
Form Fields:

1. Supplier Code
2. Delivery Date/Time

3. TicketID
4. Lot Number
5. Gross Weight
6. Tare Weight
7. Units
8. Net Weight (calculated)
9. Material Source
10. Material Destination
11. Material Type
12. Truck
13. Comments
14. Invoice No.
15. Show Comments On Invoice?
16. Delivery Approved?
17. Assigned to Invoice?
18. Sample Taken?
19. Delivery To Other Facility?

Form Filters: Supplier, Start/End Date
Form Sorting: Key fields in table header.

Form Name: Plant Deliveries
Form Description: This screen holds individual SMS delivery records for fuel deliveries in and out of the SSC Plant (Biomass Boiler).
Form Notes: While data entry is automated through SMS integration, system administrators can add, modify, and delete delivery records.
Form Fields:

1. Supplier Code
2. Delivery Date/Time
3. Arrived at Plant
4. TicketID
5. Lot Number
6. Gross Weight
7. Tare Weight
8. Units
9. Net Weight (calculated)
10. Material Source
11. Material Destination
12. Material Type
13. Truck
14. Comments
15. Invoice No.
16. Show Comments On Invoice?
17. Delivery Approved?
18. Assigned to Invoice?
19. Sample Taken?
20. Delivery To Other Facility?

Form Filters: Supplier, Start/End Date
Form Sorting: Key fields in table header.

Form Name: Invoice Creation Page

Form Description: This screen automatically generates supplier invoices, through user prompts, based on deliveries in the billing period.
Form Notes: This form can also be used to generate a blank invoice that can be manually adjusted to bill a specific invoice amount.
Form Fields:

1. Supplier-Type
2. Supplier
3. Include Unapproved Deliveries flag
4. Include Inactive Suppliers flag
5. Start Date
6. End Date
7. Invoice Date
8. Apply Min Monthly Charge Calculation

Form Filters: Supplier Type, Supplier
Form Sorting: NA

Form Name: Invoice Admin
Form Description: This screen holds all invoice information after an invoice in created in the Invoice Creation Page. This screen displays the invoice details for SSC administration review, adjustment and approval.
Form Notes:
Form Fields:

1. Supplier Code
2. Delivery Start Date
3. Delivery End Date
4. Invoice Number
5. Invoice Date
6. Current Month Total
7. Total Due
8. Fuel to Staging (Tons)
9. Fuel to Plant (Tons)
10. Approved?
11. Comments
12. Show Invoice Comments On Bill
13. View Bill link

Form Filters: Supplier, Start/End Date
Form Sorting: Key fields in table header.

Form Name: Invoice Admin - Invoice Details Screen
See Above: Additional fields

1. Due Date
2. Show Moisture Details List on Bill
3. Fuel Deliveries To Staging $
4. Adjustments $
5. Minimum Charge $
6. Taxes $
7. Current Month Total $
8. Previous Balance $
9. Late Charge $
10. Credit $
11. Miscellaneous Charge $
12. Total Due $
13. Supplier Code

14. Delivery Date
15. Lot Number
16. Net Weight
17. Assigned to Invoice
18. Delivery Approved?
19. Delivery To Other Facility?
20. Comments
21. Show Delivery Comment on Bill

Form Name: Tax Rates
Form Description: This screen is used to set SSC tax information, used in supplier invoice generation.
Form Notes:
Form Fields:

1. Effective Date
2. Percent Tax
3. Approved Invoices Exist?

Form Filters: NA
Form Sorting: NA

Form Name: Material Locations
Form Description: This screen holds all material source locations defined in the SMS system. This includes supplier location ids, SSC internal location ids, and additional ids for material moved out of SSC operations.
Form Notes: Automated integration with the Scale Management System updates these records twice daily.
Form Fields:

1. Supplier
2. Location Code
3. Supplier Code
4. Location Name
5. Material Source Code
6. Effective Date
7. Miles Per Trip
8. Address 1
9. Address 2
10. City
11. State
12. Zip
13. Contact first name
14. Contact last name
15. Contact email address
16. Contact phone 1
17. Contact phone 2
18. Notes
19. Active?
20. Source Location?
21. Destination Location?

Form Filters: Supplier
Form Sorting: Key fields in table header.

Form Name: Material Types

Form Description: This screen holds all material type ids, defined in the SMS system. These ids include ground, unground and burner-ready material.
Form Notes: Automated integration with the Scale Management System updates these records twice daily.
Form Fields:

1. Material Type Code
2. Material Type Desc
3. Notes
4. Active?
5. Delivery To Other Facility?

Form Filters: NA
Form Sorting: Key fields in table header.

Form Name: Trucks
Form Description: This screen holds information for the supplier and SSC transport trucks that delivery fuel.
Form Notes: Automated integration with the Scale Management System updates these records twice daily.
Form Fields:
Truck Code
Supplier Code
Truck Number
Make
Model
Year
Effective Date
Miles Per Gallon
Notes
Active?
Form Filters: Supplier
Form Sorting: Key fields in table header.

User Access Matrix

Organization	FMS Level	Level Description	Notes
SSC	1 Master Executive	Access to all screens and data input including User Administration.	User Admin
SSC	2 Executive	Access to all screens and data input except User Admin.	
SSC	3 Analyst	Data Entry (MC); Corporate Reporting; Cannot approve/create invoices (No Invoice Creation or Invoice Admin edit).	Assume they can view these admin screens: Suppliers & Rates Deliveries to Staging Deliveries to SSC Plant Invoice Admin Material Source Locations Material Types Trucks
SSC	4 Data Entry	Data entry for Moisture Content; View Reports of Deliveries (to see Sample flag); View Moisture Content to check data accuracy in report	
SSC	5 Read Only	Read only - no data entry. All screens - or vary by area of responsibility	
Supplier	6 Read Only	Read only - no data entry. View only – all deliveries and only their invoices.	Like OFP
Supplier	7 Read Only	Limited screens: View only – their deliveries and invoices	Wood Suppliers