Appendix E2: Unit Design Data – Fluidized Bed Combustion

Note: The NERC Board of Trustees approved the *GADS Task Force Report* (dated July 20, 2011)[1], which states that design data collection outside the required nine fields is solely voluntary. However, the GADS staff encourages that reporters report and update GADS design data frequently. This action can be completed by sending in this form to gads@nerc.net. GADS staff encourages using the software for design entry and updating.

Instructions

Use these forms to report design and installed equipment information for FLUIDIZED BED COMBUSTION (FBC) units. These units include atmospheric (circulating (CFB) and bubbling (BFB)) fluidized bed only.

Data reported on these forms should reflect the current condition and design of the unit (installed equipment, etc.). Do not report data for start-up equipment or for equipment that is not used to carry normal load unless specifically requested.

Some data fields are designated as M1 and M2. These indicate that the equipment being reported may have been supplied by more than one manufacturer. Use fields designated as M1 to report all the data associated with one manufacturer's equipment and M2 for the other.

Unit Name ______________________________

Location of Unit (State) ______________________________

Energy Information Administration (EIA) Number ______________________________

Regional Entity ______________________________

Subregion ______________________________

Date Reporter ______________________________

Telephone Number ______________________________

Date ______________________________

GENERAL UNIT DATA

1. Identification

A series of codes uniquely identifies your utility and units. NERC assigned a unique code to identify your utility. You must assign the unique code that will identify the FBC unit being reported. This code may be any number from 650 to 699. Enter the unique utility and unit code and the full name of the unit below:

Utility Codes: ____________________ Unit Codes: ____________________

Name of Unit: ______________________________

[1] http://www.nerc.com/pa/RAPA/gads/MandatoryGADS/Revised_Final_Draft_GADSTF_Recommendation_Report.pdf

2. Date the Unit Entered Service

The in–service date establishes the starting point for review of historical performance of each unit. Using the criteria described below, report the date the unit entered service:

__________ Year __________ Month __________ Day

Criteria:

a. The date the unit was first declared available for dispatch at some level of its capability, OR

b. The date the unit first operated at 50% of its generator nameplate megawatt capability (product of the megavolt amperes (MVA) and the rated power factor as stamped on the generator nameplate(s)).

3. Unit Loading Characteristics at Time of Unit's Design

______ Enter the number from the list below that best describes the mode of operation the unit *was originally designed for*

1 – Base loaded with minor load following at night and on weekends

2 – Periodic startups with daily load-following and reduced load nightly

3 – Weekly startup with daily load-following and reduced load nightly

4 – Daily startup with daily load-following and taken off-line nightly

5 – Startup chiefly to meet daily peaks

6 – Other, describe ______________________________

7 – Seasonal Operation

4. Design and Construction Contractors

Identify both the architect/engineer and the general construction contractor responsible for the design and construction of the unit. If your utility was the principal designer or general constructor, enter "SELF."

____________________ Architect/Engineer

____________________ Constructor

5. Boiler – Manufacturer

Enter the name of the manufacturer and the model or series name or number of the boiler:

____________________ Boiler manufacturer (original)

____________________ Boiler manufacturer (FBC portion) - retrofit

____________________ Manufacturers' model, series name, or number (original)

____________________ Manufacturers' model, series name, or number (retrofit)

6. Boiler – Enclosure

Is 50% or more of the boiler outdoors (not enclosed in building framing and siding)?

______ 1 – Yes 2 – No

7. Boiler – Nameplate Conditions

Enter the following steam conditions for the MAIN STEAM LINES at the full-load, valves-wide-open design point:

________________________ Steam flow rate (in lbs/hr)

________________________ Design temperature (ºF)

________________________ Design pressure (psig)

8. Boiler – Fuel Firing System

_______ Enter the type of fuel firing system found in the furnace::

1 – *Circulating fluidized bed (CFB)* - an FBC with no clear region between the relatively dense bed and lean phase. A circulating bed usually has a superficial velocity greater than 13 ft./sec. and has a reinjection/recycle ratio greater than 5. Compared to a bubbling bed, a circulating bed has significantly higher solids concentration throughout the combustor.

2 – *Bubbling fluidized bed (BFB)* - an FBC with a definite region between the relatively dense bed and lean phase. A bubbling bed usually has a superficial velocity of less than 13 ft./sec. and a reinjection/recycle ratio of less than 5. In addition, the fuel and sorbent are usually fed either over-bed or under-bed.

9. Boiler – Method of Solid Feed to the Boiler

Enter the method of feeding solid fuel, bed material and sorbent into the boiler.

_______ For fuel:

1 – *Over-bed feed (BFB)* – injection of solids above the fluidized bed into a slightly negative pressure environment where the solids then fall into the fluidized bed.

2 – *Under-bed feed (BFB)* – injection of solids through multiple points to the bottom of the fluidized bed into a positive pressure environment.

3 – *Both over–bed and under-bed feed (BFB)* - combination of the two above.

4 – *Within-bed feed (CFB)* - injection of solids through a few feed points to the fluidized bed into a positive pressure environment. (This refers to the method of fuel feed in a circulating bed.)

_______ For sorbent:

1 – *Over-bed feed (BFB)* – injection of solids above the fluidized bed into a slightly negative pressure environment where the solids then fall into the fluidized bed.

2 – *Under-bed feed (BFB)* – injection of solids through multiple points to the bottom of the fluidized bed into a positive pressure environment.

3 – *Both over–bed and under-bed feed (BFB)* - combination of the two above.

4 – *Within-bed feed (CFB)* - injection of solids through a few feed points to the fluidized bed into a positive pressure environment. (This refers to the method of fuel feed in a circulating bed.)

_______ Feed with fuel:

1 – Yes

2 – No

________ For bed material

1 – *Over-bed feed (BFB)* – injection of solids above the fluidized bed into a slightly negative pressure environment where the solids then fall into the fluidized bed.

2 – *Under-bed feed (BFB)* – injection of solids through multiple points to the bottom of the fluidized bed into a positive pressure environment.

3 – *Both over–bed and under-bed feed (BFB)* - combination of the two above.

4 – *Within-bed feed (CFB)* - injection of solids through a few feed points to the fluidized bed into a positive pressure environment. (This refers to the method of fuel feed in a circulating bed.)

10. Boiler – Type of Circulation

________ Enter the type of circulation

1 – *Natural (thermal)* – water flows through furnace wall tubes unaided by circulating pumps (primarily used with subcritical units).

2 – *Controlled (forced or pump-assisted thermal)* – water flows through furnace wall and/or in-bed evaporator tubes aided by boiler recirculation pumps located in the down comers or lower headers of the boiler (used on some subcritical units).

3 – *Once through* – no recirculation of water through the furnace wall tubes and no steam drum (used on super and subcritical units).

4 – *Combination natural and controlled*

11. Boiler – Circulation System

Enter the following information on the pump(s) used to recirculate water through the boiler:

________________________ Boiler recirculation pump(s) manufacturer(s)

________________________ Number of boiler recirculation pumps per manufacturer; include installed spares

________________________ TOTAL number of boiler recirculation pumps for the unit

________________________ MINIMUM number of boiler recirculation pumps required to obtain maximum capacity from the unit

________ ________ Enter the type of boiler recirculation pump(s) used
M1 M2

1 – *Injection (or injection seal)* – controlled-leakage boiler recirculation pumps mounted vertically with a rigid shaft designed to carry its own thrust.

2 – *Leak-less (canned, canned-motor or zero-leakage)* – leak-less pump and its motor designed as an integral pressurized sealed unit.

9 – *Other, describe* ____

12. Boiler – Heat Excahnge

In bed:	**Reheat**	**Supht**	**Evap**	**Preheat**
Type of heat exchanger	________	________	________	________
Tube materials*	________	________	________	________

Manufacturer				
Total number of exchangers including spares				
Minimum number of exchangers for full load operation				
Location of exchangers (external/internal)				
Square feet of surface				

Convective:	**Reheat**	**Supht**	**Evap**	**Preheat**
Type of heat exchanger				
Tube materials*				
Manufacturer				
Total number of exchangers including spares				
Minimum number of exchangers for full load operation				
Location of exchangers (external/internal)				
Square feet of surface				

Radiant	**Reheat**	**Supht**	**Evap**	**Preheat**
Type of heat exchanger				
Tube materials*				
Manufacturer				
Total number of exchangers including spares				
Minimum number of exchangers for full load operation				
Location of exchangers (external/internal)				
Square feet of surface				

*If more than one material is used, indicate each type with the predominant one mentioned first.

