

# Second Generation PFBC Systems R & D

DOE Award No.: DE-AC21-86MC21023--81

Monthly Report 05/01/2000-05/31/2000

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**TECHNICAL PROGRESS REPORT NUMBER 21023R60  
FOR MONTH 146 (MAY 2000) -- PHASE 2**

No work was performed; the two remaining Multi Annular Swirl Burner test campaigns are on hold pending selection of a new test facility (replacement for the shut down UTSI burner test facility) and identification of associated testing costs.

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**TECHNICAL PROGRESS REPORT NUMBER 21023R61  
FOR MONTH 115 (MAY 2000) -- PHASE 3**

**Commercial Plant Design Update**

**Introduction**

The Second-Generation PFB Combustion Plant conceptual design prepared in 1987 is being updated to reflect the benefit of pilot plant test data and the latest advances in gas turbine technology. The updated plant is being designed to operate with 95 percent sulfur capture and a single Siemens Westinghouse (SW) 501G gas turbine. Using carbonizer and gas turbine data generated by Foster Wheeler (FW) and SW respectively, Parsons Infrastructure & Technology prepared preliminary plant heat and material balances based on carbonizer operating temperatures of 1700 and 1800EF; the former yielded the higher plant efficiency and has been selected for the design update.

The 501G gas turbine has an air compressor discharge temperature of 811EF and an exhaust temperature of 1140EF. Both of these streams represent high sources of heat and must be cooled, the air to 600EF to be compatible with a 650EF PCFB pressure vessel design temperature and the exhaust for a 275EF stack gas temperature. Because of their relatively high temperature, they can be used for feed water heating, steam generation and/or steam superheating and reheating. As a result, the plant could have one boiler (the PCFB boiler), or as many as three boilers if their cooling is used to generate steam. Three different plant arrangements using one, two and then three boilers were considered with the three-boiler arrangement minimizing the feedwater flow/steam turbine size and maximizing the plant efficiency. After reviewing the three arrangements it was felt the operating complexity associated with a three-boiler plant did not justify the ½ point increase in plant efficiency it provided and a two-boiler plant was selected.

Parsons generated a preliminary full load heat and material balance for the plant shown in Fig. 1. The estimated performance of the plant is:

Gross Power, MWe	
Gas Turbine	239.25
Steam Turbine	267.46
Total	506.71
Auxiliary Power, MWe	24.89
Net Power, MWe	481.82
Plant HHV Efficiency, %	47.5
Plant HHV Heat Rate, Btu/kwhr	7184



The carbonizer required by the plant is shown in Fig. 2; it is a 15-ft ID vertical, refractory-lined pressure vessel approximately 47 ft high, with a conical bottom. The unit operates with a 25-ft-deep jetting fluidized bed, a superficial gas velocity of approximately 3.5 ft/s, a 20-ft tall freeboard, and is described in greater detail in the April Progress Report.

### **Work Performed in May 2000**

To protect the gas turbine from erosion, ceramic candle filter systems will be provided to strip the carbonizer syngas and PCFB flue gas/vitiated air of entrained particulate. Operating face velocities of 4.3 and 8.1 ft/min have been selected for the ceramic candle filters, and both gas streams will require four filter vessels. Each carbonizer filter vessel will contain 748 2-3/8" OD x 60" long silicon carbide candles and have the approximate overall dimensions shown in Fig. 3.

