Second-Generation PFBC Systems R&D

Phase 2

Monthly Report
Start Date: 04/01/2000
End Date: 04/30/2000

Award No.: DE-AC21-86MC21023—80

Foster Wheeler Development Corporation
12 Peach Tree Hill Road
Livingston, NJ 07039

TECHNICAL PROGRESS REPORT NUMBER 21023R58
FOR MONTH 145 (APRIL 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.

TECHNICAL PROGRESS REPORT NUMBER 21023R59
FOR MONTH 114 (APRIL 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 and found the former to yield the higher plant efficiency.

As a result, 1700EF has been selected as the preferred operating condition for the carbonizer. 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. If the two streams are used to heat feed water, the feed water flow must be increased to absorb this heat while staying below the boiling point, and the steam turbine output increases; this decreases both the gas turbine to steam turbine power ratio and plant efficiency. If the feed water flow is reduced, these streams are used for steam generation and superheating; the steam throughput/output decreases and plant efficiency is maximized. Three different plant arrangements using one, two and then three boilers were considered. 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.

Work Performed in April 2000

Parsons generated a full load heat and material balance for the plant shown in Figure 1 and possessing the simplified feed water/steam circuitry shown in Figure 2. The gas turbine exhaust is used for high pressure feed water heating (economizer) and steam superheating. Cooling of the compressor air is accomplished in two stages: the first generates 2400 psi steam and the second heats boiler feed water. 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

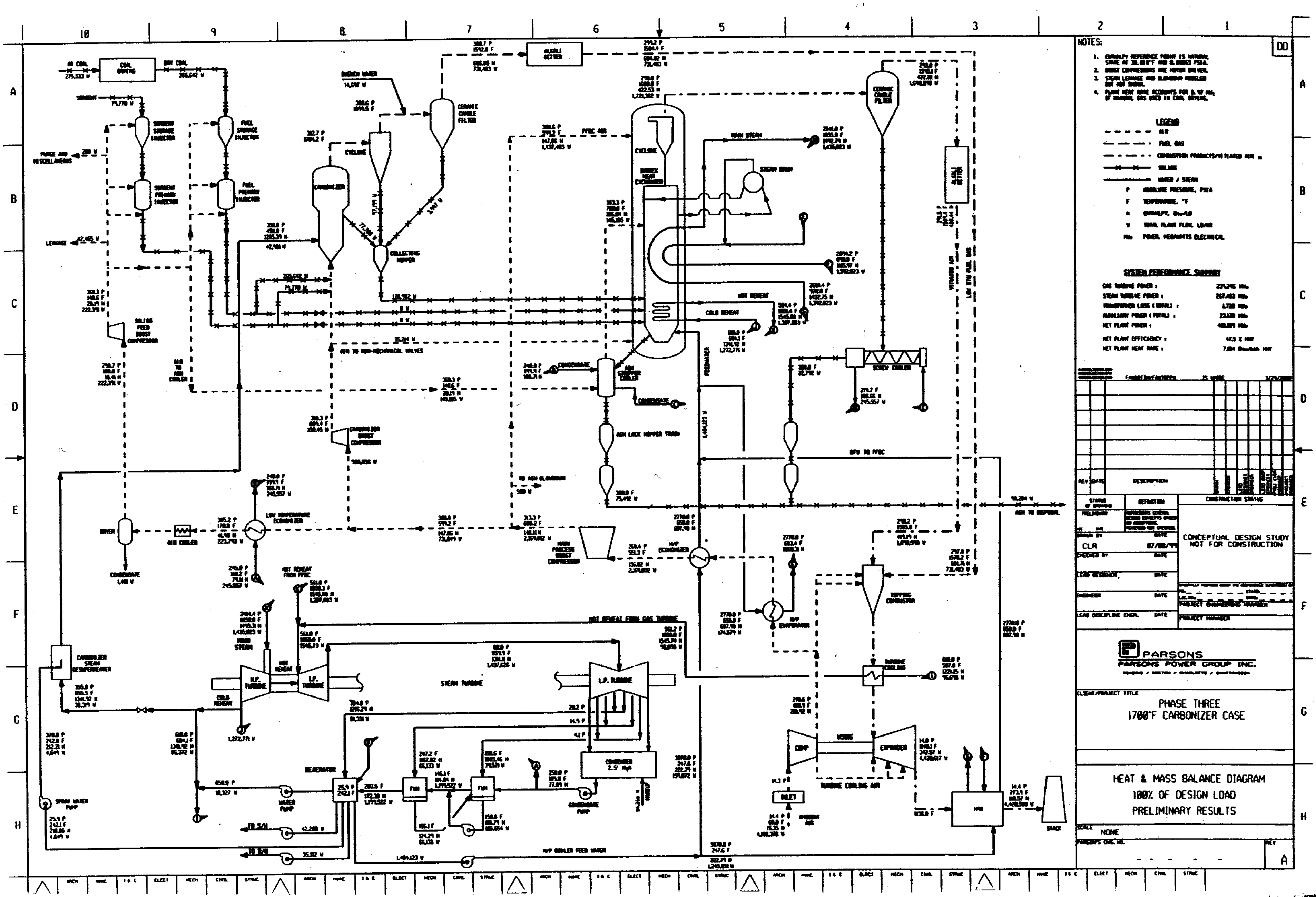
NOTES:
LEGEND
SYSTEM PERFORMANCE SUMMARY
CONCEPTUAL DESIGN STUDY NOT FOR CONSTRUCTION
PARSONS
PARSONS POWER GROUP INC.
PHASE THREE
1700°F CARBONIZER CASE
HEAT & MASS BALANCE DIAGRAM
100% OF DESIGN LOAD
PRELIMINARY RESULTS
STEAM TURBINE
H.P. TURBINE
I.P. TURBINE
L.P. TURBINE
CONDENSER
DEAERATOR
CARBONIZER
CYCLONE
COLLECTING HOPPER
CERAMIC CANDLE FILTER
SCREW COOLER
TOPPING COMBUSTOR
COMP
EXPANDER
HRSG
STACK
INLET