13. Boiler – Char Reinjection System

Char (unburned fuel, sorbent, and ash) is captured by the separator and transferred to disposal and/or reinjected into the fluidized bed. Enter the following information on the char reinjection system.

________________________ Separator manufacturer(s)

________________________ Number of separators including spares

________________________ Minimum number of separators for full load operation

________________________ Type of separator (cyclone, multi-clone, u-beam, horizontal)

________________________ Separator recirculation temperature

____

______________________ Liner (refractory or water cooled)

______________________ Type of pressure seal (lock hoppers, rotary valve, gravimetric pump, loop seal)

______________________ Number of char reinjection systems including installed spares

______________________ High pressure loop seal air fan(s)/blower(s) manufacturer(s)

______________________ Manufacturer(s) of the motor(s) that drives the high pressure loop seal fan(s)/blower(s)

______________________ Number of high pressure loop seal fans/blowers per manufacturer; include installed spares

______________________ TOTAL number of high pressure loop seal fans/blowers for the unit

______________________ MINIMUM number of high pressure loop seal fans/blowers required to obtain maximum capacity from the unit

______ M1 ______ M2 Enter the type of high pressure loop seal fan(s)/blower(s) at the unit

1 – *Injection (or injection seal)* – controlled-leakage boiler recirculation pumps mounted vertically with a rigid shaft designed to carry its own thrust.

2 – *Leak-less (canned, canned-motor or zero-leakage)* – leak-less pump and its motor designed as an integral pressurized sealed unit.

9 – *Other, describe* ______________________

14. Boiler – Design Parameters

______________________ Percent SO_2 removal

______________________ *Calcium-to-sulfur molar ratio* – moles of calcium in the sorbent divided by the moles of sulfur in the fuel. (This is an indicator of the amount of sorbent required to reduce SO_2 to desired limit.)

______________________ *Reinjection/recycle ratio* – mass flow rate of char material that is reinjected to the combustor divided by the mass flow rate of fuel feed

______________________ *Average superficial air velocity (ft/sec)* – velocity of air through a fluidized bed. The superficial velocity is based on the cross sectional area of the bed and the total air flow rate. The density used to calculate superficial velocity is based on the average bed temperature and pressure.

______________________ *Fuel feed rate*

______________________ *Sorbent feed rate*

15. Boiler – Furnace (Surface) Release Rate

Enter the furnace (surface) release rate of the PRIMARY FUEL. This rate is specified in the boiler contract as the heat available per hour, in Btu per square foot of heat absorbing surface in the furnace. The absorbing surface includes all heat exchange surfaces (waterwall, super heater, external, etc.).

______________________ Furnace (surface) release rate at maximum continuous rating (in Btu’s/SqFt/Hr)

16. Boiler – Furnace Volumetric Heat Release Rate

Enter the furnace volumetric heat release rate of the PRIMARY FUEL. This rate is the total quantity of thermal energy released into the furnace by the fuel at its higher heating value (HHV). The volumetric heat release rate is expressed in Btu per cubic foot of total heat exchanger volume per hour. It does not include the heat added by preheated air or the heat unavailable due to evaporation of moisture in the fuel and combustion of hydrogen.

________________________________ Furnace volumetric heat release rate at maximum continuous rating (in Btu/CuFt/Hr)

17. Boiler – Primary and Secondary Design Fuel, Sorbents, and Non-sorbent

The PRIMARY fuel is defined as that fuel primarily used to sustain load on the unit, (i.e., the first fuel of choice for either economic or control reasons) or that fuel contributing 50% or more of the load-carrying Btu. The SECONDARY fuel is that normally used to sustain load if the PRIMARY fuel is unavailable or uneconomical. Do NOT report ignition or warm-up fuel.

Sorbent is a material (usually a limestone or dolomite) that is fed into the combustor with the solid fuel (coal) thereby reducing the SO_2 that is released during the combustion process.

Non-sorbent is a material other than sorbent that is used to build the bed. All characteristics are based on an ultimate analysis of the as-received fuel using appropriate ASTM testing methods. Additional notes are provided where appropriate.

________________	________________
Primary Fuel	**Secondary Fuel**

Fuel Codes

BM	Biomass	OO	Oil
CC	Coal	OS	Other-Solid (Tons)
DI	Distillate Oil (No. 2)	PC	Petroleum Coke
GE	Geothermal	PE	Peat
GG	Gas	PR	Propane
JP	JP4 or JP5	SL	Sludge Gas
KE	Kerosene	SO	Solar
LI	Lignite	WA	Water
NU	Nuclear	WD	Wood
OG	Other-Gas (Cu. Ft.)	WH	Waste Heat
OL	Other-Liquid (BBL)	WM	Wind

Fuel Characteristics

Primary Fuel	Secondary Fuel	Type
________________	________________	Average Heat Content in Fuel (Btu/lb, Btu/bbl, Btu/CuFt)
________________	________________	% Ash Content (to one decimal place) (Btu/lb,Btu/bbl,Btu/CuF)
________________	________________	% Sulfur Content (to one decimal place) (Btu/lb,Btu/bbl,Btu/CuF)
________________	________________	% Moisture Content (to one decimal place) (Btu/lb,Btu/bbl,Btu/CuF)
________________	________________	Ash Softening Temp (°F) (in a reducing atmosphere)

________	________	
________	________	(ASTM STD D-1857, Part 26) (coal units only)
________	________	Grindability Hardgrove Index (ASTM STD D-409, Part 26) (coal units only)
________	________	% Vanadium & Phosphorous (to one decimal place) (oil units only)
________	________	Fuel Top (largest particle) size

Sorbent:

Primary Fuel	Secondary Fuel	Type
________	________	Abrasion Index (identify index used)
________	________	% by Mass Magnesium Content (to one decimal place)
________	________	% by Mass Calcium Content (to one decimal place) (Btu/lb, Btu/bbl, Btu/Cuf)
________	________	% by Mass Carbon Dioxide Content (to one decimal place)
________	________	Sorbent top (largest particle size)

Non-Sorbent:

Primary Fuel	Secondary Fuel	Type
________	________	Initial Ash Fusion Temperature (ºF)
________	________	Non-sorbent Top (largest particle size)

18. Boiler – Fuel Oil Forwarding System

The fuel oil forwarding system transfers oil from the main storage tanks to smaller tanks closer to the unit. (See Item 20 for pumps that feed oil directly to the burners.) Enter the following data for this system:

________________	Fuel forwarding/transfer pump(s) manufacturer(s)
________________	Manufacturer(s) of the motor(s) that drives the fuel forwarding/transfer pump(s)
________________	Number of fuel forwarding/transfer pumps per manufacturer; include installed spares
________________	TOTAL number of fuel forwarding/transfer pumps for the unit
________________	MINIMUM number of pumps required to obtain maximum capacity from the unit

19. Boiler – Burner Management Systems

Enter the name of the manufacturers for the following burner management systems:

________________	Manufacturer of the combustion control system that coordinates the feed water, air, and fuel subsystems for continuous unit operation.
________________	Manufacturer of the burner management system that monitors only the fuel and air mixture during all phases of operation to prevent the formation of an explosive mixture.

20. Boiler – Fuel Oil Burner Supply System (In-plant)

These are secondary, high pressure pumps within the area of the boiler used to feed fuel oil directly to the burners.

