2.0 PROCESS DESCRIPTION

Consumers performed a technology assessment to review and assess the various technologies currently available through commercial means for baseload power generation. A summary of that analysis is included as Appendix I. Consumers selected the ASCPC technology for this baseload plant. This section describes the major equipment and components of the ASCPC project.

2.1 ASCPC BOILER AND STEAM TURBINE

Coal is the most widely used fuel for electrical generation, and most coal-burning power plants use pulverized coal (PC) to fuel the boilers. PC combustion technology is a well-proven technology characterized by the firing of coal that is pulverized into a talcum powder consistency (50 microns or smaller in size), and then blown into the furnace, generating typical combustion temperatures of approximately 2,400°F. PC firing is proven for most types of coal, and its versatility has made it the most widely used method of coal firing for power generation worldwide. The coal is pulverized, sized, and blown through a classifier section to ensure that the proper coal particle size is achieved prior to injection into the furnace. Air is compressed via primary air fans, preheated through a regenerative air heater, and blown through the pulverizer as a motive source to inject the pulverized coal into the furnace. Forced draft (FD) fans provide the secondary combustion air required by the furnace. FD fans are sized to supply the proper quantity of combustion air. The secondary air is preheated to approximately 600°F in a regenerative air heater as required by the burner design.

The pulverized coal will be injected through burners located on the furnace walls. The burners will be designed to limit the formation of NO_x and are called low NO_x burners (LNBs). LNBs are designed to drive the fuel’s nitrogen compounds into the gas phase under overall rich fuel conditions. Staged OFA is also supplied by the FD fans and used to complete combustion and minimize the formation of NO_x within the furnace. OFA is admitted into the furnace above the coal burner registers (primary combustion zone).

The flue gas (combustion products) flows upward through the furnace and enters the backpass, or convective section of the boiler, which includes steam secondary superheaters, reheaters, and economizer. Exiting the boiler economizer, the flue gas enters the section containing the SCR catalysts and air heaters. Additional air pollution control equipment downstream of the SCR is used to remove pollutants from the flue gases prior to release to the atmosphere. These controls are described in Section 2.4.

The ASCPC boiler will be nominally rated at 8,190 MMBtu/hr heat input with a gross output of approximately 930 MW. The ASCPC boiler will produce steam at 1,100°F and 3,805 pound per square inch gauge (psig) (conditions at the steam turbine inlet) that will drive a steam turbine generator to produce electricity. The boiler will operate with a superheater temperature of 1,100°F, and a reheat temperature of nominally 1,100°F (referred to as an 1100/1100 cycle). The temperatures and pressures of the steam for the proposed ASCPC boiler will be much higher than for a subcritical PC boiler that typically operate at 2,400 psig and 1000°F. Because of this, the ASCPC will have a higher efficiency than a subcritical PC boiler. Supercritical technologies operate on a once-through steam/water cycle concept with no steam drum in the steam generator flow path. Heat is transferred to the feedwater fluid, increasing its enthalpy to acceptable levels, prior to admission to the steam turbine generator. The supercritical cycle will be implemented with a single steam reheat system. Figure 2-1, on page 2-11, presents a diagram of a typical supercritical pulverized coal steam generator system. At this time, Consumers has not selected the vendor for this equipment.

2.2 COAL SPECIFICATIONS

Western sub-bituminous PRB coal is currently the principal coal fuel for the existing Karn/Weadock complex and will be for the new ASCPC boiler also. The ASCPC boiler is being designed to burn 100% PRB coal as the primary fuel, but also will have the ability to burn up to a 50/50 blend of Eastern and PRB coal, based on heat input. The purpose of designing the ASCPC boiler for this blend is to provide long-term fuel flexibility for the project. Both Eastern bituminous and PRB sub-bituminous coals have a range of heating values, sulfur content, ash content and trace metals. The blends that will be used for the new boiler will be selected on the basis of sulfur content, as the FGD system is being designed for a maximum SO_2 inlet concentration of 1.4 lb/MMBtu. Based on the analysis of available coals and coals purchased by Consumers since 2001, there will be opportunities to blend in higher sulfur Eastern coal with PRB and still meet the 1.4 lb/MMBtu design criterion for the FGD system inlet.

PRB coal has a lower heating value (Btu/lb) than Eastern bituminous coal, and thus dictates the size of the boiler. Consumers had previously researched future fuel specifications for low sulfur PRB coal and determined that a minimum heating value of 8,300 Btu/lb was needed to properly size the boiler. This is based on PRB coal identified as PRB17. Since the heating values, sulfur, mercury and lead contents of coals vary between different mines and between shipments from the same mine, a review and statistical analysis of the "as received" values for each of these parameters for the shipments of coal to the existing Consumers power plants during 2001-2005 was conducted. Data on the ranges of values from other PRB mines previously identified as possible fuel sources for other fleet units were also reviewed by Cummins and Barnard Inc., the project Owner's Engineer.