Figure 1

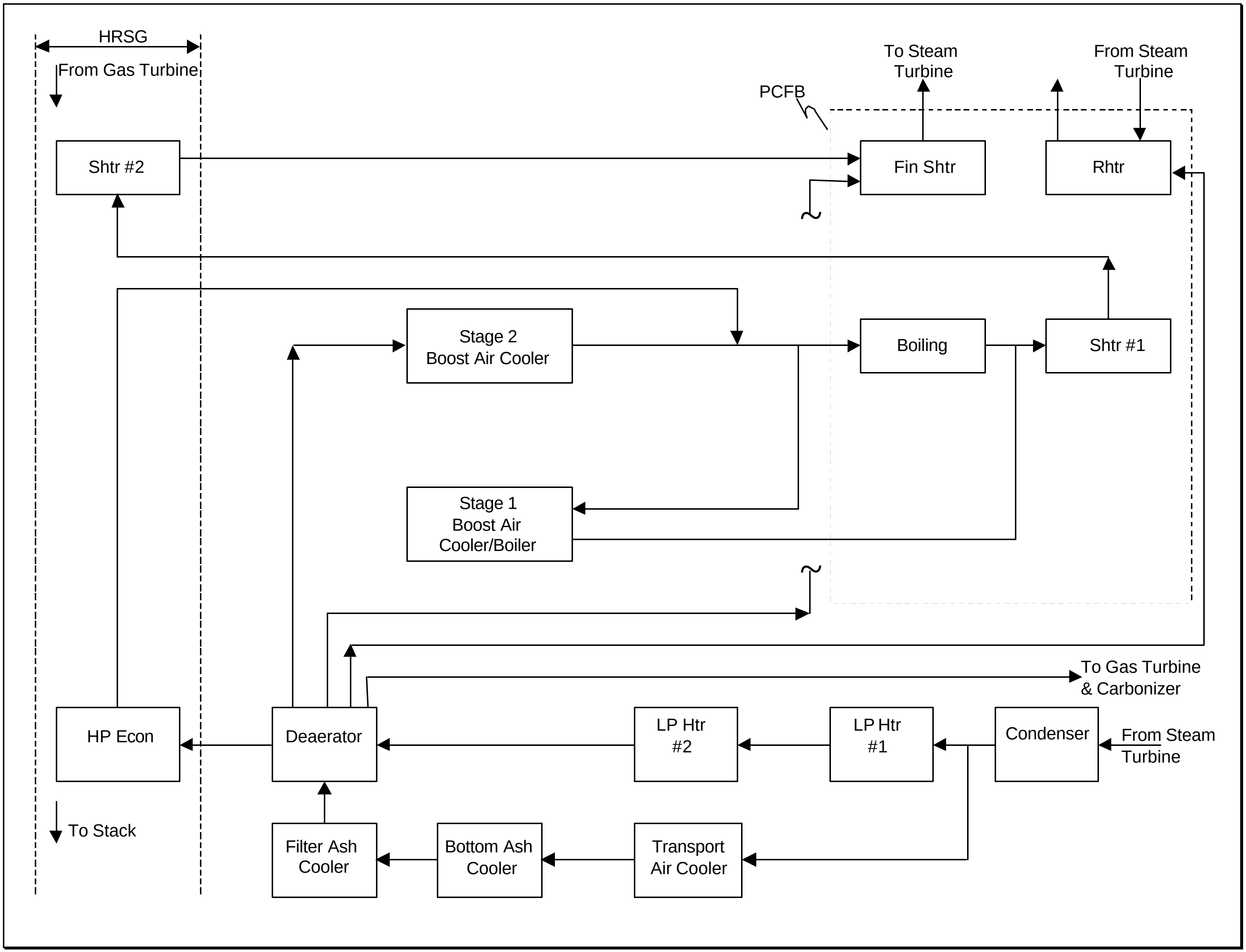

Figure 2 Boiler Feed Water Circuitry Arrangement

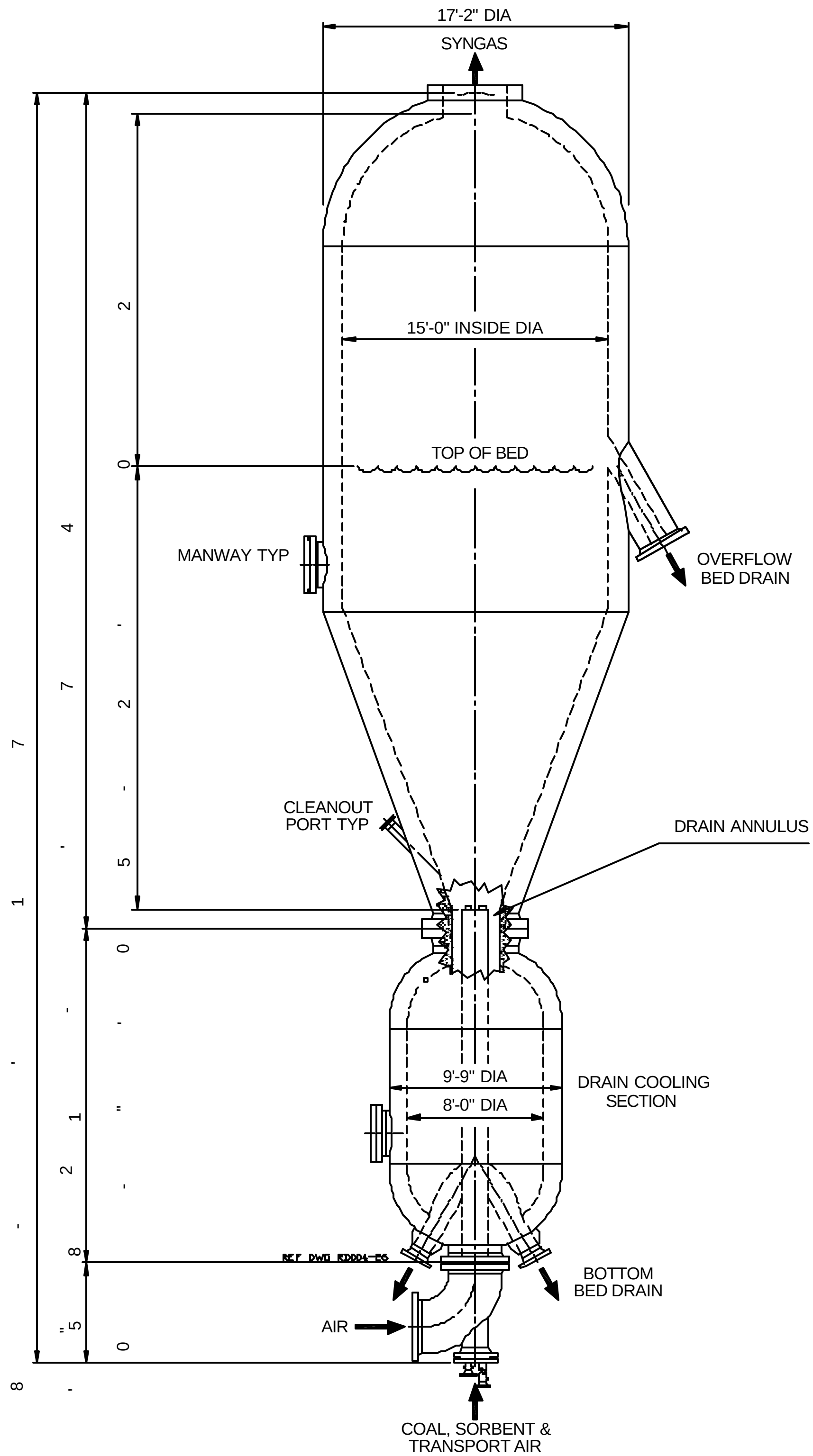

Figure 3 Carbonizer Arrangement

Carbonizer: The carbonizer 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 and a superficial gas velocity of approximately 3.5 ft/s; and a 20 ft tall freeboard is provided to control particulate elutriation rates.