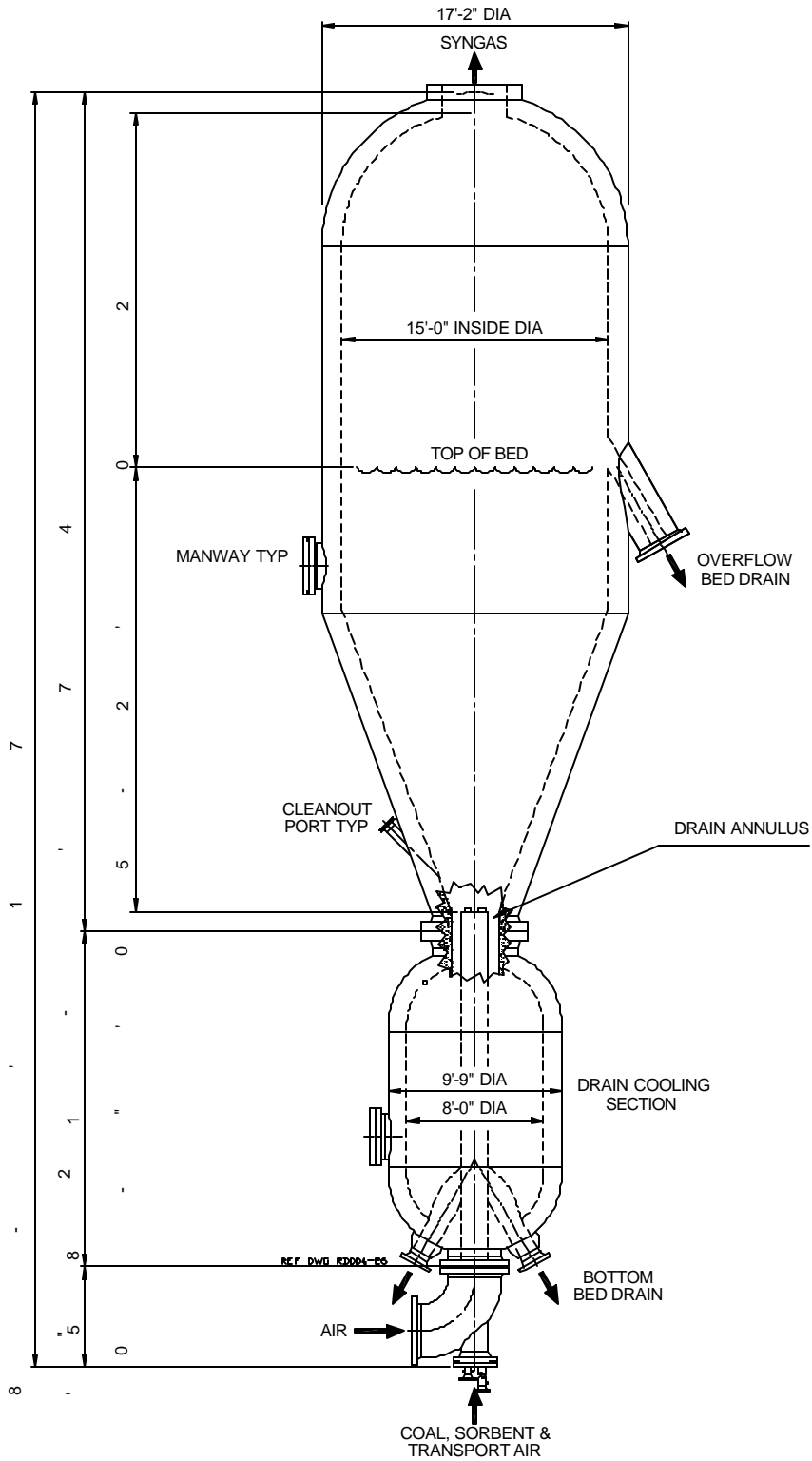
