DOE/MC/27363 -- 5012
(DE95009742)

Integrated Gasification Combined Cycle (IGCC) Demonstration Project Polk Power Station -- Unit No. 1

Annual Report
October 1993 - September 1994

May 1995

Work Performed Under Contract No.: DE-FC21-91MC27363

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Tampa Electric Company
Tampa, Florida

DISCLAIMER

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Morgantown, West Virginia 26507-0880

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P.O. Box 111
Tampa, Florida 33601

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I. PROJECT DESCRIPTION

Tampa Electric Company's Polk Power Station Unit 1 (PPS-1) Integrated Gasification Combined Cycle (IGCC) demonstration project will use a Texaco pressurized, oxygen-blown, entrained-flow coal gasifier to convert approximately 2300 tons per day of coal (dry basis) coupled with a combined cycle power block to produce a net 250 MW electrical power output. Coal is slurried in water, combined with 95 percent pure oxygen from an air separation unit, and sent to the gasifier to produce a high temperature, high pressure, medium-Btu syngas with a heat content of about 250 Btu/scf (LHV). The syngas then flows through a high temperature heat recovery unit which cools the syngas prior to its entering the cleanup systems. Molten coal ash flows from the bottom of the high temperature heat recovery unit into a water-filled quench chamber where it solidifies into a marketable slag by-product.

Approximately 10 percent of the raw, hot syngas is cooled to 900°F and passed through an intermittently moving bed of zinc-based sorbent which removes sulfur-bearing compounds from the syngas. PPS-1 will be the first unit in the world to demonstrate this advanced metal oxide hot gas desulfurization technology on a commercial unit.

The remaining portion of the raw, hot syngas is cooled to 100°F for conventional acid gas removal. This portion of the plant is capable of processing 100 percent of the raw syngas.

Sulfur-bearing compounds from both cleanup systems are sent to a double absorption sulfuric acid plant to produce a marketable, high-purity sulfuric acid by-product.

The cleaned medium-Btu syngas from these processes is routed to the combined cycle power generation system where it is mixed with air and burned in the combustion section of the combustion turbine. Nitrogen from the air separation unit at 98 percent purity is simultaneously injected into the combustion section to reduce the formation of nitrogen oxides and to enhance mass flow through the combustion turbine for power augmentation. This combination results in the generation of about 192 MW of electricity from the combustion turbine-generator.

Heat is extracted from the expanded exhaust gases in a heat recovery steam generator (HRSG) to produce steam at three pressure levels for use throughout the integrated process. The majority of this steam, at high pressure, together with high pressure steam generated in the gasification process, drives a steam turbine-generator set to produce additional electrical output of about 121 MW. Internal plant power consumption is approximately 63 MW, resulting in a net power output from the integrated unit of 250 MW.

A highly modular, microprocessor-based distributed control system (DCS) will provide continuous and sequential control for most of the equipment on PPS-1. This network has been designed to communicate with other key plant control units like the combustion turbine and steam turbine control systems and the gasification system emergency shutdown system. The DCS is an important part of the IGCC facility in that it provides the control link that will integrate these complex processes.

Also important to this project is the development and utilization of a valuable diagnostic tool in the form of a dynamic simulator. This tool will be used to simulate various operating modes of plant equipment, including upset conditions that could occur within the complex systems which comprise the IGCC facility, and will also be a valuable tool during the training program for plant operators and technical personnel.

An artist's rendering of the IGCC facility is included as **Exhibit F** in the Appendix of this report to serve as a graphic illustration of the site layout of the primary equipment for this uniquely configured electric generating plant.

II. PROJECT HIGHLIGHTS

This section describes in condensed form some of the key features of the Polk IGCC Project which make it unique and contribute to the advantages associated with integrated gasification combined cycle technology.

Tampa Electric's Polk IGCC Demonstration Project is co-funded by the U. S. Department of Energy (DOE) as an important part of its Clean Coal Technology (CCT) Program, Round III. The primary objectives of this project include the successful demonstration of commercial-scale integration of the coal gasification facility with the state-of-the-art combined cycle power island, and the demonstration of a technically and commercially viable hot gas cleanup system.

Site selection for Polk Power Station (PPS) was made with the guidance of a uniquely conceived and assembled team of experts. Tampa Electric formed a Power Plant Siting Task Force composed of prominent environmentalists, educators, and business and community leaders. Environmental impact was a primary driver in the choice of allowable sites for the plant. Consequently, the property in Polk County, Florida which was selected for the plant is comprised mostly of land which had previously been mined for phosphate rock. Substantial work in the areas of mine reclamation, wetlands and uplands restoration, and establishment of a wildlife corridor will be completed in conjunction with the development of the demonstration IGCC facility.

The blending of specific technologies which comprise Polk Power Station Unit No. 1 results in a fully integrated system which utilizes virtually all of the oxygen and nitrogen produced in the plant's air separation unit to meet gasifier oxygen demand and diluent nitrogen requirements for the advanced combustion turbine. The result is highly efficient, environmentally superior performance.

The syngas cooling systems make effective use of available heat within the cycle and generate supplemental steam which is integrated into the process to produce significant overall plant efficiency gains.

The innovative hot gas cleanup system on PPS-1 utilizes an intermittently-moving bed of sorbent to remove sulfur-bearing compounds from the hot syngas. The benefits include heat rate improvement as well as reduced plant power consumption as compared to the conventional process of cold gas cleanup using acid gas removal technology.

By-products from this unique combination of technologies are extracted as marketable products, primarily as slag and high grade sulfuric acid.

Finally, to integrate the control logic for this complex facility, a number of important control features are being developed which include a dynamic simulator, a distributed control system, and an emergency shutdown system.

III. ENVIRONMENTAL / PERMITTING

The following significant events related to the Polk IGCC Project's Environmental and Permitting requirements occurred in 1994.

FEDERAL ACTIVITIES

- The draft Environmental Impact Statement (EIS) including the draft National Pollutant Discharge Elimination System (NPDES) permit was issued by the U.S. Environmental Protection Agency (EPA) on February 25, 1994. The public comment period on these documents ended on April 11, 1994.

- The final EIS including the final draft NPDES permit was issued on June 10, 1994. The public comment period on these documents ended on July 11, 1994.

- EPA issued a favorable Record Of Decision (ROD) on the project on July 14, 1994. Issuance of the ROD allowed EPA to issue the NPDES permit and allowed the U.S. Army Corps of Engineers (COE) to issue the Section 404 dredge and fill permit.

- The COE issued the Section 404 dredge and fill permit for the project on July 18, 1994. Receipt of this permit allowed full initiation of construction activities at the site.

- The U.S. Department of Energy (DOE) issued a favorable ROD on the project on August 17, 1994.

- EPA issued the NPDES permit for the project on September 29, 1994. This permit allows the startup and operation of the project.

STATE ACTIVITIES

- The Governor and Cabinet, sitting as the Siting Board, certified the project on January 25, 1994.

- The Secretary of the Florida Department of Environmental Protection (DEP) signed the modification to the Bid Bend Station certification on March 31, 1994, to allow construction and operation of the coal transloading facility that will be used to transfer coal to the project.