________________	Fuel oil burner supply pump(s) manufacturer(s)

____

_______________ Manufacturer(s) of the motor(s) that drives the fuel oil burner supply pump(s)

_______________ Number of fuel oil burner supply pumps per manufacturer; include installed spares

_______________ TOTAL number of fuel oil burner supply pumps for the unit

_______________ MINIMUM number of fuel oil burner supply pumps required to obtain maximum capacity from the unit

21. Boiler – Burner Systems

Enter the following information on the installed burner systems used for the preliminary heat up of the boiler:

Duct burner:

_______________ Duct burner manufacturer

_______________ Btu rating

________ Enter the type of duct burner fuel used:

A – Light (distillate) oil
B – Heavy oil
C – Gas
D – Coal
E – Oil and Gas
F – Propane
M – More than one

________ Enter the type of duct burner used:

1 – *Pilot torch lighter* – an oil or gas igniter that uses an electric spark to ignite the fuel
2 – *Carbon arc* – a carbon or graphite electrode that is energized and used to ignite the fuel
3 – *High energy arc* – a low voltage, high energy pulse arc that is used to ignite the fuel
4 – *Plasma arc* – a high dc voltage current used to ionize the air resulting in a high energy arc that ignites the fuel
5 – *Manual* – Ignition torch or lance inserted into boiler by operating personnel.
6 – *Combination* of any burner types above
9 – *Other, describe* _______________

Warmup burner:

_______________ Warmup burner manufacturer

_______________ Btu rating

________ Enter the type of warmup burner fuel used:

A – Light (distillate) oil
B – Heavy oil

C – Gas
D – Coal
E – Oil and Gas
F – Propane
M – More than one

________ Enter the type of warmup burner used:

1 – *Pilot torch lighter* – an oil or gas igniter that uses an electric spark to ignite the fuel
2 – *Carbon arc* – a carbon or graphite electrode that is energized and used to ignite the fuel
3 – *High energy arc* – a low voltage, high energy pulse arc that is used to ignite the fuel
4 – *Plasma arc* – a high dc voltage current used to ionize the air resulting in a high energy arc that ignites the fuel
5 – *Manual* – Ignition torch or lance inserted into boiler by operating personnel.
6 – *Combination* of any burner types above
9 – *Other, describe* ____

Lance injection burner:

______________________________ Lance injection burner manufacturer
______________________________ Btu rating

________ Enter the type of Lance injection burner fuel used:

A – Light (distillate) oil
B – Heavy oil
C – Gas
D – Coal
E – Oil and Gas
F – Propane
M – More than one

________ Enter the type of duct burner used:

1 – *Pilot torch lighter* – an oil or gas igniter that uses an electric spark to ignite the fuel
2 – *Carbon arc* – a carbon or graphite electrode that is energized and used to ignite the fuel
3 – *High energy arc* – a low voltage, high energy pulse arc that is used to ignite the fuel
4 – *Plasma arc* – a high dc voltage current used to ionize the air resulting in a high energy arc that ignites the fuel
5 – *Manual* – Ignition torch or lance inserted into boiler by operating personnel.
6 – *Combination* of any burner types above
9 – *Other, describe* ____

22. Boiler – Solid Fuel Handling Systems – Yard Area

Enter the following information on the equipment installed in the solid fuel yard:

________________ Stacker/re-claimer system manufacturer

________________ Number of critical path solid fuel conveyor systems available to the UNIT

23. Boiler – Solid Fuel Crushers

Enter the following information on the solid fuel crushing equipment used to supply solid fuel to the in-plant solid fuel-holding bunkers for burning in the boiler:

________________ Crusher(s) manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the crusher(s)

________________ Type of crusher(s)

________________ TOTAL number of crushers

24. Boiler – Solid Fuel Feed to Boiler

Enter the following information on the solid fuel feed equipment used to supply solid fuel from the in-plant solid fuel-holding bunkers to the over-bed, under-bed, or within-bed entrance of the boiler:

________________ Crusher(s) manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the crusher(s)

________________ Type of crusher(s)

________________ TOTAL number of crushers

________________ Gravimetric feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the gravimetric feeder(s)

________________ TOTAL number of gravimetric feeders

________________ Volumetric feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the volumetric feeder(s)

________________ TOTAL number of volumetric feeders

________________ Pneumatic feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the pneumatic feeder(s)

________________ TOTAL number of pneumatic feeders

________________ Type of pressure seal (lock hoppers, rotary valve, gravimetric pump, loop seal)

________________ Number of solid fuel trains including installed spares

25. Boiler – Secondary Fuel Feed (other than coal)

_____ Type of secondary boiler fuel feed system:

1 – *Lance*
2 – *Nozzle*
9 – *Other, describe* ________________________________

________________ Percent (%) load carrying capability

Enter the type of solid fuel feed(s):

________________ Gravimetric feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the gravimetric feeder(s)

________________ TOTAL number of gravimetric feeders

________________ Volumetric feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the volumetric feeder(s)

________________ TOTAL number of volumetric feeders

________________ Pneumatic feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the pneumatic feeder(s)

________________ TOTAL number of pneumatic feeders

________________ Type of pressure seal (lock hoppers, rotary valve, gravimetric pump, loop seal)

________________ Number of secondary solid fuel trains including installed spares

26. Boiler – Sorbent Crusher or Pulverizer Capability

Enter the following information on the capability of the installed crusher(s) or pulverizer(s):

________________ Sorbent crusher(s) or pulverizer(s) manufacturer(s)

________________ Manufacturers’ model number for the sorbent crusher(s) or pulverizer(s)

________________ Design sorbent flow rate in lb/hr PER sorbent crusher or pulverizer using design fuel specifications

________________ Number of sorbent crushers or pulverizers per manufacturer; include installed spares

________________ TOTAL number of sorbent crushers or pulverizers for the unit

________________ MINIMUM number of sorbent crushers or pulverizers required to obtain maximum capacity from the unit

________________ Sorbent stacker/re-claimer manufacturer

_____ (M1) _____ (M2) Enter the type of sorbent crusher(s) or pulverizer(s) at the unit:

1 – *Ball* – grinding elements are balls that operate freely in a race on a rotating grinding table

2 – *Roll race* – rotating grinding table that moves sorbent through a series of rollers or wheels supported within the pulverizer.

3 – *Ball tube (Hardinge)* – horizontal, rotating, grinding cylinder containing steel balls that move within the cylinder and grind or crush the sorbent.

4 – *Impact (Attrition)* – series of fixed or hinged hammers that rotate within a closed chamber impacting and crushing the sorbent.

9 – *Other, describe* ______________________________

27. Boiler – Sorbent Feed System to Boiler

Enter the following information on the sorbent feeder equipment used to supply sorbent from the in-plant sorbent-holding bunkers to the boiler:

________________ Gravimetric feeder manufacturer(s)

________________ Manufacturer(s) of the motor(s) that drives the gravimetric feeder(s)

__________ TOTAL number of gravimetric feeders
__________ Volumetric feeder manufacturer(s)
__________ Manufacturer(s) of the motor(s) that drives the volumetric feeder(s)
__________ TOTAL number of volumetric feeders
__________ Pneumatic feeder manufacturer(s)
__________ Manufacturer(s) of the motor(s) that drives the pneumatic feeder(s)
__________ TOTAL number of pneumatic feeders
__________ Type of pressure seal (lock hoppers, rotary valve, gravimetric pump, loop seal)
__________ Number of secondary solid fuel trains including installed spares

28. Boiler – Bed Material Injection Feed System

Bed materials are the solids in the bed or dense phase of the combustor. Enter the following information on the bed material feed equipment used to supply bed material from the in-plant bed material-holding bunkers to the boiler:

__________ Gravimetric feeder manufacturer(s)
__________ Manufacturer(s) of the motor(s) that drives the gravimetric feeder(s)
__________ TOTAL number of gravimetric feeders
__________ Volumetric feeder manufacturer(s)
__________ Manufacturer(s) of the motor(s) that drives the volumetric feeder(s)
__________ TOTAL number of volumetric feeders
__________ Pneumatic feeder manufacturer(s)
__________ Manufacturer(s) of the motor(s) that drives the pneumatic feeder(s)
__________ TOTAL number of pneumatic feeders
__________ Type of pressure seal (lock hoppers, rotary valve, gravimetric pump, loop seal)
__________ Number of secondary solid fuel trains including installed spares

29. Boiler – Balanced Draft or Pressurized Draft

_____ Enter the type of boiler draft*:*

1 – *Balanced draft* – equipped with both induced draft and forced draft fans. The furnace operates at positive pressure at air entry and negative pressure at flue gas exit

2 – *Pressurized draft* – equipped with forced draft fans only. The furnace and draft system operate at positive pressure

