

## Unit Design Data

### Fluidized Bed Combustion (Voluntary Reporting)

**(Note:** The NERC Board of Trustees approved the *GADS Task Force Report* ([dated July 20, 2011](#))<sup>i</sup>, 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](mailto: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:

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Location of unit (State):

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Energy Information Administration (EIA) Number:

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Regional Entity:

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Subregion:

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Data reporter:

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Telephone number:

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Date:

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**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 Code       Unit Code

Name of unit

**2. Date the Unit Entered Service**

The in-service date establishes the starting point for review of the 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 megavoltamperes (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 load with minor load following
  - 2 - Periodic start-up, load follow daily, reduced load nightly
  - 3 - Weekly start-up, load follow daily, reduced load nightly
  - 4 - Daily start-up, load follow daily, off-line nightly
  - 5 - Start-up chiefly to meet daily peaks
  - 9 - None of the above

**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             |
| _____ | Manufacturer’s model or series name or number (original) |
| _____ | Manufacturer’s model or 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 overbed or underbed.

**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) - defined above
- 2 Under-bed feed (BFB) - defined above
- 3 Both over-bed and under-bed feed (BFB) - defined above
- 4 Within-bed feed (CFB) - defined above

Feed with fuel:

- 1 - Yes
- 2 - No

For bed material:

- 1 - Over-bed feed (BFB) - defined above
- 2 - Under-bed feed (BFB) - defined above
- 3 - Both over-bed and under-bed feed (BFB) - defined above
- 4 - Within-bed feed (CFB) - defined above

**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 downcomers 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.

M1

M2

Enter the type of boiler recirculation pump(s) used:

- 1 *Injection (or injection seal)* – controlled-leakage boiler recirculation pumps mounted vertically with a rigid shaft designed to carry its own thrust.
- 2 *Leakless (canned, canned-motor or zero-leakage)* – leakless pump and its motor designed as an integral pressurized sealed unit.
- 9 *Other, describe* \_\_\_\_\_

**12. Boiler – Heat Exchanger**

| <b>In bed:</b>                                       | <b>Reheat</b> | <b>Supht</b> | <b>Evap</b> | <b>Preheat</b> |
|--|---------------|--------------|-------------|----------------|
| 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                               | _____         | _____        | _____       | _____          |

| <b>Convective:</b>                                   | <b>Reheat</b> | <b>Supht</b> | <b>Evap</b> | <b>Preheat</b> |
|--|---------------|--------------|-------------|----------------|
| 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                               | _____         | _____        | _____       | _____          |

| <b>Radiant:</b>                                      | <b>Reheat</b> | <b>Supht</b> | <b>Evap</b> | <b>Preheat</b> |
|--|---------------|--------------|-------------|----------------|
| 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, multiclone, ubeam, horizontal).   |
| _____ | Separator recirculation temperature.  |
| _____ | Liner (refractory or water cooled).   |
| _____ | Type of pressure seal (lockhoppers, 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**

*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.
- 5 – *Positive displacement (rotary)* – such blowers are essentially constant-volume blowers with variable discharge pressure. Volume can be varied only by changing the speed or by by-passing or wasting some of the capacity of the machine. The discharge pressure will vary with the resistance on the discharge side of the system.
- 9 – *Other, describe* \_\_\_\_\_

**14. Boiler – Design Parameters**

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Percent SO<sub>2</sub> 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<sub>2</sub> 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 (waterwalls, superheaters, external, etc.).

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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.

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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<sub>2</sub> 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**

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**Secondary Fuel**

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**Fuel Codes**

|           |                     |           |                      |
|-----------|---------------------|-----------|----------------------|
| <b>CC</b> | Coal                | <b>PR</b> | Propane              |
| <b>LI</b> | Lignite             | <b>SL</b> | Sludge Gas           |
| <b>PE</b> | Peat                | <b>GE</b> | Geothermal           |
| <b>WD</b> | Wood                | <b>NU</b> | Nuclear              |
| <b>OO</b> | Oil                 | <b>WM</b> | Wind                 |
| <b>DI</b> | Distillate Oil (#2) | <b>SO</b> | Solar                |
| <b>KE</b> | Kerosene            | <b>WH</b> | Waste Heat           |
| <b>JP</b> | JP4 or JP5          | <b>OS</b> | Other - Solid (Tons) |
| <b>WA</b> | Water               | <b>OL</b> | Other - Liquid (BBL) |
| <b>GG</b> | Gas                 | <b>OG</b> | Other - Gas (Cu.Ft.) |

**Fuel Characteristics**

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Average Heat Content in Fuel  
(Btu/lb, Btu/bbl, Btu/CuFt)

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% Ash Content (to one decimal place)

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% Sulfur Content (to one decimal place)

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% Moisture Content (to one decimal place)

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Ash Softening Temp (°F) (in a reducing atmosphere)  
(ASTM STD D-1857, Part 26) (coal units only)

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Grindability Hardgrove Index  
(ASTM STD D-409, Part 26) (coal units only)

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% Vanadium & Phosphorous (to one decimal place)  
(oil units only)