The PRB coal identified for future use that has the maximum sulfur content is labeled as PRB9. It has a sulfur content of 0.54% (or 0.635 lb sulfur/MMBtu at 8,500 Btu/lb), which will produce an SO_2 concentration of 1.27 lb/MMBtu at the FGD system inlet. This coal represents the worst-case PRB sulfur content coal being considered by Consumers. Currently Consumers is not purchasing this coal, so it is not included in the "as received" coal data set described below. The highest sulfur content Eastern coal from the 5 year data set shows a maximum sulfur content of 1.29 lb sulfur/MMBtu or 1.58% at 12,279 Btu/lb. This would produce an SO_2 concentration of 2.57 lb/MMBtu at the FGD system inlet, so if this coal were to be used it would be blended with a lower sulfur fuel. A sulfur dioxide concentration less than or equal to 1.4 lb SO_2/MMBtu at the FGD system inlet, will result in emissions of sulfur dioxide and sulfuric acid mist at or below their BACT limit as described in Section 5. The amount of Eastern coal that could be blended at any one time would be dependent on the actual sulfur content of the PRB coal and Eastern coal being used.

In order to conservatively estimate the emissions, an evaluation of the range of values for each parameter for anticipated future coals was conducted. The identification of future coals includes many of the coals that Consumers has received from 2001 to 2005. The 5-year data set was divided into calendar years and a statistical analysis was performed using the ProUCL statistical software program available from USEPA. Since this past data is being used to predict future emissions for air permitting purposes, conservative values were chosen so as not to underestimate potential emissions. Therefore the 99^{th} percentile values from the worst-case year were chosen for the maximum short-term values and the 95% Upper Confidence Level (UCL) on the mean values were chosen for the annual averages. The 99th percentile indicates the percent of the distribution that is equal to or below 99% of the values. UCL's represent a confidence of 95% that the mean values will not be greater than these values. In performing these statistical analyses, the entire data was used, (i.e., no potential outliers were discarded so as to be as conservative as possible).

This means that there is no single coal that represents the worst case for all pollutants. To conservatively estimate emissions, the maximum short term (99^{th} percentile) values were used if the pollutant has an NAAQS or an air toxics screening level averaging time of 24 hours or less, and annual average (95% UCL) values were selected for longer term emission averaging times and to estimate annual emission rates. The sulfur and other fuel parameters used to calculate emissions are shown in Table 2-1 on page 2-5.

2.3 PLANT CONFIGURATION

The plant configuration is shown in a series of drawings included in Appendix C.

2.4 AIR QUALITY CONTROL SYSTEM (AQCS)

Based on the BACT considerations described in Section 5.0, the Air Quality Control System (AQCS) will consist of LNB's with OFA to minimize thermal NO_x formation, an SCR system to control NO_x emissions, a hydrated lime injection system to control sulfur trioxide (SO_3) and limit acid gas formation, an activated carbon injection (ACI) system to control mercury emissions, a fabric filter to remove particulate from the flue gases, and a wet FGD system using a limestone slurry to remove sulfur dioxide and other acid gases. A schematic drawing showing the flue gas flow path through the AQCS is included as Figure 2-2.

Table 2-1: Air Permitting Coal Specifications[1]

Parameter	Powder River Basin	Eastern Bituminous
Heating Value (Btu/lb)	8,300	12,300
Sulfur Concentration (@ Btu/lb) PRB#9 Coal, Eastern 99th Percentile	0.54 wt. % S (@8,500) (1.27 lb SO_2/MMBtu)	1.58 wt.% S (@12,279) (2.57 SO_2/MMBtu)
Sulfur Concentration (@ Btu/lb) Average (95% UCL)	0.30 wt. %S (@8,851) (0.69 lb SO_2/MMBtu)	0.89 wt. %S (@12,279) (1.44 lb SO_2/MMBtu)
Mercury Content (@ Btu/lb) Average (95% UCL)	0.06 ppmw (@8,300) (6.96E-06 lb/MMBtu)	0.14 ppmw (@12,300) (1.10E-05 lb/MMBtu)
Lead Content (@ Btu/lb) Average (95% UCL)	3.76 ppmw (@8,805) (4.27E-04 lb/MMBtu)	14.4 ppmw (@12,350) (1.17E-03 lb/MMBtu)
Fluorine Content (@ Btu/lb) Maximum (99th percentile)	83.7 ppmw (@8,816) (9.49E-03 lb/MMBtu)	93 ppmw (@12,538) (7.42E-03 lb/MMBtu)
Fluorine Content (@ Btu/lb) Average (95% UCL)	68.1 ppmw (@8,805) (7.73E-03 lb/MMBtu)	72.5 ppmw (@12,538) (5.78E-03 lb/MMBtu)

[1] The coal constituent listed represent the maximum in any given year, and are associated with the heating value for that coal for that year.