IF the unit was originally designed as a pressurized draft unit and converted to a balanced draft design, indicate the date the conversion was completed:

________ ________ ________
Year Month Day

30. Boiler – Primary Air (Forced Draft) Fan System

Primary air is used for combustion and/or fluidization processes. Enter the following information on the installed primary air (forced draft) fans:

______________________ Primary air (forced draft) fan(s) manufacturer(s)

______________________ Manufacturer(s) of the motor(s)/steam turbine(s) that drives the primary air (forced draft) fan(s)

______________________ Number of primary air (forced draft) fans per manufacturer; include installed spares

______________________ TOTAL number of primary air (forced draft) fans for the unit

______________________ MINIMUM number of primary air (forced draft) fans required to obtain maximum capacity from the unit

______________________ Horsepower of fan(s)

_______ M1 _______ M2 Enter the type of primary air (forced draft) fan(s) at the unit:

Centrifugal – blades mounted on an impeller (or rotor) which rotates within a spiral or volute housing. Mark the type of blades used on this type of fan:

1 – Forward curved

2 – Straight (radial or radial tipped)

3 – Backward curved (air foil or flat)

4 – Axial (fixed or variable pitch) – blades attached to central hub parallel to air flow

9 – *Other, describe* ____

_______ M1 _______ M2 Enter the type of primary air (forced draft) fan drives(s) at the unit:

1 – Single speed motor

2 – Two speed motor

3 – Variable speed motor

4 – Steam turbine

5 – Fluid drive

9 – *Other, describe* ____

31. Boiler – Induced Draft Fan System

Enter the following information on the induced draft fans installed at the unit:

______________________ Induced draft fan(s) manufacturer(s)

______________________ Manufacturer(s) of the motor(s)/steam turbine(s) that drives the induced draft fan(s)

______________________ Number of induced draft fans per manufacturer; include installed spares

______________________ TOTAL number of induced draft fans for the unit

______________________ MINIMUM number of induced draft fans required to obtain maximum capacity from the unit

____________________ Horsepower of fan(s)

________ ________ Enter the type of induced draft fan(s) at the unit:
M1 M2

Centrifugal – blades mounted on an impeller (or rotor) which rotates within a spiral or volute housing. Mark the type of blades used on this type of fan:

1 – Forward curved
2 – Straight (radial or radial tipped)
3 – Backward curved (air foil or flat)
4 – Axial (fixed or variable pitch) – blades attached to central hub parallel to air flow
9 – *Other, describe* ____________________

________ ________ Enter the type of induced draft fan drives(s) at the unit:
M1 M2

1 – Single speed motor
2 – Two speed motor
3 – Variable speed motor
4 – Steam turbine
5 – Fluid drive
9 – *Other, describe* ____________________

32. Boiler – Secondary Air Fan System

Secondary air is used for purposes such as fuel transport. Enter the following information on the secondary air fans installed at the unit:

____________________ Secondary air fan(s) manufacturer(s)

____________________ Manufacturer(s) of the motor(s)/steam turbine(s) that drives the secondary air fan(s)

____________________ Number of secondary air fans per manufacturer; include installed spares

____________________ TOTAL number of secondary air fans for the unit

____________________ MINIMUM number of i secondary air fans required to obtain maximum capacity from the unit

____________________ Horsepower of fan(s)

________ ________ Enter the type of secondary air fan(s) at the unit:
M1 M2

Centrifugal – blades mounted on an impeller (or rotor) which rotates within a spiral or volute housing. Mark the type of blades used on this type of fan:

1 – Forward curved
2 – Straight (radial or radial tipped)
3 – Backward curved (air foil or flat)

4 – Axial (fixed or variable pitch) – blades attached to central hub parallel to air flow

9 – *Other, describe* ____________________

________ ________ Enter the type of secondary air fan drives(s) at the unit:
M1 M2

1 – Single speed motor

2 – Two speed motor

3 – Variable speed motor

4 – Steam turbine

5 – Fluid drive

9 – *Other, describe* ____________________

33. Boiler – Primary Air Heating System

Enter the following information about the air heaters used to transfer the excess heat from the flue gases to the incoming primary air for the furnace:

____________________ Primary air heater(s) manufacturer(s)

____________________ TOTAL number of primary air heaters per manufacturer

____________________ Air heater outlet temperature

________ ________ Enter the type of primary air heater(s) at the unit:
M1 M2

1 – *Regenerative (Ljungstrom)* – rotating heat exchanger that continuously rotates sections (baskets) composed of metal plates from the hot flue gas furnace exit plenum to the furnace intake air plenums thus heating the intake air.

2 – *Tubular* – hot flue gas from the furnace is channeled through tubes (vertical or horizontal) where the heat is transferred to the furnace intake air passing across the outside of the tubes.

3 – *Steam Coil* – similar to tubular except steam is used to preheat the intake air.

4 – *Regenerative (Rothemule)* – rotating heat exchanger similar to Regenerative (Ljungstrom) except sections (baskets) remain stationary while the housing rotates.

5 – *Recuperative (plate-type)* – air heater which uses thin, flat, parallel plates with alternate wide and narrow spacing to match the ratio of gas weight to air weight. Thus, flue gas is made to pass through the wider spaced passages (1” to ½”) and the air through the narrower passages (3/4” to ¼”) generally in counter flow relation

6 – *Heat pipe* – this air heater allows the transfer of very substantial quantities of heat through small surface areas. Hollow pipes with wicking material covering the inside surface area used to transfer the heat in the following manner. A condensable fluid inside the pipes permeates the wicking material by capillary action. When heat is added by the flue gas at one end of the pipes (evaporator), liquid is vaporized in the wick and the vapor moves to the central core. At the air end of the pipes, heat is removed (the condenser) and the vapor condenses back into the wick. Liquid is replenished in the evaporator section by capillary action.

9 – *Other, describe* ____________________

34. Boiler – Secondary Air Heating System

Enter the following information about the secondary (or backup) air heaters used in the transfer of excess heat from the flue gases to the incoming primary air for the furnace:

____________________ Secondary air heater(s) manufacturer(s)

____________________ TOTAL number of secondary air heaters per manufacturer

____________________ Air heater outlet temperature

______ ______ Enter the type of primary air heater(s) at the unit:

M1 M2

1 – *Regenerative (Ljungstrom)* – rotating heat exchanger that continuously rotates sections (baskets) composed of metal plates from the hot flue gas furnace exit plenum to the furnace intake air plenums thus heating the intake air.

2 – *Tubular* – hot flue gas from the furnace is channeled through tubes (vertical or horizontal) where the heat is transferred to the furnace intake air passing across the outside of the tubes.

3 – *Steam Coil* – similar to tubular except steam is used to preheat the intake air.

4 – *Regenerative (Rothemule)* – rotating heat exchanger similar to Regenerative (Ljungstrom) except sections (baskets) remain stationary while the housing rotates.

5 – *Recuperative (plate-type)* – air heater which uses thin, flat, parallel plates with alternate wide and narrow spacing to match the ratio of gas weight to air weight. Thus, flue gas is made to pass through the wider spaced passages (1” to ½”) and the air through the narrower passages (3/4” to ¼”) generally in counter flow relation

6 – *Heat pipe* – this air heater allows the transfer of very substantial quantities of heat through small surface areas. Hollow pipes with wicking material covering the inside surface area used to transfer the heat in the following manner. A condensable fluid inside the pipes permeates the wicking material by capillary action. When heat is added by the flue gas at one end of the pipes (evaporator), liquid is vaporized in the wick and the vapor moves to the central core. At the air end of the pipes, heat is removed (the condenser) and the vapor condenses back into the wick. Liquid is replenished in the evaporator section by capillary action.

9 – *Other, describe* ____________________

35. Boiler – Soot blowers

Enter the following information on the soot blower system installed on the furnace:

____________________ Soot blower(s) manufacturer(s

____________________ TOTAL number of soot blowers installed on the furnace per manufacturer.

____________________ Air heater outlet temperature

______ ______ ______ Enter the type(s) of medium(s) used to blow the soot. If a variety of soot blowers are used at the unit, note the number of each.