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Fuel Top (largest particle) size

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

**Sorbent:**

**Primary**

**Secondary**

**Type**

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Abrasion Index (identify index used)

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% by Mass Magnesium Content (to one decimal place)



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% by Mass Calcium Content (to one decimal)



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% by Mass Carbon Dioxide Content (to one decimal place)



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% by Mass Moisture Content (to one decimal)



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Sorbent top (largest particle size)

**Non-sorbent:**

**Primary**

**Secondary**

**Type**

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Initial Ash Fusion Temperature (°F)

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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 feedwater, 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 | E – Oil and Gas   |
| B – Heavy oil              | F – Propane       |
| C – Gas                    | M – More than one |
| D – Coal                   |                   |

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 is energized and used to ignite the fuel.
- 3 – *High energy arc* – a low voltage, high energy pulse arc is used to ignite the fuel.
- 4 – *Plasma arc* – a high dc voltage current is used to ionize the air resulting in a high energy arc that ignites the fuel.
- 4 – *Manual* – Ignition torch or lance inserted into boiler by operating personnel.
- 5 – *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 | E – Oil and Gas   |
| B – Heavy oil              | F – Propane       |
| C – Gas                    | M – More than one |
| D – Coal                   |                   |

**21. Boiler – Burner Systems (Continued)**

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 is energized and used to ignite the fuel.
- 3 – *High energy arc* – a low voltage, high energy pulse arc is used to ignite the fuel.
- 4 – *Plasma arc* – a high dc voltage current is 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 | E – Oil and Gas   |
| B – Heavy oil              | F – Propane       |
| C – Gas                    | M – More than one |
| D – Coal                   |                   |

Enter the type of lance injection 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 is energized and used to ignite the fuel.
- 3 – *High energy arc* – a low voltage, high energy pulse arc is used to ignite the fuel.
- 4 – *Plasma arc* – a high dc voltage current is 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/reclaimer 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:

|       |   |
|-------|---|
| _____ | Type of crusher(s).   |
| _____ | Crusher(s) manufacturer(s).   |
| _____ | Manufacturer(s) of the motor(s) that drives the 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 (lockhoppers, 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 (lockhoppers, 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/reclaimer manufacturer.   |

**26. Boiler – Sorbent Crusher or Pulverizer Capability (Continued)**

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 (lockhoppers, rotary valve, gravimetric pump, loop seal). |
| _____ | Number of sorbent feed 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 (lockhoppers, rotary valve, gravimetric pump, loop seal). |
| _____ | Number of bed material 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 systems 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:

|                      |                      |                      |                      |      |                      |                      |       |                      |                      |     |
|----------------------|----------------------|----------------------|----------------------|------|----------------------|----------------------|-------|----------------------|----------------------|-----|
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | Year | <input type="text"/> | <input type="text"/> | Month | <input type="text"/> | <input type="text"/> | 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 drive(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) |
|--|--|--|--|----------------------|

|    |    |   |
|----|----|---|
| M1 | M2 | Enter the type of induced 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 induced draft fan drive(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* \_\_\_\_\_

**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)

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

- 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.

**33. Boiler – Primary Air Heating System (Continued)**

M1  M2

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

- 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 condensible 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.

M1  M2

Enter the type of additional air heater(s) at the unit (see item 33 for definitions of each type):

- 1 – Regenerative (Ljungstrom)
- 2 – Tubular
- 3 – Steam Coil
- 4 – Regenerative (Rothemule)
- 5 – Recuperative (plate type)
- 6 – Heat Pipe
- 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.

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

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

Type    Number

M2

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

Type    Number

M3

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

Type    Number

- 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 char disposal 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 the 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<sup>2</sup>/kacfm) at maximum continuous rating (MCR).

**39. Boiler – Electrostatic Precipitator (Continued)**

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/kft<sup>2</sup>.

\_\_\_\_\_ Bag material.

Sonic assisted 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 (megavoltamperes) 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 Steam  | First Reheat  | Second Reheat                             |
|------------------|---|---|---|
| Temperature (°F) | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> |
| Pressure (psig)  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> |

**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  | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| Megavoltamperes (MVA) Capability | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| RPM                              | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| Power Factor (enter as %)        | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

\*Cross compound units.

**54. Generator – Cooling System**

Two types of cooling methods are typically used. First is the “innercooled” 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 innercooled and rotor innercooled.
- 2 – Stator conventionally cooled and rotor conventionally cooled.
- 3 – Stator innercooled and rotor conventionally cooled.
- 9 – Other, describe \_\_\_\_\_

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

| <input type="checkbox"/> Stator | Medium        | Rotor        | <input type="checkbox"/> |
|---------------------------------|---------------|--------------|--------------------------|
| <u>  A  </u>                    | Air           | <u>  A  </u> |                          |
| <u>  H  </u>                    | Hydrogen      | <u>  H  </u> |                          |
| <u>  O  </u>                    | Oil           | <u>  O  </u> |                          |
| <u>  W  </u>                    | Water         | <u>  W  </u> |                          |
| <u>  M  </u>                    | More than one | <u>  M  </u> |                          |

**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 dc is obtained by rectifying ac from generator terminals, and dc is fed into rotor by collector rings.
- 2 – *Rotating dc generator* – exciter supplies dc from a commutator into the main rotor by means of collector rings.
- 3 – *Brushless* – an ac (rotating armature type) exciter 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 ac 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        | 4 – Cooling Tower         |
| 2 – Lake         | 5 – Fresh water wells     |
| 3 – Ocean or Bay | 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 – Staff 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.