- Subsequent to the certification, a number of design changes to the project were made. These design changes required a modification of the certification. A package detailing the modifications was submitted to the DEP in May 1994. Responses to agency questions on the modifications were submitted to DEP in

September 1994. Approval of these modifications, along with a modified PSD permit, is expected in early 1995.

- A permit application which allows widening and tie-in from State Road 37 at the two entrances to the site was issued on March 9, 1994. State approval was received on June 23, 1994.

- The Florida Department of Transportation (FDOT) issued the Railroad Grade Crossing permit on June 29, 1994, to allow construction of the rail crossing at grade into the site across Fort Green Road.

COUNTY ACTIVITIES

- Polk County issued a road tie-in permit on July 25, 1994, to allow widening and tie-in from State Road 37 at the two entrances to the site.

- A Polk County Building Permit application was submitted on October 1, 1994, to allow construction of all site facilities. Polk County issued the permit on November 1, 1994.

CONDITIONS OF CERTIFICATION SUBMITTALS

- Transmission line plans were submitted on September 2, 1994, to the Florida DEP and were approved on November 21, 1994. The COE approved the Dredge and Fill permit on December 1, 1994 (submitted on November 29, 1994) for construction of one of the poles.

- Heat input correction curves were submitted to the Florida Department of Environmental Protection and the U.S. Department of Energy. No approval is required.

- A Biological Plan of Study for Microinvertebrates was submitted on November 18, 1994, to the EPA and was approved on December 2, 1994.

- Descriptions of the selected combustion turbine (CT) and the auxiliary boiler were submitted to the Bureau of Air Regulation of the Florida DEP on November 11, 1994. Approval is expected in early 1995.

- The Domestic Wastewater Treatment System construction application was submitted on December 13, 1994 to the Florida DEP. Approval is expected in early 1995.

- The Industrial Wastewater Treatment System and Reverse Osmosis Plant plans and details were submitted on December 19, 1994 to the Florida DEP. Approval is expected in early 1995.

- The Chemical and Used Oils Handling Facility plans and details were submitted on December 20, 1994 to the Florida DEP. Approval is expected in early 1995.
- The Groundwater Monitoring Plan was submitted on May 31, 1994 to the Florida DEP. Approval is expected in mid-1995.
- The Surface Water Management Plan (submitted on September 27, 1993) was approved on June 16, 1994, by the Southwest Florida Water Management District.
- The Preliminary Spill Prevention Control and Countermeasure (SPCC) Plan was submitted on October 27, 1994 to Polk County.

IV. STATUS OF MAJOR CONTRACTS

A. DETAILED PROFESSIONAL ENGINEERING AND TECHNICAL SERVICES

Overall progress of Bechtel's detailed engineering is presented in Figure 1 included at the end of this section. The drawing status (as of December 18, 1994) is presented in Table 1, also included at the end of this section.

B. HOT GAS CLEAN UP SYSTEM DESIGN AND STARTUP SUPPORT

The contract for preliminary definition of the Hot Gas Clean Up (HGCU) system design, dated June 2, 1993, was awarded to General Electric Environmental Services, Inc. (GEESI). The HGCU system is designed to process 10 percent of syngas output from gasification. GEESI provided estimates for detailed design, procurement support and startup support activities. At year's end engineering for the HGCU was 45 percent complete and procurement was 95 percent complete with 77 percent of the plant's material cost committed. Construction mobilization is scheduled for May 1995, with mechanical completion targeted for July 1996. All major processing equipment in the HGCU was committed by year's end, and key milestones required to support the Distributed Control System Engineered Equipment Package were achieved on schedule. HAZOP analysis of the plant's system has been performed. Resident Engineering presence in GEESI's offices by Bechtel was initiated in September 1994.

C. G.E. STAG 107F ENGINEERED EQUIPMENT PACKAGE (POWER ISLAND)

The contract for the engineering, manufacture, and supply of the engineered equipment package for the Power Island was awarded to GE in November 1992. The equipment furnished under this Contract includes the following:

- One Frame 7F Single Shaft Combustion Turbine with Low NOx combustors capable of firing fuel oil No. 2 as well as syngas
- One 229,741 KVA hydrogen cooled generator
- One tandem compound, double flow condensing steam turbine with one uncontrolled extraction
- One 156,471 KVA hydrogen cooled generator
- All the engineered skids required to provide the auxiliary and accessory systems for the combustion turbine, steam turbine and the generators
- Control Cabinets

- One three-pressure, unfired Heat Recovery Steam Generator with integral deaerator. The HRSG is capable of accepting saturated steam from the gasification plant at two pressure levels and supply steam at rated conditions of 1500 psig at 1000°F, 400 psig at 1000°F and 50 psig saturated.

In 1994, the combustion turbine was manufactured and shop tested for performance. It was sent to storage along with the accessory module. The CT generator was also manufactured, tested and shipped to storage. The control panels were manufactured and the steam turbine control panel was shipped to the DCS vendor to check out the communication link. Manufacture of all the Heat Recovery Steam Generator (HRSG) modules, the boiler drums and the deaerator was complete with delivery planned in first quarter 1995.

D. TURNKEY AIR SEPARATION UNIT

The contract for engineering, supply and erection of the Air Separation Unit (ASU), dated April 14, 1993, was awarded to Air Products & Chemicals, Inc. (APCI). The ASU is designed to produce 2020 tons per day (TPD) of 95 mol% pure oxygen, 1985 TPD at 575 psig and 35 TPD at 50 psig, and 6400 TPD of nitrogen, 6000 TPD at 255 psig and 98 mol% purity for syngas diluent and 400 TPD at high pressure and 99.99 mol% purity for sootblowing. Air Products released P&IDs for HAZOP and conducted process hazards analysis, operability, reliability and 3-D model reviews. All major mechanical equipment was purchased. The main air compressor supplier, Demag, successfully completed mechanical testing. APCI and Bechtel completed the design of electrical and piping interfaces at the battery limits. Piping and civil/structural design effort for the ASU is 95 percent complete. APCI mobilized their site construction manager, awarded the civil/underground construction contract, and mobilized the contractor. Also, APCI issued the cold box erection contract and a purchase order for prefabricated cold box area large bore pipe. APCI began fabrication of distillation columns, issued the DCS documentation package for ASU, and issued the large bore yard area prefabricated piping package for bid.

E. RADIANT SYNGAS COOLING SYSTEM ENGINEERED EQUIPMENT PACKAGE

The contract for the engineering, design, manufacture and preparation for shipment of the Radiant Syngas Cooling (RSC) system, dated June 4, 1993, was awarded to MAN Gutehoffnungshütte AG (MAN GHH). The RSC system is designed to cool the hot syngas exiting the gasifier, generate high pressure steam to be sent to the HRSG, and remove coal ash from the syngas stream in the form of slag. At year's end engineering for the RSC was approximately 80 percent complete and fabrication was approximately 75 percent complete. Installation of the RSC shell and internals is scheduled for July 1995.