M1 M2 M3

1 – Steam

2 – Air

3 – *Water*

4 – *Sonic*

5 – *Steam/Air*

9 – *Other, describe* ______________________________

36. Boiler – Bed Material Coolers

Bed material coolers are heat exchangers used to cool the hot bed material as it is drained from the fluidized bed. Enter the following information on the bed material coolers:

______________ Bed material cooler manufacturer.

______________ TOTAL number of bed material coolers installed on the unit.

______________ Bed material cooler tube materials used in the majority (50% or greater) of the tubes made by each manufacturer.

______________ Bed material cooler type (screw, counter flow, fluid bed, other)

______________ Exit material temperature (ºF)

37. Boiler – Bed Material Handling System

Enter the following information on the bed material handling equipment:

______________ Bed material handling system manufacturer

________ Enter the type of bed material removal system used

1 – *Vacuum* – bed material conveying system operates at a vacuum relative to the bed material collection hoppers.

2 – *Pressure* – bed material conveying system operates at a pressure greater than the pressure in the bed material collection hoppers

3 – *Vacuum pressure* – employs the best features of both the vacuum and pressure systems.

4 – *Water (sluice)* – employs water to sluice the bed material away from the hoppers

5 – *Vacuum/water slurry* – bed material conveying system operates at a vacuum relative to the bed material collection hoppers

6 – *Mechanical* – refers to mechanical conveying systems such as conveyor belts, bucket elevators, and screw conveyors

9 – *Other, describe* ______________________________

38. Boiler – Char Disposal System

Char (unburned fuel, sorbent, and ash) is captured by the separator and transferred to disposal and/or reinjected into the fluidized bed. Enter the following information on the char disposal handling equipment:

______________ Char disposal handling system manufacturer

________ Enter the type of bed material removal system used

1 – *Vacuum* – char disposal conveying system operates at a vacuum relative to the char disposalcollection hoppers.

2 – *Pressure* – char disposal conveying system operates at a pressure greater than the pressure in the char disposal collection hoppers

3 – *Vacuum pressure* – employs the best features of both the vacuum and pressure systems.

4 – *Water (sluice)* – employs water to sluice the char disposal away from the hoppers

5 – *Vacuum/water slurry* – char disposal conveying system operates at a vacuum relative to char disposal collection hoppers

6 – *Mechanical* – refers to mechanical conveying systems such as conveyor belts, bucket elevators, and screw conveyors

9 – *Other, describe* ______________________________

39. Boiler – Electrostatic Precipitator

Fly ash contained in the furnace exit flue gases can be removed by using an electrostatic precipitator. Enter the following information:

______________ Electrostatic precipitator manufacturer

______________ Number of fields

______________ Surface collection area (SCA) (ft^2/kacfm) at maximum continuous rating (MCR)

______ Enter the location of the electrostatic precipitator with respect to the air

1 – Before air heaters

2 – After air heaters

3 – Both before and after, or between the air heaters

40. Boiler – Baghouse Fly Ash System

Fly ash contained in the furnace exit flue gas is removed using fabric or fabric bag fillers. Enter the following information:

______________ Baghouse system manufacturer

______________ Manufacturer(s) of the baghouse exhauster booster fan(s)

______________ Manufacturer(s) of the motor(s) that drive the baghouse booster fan(s)

______________ TOTAL number of baghouse booster fans installed on the unit

______________ Air-to-cloth ratio, in ACFM/kft^2

______________ Bag material

______ Sonic assist cleaning? 1 – Yes 2 – No

______ Enter the type of baghouse at the unit:

1 – *Reverse* – clean flue gas is blown in a direction counter to normal operation to remove the fly ash from the bag.

2 – *Pulse (or pulse set)* – short bursts of compressed air are blown into the bag to cause a momentary expansion of the bag which dislodges the entrapped fly ash.

3 – *Shaker* – the bag is literally shaken to remove the fly ash collected on its surface.

4 – *Combination (reverse/shaker)*

9 – *Other, describe* ______________________________

________ Enter the type of baghouse booster fan(s) at the unit:

Centrifugal – blades mounted on an impeller (or rotor) which rotates within a spiral or volute housing. Mark the type of blades used on this type of fan:

1 – Forward curved

2 – Straight (radial or radial tipped)

3 – Backward curved (air foil or flat)

4 – Axial *(fixed or variable pitch)* – blades attached to central hub parallel to air flow.

9 – *Other, describe* ____

41. Boiler – Fly Ash Transport System

Enter the following information:

________________________ Fly ash removal system manufacturer

________ Enter the type of fly ash removal system used:

1 – *Vacuum* – ash-conveying system operates at a vacuum relative to the fly ash collection hoppers. Ash is dry.

2 – *Pressure* – ash conveying system operates at a pressure greater than the pressure in the fly ash collection hoppers. Ash is dry.

3 – *Vacuum-pressure* – employs the best features of both the vacuum and pressure systems.

4 – *Water (sluice)* – employs water to sluice the ash away from the hoppers.

5 – Vacuum/water slurry – ash conveying system operates at a vacuum relative to the fly ash collection hoppers. Ash is wet.

6 – *Mechanical* – refers to mechanical conveying systems such as conveyor belts, bucket elevators, and screw conveyors.

9 – *Other, describe* ____

42. Steam Turbine – Manufacturer

Enter the name of the manufacturer of the steam turbine:

________________________ Steam turbine manufacturer

43. Steam Turbine – Enclosure

Is 50% or more of the steam turbine outdoors (not enclosed in building framing and siding)?

________ 1 – Yes 2 – No

44. Steam Turbine – Nameplate Rating in MW

"Nameplate" is the design capacity stamped on the steam turbine's nameplate or published on the turbine guarantee flow diagram. In cases where the steam turbine's nameplate rating cannot be determined, approximate the rating by multiplying the MVA (megavolt amperes) by the rated power factor found on the nameplate affixed to the unit's generator (or nameplates in the case of cross compound units).

________________________ Steam turbine's nameplate rating (MW)

45. Steam Turbine – Type of Steam Turbine

Identify the steam turbine's casing or shaft arrangement.

________ Enter the type of steam turbine at the unit:

1 – *Single casing* – single (simple) turbine having one pressure casing (cylinder).

2 – *Tandem compound* – two or more casings coupled together in line.

3 – *Cross compound* – two cross-connected single casing or tandem compound turbine sets where the shafts are not in line.

4 – *Triple compound* – three cross-connected single casing or tandem compound turbine sets.

9 – *Other, describe* ____

46. Steam Turbine – Manufacturer's Building Block or Design Codes

Steam turbine building blocks or manufacturer's design codes are assigned by the manufacturer to designate a series of turbine designs (LM5000 or W501 for example). Enter the following information:

________________________ Manufacturer's code, first shaft

________________________ Manufacturer's code, second shaft (cross or triple compound

________________________ Turbine configuration and number of exhaust flows (e.g. tandem compound, four flow)

47. Steam Turbine – Steam Conditions

Enter the following information on the Main, First Reheat, and Second Reheat Steam design conditions:

	Main Stream	**First Reheat**	**Second Reheat**
Temperature (ºF)	________	________	________
Pressure (psig)	________	________	________

48. Steam Turbine – High, Intermediate, and Low Pressure Sections

Enter the following information describing the various sections of the steam turbine:

High Pressure Casings

________________________ TOTAL number of high pressure casings, cylinders or shells

________________________ Back pressure of the high pressure condenser (if applicable) to the nearest one-tenth inch of mercury at the nameplate capacity and design water temperature.

Combined High Pressure/Intermediate Pressure Casings

________________________ TOTAL number of high/intermediate pressure casings, cylinders, or shells.

Intermediate Pressure Casings

________________________ TOTAL number of intermediate pressure casings, cylinders, or shells.

Combined Intermediate/Low Pressure Casings

____________________ TOTAL number of intermediate/low pressure casings, cylinders, or shells.

Low Pressure Casings

____________________ TOTAL number of low pressure casings, cylinders or shells.

____________________ Back pressure of the low pressure condenser to the nearest one-tenth inch of mercury at nameplate capacity and design water temperature.

____________________ The last stage blade length (inches) of the low pressure turbine, measured from hub to end of top of blade.

49. Steam Turbine – Governing System

Enter the following information for the steam turbine governing system:

________ Enter the type of governing system used at the unit:

1 – *Partial arc* – main steam flow is restricted to one sector of the turbine's first stage at startup.