M1

M2



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

- 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.               |

M1      M2  
   

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

- 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.                        |

M1      M2  
   

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

- 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)

M1  M2

Enter the type of deaerator heater(s):

- 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)**

M1  M2

Enter the type of cooling tower used by the unit:

- 1 – *Mechanical draft* (induced, forced, cross-flow and counterflow) – 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.

\_\_\_\_\_ Megavoltampere (MVA) size of the main transformer(s); per manufacturer.

M1  M2

Enter the type of MAIN transformer at the unit:

- 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°, 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°, per manufacturer.

\_\_\_\_\_ LOW SIDE voltage in kilovolts (kV) of the station service transformer(s) at 55°, 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).

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 \_\_\_\_\_

M1

M2

Describe how the plant process computers are linked within the plant:

- 1 – Centralized
- 2 – Distributive
- 3 – Stand alone
- 9 – Other, describe \_\_\_\_\_

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

M1

M2

Enter the system capability of the plant process computer:

- 1 – Monitor only
- 2 – Monitor and control
- 9 – Other, describe \_\_\_\_\_

**78. CEMS – General**

\_\_\_\_\_ 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**

**1. Sulfur Dioxide (SO<sub>2</sub>) Analyzers**

\_\_\_\_\_ Manufacturer(s)

\_\_\_\_\_ Model number(s)

M1 M2  
    Number of installed analyzers

M1 M2  
    Number of installed spare analyzers

M1 M2  
  Type(s)

- 1 – Ultraviolet
- 2 – Infrared
- 3 – Fluorescence
- 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)

**2. Oxides of Nitrogen (NO<sub>x</sub>) Analyzers**

\_\_\_\_\_ Manufacturer(s)

\_\_\_\_\_ Model number(s)

M1 M2  
    Number of installed analyzers

M1 M2  
    Number of installed spare analyzers

M1 M2  
  Type(s)

79. **CEMS - Pollutant Gas and Diluent Gas Analyzers/Monitors** (Continued)

- 1 - Infrared
- 2 - Chemiluminescent
- 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)

**3. 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 \_\_\_\_\_

79. **CEMS – Pollutant Gas and Diluent Gas Analyzers/Monitors (Continued)**

**4. Carbon Dioxide (CO<sub>2</sub>) Analyzers**

\_\_\_\_\_ Manufacturer(s)  
 \_\_\_\_\_ Model number(s)

M1 M2  
    Number of installed analyzers

M1 M2  
    Number of installed spare analyzers

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)

**5. Oxygen (O<sub>2</sub>) Analyzers**

\_\_\_\_\_ Manufacturer(s)  
 \_\_\_\_\_ Model number(s)

M1 M2  
    Number of installed analyzers

M1 M2  
    Number of installed spare analyzers

M1 M2  
  Type(s)

- 1 - Zirconia oxide
- 2 - Paramagnetic
- 3 - Fuel cell
- 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)

**79. CEMS – Pollutant Gas and Diluent Gas Analyzers/Monitors (Continued)**

**6. Opacity Monitors**

\_\_\_\_\_ Manufacturer(s)

\_\_\_\_\_ Model number(s)

M1 M2  
    Number of installed analyzers

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

Volumetric Flow Rate (ACFM):

M1 M2

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 – Other, describe \_\_\_\_\_

**81. CEMS – Data Acquisition and Reporting System**

\_\_\_\_\_ Hardware manufacturer

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)

**NO<sub>x</sub> REDUCTION SYSTEMS**

These systems include Selective Non-catalytic Reduction, Selective Catalytic Reduction, Catalytic Air Heaters, and Staged NO<sub>x</sub> Reduction, which is a combination of the three methods. Excluded from this category are Low NO<sub>x</sub> burners, combustion modifications, and flue gas recirculation.

Please complete the following information for the NO<sub>x</sub> Reduction Systems installed on your unit. (The appropriate items under each method should be completed for a Staged NO<sub>x</sub> 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 \_\_\_\_\_

**83. Selective Catalytic Reduction System (SCR) (Continued)**

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)

Sootblowers (if applicable)

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

\_\_\_\_\_ Manufacturer(s)

\_\_\_\_\_ Number of sootblowers



**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)

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<sup>i</sup> [http://www.nerc.com/pa/RAPA/gads/MandatoryGADS/Revised\\_Final\\_Draft\\_GADSTF\\_Recommendation\\_Report.pdf](http://www.nerc.com/pa/RAPA/gads/MandatoryGADS/Revised_Final_Draft_GADSTF_Recommendation_Report.pdf)