Coal, dolomite, and air enter the unit as a vertical, upward-flowing jet, through a bottom nozzle/manifold assembly. The carbonizer syngas, containing elutriated char and sorbent, leaves the 1700EF unit through a 40 in ID nozzle at the top of the vessel. An 11-in ID bed-overflow nozzle near the midpoint of the vessel limits the bed height to approximately 25 ft. A 4-in wide drain annulus provided around the feed pipe allows material to drain into a lower, packed bed cooling section. Nitrogen is admitted at the bottom, flows up through the section cooling the collected char-sorbent residue, and fluidizes the drain annulus region. Two nozzles at the bottom of the section facilitate draining the unit at shutdown and allow for a small continuous drain during operation. With most of the char-sorbent residue draining through the bed overflow nozzle, the bottom drains are used primarily for bed cleansing, i.e., removing any oversize material accumulating at the bottom of the unit.

There is no heat-transfer surface in the refractory-lined carbonizer. The refractory lining consists of a 6-in inner layer for thermal resistance and a 5-in outer layer of hard-faced refractory for erosion resistance. 20-in ID manways provide maintenance access to the carbonizer and its bottom cooling section.

Schedule: With the plant design effort being released to proceed in April, Figure 4 presents the schedule for the commercial plant design update.

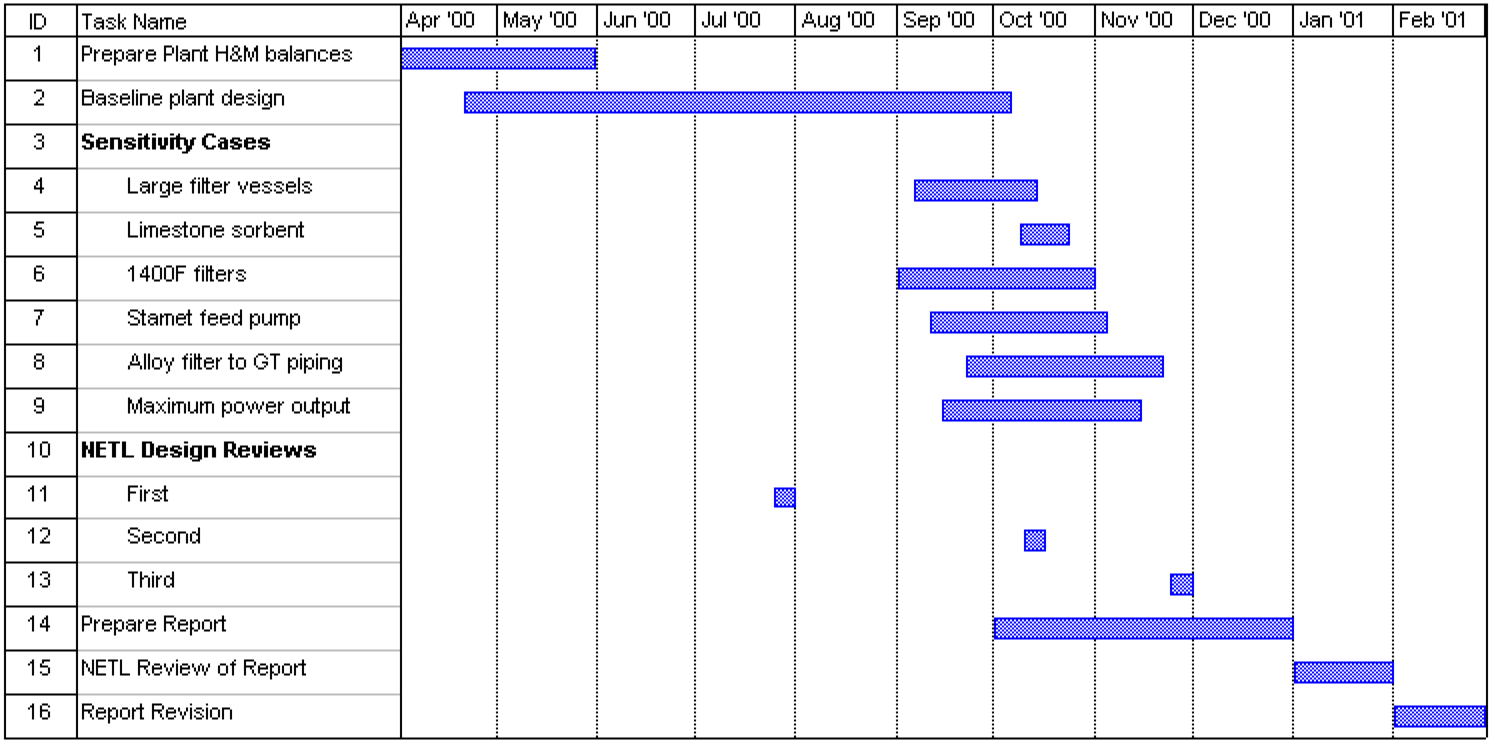

Figure 4 Schedule for Commercial Plant Design Update