

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
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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 (°F)

_____ 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 Exchange

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

_____ Enter the type of high pressure loop seal fan(s)/blower(s) at the unit
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* _____

14. Boiler – Design Parameters

_____	Percent SO ₂ removal
_____	<i>Calcium-to-sulfur molar ratio</i> – 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.)
_____	<i>Reinjection/recycle ratio</i> – mass flow rate of char material that is reinjected to the combustor divided by the mass flow rate of fuel feed
_____	<i>Average superficial air velocity (ft/sec)</i> – 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.
_____	<i>Fuel feed rate</i>
_____	<i>Sorbent feed rate</i>

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 SO₂ 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
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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 (°F)
_____	_____	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)
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	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:

_____ Stack/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

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

- 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)

_____ Enter the type of primary air (forced 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 primary air (forced 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* _____

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 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 (¾" 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 (°F)

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 disposal collection 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) (ft²/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 exhaust 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/kft²
 _____ 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 (°F)	_____	_____	_____
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).
--	------------------------------------------------------------------------------------

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

M1	M2
<p>1 – Motor – single speed</p> <p>2 – Motor – two speed</p> <p>3 – Motor – variable speed</p> <p>4 – Steam turbine</p> <p>5 – Shaft</p> <p>6 – Motor gear</p> <p>7 – Steam gear</p> <p>8 – Shaft gear</p> <p>9 – <i>Other, describe</i> _____</p>	

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

M1	M2
<p>1 – Hydraulic</p> <p>2 – Mechanical</p> <p>9 – <i>Other, describe</i> _____</p>	

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.

Indicate the additional capabilities of the startup feedwater pump:

M1	M2
<p>1 – ADDITIVE: operated in conjunction with the feedwater (boiler feed) pumps.</p> <p>2 – REPLACEMENT: can carry load for the feedwater (boiler feed) pumps at such times when the feedwater pumps are inoperative.</p> <p>3 – STARTUP ONLY: cannot be used in lieu of the feedwater pumps.</p> <p>9 – <i>Other, describe</i> _____</p>	

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 °F, 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 °F, per manufacturer
 _____ LOW SIDE voltage in kilovolts (kV) of the station service transformer(s)
 _____ at 55 °F, 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).

_____ Is the auxiliary generator shaft driven?
 M1 M2

- 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).

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

- 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 (SO₂) 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* _____

M1 _____
M2 Shared? (1 - Yes, 2 – No)

Carbon Monoxide (CO) Analyzers

Manufacturer(s)

Model number(s)

M1 _____
M2 Number of installed analyzers

M1 _____
M2 Number of installed spare analyzers

M1 _____
M2 Type(s)

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

M1 _____
M2 Instrument range (parts per million)

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

M1 _____
M2 Shared? (1 - Yes, 2 – No)

Carbon Dioxide (CO₂) Analyzers

Manufacturer(s)

Model number(s)

M1 _____
M2 Number of installed analyzers

M1 _____
M2 Number of installed spare analyzers

_____ 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 (O₂) 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	
M1	M2	Number of installed spare analyzers
M1	M2	Probe placement (if unit is equipped with a FGD system)
		1 – Before scrubber 2 – After scrubber

80. CEMS – Flue Gas Flow Monitors

	Manufacturer(s)	
	Model number(s)	
M1	M2	Number of installed monitors
M1	M2	Number of installed spare monitors
M1	M2	Volumetric Flow Rate (ACFM):
M1	M2	Flow rate measurement technique
		1 – Thermal sensing (hot-wire anemometer or dispersion)
		2 – Differential pressure array
		3 – Acoustic velocimetry (ultrasonic transducers)
		4 – Combination
		9 – <i>Other, describe</i> _____

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 – <i>Other, describe</i> _____	
	Software supplier	
M1	M2	Shared? (1 - Yes, 2 – No)

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)