F. CONVECTIVE SYNGAS COOLING SYSTEM ENGINEERED EQUIPMENT PACKAGE

The contract for the engineering, design, manufacture, preparation for shipment, and onsite delivery of the convective syngas cooling (CSC) system, dated June 4, 1993, was awarded to L & C Steinmüller GmbH. The CSC system is designed to cool the raw syngas exiting the RSC system and exchange the heat energy with portions of clean syngas and nitrogen from the remainder of the integrated process. At year's end engineering for the CSC was approximately 97 percent complete and fabrication was approximately 77 percent complete. Delivery to the jobsite is scheduled for May 1995.

G. TURNKEY SULFURIC ACID PLANT

The contract for engineering, supply, and erection of the sulfuric acid plant for Polk Power Station Unit 1, dated June 8, 1994, was awarded to Monsanto Enviro-Chem Systems, Inc. The sulfuric acid plant is being designed to produce 98 percent sulfuric acid at a rate of 208 STPD (100% H_2SO_4 basis) when fed with cold gas clean-up (CGCU) acid gas at design rates and 211 STPD (100% H_2SO_4 basis) when fed with CGCU and HGCU acid gases at design rates. At year's end, engineering for the sulfuric acid plant was 47 percent complete and procurement was 43 percent complete with 43 percent of the plant's material cost committed. Construction mobilization is scheduled for mid-April 1995 with mechanical completion targeted for December 15, 1995 (a two-month improvement over the original schedule). All major processing equipment in the acid plant was committed by year's end, and key milestones required to support the Distributed Control System Engineered Equipment Package were achieved on schedule. HAZOP analysis of the plant's systems has been performed, and two of the four scheduled plant CAD model reviews (comprising over 80 percent of the plant's scope) have been completed. Bechtel's resident engineering presence in Enviro-Chem's offices was discontinued at the completion of basic engineering (approximately 25 percent engineering complete).

H. DISTRIBUTED CONTROL SYSTEM

The contract for engineering, design, manufacturing, assembly, and shipping of the Distributed Control System (DCS) to serve as the controls for the IGCC Polk Power Station Unit 1, dated October 8, 1993, was awarded to Bailey Controls Company, a division of Elsag Bailey, Inc. The DCS includes all system hardware, software, associated interfaces, and auxiliary equipment necessary to successfully control the entire plant from a centrally located control room. The DCS integrates controls for the following major plant systems:

- Gasifier
- Syngas cooling
- Syngas clean-up
- Air separation unit
- Coal handling
- Power block equipment
- Sulfuric acid plant
- Brine concentration
- Cooling water

- Wastewater treatment
- Water treating

The DCS also interfaces with separate control systems provided with the Emergency Shutdown System (ESD) and the GE Mark V power equipment package. The basic system architecture is known as Bailey XRS90 configuration. At year's end Bailey was in possession of all P&IDs, logic, loops, I/O points, and all sketches required for complete integration and design. Manufacturing was well underway. Programming, graphics creation and review were proceeding on schedule. Resident Engineering presence by Bechtel and Tampa Electric is expected for the first quarter of 1995 for the purpose of programming/graphics review and factory acceptance testing. DCS shipment is anticipated for April-May 1995.

I. EMERGENCY SHUTDOWN SYSTEM

The contract for engineering, design, manufacturing, assembly, and shipping of the Emergency Shutdown System (ESD) to serve as a safe emergency shutdown apparatus for the IGCC Polk Power Station Unit 1, dated June 24, 1994, was awarded to Triconex Corporation. The ESD includes all system hardware, software, associated interfaces, and auxiliary equipment to provide for a fully functional system. The system is known as a Triple Modular Redundant (TMR) Programmable Logic Control ESD System. It includes software to fully interface with the Bailey Controls XRS90 DCS. At year's end the system design, configuration review, and acceptance testing procedures were completed on schedule. Manufacturing was near completion. It is expected that factory acceptance testing would be complete in February 1995. The chassis will be shipped to Bailey Controls' factory in Ohio for integration testing with the DCS in March 1995. Shipment of the ESD to the jobsite is expected in May 1995, as scheduled.

J. BRINE CONCENTRATION SYSTEM

A purchase order to include the engineering, design, fabrication, supply, and delivery of a complete Brine Concentration Unit (BCU) for the Polk Power Station - Unit 1, dated June 7, 1994, was awarded to Aqua-Chem, Inc. The BCU processes grey water discharge from the gas clean-up systems. The BCU is to be designed as a prefabricated skid-mounted system to the maximum extent possible. The system discharges a land fillable solid waste stream and a reusable liquid stream. Aqua-Chem will furnish all equipment, large bore piping (>2 in.), teflon lined piping, valves, instruments, structures and skids, and startup/operational testing services. The purchase order provides for performance guarantees for minimum throughput, maximum power consumption, and maximum solid discharge moisture content. By year end 1994, Aqua-Chem had completed P&IDs, PFDs, material selections, system descriptions, and equipment lists. Purchase orders had been placed for major rotating equipment, and plate material for tubesheets and vessels. Fabrication of major vessels and heat exchangers was underway. System delivery to the jobsite is expected by May 1995.

K. CONSTRUCTION MANAGEMENT SERVICES

Bechtel Power Corporation is providing construction management (CM) services. As of December 31, 1994, the following contracts were awarded and mobilized in the field:

Contract No.	Description
CP-001	**Site Development:** Clearing and grubbing; earthwork, reclamation of wetlands east of State Road (SR) 37, surveying, roads, site revegetation, and dewatering.
CP-003	**Railroad:** Install ballast, rail ties, switches, and track; construct road crossing.
CP-008	**Civil and Underground Pipe:** Earthwork for foundations; installation of foundations and supporting steel, site wells (piezometers), underground duct banks, and all concrete for fuel oil storage tanks and instrument air.
CP-010-A	**Control Building:** All civil, architectural, interior finishes, fire protection, electrical power and lighting, plumbing, HVAC, communication systems, foundations, underground utilities, etc.
R-001	**Warehouse and Maintenance Buildings:** All civil, architectural, interior finishes, fire protection, electrical power and lighting, plumbing, HVAC, communication systems, foundations, underground utilities, etc.
CP-015	**Well Drilling:** Permanent site wells including sampling and logging, and setting of pumps and motors.

Contracts were awarded for D-001 and T-013 in 1994, but the contractors had not yet mobilized. These contracts are described below:

Contract No.	Description
D-001	**Field Erected Tanks:** Supply and erection of atmospheric pressure tanks including hydrotesting, coatings, painting, and cathodic protection.
T-013	**Coal Silos:** Supply and installation of coal storage silos including foundations.