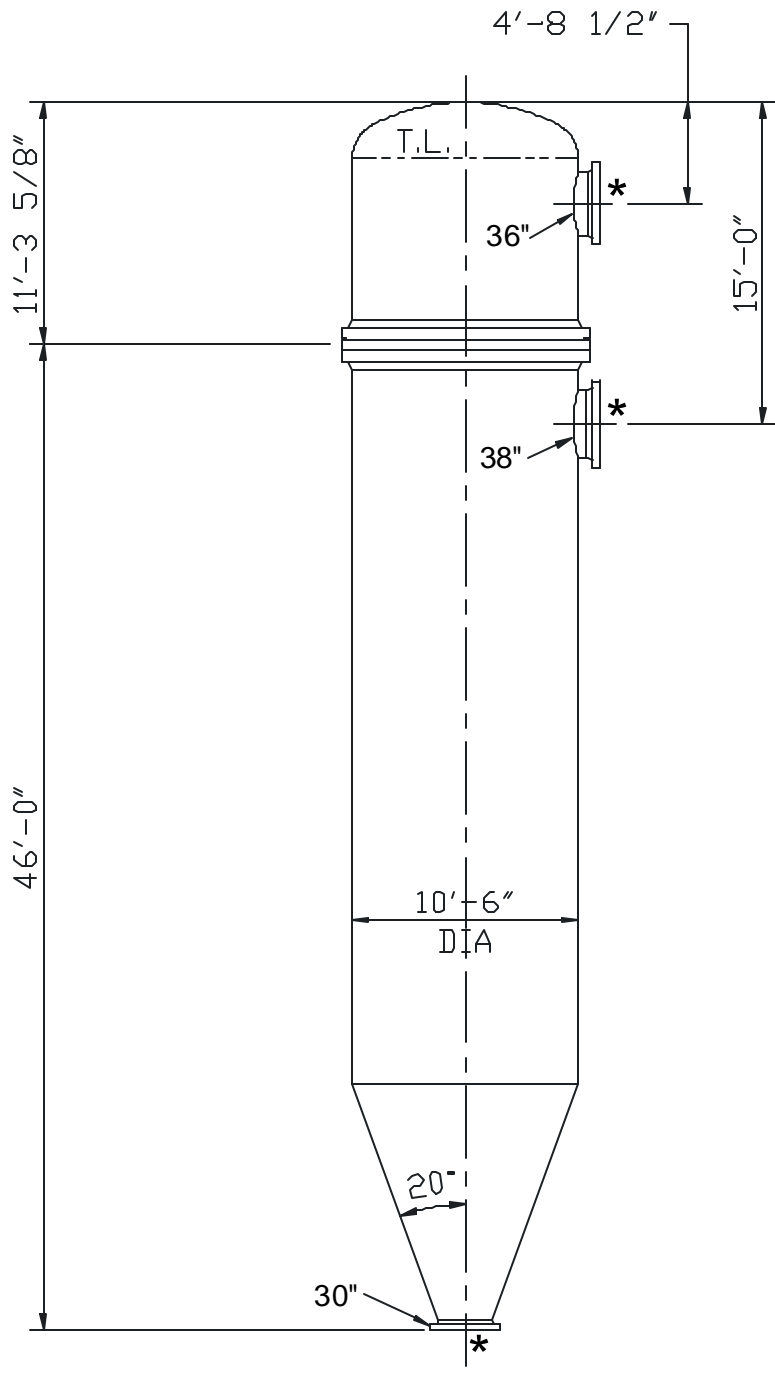