2.5 COOLING TOWER

Water will circulate through the condenser tubes to remove heat from the steam that is exhausted from the steam turbine. This circulating water, now warmer from the heat transferred from the condensing steam, will then flow to two mechanical draft cooling towers. The cooling towers will reject heat to the outdoor air, primarily through evaporation of a portion of the cooling water. This evaporated cooling water will be released to the environment as a vapor. A very small portion of the circulating water flow is released in the form of water droplets. These droplets, referred to as “drift”, may contain mineral compounds. As the water droplets evaporate into the air, the mineral compounds will be left behind, in the form of a particulate emission. To control the amount of drift, the cooling tower will be equipped with mist eliminators designed to limit drift to 0.0005% of the circulating water flow.

2.6 ANCILLARY EQUIPMENT

The ancillary equipment will include an auxiliary boiler, an emergency generator, a diesel driven fire pump, a diesel driven fire booster pump, and a diesel driven FGD quench pump. The 220 MMBtu/hr natural gas-fired auxiliary boiler will be used to assist in start up of the ASCPC boiler, and to provide heat when the ASCPC boiler is down. The boiler will have LNB, flue gas recirculation and combustion control optimization to minimize emissions. The emergency generator, as well as the pumps, will be driven by diesel fired engines, using low sulfur diesel fuel. The emergency generator will utilize a diesel engine to drive an electrical generator. The generator will be designed for 2,000 kilowatts (kW) and will be used to provide safe plant shutdown and critical load operation in the event of a power grid failure. An above ground 10,000 gallon diesel fuel storage tank will be installed.

2.7 MATERIAL HANDLING

2.7.1 Coal Handling

Bulk deliveries of coal will be received by rail and by ship, depending upon factors such as weather and market fluctuation. Coal received by rail will be brought into the Dumper House where rubber curtains will be utilized to create a total enclosure around the car being unloaded, and exhausted to a fabric filter dust collection system. The cars will be connected with a rotary coupling for rotational dumping (i.e. the entire car will rotate 160° dumping the coal through the top of the car). Coal will enter a hopper at the bottom of the Dumper House and transfer by conveyor to the active storage pile in the Coal Barn, Coal Dome, Crusher House or the Reserve (inactive) Storage pile.

Dust collection equipment (fabric filters) will be arranged at the transfer towers to collect fugitive emissions from the transfer points located therein and from the dust generated at the underground receiving hoppers as coal is transferred from the hoppers to the conveyors. Fabric filters will also be located in the plant to capture fugitive dust from the transfer of coal to the unloading stations, receiving hopper discharges, Coal Barn, Coal Dome, Crusher House, and the fuel silos (new boiler Tripper Rooms). In addition, all conveyors will have 360° enclosures to prevent fugitive emissions during coal conveyance.

From the Dumper House, the coal will be placed into the active pile in the Coal Barn by the traveling stacker, sent to the Reserve Storage area or sent directly to the Crusher House. The Coal Barn is a completely enclosed structure for the 60,000-ton active storage pile with fugitive emissions further controlled by a fabric filter dust collection system. Dual-chain, traveling reclaimers will load the coal stored in the Coal Barn onto a conveyor to be sent to the Crusher House.

The Crusher House will contain equipment used to reduce the coal particle size before being sent to the new Tripper Rooms in the boiler house. The Tripper Rooms in the boiler house feed coal to the day silos, which in turn feed the pulverizing equipment located in the boiler house.

The Reserve Storage area will consist of up to three (3) piles; two (2) 18,000-ton conical piles, and one (1) inactive, compacted pile with a 1,000,000-ton capacity. Coal entering the Reserve Storage area will first be placed in one of the conical piles. Bulldozers will push the coal from the conical piles into an underground receiving hopper or by compacting onto the inactive pile. Bulldozers will also be utilized to compact and shape the inactive coal pile. The inactive pile will be sprayed with a chemical surfactant or covered with a crusting agent to further control fugitive emissions. During high wind events, water canons will be utilized as required to reduce the potential for wind erosion. The supply of coal will be built-up during the summer months such that the size of the on-site coal pile will vary depending on time of year, reaching a peak storage size around November.