Construction Management (CM) activities performed during 1994 were focused on the following key areas:

- Development and review of major contract packages

- Familiarization with existing environmental documents and with future requirements to ensure compliance at all levels
- Development of preferred contracting strategies for construction
- Coordination with ongoing engineering activities
- Schedule review and integration with engineering and procurement needs
- Input into project cost estimates
- Development of key construction management policies and procedures to be used throughout the project
- Continued selection of key members of the Construction Management Team. As of December 31, 1994, 27 personnel were part of the CM team.
- Implementation of the Constructability Program which has produced substantial savings to the total project cost
- Mobilization of key members of the CM team to the project jobsite
- Award of the surveying, site security, civil testing, and general services CM subcontracts
- Management of awarded contracts

L. SITE DEVELOPMENT

The contract for site development includes soil erosion control, clearing, grubbing, site dewatering, and cut and fill for plant areas; construction of temporary and permanent berms, water ponds, ditches, trenches, culverts and reclamation of wetlands east of SR-37; performance of layout and surveying of work areas; installation of base material for roads and asphalt base course; construction of temporary and permanent parking areas, laydown areas and railroad subgrade; slope stabilization of berms, trenches and ditches; initial site revegetation; and installation of the coal delivery ramps. This contract was awarded to Johnson Brothers Corporation on February 7, 1994. Major areas worked during the year included clearing, grubbing and site drainage structures; site roads, parking and material laydown areas; underground stormwater, circulating and cooling water systems; and cooling water basins. By year's end, JBC had completed 48 percent of the work versus 50 percent of the scheduled work.

M. CIVIL/STRUCTURAL CONSTRUCTION PACKAGE

The contract for civil/structural site construction included:

- Earthwork associated with foundation installation, tank foundations and liners for plant storage tanks
- All underground ductbank (except for cable)
- All fuel oil storage area concrete and earthwork
- Instrument air compressor foundations
- Cooling water intake structure concrete
- Grounding and underground pipe
- Power Block equipment foundations
- Pipe rack foundations and steel erection
- Flare foundation
- Underground piping not included in the site development contract
- Gasification structure foundation and structural steel erection to 85 feet above grade
- Coal handling and coal grinding area foundations
- Wastewater treatment area civil and underground electrical and utilities

This contract was awarded to Johnson Brothers Corporation (JBC) on October 14, 1994. Major areas worked during 1994 included foundations for four of the nine plant storage tanks, power block equipment foundations, underground ductbank, cooling water intake structure, cooling water outfall structure, underground fire protection piping, and pipe rack and flare foundations.

By the end of 1994, JBC had completed 15 percent of this work versus 22 percent of the scheduled work.

Figure 1

TAMPA ELECTRIC - POLK POWER STATION - 22269
BECHTEL ENGINEERING
% COMPLETE (STATUS AS OF 12/18/94)

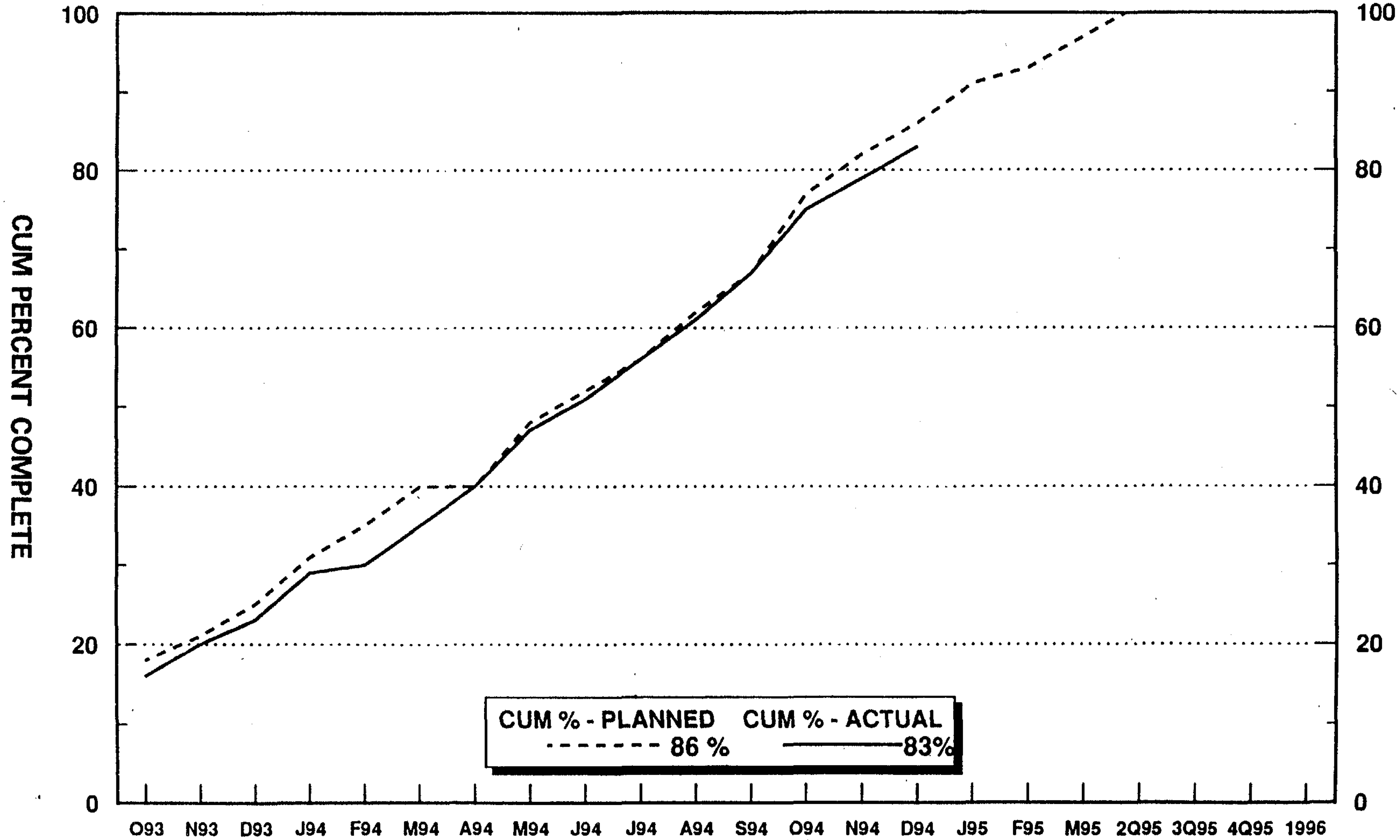

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Table 1

POLK POWER STATION – UNIT 1

DRAWING STATUS – BECHTEL
AS OF DECEMBER 18, 1994

CLASSIFICATION	NO. OF DWGS	IFR		IFD / IFQ		IFP / IFC	
		SCH	ACT	SCH	ACT	SCH	ACT
PROJECT ENGINEERING	166	166	166	165	165	165	165
PROCESS	52			52	52		
VESSEL	76			76	76	76	76
CONTROL SYSTEMS	643	499	492	438	439	60	59
PIPING	76	76	76	76	76	76	76
PIPING (PLANNING STUDIES)	213	213	213	212	211		
ELECTRICAL	636	538	515	77	77	535	487
CIVIL	374					280	250
ARCHITECTURAL	31	16	16			29	26
MECH HVAC / PLUMBING	9					9	9
TOTAL	2,276	1,508	1,478	1,096	1,096	1,230	1,148

p:\nathan\dwg_cnt.wk3

Legend:

IFR = Issue for Review
IFD = Issue for Design
IFQ = Issue for Quotation
IFP = Issue for Procurement
IFC = Issue for Construction

V. PROCESS DESCRIPTION

A. COAL HANDLING, GRINDING, AND SLURRY PREPARATION

Coal is delivered to the site from a coal transloading facility at Tampa Electric Company's Big Bend Station. The coal is delivered in covered, bottom-dump trucks with a 28-ton payload, with a total of 80 to 100 trucks per day required at design rate. On the site, the trucks off-load in an enclosed unloading structure into an above-grade unloading hopper. Dust suppression sprays are provided at the top of the hopper to control dust emissions. Belt feeders transfer coal from the hopper outlets onto an enclosed unloading conveyor.