Figure 2 Carbonizer Arrangement



\* 300 lb RF FLANGE

Figure 3 748 Element Syngas Ceramic Candle Filter Vessel

Using the Fig. 3 filter dimensions with vendor supplied cyclone dimensions, two different first cut equipment arrangements were made for the carbonizer leg of the plant. In the first arrangement shown in Fig. 4, the carbonizer is provided with two syngas outlet nozzles. This results in two 50% capacity gas flow paths each possessing its own cyclone, spray tower, two filter vessels, and char hopper; the latter collects the char sorbent residue draining from the two filters, one cyclone, and one of the carbonizer's two bottom drain and two bed overflow drain nozzles. The char hopper will operate at the filter dirty gas side pressure, and the cyclone and bed overflow drain lines will have loop seals to compensate for the differences in pressure. The 500EF residue draining from the bottom of the carbonizer passes through a pipe line delumper, and a rotary valve controls the drain rate while providing the necessary pressure seal as this material drains to the char hopper. Each of the two char hoppers drains to an N valve which controls the transfer of residue to the PCFB boiler.

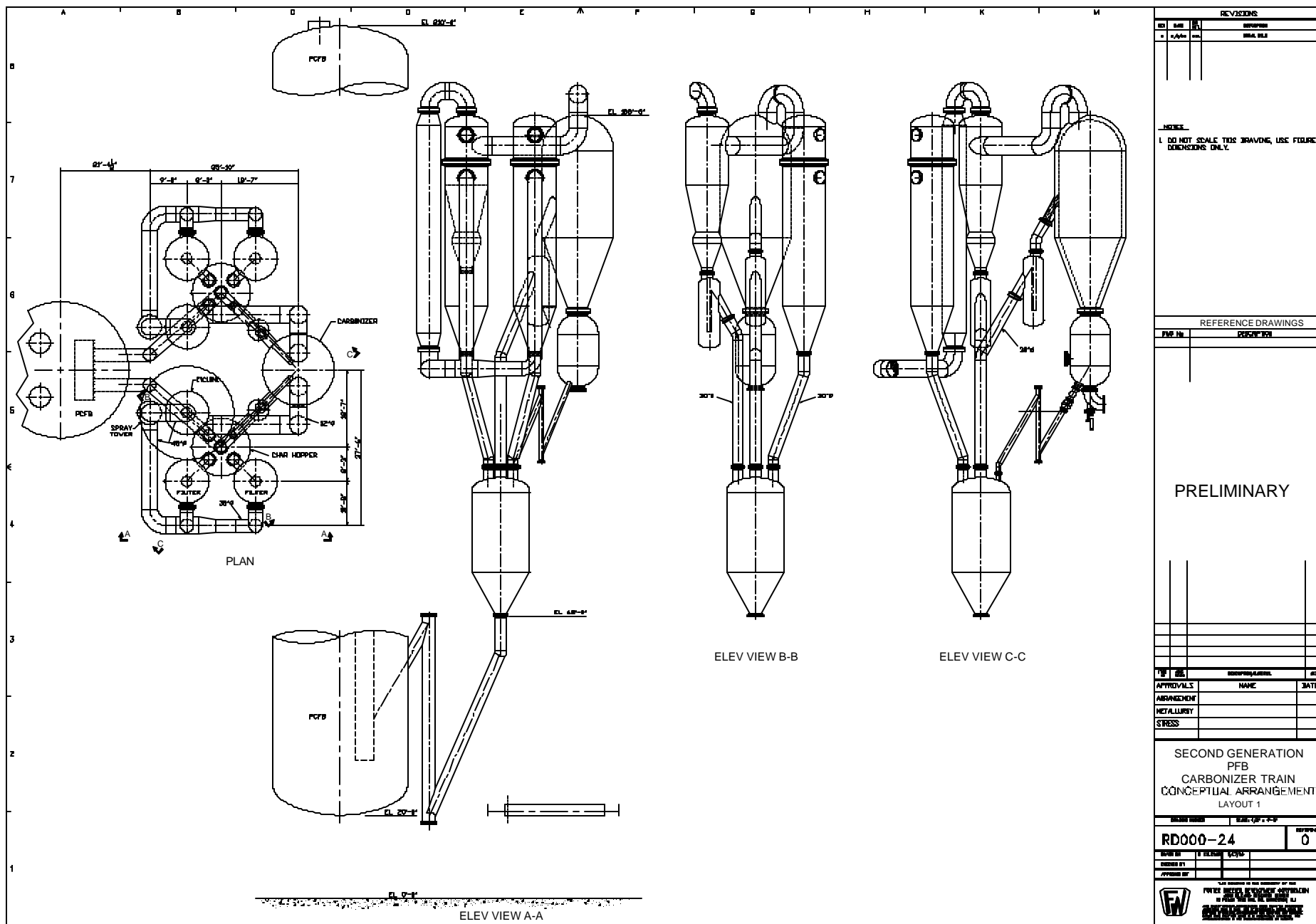


Figure 4 Dual Syngas Flow Path Arrangement

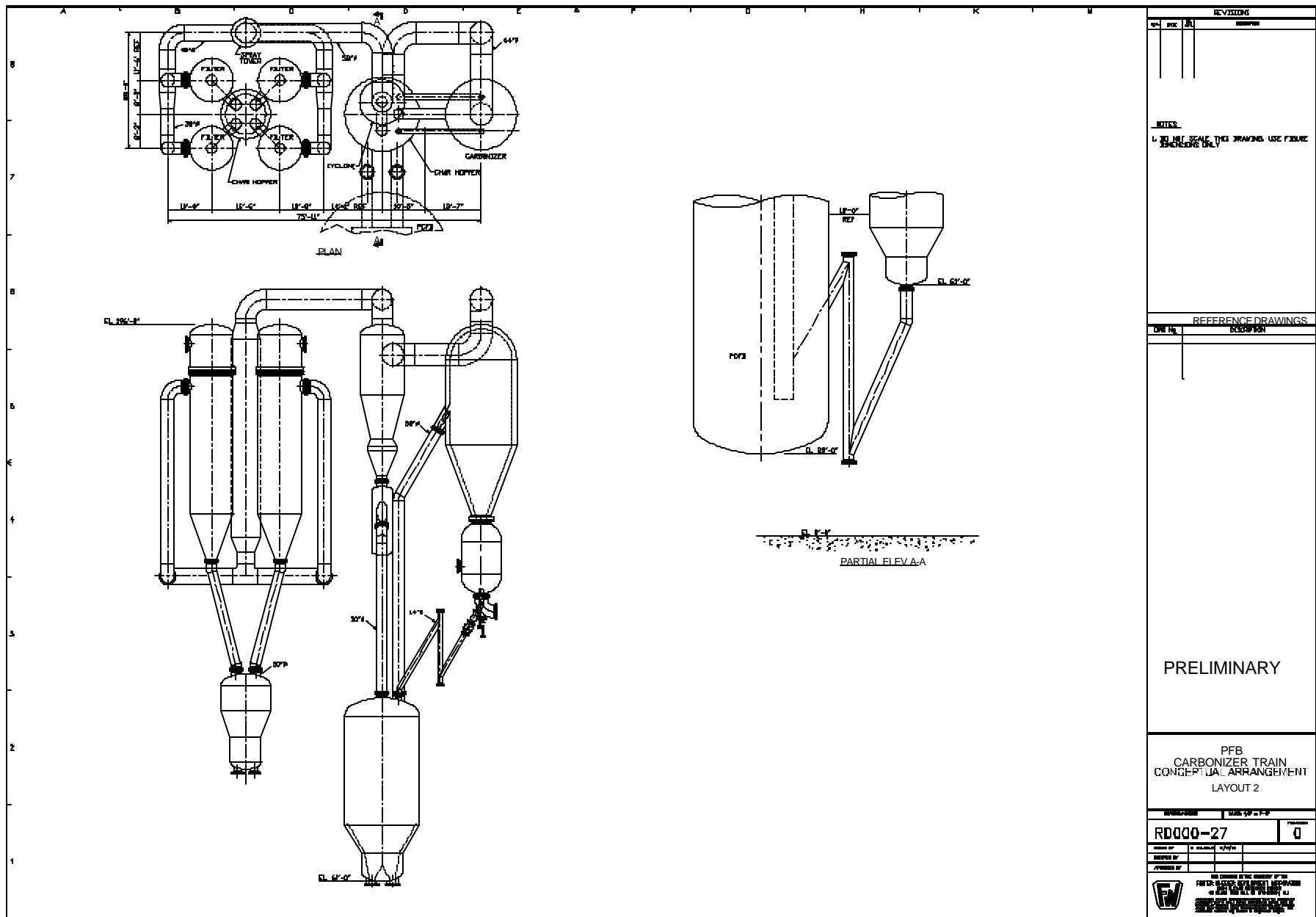


Figure 5 Single Syngas Flow Path Arrangement

In the second arrangement shown in Fig. 5, the carbonizer operates with a single gas outlet, one large cyclone, one large spray tower, and two different size char hoppers. The larger hopper runs at the carbonizer freeboard pressure and receives residue draining from the cyclone and the carbonizer. The second char hopper collects the residue draining from the four filter vessels, operates at the filter dirty gas side pressure, and, receiving less than 10% of the residue generated, is much smaller in size.