2 – *Full arc* – main steam is admitted to all sectors of the turbine's first stage at startup.

3 – *Either* – capable of admitting steam using either partial or full arc techniques.

9 – *Other, describe* ____

________ Enter the type of turbine governing system used at the unit:

1 – *Mechanical hydraulic control (MHC)* – turbine speed monitored and adjusted through mechanical and hydraulic linkages.

2 – *Analog electro-hydraulic control (EHC)* – analog signals control electro-hydraulic linkages to monitor and adjust turbine speed.

3 – *Digital electro-hydraulic control (DHC)* – same as EHC except signals are digital rather than analog.

9 – *Other, describe* ____

50. Steam Turbine – Lube Oil System

Enter the following information for the steam turbine main lube oil system:

____________________ Main lube oil system manufacturer.

____________________ Main lube oil pump(s) manufacturer(s).

____________________ Manufacturer(s) of the motor(s)/steam turbine(s) that drives the main lube oil pump(s).

____________________ TOTAL number of steam turbine main lube oil pumps; include installed spares.

________ Enter the type of driver on the main lube oil pump:

1 – Motor

2 – Shaft

3 – Steam Turbine

4 – More than one

9 – *Other, describe* ____________________

51. Generator – Manufacturer

Enter the name of the manufacturer of the electric generator:

____________________ Generator manufacturer

52. Generator – Enclosure

Is 50% or more of the generator outdoors (not enclosed in building framing and siding)?

________ 1 – Yes 2 – No

53. Generator – Ratings and Power Factor

Enter the following information about the generator:

Design (Nameplate) Item	Main Generator	Second* Shaft	Third* Shaft
Voltage to nearest one-tenth kV	________	________	________
Megavolt amperes (MVA) Capability	________	________	________
RPM	________	________	________
Power Factor (enter as %)	________	________	________
*Cross compound units	________	________	________

54. Generator – Cooling System

Two types of cooling methods are typically used. First is the "inner cooled" method, where the cooling medium is in direct contact with the conductor copper or is separated by materials having little thermal resistance. The other is the "conventional" cooling method where the heat generated within the windings must flow through the major ground insulation before reaching the cooling medium.

________ Enter the type of cooling method used by the generator:

1 – Stator inner cooled and rotor inner cooled.

2 – Stator conventionally cooled and rotor conventionally cooled.

3 – Stator inner cooled and rotor conventionally cooled.

9 – *Other, describe* ____________________

________ ________ Enter the mediums used to cool the generator's stator and rotor:

Stator Rotor

A – Air

H – Hydrogen

O – Oil

W – Water

M – More than one

55. Generator – Hydrogen Pressure

____________________ Enter the generator hydrogen pressure IN PSIG at nameplate MVA.

56. Exciter – Configuration

Enter the following information about the main exciter:

____________________ Exciter manufacturer

____________________ TOTAL number of exciters; include installed spares.

____________________ MINIMUM number of exciters required to obtain maximum capacity from the unit.

_____ Enter the type of main exciters used at the unit:

1 – *Static* – static excitation where D.C. is obtained by rectifying A.C. from generator terminals and D.C. is fed into rotor by collector rings.

2 – *Rotating D.C. generator* – exciter supplies D.C. from a commutator into the main rotor by means of collector rings.

3 – *Brushless* – an A.C. exciter (rotating armature type) whose output is rectified by a semiconductor device to provide excitation to an electric machine. The semiconductor device would be mounted on and rotate with the A.C. exciter armature.

4 – *Alternator rectifier*

9 – *Other, describe* ____

_____ Enter the type(s) of exciter drive(s) used by the main exciter IF it is rotating:

1 – Shaft direct

2 – Shaft gear

3 – Motor

9 – *Other, describe* ____

57. Auxiliary Systems – Main Condenser

Enter the following information for the main condenser and its auxiliaries:

____________________ Main condenser manufacturer

____________________ TOTAL number of passes made by the circulating water as it passes through the condenser.

____________________ TOTAL number of condenser shells.

____________________ Condenser tube materials used in the majority (50% or more) of the condenser tubes.

____________________ Air ejector or vacuum pump manufacturer.

_____ Enter the type of air removal equipment used on the condenser:

1 – Vacuum pump

2 – Steam jet air ejector

3 – Both

9 – *Other, describe* ____________________

________ Enter the type of cooling water used in the condenser:

1 – *Fresh* – salinity values less than 0.50 parts per thousand.
2 – *Brackish* – salinity value ranging from approximately 0.50 to 17 parts per thousand.
3 – *Salt* – salinity values greater than 17 parts per thousand.
9 – *Other, describe* ____________________

________ Enter the origin of the circulating water used in the condenser:

1 – River
2 – Lake
3 – Ocean or Bay
4 – Cooling Tower
5 – Fresh water wells
9 – *Other, describe* ____________________

58. Auxiliary Systems – Condenser Cleaning System

Enter the following information about the ON-LINE main condenser cleaning system at the unit (leave blank if cleaning is manual):

____________________ On-line main condenser cleaning system manufacturer.

________ Enter the type of on-line main condenser cleaning system used at the unit:

1 – Ball sponge rubber
2 – Brushes
3 – Chlorination
4 – On-line backwash
9 – *Other, describe* ____________________

59. Auxiliary Systems – Condensate Polishing System

A “condensate polisher” is an in-line demineralizer located in the condensate water system to treat water coming from the condenser to the boiler. It is not the demineralizer that prepares raw or untreated water for eventual use in the steam production process.

Enter the following information about the condensate polishing system at the unit:

____________________ Condensate polishing system manufacturer

Enter the % treated of the condensate flow at maximum unit capacity that can be treated:

____________________ % Treated

60. Auxiliary Systems – Condensate Pumps

Enter the following information for the main condensate pumps (those at the discharge of the condenser):

______________________	Condensate pump(s) manufacturer(s).
______________________	Manufacturer(s) of the motor(s) that drives the condensate pump(s).
______________________	Number of condensate pumps per manufacturer; include installed spares.
______________________	TOTAL number of condensate pumps for the unit.
______________________	MINIMUM number of condensate pumps required to obtain maximum capacity from the unit.

61. Auxiliary Systems – Condensate Booster Pumps

Condensate booster pumps increase the pressure of the condensate water between the low pressure and the intermediate or high pressure feedwater heaters. Enter the following information for the condensate booster pumps:

______________________	Condensate booster pump(s) manufacturer(s)
______________________	Manufacturer(s) of the motor(s) that drives the condensate booster pump(s).
______________________	Number of condensate booster pumps per manufacturer; include installed spares.
______________________	TOTAL number of condensate booster pumps for the unit.
______________________	MINIMUM number of condensate booster pumps required for maximum capacity from the unit.

62. Auxiliary Systems – Feedwater (Boiler Feed) Pumps

The feedwater (boiler feed) pumps move the feedwater through the feedwater system into the boiler. Enter the following information on the feedwater pumps installed at the unit:

______________________	Feedwater (boiler feed) pump(s) manufacturer(s).
______________________	Operating speed (RPM) of the feedwater pump(s) at full load.
______________________	Number of feedwater pumps per manufacturer; include installed spares.
______________________	TOTAL number of feedwater pumps for the unit.
______________________	MINIMUM number of feedwater pumps required to obtain maximum capacity from the unit.
______________________	PERCENT (%) of the unit's maximum capacity that can be achieved with a single feedwater pump.