The unloading conveyor transports coal from the unloading structure up and into one of the two storage silos. A diverter gate and a silo feed conveyor provide the set-up to feed the second, adjacent silo. A dust collection system is provided at the top of the silos to collect dust at the conveyor/feeder/silo transfer points.

Coal is conveyed from the coal silos and fed to the grinding mill with recycled process water and makeup water from the plant service water supply system. The grinding mill may also be fed fine coal recovered by the dust collection system. Ammonia may be added to the mill for pH adjustment, if necessary. The pH of the slurry is maintained between 6 and 8 to minimize corrosion in the carbon steel equipment. A slurry additive for reducing viscosity is also pumped continuously to the grinding mill.

The grinding mill reduces the feed coal to the design particle size distribution. The mill is a conventional rod-type system with an overflow discharge of the slurry. Slurry discharged from the grinding mill passes through a trommel screen and over a vibrating screen to remove any oversized particles before entering the slurry tank. Oversized particles are recycled to the grinding mill.

A below-grade grinding sump is located centrally within the coal grinding and slurry preparation area to handle and collect any slurry drains or spills in the area. Materials collected in the sump are routed to the recycle tank for reuse in the process.

In order to minimize groundwater withdrawal and use, water for the slurry preparation system is provided from several sources; primarily by the moisture contents of the feedstock coal, the recycled feed, and the grinding sump water. Additional makeup water to the slurry system is provided from the plant service water system. Through the collection and recycling process, there are no water discharges from the coal grinding and slurry preparation system. All water from the system is fed to the gasifier in the coal slurry.

Potential particulate matter air emissions from the coal storage bin, grinding mill, and rod mill overflow discharge are primarily controlled by the wet nature of these subsystems and by the use of enclosures for the subsystems with vents through fabric filters or baghouses. The slurry tank vents are equipped with carbon canisters for absorption of potential H_2S or ammonia (NH_3) emissions.

B. GASIFIER SYSTEM

The IGCC unit uses the Texaco oxygen-blown, entrained-flow, single-train gasification system to produce syngas for combustion in the advanced combustion turbine (CT).

Coal slurry from the slurry feed tank and oxygen from the air separation unit are fed to the gasifier and sent to the process burner. The gasifier is a refractory lined vessel capable of withstanding high temperatures and pressures. The coal slurry and oxygen react in the gasifier to produce syngas at high temperature. The syngas consists primarily of hydrogen, CO, water vapor, and CO_2, with small amounts of H_2S, COS, methane, argon, and nitrogen. Coal ash and unconverted carbon form a liquid melt called slag in the gasifier.

Hot syngas and slag flow downward in the gasifier into the radiant syngas cooler, which is a high pressure steam generator equipped with a water wall to protect the vessel shell. Heat is transferred primarily by radiation from the hot syngas to the feed water circulating in the water wall. High pressure steam produced in this cooler is routed to the heat recovery steam generator (HRSG) in the power block area which supplements the heat input from the CT to the HRSG and increases the efficiency of the generating unit.

The syngas passes over the surface of a pool of water at the bottom of the radiant syngas cooler and exits the vessel. The raw syngas is sent to the convective coolers and then to the low temperature syngas cooling system in the CGCU system for further heat recovery and to the demonstration HGCU system. The slag drops into the water pool and is fed to the lockhopper from the radiant syngas cooler sump.

The black water which flows out with the slag from the bottom of the radiant syngas cooler is separated from the slag and recycled after processing in the dewatering system.

C. COLD GAS CLEAN UP (CGCU) SYSTEM

The raw, hot syngas from the gasifier is routed to the separate conventional CGCU and demonstration HGCU systems for appropriate treatment. The CGCU system is designed to treat 100 percent of the syngas flow for the unit, while the HGCU system is capable of treating approximately 10 percent of the syngas. The CGCU system is described in the following paragraphs, and description of the HGCU system is provided starting in the next subsection.

The initial treatment process for the raw syngas within the CGCU system involves the syngas scrubbing and cooling systems.

The raw, hot syngas from the gasifier contains entrained solids or fine slag particles which must be removed to produce the clean syngas fuel. Also, the raw hot syngas needs to be cooled in order to be effectively cleaned in the acid gas removal unit.

The raw, hot syngas from the gasifier is first cooled in the high temperature syngas cooling system, then sent to the syngas scrubbers where entrained solids are removed. The syngas is then routed to the low temperature gas cooling section, where the syngas is cooled by recovering its waste heat to generate steam and preheat boiler feedwater.

The syngas scrubber bottoms are routed to the black water handling system. All the black water from the gasification and syngas cleanup processes are collected, processed, recycled to the extent possible, and contained within the processes. The solids that were not removed in the radiant syngas cooler sump are separated from the system as fines. There are no liquid discharges of these process waters to other systems or to the cooling reservoir.

The effluent from the black water handling system is concentrated and crystallized into a solid consisting primarily of salt called brine which is shipped off-site for disposal in an appropriately permitted landfill. The water separated from the salts is recycled for slurrying coal feed.

After removal of the entrained solids, the gaseous sulfur compounds (H_2S and COS) are to be removed from the syngas prior to firing in the advanced CT unit to control potential SO_2 air emissions.

In the acid gas removal unit, the cooled syngas is first water-washed in the water wash column. Wash water is pumped to the column to remove contaminants which would potentially degrade the amine from the syngas. The wash water from the column is sent to the NH_3 water stripper.

The washed syngas then flows to the amine absorber where the syngas is in contact with circulating amine. Acting as a weak base, the amine absorbs acid gases such as H_2S by chemical reaction. The purified syngas flows through a knockout drum to remove entrained amine. The recovered liquid is returned to the amine stripper.

The rich amine is stripped of the acid gas in the amine stripper by steam generated in the stripper reboiler. The acid gas overhead is partially condensed by the reflux condenser and collected in the reflux accumulator. The acid gas, primarily H_2S and CO_2, from the reflux accumulator goes to the sulfuric acid plant and the condensed liquid reflux is returned to the amine stripper.

D. HOT GAS CLEAN UP (HGCU) SYSTEM

For the system demonstration, this unit is designed to handle 10 percent of the hot, raw syngas from the gasifier for cleanup prior to firing in the combustion turbine. The key process steps for the system are described in the following paragraphs.