In comparing the two “first cut” plant layouts, the Fig. 5 single syngas path arrangement offers the advantage of fewer and larger diameter components (one cyclone, one spray tower, and elimination of bed overflow loop seal) but complicates the injection of filter captured residue into the PCFB. Both arrangements will be further investigated to select a preferred arrangement.

Schedule: Work is proceeding per the attached Fig. 6 schedule.

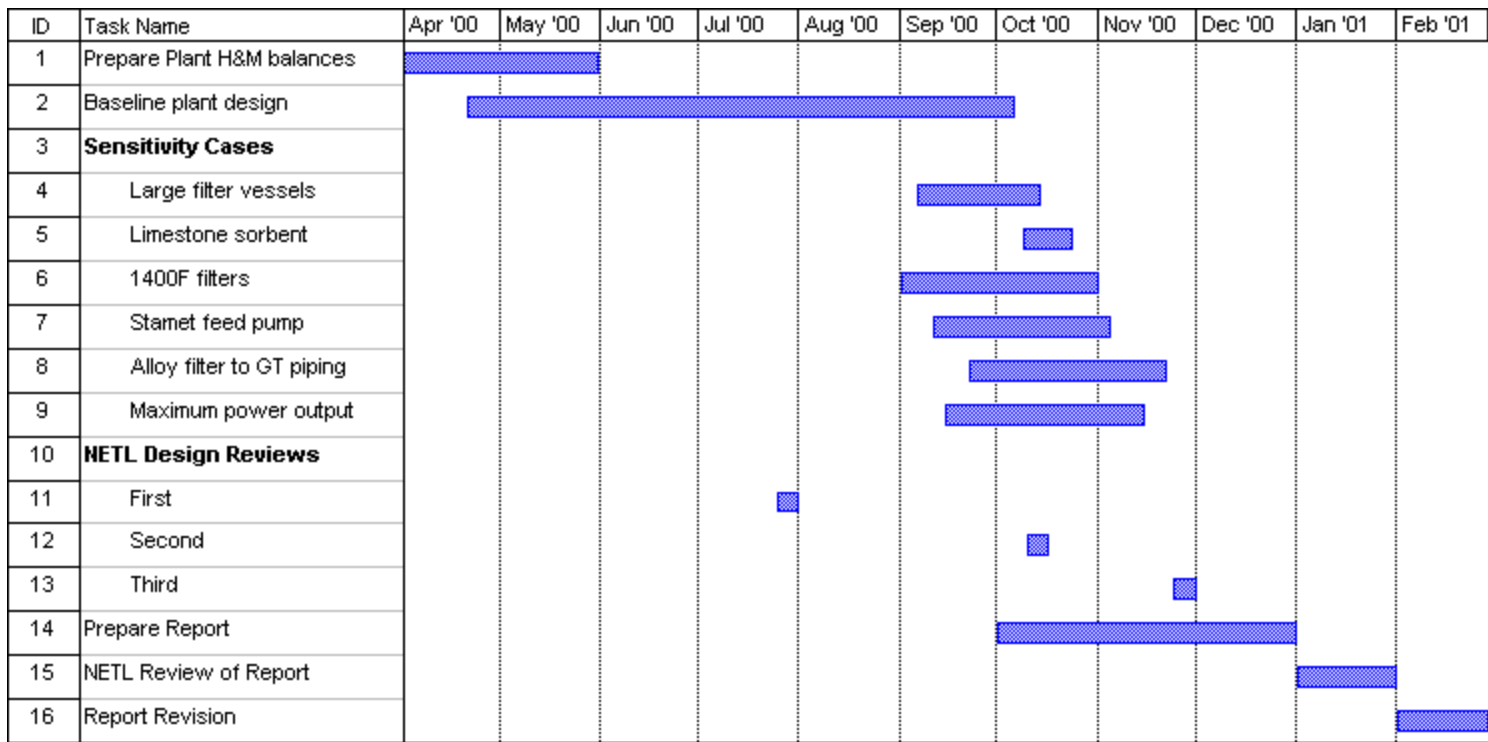


Figure 6 Schedule for Commercial Plant Design Update