63. Auxiliary Systems – Feedwater (Boiler Feed) Pump Drives

Enter the following information for the feedwater (boiler feed) pump drives:

______________________	Manufacturer(s) of motor(s) or steam turbine(s) that drives the feedwater pump(s).

______ M1 ______ M2 Enter the type of equipment used to drive the feedwater (boiler feed)

1 – Motor – single speed
2 – Motor – two speed
3 – Motor – variable speed
4 – Steam turbine
5 – Shaft
6 – Motor gear
7 – Steam gear
8 – Shaft gear
9 – *Other, describe* ____________________

______ M1 ______ M2 Specify coupling type used for feedwater (boiler feed) pump.

1 – Hydraulic
2 – Mechanical
9 – *Other, describe* ____________________

64. Auxiliary Systems – Startup Feedwater (Boiler Feed) Pumps

Enter the following information for the startup feedwater pump(s) at the unit:

________________ Startup feedwater pump(s) manufacturer(s).

________________ Manufacturer(s) of the motor(s) that drives the startup feedwater pump(s).

________________ TOTAL number of startup feedwater pumps for the unit.

________________ PERCENT (%) of the unit's maximum capacity that can be achieved using a single startup feedwater pump.

______ M1 ______ M2 Indicate the additional capabilities of the startup feedwater pump:

1 – ADDITIVE: operated in conjunction with the feedwater (boiler feed) pumps.
2 – REPLACEMENT: can carry load for the feedwater (boiler feed) pumps at such times when the feedwater pumps are inoperative.
3 – STARTUP ONLY: cannot be used in lieu of the feedwater pumps.
9 – *Other, describe* ____________________

65. Auxiliary Systems – High Pressure Feedwater Heaters

High pressure feedwater heaters are those heat exchangers between the feedwater (boiler feed) pumps discharge and the economizer inlet. Enter the following information for the HIGH pressure feedwater heaters at the unit:

________________ High pressure feedwater heater(s) manufacturer(s).

________________ Number of high pressure feedwater heaters per manufacturer.

____________ Feedwater heater tube materials used in 50% or more of the tubes per manufacturer.

____________ TOTAL number of high pressure feedwater heaters for the unit.

______ ______ Enter the type of HIGH pressure feedwater heater(s):
M1 M2

1 – *Horizontal* – longitudinal axis of the heater shell is horizontal.
2 – *Vertical* – longitudinal axis of the heater shell is vertical.
3 – *Both*
9 – *Other, describe* ____________

66. Auxiliary Systems – Intermediate Pressure Feedwater Heaters

Intermediate pressure feedwater heaters are those heat exchangers between the condensate booster pump discharge and the deaerator. Enter the following information for the INTERMEDIATE pressure feedwater heaters at the unit:

____________ Intermediate pressure feedwater heater(s) manufacturer(s).

____________ Number of intermediate pressure feedwater heaters per manufacturer.

____________ Feedwater heater tube materials used in 50% or more of the tubes, per manufacturer.

____________ TOTAL number of intermediate pressure feedwater heaters for the unit.

______ ______ Enter the type of INTERMEDIATE pressure feedwater heater(s):
M1 M2

1 – *Horizontal* – longitudinal axis of the heater shell is horizontal.
2 – *Vertical* – longitudinal axis of the heater shell is vertical.
3 – *Both*
9 – *Other, describe* ____________

67. Auxiliary Systems – Low Pressure Feedwater Heaters

Low pressure feedwater heaters are those heat exchangers between the condensate pump discharge and the condensate booster pump inlet. If the unit does not have condensate booster pumps, the low pressure feedwater heaters are located between the condensate pumps and the deaerator. Enter the following information for the LOW pressure feedwater heaters at the unit:

____________ Low pressure feedwater heater(s) manufacturer(s).

____________ Number of low pressure feedwater heaters per manufacturer.

____________ Feedwater heater tube materials used in 50% or more of the tubes, per manufacturer.

____________ TOTAL number of low pressure feedwater heaters for the unit.

______ ______ Enter the type of LOW pressure feedwater heater(s):
M1 M2

1 – *Horizontal* – longitudinal axis of the heater shell is horizontal.

2 – *Vertical* – longitudinal axis of the heater shell is vertical.

3 – *Both*

9 – *Other, describe* ______________________________

68. Auxiliary Systems – Deaerator Heater

Enter the following information on the deaerator heater at the unit:

______________________ Deaerator manufacturer(s)

________ ________ Enter the type of deaerator heater(s):

M1 M2

1 – *Spray* – high-velocity stream jet atomizes and scrubs the condensate.

2 – *Tray* – series of trays over which the condensate passes and is deaerated.

3 – *Vacuum* – a vacuum condition inside the shell for deaeration.

4 – *Combination*

9 – *Other, describe* ______________________________

69. Auxiliary Systems – Heater Drain Pumps

Enter the following information for the heater drain pumps at the unit:

______________________ Heater drain pump(s) manufacturer(s).

______________________ Manufacturer(s) of the motor(s) that drives the heater drain pump(s).

70. Auxiliary Systems – Circulating Water Pumps

Enter the following information for the circulating water pumps:

______________________ Circulating water pump(s) manufacturer(s).

______________________ Manufacturer(s) of the motor(s) that drives the circulating water pump(s).

______________________ Number of circulating water pumps per manufacturer; include installed spares.

______________________ TOTAL number of circulating water pumps for the unit.

______________________ MINIMUM number of circulating water pumps required to obtain maximum capacity from the unit DURING WINTER SEASON.

71. Auxiliary Systems – Cooling Tower and Auxiliaries

Enter the following information for the cooling tower and all its related auxiliary equipment at the unit:

______________________ Cooling tower manufacturer(s)

______________________ Cooling tower fan(s) manufacturer(s).

______________________ Manufacturer(s) of the motor(s) that drives the cooling tower fan(s).

71. Auxiliary Systems – Cooling Tower and Auxiliaries (Continued)

________ ________ Enter the type of cooling tower used by the unit:
M1 M2

1 – *Mechanical draft* (induced, forced, cross-flow and counter-flow) – fan(s) used to move ambient air through the tower.

2 – *Atmospheric spray* – air movement is dependent on atmospheric conditions and the aspirating effect of the spray nozzles.

3 – *Hyperbolic* (natural draft) – temperature difference between condenser circulating water and ambient air conditions, aided by hyperbolic tower shape, creates natural draft of air through the tower to cool the water.

4 – *Deck-filled* – wetted surfaces such as tiers of splash bars or decks aid in the breakup and retention of water drops to increase the evaporation rate.

5 – *Coil shed* – a combination structure of a cooling tower installed over a substructure that houses atmospheric coils or sections.

9 – *Other, describe* ____________________

The cooling tower booster pumps increase the pressure of the circulating water and force the water to the top of the cooling tower.

____________________ Cooling tower booster pump(s) manufacturer(s).

____________________ Manufacturer(s) of the motor(s) that drives the cooling tower booster pump(s).

____________________ Number of cooling tower booster pumps per manufacturer; include installed spares.

____________________ TOTAL number of cooling tower booster pumps for the unit.

____________________ MINIMUM number of cooling tower booster pumps required to obtain maximum capacity from the unit.

72. Balance of Plant – Main Transformer

The "main transformer" is the unit step-up transformer connecting the generator (or multiple generators if unit is cross compound) to the transmission system. Enter the following information for the MAIN transformer(s) at the unit:

____________________ Main transformer(s) manufacturer(s).

____________________ TOTAL number of main transformers per manufacturer; include installed spares.

____________________ Megavolt ampere (MVA) size of the main transformer(s); per manufacturer

________ ________ Enter the type of MAIN transformer at the unit
M1 M2

1 – Single phase

2 – Three phase

9 – *Other, describe* ____________________

73. Balance of Plant – Unit Auxiliary Transformer

The "unit auxiliary transformer" supplies the auxiliaries when the unit is synchronized. Enter the following information for this transformer:

____________________ Unit auxiliary transformer(s) manufacturer(s).

____________________ TOTAL number of unit auxiliary transformers per manufacturer.

____________________ LOW SIDE voltage in kilovolts (kV) of the unit auxiliary transformer(s) at 55 ºF, per manufacturer

74. Balance of Plant – Station Service Transformer

The "station service (start-up) transformer" supplies power from a station high voltage bus to the station auxiliaries and also to the unit auxiliaries during unit start-up and shutdown. It also may be used when the unit auxiliary transformer is not available (or nonexistent).

____________________ Station service transformer(s) manufacturer(s).

____________________ TOTAL number of station service transformers per manufacturer.

____________________ HIGH SIDE voltage in kilovolts (kV) of the station service transformer(s) at 55 ºF, per manufacturer

____________________ LOW SIDE voltage in kilovolts (kV) of the station service transformer(s) at 55 ºF, per manufacturer

75. Balance of Plant – Auxiliary (Start-up) Boiler

Enter the following information on the auxiliary boiler at the unit:

____________________ Auxiliary boiler manufacturer(s).

76. Balance of Plant – Auxiliary Generator

Enter the following information on the auxiliary generator at the unit:

____________________ Auxiliary generator manufacturer(s).

________ M1 ________ M2 Is the auxiliary generator shaft driven?

1 – Yes

2 – No

77. Balance of Plant – Plant Process Computer

Enter the following information for the plant process computer(s):

____________________ Plant process computer manufacturer(s).

________ M1 ________ M2 Enter the number of plant process computers available to the unit

1 – One computer for this unit only.