In addition to rail delivery, the new ASCPC boiler will have the option of receiving Western coal through ship delivery. Coal, received by ship, will be unloaded utilizing a self-unloading conveyor equipped with a movable boom to minimize fugitive emissions. The coal will be conveyed to a dockside hopper at a design rate of 7000 tons per hour, where it will be dropped through a wet-suppression ring to further minimize the fugitive emissions.

From the hopper, the coal will be conveyed into a 90,000-ton totally enclosed Coal Dome. The Coal Dome is a completely enclosed structure, equipped with a fabric filter dust collection system. The PRB coal received by ship for the new ASCPC boiler will be stored in the Coal

Dome, minimizing the creation of fugitive emissions. Dual-chain, radial reclaimers will load the coal from the Coal Dome into an underground hopper. When coal leaves the dome it will enter either the existing conveyance system (to feed Karn Units 1 & 2 or Weadock 7 & 8) or the Crusher House to feed the new ASCPC boiler.

The construction of the Coal Dome will also allow the current outdoor storage pile of Western coal, being blended for use in Weadock 7 & 8 and Karn 1 & 2, to be eliminated. This will reduce the potential for fugitive dust emissions from the current dockside storage piles. The Eastern coal will continue to be stored in its current dockside location.

The coal material handling flow charts are included in Appendix C.

2.7.2 Limestone Handling

Ships will also be used to deliver bulk limestone. The ships utilize a self-unloading conveyor consisting of a movable boom to minimize fugitive emissions. The limestone will be conveyed to a dockside hopper at a design rate of 7000 tons per hour, where it will be dropped through a wet-suppression ring into a receiving hopper.

From the hopper, the limestone will be conveyed to the radial stacker in the Limestone Dome, a 90,000-ton capacity dome used to control fugitive emissions near the river. The Limestone Dome is a completely enclosed structure, equipped with a fabric filter dust collection system. Inside the dome, a front-end loader will load the limestone into one of the two underground hoppers. When limestone leaves the dome it will be conveyed to the Limestone Reagent Preparation Building where the limestone slurry reagent will be prepared.

The Limestone Reagent Preparation Building contains the slurry reagent preparation system. Limestone is conveyed to a day silo for storage. Limestone flows from the bottom of the silos to totally enclosed weigh belt feeders, which control the flow of limestone to ball mills for grinding. The ball mill is part of a wet closed circuit limestone grinding system. Limestone is ground in the ball mill and collected in the mill product tank. Each mill product tank is furnished with redundant mill slurry pumps, which pump the ball mill product into a dedicated mill classifier system for separation of the finer particles from the ball mill grind. The finer particle slurry overflows to the reagent storage tanks, while the larger particles return to the ball mills for re-grinding. The reagent storage tanks store limestone reagent slurry. One of the two redundant reagent feed pumps move the slurry from the reagent storage tank for feed to the wet FGD system. The reagent storage tanks are located outside the building.

Dust collection equipment (fabric filters) will be located at the limestone transfer towers to collect fugitive emissions from the transfer points located therein and from the dust generated at the underground receiving hoppers as limestone is transferred from the underground hoppers to the belt conveyors. Fabric filters will also be located in the plant to capture fugitive dust from the transfer of limestone to the unloading station, receiving hopper discharge, and the Limestone Reagent Preparation Building. Also, all conveyors will have 360° enclosures to prevent fugitive emissions during limestone conveyance. The emissions from the limestone day silo will be controlled by a fan assisted bin vent fabric filter.

The limestone material handling flow charts are included in Appendix C.

2.7.3 Lime and Activated Carbon Handling

The lime and activated carbon will be received by truck and unloaded pneumatically into storage silos, equipped with a fabric filter dust control system. These materials will be taken as needed from their respective silo, and conveyed in closed systems to their point of injection into the ductwork upstream of the ASCPC boiler fabric filter. See Figure 2-2.

2.7.4 Fly Ash Handling

Ash generated by the proposed ASCPC boiler will be collected in two forms, bottom ash and fly ash. Approximately 80 percent of the ash production will be in the form of fly ash and 20 percent in the form of bottom ash. The fly ash will be collected from the economizer, air heater hoppers, and the baghouse hoppers. The fly ash will be stored in a silo utilizing a fabric filter for controlling emissions. Once collected in the ash silo, ash will be unloaded to trucks utilizing a wet ash unloading system to minimize fugitive dust. Trucks will transport ash from the ash silo to on-site storage. The silos will also have a dry ash unloading system to be used as a backup system if the wet unloading system is out of service.