Entrained fine particles in the hot syngas are removed in the primary cyclone first and recycled to the black water handling system. The exiting gas is injected with sodium bicarbonate and enters a secondary cyclone where the halogen compounds in the gas are chemically absorbed. The collected solids from the cyclone are sent offsite for disposal in an appropriately permitted landfill and the syngas flows to an absorber.

A large fraction of any remaining particulate matter entering the absorber is captured by the zinc oxide sorbent bed, reducing particle concentration to below 30 ppm. A small amount of sorbent fines is entrained from the absorber and collected in a high efficiency barrier filter. The barrier filter practically eliminates all fines larger than 5 microns, with 99.5 percent of particulate matter removed. The solids from the barrier filter are sent offsite for disposal. Larger fines are sieved on screens at the regenerator sorbent outlet. Fugitive fines from the screens are collected in a small, low temperature bag filter. The sorbent fines from both collection points are reclaimed offsite, as a marketable by-product.

The absorber is an intermittently moving bed reactor. The sulfur-containing syngas from the cyclones enters the absorber through a gas manifold at its bottom and flows upward countercurrent to the moving bed of sorbent pellets. The sulfur compounds, mainly H_2S in the syngas, react with the zinc oxide sorbent to form zinc sulfide. The syngas leaving the absorber is expected to contain less than 30 ppmv of H_2S and COS.

To maintain low H_2S outlet concentrations, the absorber bed is periodically moved. A timed signal or an H_2S breakthrough control signal activates solids flow from the bottom of the absorber into the absorber's outlet lockhopper, causing the bed and the reaction zone to move downward by gravity. The displaced sulfided sorbent is replaced by regenerated sorbent from the absorber's inlet lockhopper.

The ability to regenerate and recycle the sorbent is essential for economically viable hot syngas desulfurization. The regeneration with oxygen is a highly exothermic oxidation process which requires careful temperature control. Too high a temperature will sinter and destroy the sorbent structure and reduce its ability to react with sulfur in consecutive absorption steps. Low temperature will result in sulfate formation and a loss of reactive sorbent returning to the desulfurization process in the absorber.

Sulfided sorbent is fed from the absorber's outlet lockhopper to the top of the regenerator where oxidation of the sulfided sorbent occurs. The sorbent moves down the regenerator in concurrent flow with the regeneration gas. The air to recycle gas ratio is controlled to limit the gas temperature.

The final step of regeneration is accomplished at the lower stage of the regenerator where nitrogen flows countercurrent to the sorbent. This stream cools the sorbent to a temperature acceptable for downstream equipment, purges the SO_2 - rich offgas, and ensures complete regeneration without sulfate formation. The gas streams from the concurrent and countercurrent flows mix to form the recycle gas stream.

The regeneration gas recycle system operates in a closed loop with dry air as an input and an SO_2 - rich offgas as a product output. The regeneration gas recycle loop is designed as an internal diluent that reduces the oxygen concentration in the air to the desired levels and removes the heat of reaction without the use of externally provided diluents such as nitrogen. Using recycle rather than external inert diluent also enriches the SO_2 concentration of the product stream.

The heat exchanger in the recycle loop is designed to control the temperature of the regenerator inlet streams. The steam generator removes the heat generated during the regeneration reaction by cooling the recycle gas stream. The recycle compressor operates at a sufficient suction temperature to avoid H_2SO_4 condensation and a regenerative gas heat exchanger reheats the compressed gas for recycle to the regeneration process. The heat of combustion of the sulfur is transferred to the combined cycle power block through the steam generated prior to recycle compression of the recycle gas stream.

E. COMBINED CYCLE POWER GENERATION

Key components of the combined cycle power generation system are the Combustion Turbine-Generator, HRSG, and Steam Turbine-Generator.

1. Combustion Turbine-Generator

The CT is a GE 7F, designed for low-NO_x emissions firing syngas, with low sulfur fuel oil for startup and backup. Rated output from the hydrogen-cooled generator when syngas is fired in the CT is 192 MW.

The syngas is delivered to the combustion turbine via control valves on the syngas fuel control skid. Nitrogen is used as the diluent to reduce the formation of NO_x in the exhaust gas. The flow of nitrogen to the combustor is regulated by valves on the nitrogen control skid.

When operating on the fuel oil backup, demineralized water is used as a diluent to reduce the formation of NO_x in the exhaust gas. The flow of fuel oil and demineralized water is controlled by a separate skid, the fuel forwarding skid.

2. Heat Recovery Steam Generator

The heat recovery steam generator recovers the combustion turbine exhaust heat to produce steam for the generation of additional power in the steam turbine. The HRSG is a three-pressure level (HP, IP, LP) natural circulation design with reheat (RH).

The HP section heats boiler feed water (BFW) and generates superheated steam for feed to the HP steam turbine. It also provides HP economized BFW to the gasification area and receives HP saturated steam from the gasification plant.

The RH section combines HP turbine exhaust with IP superheated steam and adds superheat to the mixture for feed to the IP steam turbine.

The IP section heats BFW and generates superheated steam to be mixed with cold reheat steam for feed to the RH section. The IP section also provides BFW to the gasification area and receives saturated steam from the gasification plant. During startup or when the CT is fuel oil fired, the IP section can be used to export saturated steam to the gasification plant.

The LP section heats and de-aerates BFW for the HP and IP systems and provides saturated steam for export to the gasification plant.

3. Steam Turbine-Generator

The steam turbine is a double flow reheat unit with low pressure extraction and drives a hydrogen-cooled generator. The steam turbine-generator is designed specifically for highly efficient combined cycle operation with nominal turbine inlet conditions of approximately 1450 psig and 1000°F with 1000°F reheat inlet temperature. Rated capacity is 124.2 MW; rated speed is 3600 rpm. Expected generator output during normal operation is 122 MW.

The outlet from the last stage of the turbine is condensed by heat exchange with circulating water from the plant cooling water reservoir. Condensate from the steam turbine condenser is returned to the HRSG/integral de-aerator by way of the coal gasification facilities, where some condensate preheating occurs.

4. Condensate System

The condensate system operates in this combined cycle power plant to:

- Return condensed steam to the cycle by pumping condensate from the condenser hotwell to the de-aerator
- Condense the steam from the steam turbine gland seals and return the condensate to the cycle
- Provide sources of condensate to various miscellaneous systems
- Provide a dump to the condensate storage tank on a high hotwell level
- Provide condensate makeup to the condenser hotwell

Condensate pump operation is required during combined cycle operation. One of the two 100 percent capacity condensate pumps is always in service during normal plant operation, while the other condensate pump is in the auto standby mode.

A hotwell dump line is connected from the condensate discharge line to the condensate storage tank for returning condensate in the event of a high level in the hotwell. Condensate supply to the hotwell is by way of vacuum drag under normal operation, and by the condensate make-up pump otherwise.