2 – Two computers for this unit only.
3 – One computer shared by one or more units.
4 – Two computers shared by one or more units.
9 – *Other, describe* ____________________

________ ________ Describe how the plant process computers are linked within the plant:
M1 M2

1 – Centralized
2 – Distributive
3 – Stand alone
9 – *Other, describe* ____________________

77. Balance of Plant – Plant Process Computer (Cont.)

________ ________ Enter the system capability of the plant process computer:
M1 M2

1 – Monitor only
2 – Monitor and control
9 – *Other, describe* ____________________

____________________ System vendor

First certified date

________ ________ ________
Year Month Day

________ Monitoring technique

1 – Extractive
2 – Dilution
3 – In Situ

________ Analysis Method

1 – Wet
2 – Dry
9 – *Other, describe* ____________________

79. CEMS – Pollutant Gas and Diluent Gas Analyzers/Monitors

Sulfur Dioxide (SO_2) Analyzers

____________________ Manufacturer(s)
____________________ Model number(s)

________ ________ Number of installed analyzers
M1 M2

________ ________ Number of installed spare analyzers
M1 M2

________ ________ Type(s)
M1 M2

1 – Ultraviolet
2 – Infrared
3 – Fluorescence
9 – *Other, describe* ____

________ ________ Instrument range (parts per million)
M1 M2

1 – 0-50
2 – 0-150
3 – 0-500
9 – *Other, describe* ____

________ ________ Shared? (1 - Yes, 2 – No)
M1 M2

Oxides of Nitrogen (NO_x) Analyzers

______________________________ Manufacturer(s)
______________________________ Model number(s)

________ ________ Number of installed analyzers
M1 M2

________ ________ Number of installed spare analyzers
M1 M2

________ ________ Type(s)
M1 M2

1 – Infrared
2 – Chemiluminescent
9 – *Other, describe* ____

________ ________ Instrument range (parts per million)
M1 M2

1 – 0-50
2 – 0-150
3 – 0-500
9 – *Other, describe* ______________________________

________ ________ Shared? (1 - Yes, 2 – No)
M1 M2

Carbon Monoxide (CO) Analyzers

______________________________ Manufacturer(s)
______________________________ Model number(s)

________ ________ Number of installed analyzers
M1 M2

________ ________ Number of installed spare analyzers
M1 M2

________ ________ Type(s)
M1 M2

1 – Infrared solid state
2 – Infrared luft
3 – Gas filter correlation
9 – *Other, describe* ______________________________

________ ________ Instrument range (parts per million)
M1 M2

1 – 0-50
2 – 0-150
3 – 0-500
9 – *Other, describe* ______________________________

________ ________ Shared? (1 - Yes, 2 – No)
M1 M2

Carbon Dioxide (CO_2) Analyzers

______________________________ Manufacturer(s)
______________________________ Model number(s)

________ ________ Number of installed analyzers
M1 M2

________ ________ Number of installed spare analyzers
M1 M2

________ _______ Instrument range (parts per million)
M1 M2

1 – 0-50
2 – 0-150
3 – 0-500
9 – *Other, describe* ____

________ _______ Shared? (1 - Yes, 2 – No)
M1 M2

Oxygen (O_2) Analyzers

________________________________ Manufacturer(s)
________________________________ Model number(s)

________ _______ Number of installed analyzers
M1 M2

________ _______ Number of installed spare analyzers
M1 M2

________ _______ Type(s)
M1 M2

1 – Zirconia oxide
2 – Paramagnetic
3 – Fuel cell
9 – *Other, describe* ____

________ _______ Instrument range (parts per million)
M1 M2

1 – 0-50
2 – 0-150
3 – 0-500
9 – *Other, describe* ____

________ _______ Shared? (1 - Yes, 2 – No)
M1 M2

Opacity Monitors

________________________________ Manufacturer(s)
________________________________ Model number(s)

________ _______ Number of installed analyzers

________ ________
M1 M2

________ ________ Number of installed spare analyzers
M1 M2

________ ________ Probe placement (if unit is equipped with a FGD system)
M1 M2

1 – Before scrubber 2 – After scrubber

80. CEMS – Flue Gas Flow Monitors

________________________________ Manufacturer(s)
________________________________ Model number(s)

________ ________ Number of installed monitors
M1 M2

________ ________ Number of installed spare monitors
M1 M2

________ ________ Volumetric Flow Rate (ACFM):
M1 M2

________ ________ Flow rate measurement technique
M1 M2

1 – Thermal sensing (hot-wire anemometer or dispersion)
2 – Differential pressure array
3 – Acoustic velocimetry (ultrasonic transducers)
4 – Combination
9 – *Other, describe* ____

81. CEMS – Data Acquisition and Reporting System

________________________________ Hardware manufacturer(s)

________ Hardware architecture

1 – Vendor-supplied dedicated system
2 – Modified existing plant computer
3 – Stand alone, pc-based system not supplied by CEMS system vendor
9 – *Other, describe* ____

________________________________ Software supplier

________ ________ Shared? (1 - Yes, 2 – No)
M1 M2

NO_x REDUCTION SYSTEMS

These systems include Selective Non-catalytic Reduction, Selective Catalytic Reduction, Catalytic Air Heaters, and Staged NO_x Reduction, which is a combination of the three methods. Excluded from this category are Low NO_x burners, combustion modifications, and flue gas recirculation.

Please complete the following information for the NO_x Reduction Systems installed on your unit. (The appropriate items under each method should be completed for a Staged NO_x Reduction System).

82. Selective Non-Catalytic Reduction System (SNCR)

________ Reagent

1 – Ammonia
2 – Urea
9 – *Other, describe* ____

________ Injector Type

1 – Wall nozzles
2 – Lance
9 – *Other, describe* ____

________ Injection Equipment Location

1 – Furnace
2 – Superheater
3 – Economizer
9 – *Other, describe* ____

________ Number of Injectors

82. Selective Non-Catalytic Reduction System (SNCR) (Continued)

________ Carrier Gas Type

1 – Steam
2 – Air
9 – *Other, describe* ____

________________ Total flow rate (lb/hr)
________________ Pressure at nozzle (psi)
________________ Nozzle exit velocity (ft/sec)

83. Selective Catalytic Reduction System (SCR)

________ Reactor

1 – Separate
2 – In Duct

________________________________ Flue gas take-off location

________ Reagent

1 – Ammonia
2 – Urea
9 – *Other, describe* ____

________ Ammonia Injection Grid Location

1 – Furnace
2 – Superheater
3 – Economizer
4 – Zoned

________ Duct Configuration

1 – Flow straighteners
2 – Turning vanes
3 – Dampers

________ Catalyst Element Type

1 – Plate
2 – Honeycomb
9 – *Other, describe* ____

________ Catalyst Support Material

1 – Stainless steel
2 – Carbon steel
9 – *Other, describe* ____

________ Catalytic Material Configuration

1 – Vertical
2 – Horizontal
9 – *Other, describe* ____

____________________ Surface face area (sq. ft.)

____________________ Catalyst volume (cu. ft.)

____________________ Number of layers

____________________ Layer thickness (inches)

________ Soot blowers (if applicable)

1 – Air
2 – Steam
3 – Both air and steam

____________________ Manufacturer(s)

____________________ Number of soot blowers

84. Catalytic Air Heaters

________ Element Type

1 – Laminar surface
2 – Turbulent surface
9 – *Other, describe* ____

________ Support Material, if any

1 – Stainless steel
2 – Carbon steel
9 – *Other, describe* ____

________ Catalyst Material Configuration

1 – Horizontal air shaft
2 – Carbon steel
9 – *Other, describe* ____

____________________ Total face area (sq. ft.)

____________________ Open face area (sq. ft.)

____________________ Layer thickness (inches)