2.7.5 Bottom Ash Handling

The bottom ash system for the ASCPC boiler will be a submerged chain conveyor system. This system utilizes a wet seal at the bottom of the boiler and has a drag chain, scraper bar conveyor that removes collected bottom ash from the boiler. As the bottom ash is removed from the bottom ash hopper it is conveyed at an incline which partially dewaters the ash, directing water ultimately back to the water seal at the bottom of the boiler. The bottom ash is conveyed to an open concrete bunker where it is temporarily stored until it can be loaded into a truck and removed to on-site storage/disposal. The ash collected in the concrete bunker will contain 15 to 25 percent moisture, eliminating any fugitive dust emissions as the ash is unloaded into the bunker, loaded into trucks, and placed into on-site storage.

2.7.6 Sludge/Gypsum Handling

Equipment for gypsum dewatering will be located in the Gypsum Dewatering Building. Slurry from the wet FGD is split by a classifier into a low-density stream of fines (overflow) and a high-density stream of coarse crystals (underflow). The overflow stream is gravity fed into the absorber vessel. The underflow stream, containing the coarse crystals/dense gypsum slurry, is sent to a filter feed tank. The product gypsum slurry is then pumped to a horizontal vacuum filter where the gypsum is dewatered, by vacuum, as it runs along the filtering belt. At the end of the belt, the dewatered gypsum crystals drop through a discharge chute onto conveyors. The gypsum conveyors transport the gypsum out of the building into an enclosed storage pile from where it will be transported via truck to a dedicated gypsum disposal area.

Figure 2-1. Typical Supercritical Coal-fired

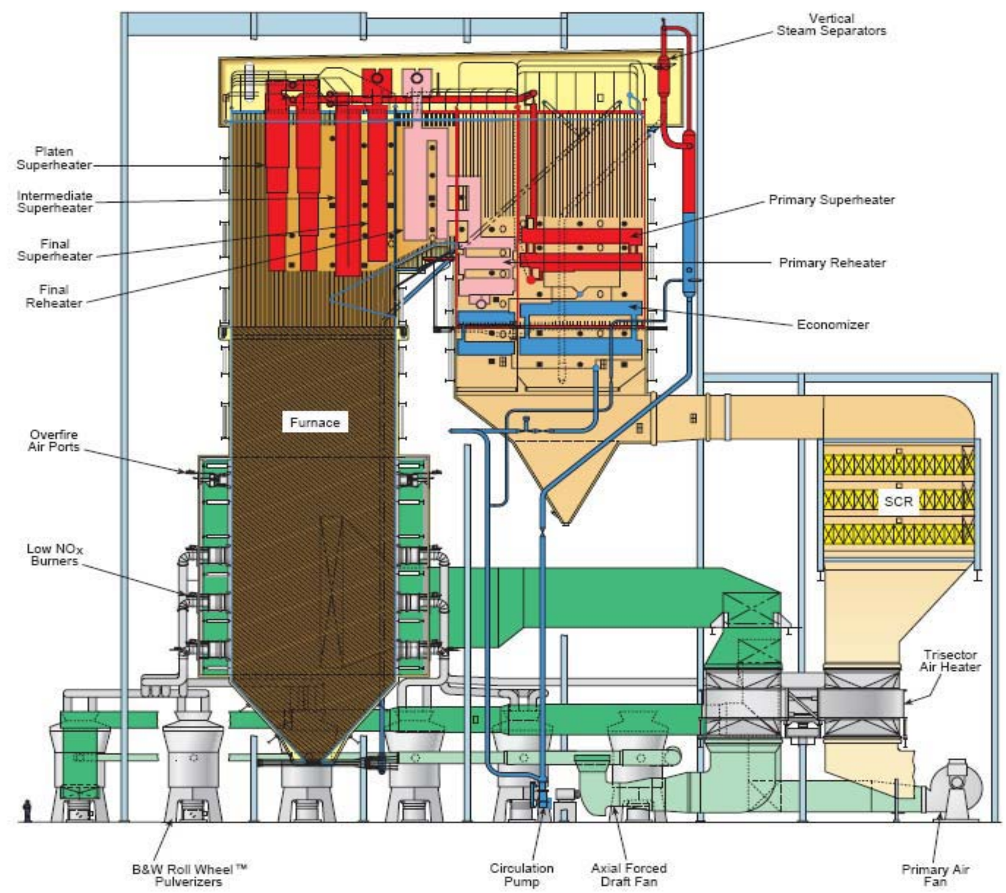

Figure 2-2
Flue Gas Flow Path