The condensate pumps also supply water to the following users in the Power Island:

- Steam Turbine Exhaust Hood Spray System
- Vacuum Pump Seals
- Condensate Receiver
- Condensate Return Tank
- Gland Seal Emergency Spray

- HRSG Chemical Injection Equipment
- Closed Cooling Water Head Tank
- Feedwater Pump Seals

5. Electrical Power Distribution System

For plant startup and periods when the plant is down, power is received at 230 KV and is back-fed through the generator step-up transformers with the generator breakers in the open position. This arrangement provides power to the station 13.8 KV auxiliary transformers. The station 13.8 KV switchgear distributes power at 13.8 KV to the various plant loads including the power block 4160 V and 480 V auxiliary transformers. The 4160 V switchgear provides power to the combustion turbine static starting system and to the 4160 V motors.

During startup, power is back-fed through the CT generator step-up transformer or the steam turbine-generator step-up transformer to power up the static starting unit. Once the combustion turbine is up to speed and self sustaining, the static starter is de-energized, and the CT generator can be synchronized to the 230 KV system by closing the 18 KV CT generator breaker. Similarly, when the steam turbine-generator is up to speed, it can be synchronized to the 230 KV system by closing the appropriate 230 KV switchyard breakers first and then the steam turbine-generator breaker.

Once the combustion turbine is started up and the CT generator synchronized to the system, the combustion turbine-generator can provide power to all of the station loads through the station 13.8 KV power distribution systems.

F. AIR SEPARATION UNIT

The air separation unit uses ambient air to produce oxygen for use in the gasification system and sulfuric acid plant, and nitrogen which is sent to the advanced CT.

Ambient air is filtered in a two-stage filter designed to remove particulate material. The first filter stage consists of a fixed panel filter; the second filter stage consists of removable elements, which are periodically replaced. The air is then compressed in a multistage centrifugal compressor equipped with inter-cooling between stages and a condensate removal system.

The compressed air is cooled in an aftercooler and fed to the molecular sieve adsorbers. The molecular sieves remove impurities, such as water vapor, CO_2, and some hydrocarbons from the air. The air is filtered once more in the dust filter to remove any entrained molecular sieve particles. Hot nitrogen is used for adsorbent regeneration. It is recovered and reused as CT diluent.

The air from the adsorbers is fed to the cold box where it is cooled against returning gaseous product streams in a primary heat exchanger (PHX). A small fraction of the air is extracted from the PHX and expanded to provide refrigeration for the cryogenic process. The expanded air is then fed to the low pressure distillation column for separation.

The remaining air exits the cold end of the PHX a few degrees above its dewpoint. The air is fed to the high pressure distillation column where it is separated into a gaseous nitrogen vapor and an oxygen-enriched liquid stream. The nitrogen vapor is condensed in the high pressure distillation column condenser against boiling liquid oxygen. The liquid nitrogen is used as reflux in the high and low pressure distillation columns.

Oxygen and nitrogen are produced in the low pressure distillation column. Heat from the condensing nitrogen vapor provides reboiler action in the liquid oxygen pool at the bottom of the low pressure distillation column. The oxygen vapor is warmed to near-ambient temperature in the PHX and fed to the oxygen compressor, where it is compressed to the pressure required by the gasification unit.

Nitrogen vapor from the low pressure distillation column is warmed to near-ambient temperature in the PHX and sent to the advanced CT.

As backup to the air separation unit, a liquid nitrogen storage system is provided for system purging and maintaining low temperature in the cold box. The backup liquid nitrogen system is maintained in a cold, ready-to-start state.

The air separation unit process does not consume water and produces only minor amounts of water from condensation in the main air compressor aftercooler. This water is sent to Industrial Water Treatment (IWT). The unit requires water only for non-contact cooling purposes which is provided from the makeup water system and/or the cooling reservoir.

G. BY-PRODUCT HANDLING

1. Slag

The slag handling system is designed to remove the slag that exits through the radiant syngas cooler sump. The slag consists of the coal ash and unconverted coal components (primarily carbon) that form in the gasifier.

Coarse solids and some of the fine solids flow by gravity from the radiant syngas cooler sump into the lockhopper. The lockhopper acts as a clarifier, separating solid from water. When the solids collection time is over, the lockhopper is isolated from the radiant cooler sump and depressured. After that the solids are water flushed into the slag sump tank. After a preset time, the water flush is discontinued and the lockhopper is filled with water and repressured. The next collection period begins when the inlet valve is opened for a new cycle.

Solids from the lockhopper are dumped onto the pad at the slag dewatering bins. In the bins, the solids settle into a pile and are dewatered by gravity. The slag, after dewatering, is then transported by front-end loaders to trucks for off-site shipment or to the on-site slag storage area. The water removed from the slag is gravity drained via concrete trenches to the slag dewatering sump for recovery.

Again, all waters produced in this slag handling system are collected and routed to the black water handling system for reuse.

This system generates the coarse slag material at a maximum rate of approximately 210 short-tons per day (stpd) on a dry basis. The slag is classified as nonhazardous and non-leachable and is marketed for various offsite commercial uses such as abrasives, roof material, industrial filler, concrete aggregate, or road base material.

2. Slag Storage Area

During periods when the slag by-product cannot be sold in a timely manner, a temporary storage area will be employed on the site. Initially, an area will be developed to be capable of storing slag generated by approximately 2-1/2 years of operation of the IGCC unit at full capacity. An additional 2-1/2 year storage area will be developed as needed in the unexpected event that sales of the slag for offsite uses are less than the slag production rates. The temporary slag storage area would provide sufficient capacity for developing storage cells for up to five years of slag production from the IGCC unit operating at 100-percent capacity. The slag storage area will include a stormwater runoff collection basin and surrounding berm to prevent runoff from reentering the area. Both the slag storage area and the runoff collection basin will be lined with a synthetic material or other materials with similar low permeability characteristics. The runoff basin will be designed to contain runoff water volumes equivalent to 1.5 times the 25-year, 24-hour storm event. Water collected in the runoff basin will be routed to the IWT for filtration.

H. SULFURIC ACID PLANT

In the sulfuric acid plant, the sulfur-containing acid gases from the hot and cold gas cleanup systems are converted to 98 percent sulfuric acid for sale to the local Florida fertilizer industry. The conversion of acid gases involves a multi-step combustion, gas cleaning, and catalytic reaction process.

In the HGCU process, an acid gas is produced containing sulfur dioxide (SO_2). In the CGCU process, hydrogen sulfide (H_2S) containing gases from the acid gas removal unit and the ammonia stripping unit is routed through separate knockout drums at the acid plant to remove any entrained water. The CGCU gases are then introduced into the decomposition furnace, along with staged combustion air to limit NO_X formation. Supplemental fuel is not normally required; but may be added to maintain the proper operating temperature during periods of low H_2S feed gas concentration. Hot gases from the HGCU unit are introduced into the system downstream of the decomposition furnace and mix with the combusted acid gas from the CGCU unit. The sulfuric acid plant is capable of operating with or without the HGCU feed gas.

The combusted gas stream (containing SO_2, SO_3, water vapor, and trace H_2SO_4) are cooled in a firetube waste heat boiler. The boiler steam side is maintained above 400 psig to avoid condensing acid in the tubes. The gases from the waste heat boiler are cooled in a DynaWave gas cleaning system via a circulating stream of weak acid. The DynaWave system consists of a gas quenching section with the hot process gas forced down through a countercurrent spray of weak acid, followed by a conventional packed gas cooling tower. Water condensed from the process gas absorbs some of the SO_3 in the process gas, thus creating the circulating weak acid stream. An effluent stream of weak acid is removed from the plant to enable the manufacture of 98 percent product acid.

Reaction air in the form of low-pressure 95-percent purity oxygen is added to the process gas stream downstream of the DynaWave system to provide the required amount of oxygen for the SO_2 to SO_3 conversion in the acid plant's catalytic converter.

The gases leaving the DynaWave system flow to a drying tower, where the remaining water vapor and SO_3 is removed by countercurrent washing with 96 percent acid. It is essential (for corrosion concerns) that these components be removed from the process gas stream prior to the catalytic conversion step. The gases from the drying tower pass through candle-type mist eliminators and go to the main blower which provides the necessary pressure for flow through the converter beds and remaining absorber towers.

The gases from the blower are then heated in the converter gas-gas exchangers to achieve the proper reaction temperature and sent through catalytic converter beds. The converter contains three catalyst beds charged with vanadium pentoxide catalyst. The gas-gas heat exchangers transfer heat generated in the SO_2 to SO_3 conversion to the process gas entering each catalyst pass, maintaining reaction threshold temperature. After the first two beds, the process gas is passed through an intermediate absorption tower, where SO_3 is absorbed by circulating 98 percent acid. After the third bed, the process gas is passed through a final absorption tower where SO_3 is again removed by countercurrent 98-percent acid absorption, and subsequently the stripped process gas is low enough in SO_2 content to release to the atmosphere. Mist eliminators at the top of each absorber tower mitigate the carryover of acid mist.

The H_2SO_4 unit is located northeast of the gasification facilities on the site. The facilities include an aboveground tank to provide for five days of temporary storage of the 98-percent H_2SO_4 saleable by-product and a loading rack that can accommodate either DOT-standard rail cars or tank trucks.

Stormwater runoff from the H_2SO_4 storage, handling, and loading area is directed to the Industrial Wastewater Treatment (IWT) system for appropriate treatment prior to being routed to the cooling reservoir for reuse. Acid spills from the storage, handling, and loading areas are contained and either routed to rail cars/tank trucks for sale or to the HRSG blowdown sump, depending upon the acid concentration.

I. BALANCE OF PLANT SYSTEMS

1. Cooling Water

The steam electric generating components of the IGCC unit require water to cool or condense the exhaust steam from the steam turbine. Cooling water is also required for gasification, ASU, sulfuric acid, and other miscellaneous users. The waste heat transferred to the cooling water must then be rejected to the atmosphere. The cooling/heat rejection system for the Polk Power Station is a cooling reservoir.

The cooling reservoir is being constructed in areas which have previously been mined for phosphate and consisted of water-filled mine cuts between rows of overburden spoil piles. The reservoir occupies an area of approximately 860 acres, including the areas of the surrounding and internal earthen berms. The reservoir is a primarily below-grade facility after final contouring and development of the site.

Intake and discharge structures to provide and subsequently discharge the cooling water are constructed within the cooling reservoir. The estimated circulating cooling water flow requirements are approximately 130,000 gpm for the steam turbine condenser and 40,000 gpm for the remainder of the plant including the air separation unit. One set of two 50 percent pumps supplies water for the condenser, and another set of two 50 percent pumps supplies water for the other users. The warmed return water is routed throughout the reservoir area by the internal berm system and cooled through evaporation prior to intake and reuse in the system.

For users that require higher quality water than that provided by the cooling reservoir, two closed loop cooling water systems are provided: one for the power generation area and the other for the gasification area. Heat is rejected from these loops to the cooling water from the reservoir.

2. Fuel Oil Storage

The plant has storage for 2,000,000 gallons of No. 2 fuel oil, which is used to fire the auxiliary boiler and the combustion turbine when it is fired with fuel oil.

Fuel oil is unloaded from the tank trucks and pumped by the fuel oil truck unloading pumps to the fuel oil storage tank. From the fuel oil storage tank, the fuel oil is pumped to either the combustion turbine fuel forwarding skid and to the auxiliary boiler.

The unloading area is curbed and the storage tank area is diked. All rainfall and spills in these areas are collected and sent to an oily-water separation system.

VI. PROJECT MANAGEMENT

The management style selected for this project has been one of fully integrated and empowered teams. This is evident from the very inception of the project. When Tampa Electric Company (TEC) assumed the Cooperative Agreement with the U. S. Department of Energy (DOE) for this Demonstration IGCC Project, an important condition was to incorporate the expertise of TECO Power Services, Inc. (TPS) to provide overall project management for the DOE portion of the project. TECO Power Services, Inc. is a TECO Energy, Inc. subsidiary and affiliate of Tampa Electric Company.

Early in the life of the project, Tampa Electric decided to form and periodically convene a panel of experts to guide the design philosophy for the facility. This Technical Advisory Committee (TAC) is comprised of key members of organizations on the leading edge of power system technology and gasification system design and operating experience. Member organizations include Texaco, General Electric Company, Bechtel Power Corporation, the Electric Power Research Institute (EPRI), Southern California Edison Company (Cool Water plant experience), Tennessee Eastman Division of Eastman Chemical Company, TECO Power Services and Tampa Electric Company. This group met three times in 1993, once in 1994, and remains involved on an as-needed basis. The substantial recommendations from this group have contributed to improvements in the areas of plant design, plant layout, equipment selection and configurations, sparing philosophies, safety considerations, reliability analysis, training requirements, start-up sequencing and others too numerous to mention. The TAC has proven to be a valuable asset to the project and we look forward to its continued involvement and contributions.

When the detailed engineering contract was signed with the project A/E, Tampa Electric and Bechtel created an integrated engineering team within the Bechtel offices in Houston, Texas. This decision was made to utilize the extensive coal-fired power plant experience within Tampa Electric to enhance the design effort of the Houston-based engineering team and to accelerate the decision making process. TEC's Engineering Project Manager and lead discipline-level engineers translocated to Houston to complete this important mission. This working arrangement has been very effective, and a true spirit of teamwork prevails. At the end of 1994, most of the TEC engineering team members and the EPRI representative returned to Tampa, and will provide guidance in making the transition from the engineering phase to the construction phase of the project.

Concurrent with the formation of the integrated engineering team, a similar team of procurement specialists was assembled. TEC team members who translocated to Bechtel's offices in Houston included the Procurement Manager, a Deputy Project Manager, Major Contracts Administrator and several procurement specialists. The integrated TEC-Bechtel procurement, contracts administration and expediting team was, and continues to be, very effective in providing expertise, consistency and timely response for this important function. In early 1995, some members of this team will transition to the field to provide continuity and assist with material receipt, while other team members will complete the mission in Houston.

Another key member of the integrated project team based in Houston was TEC's Construction Manager. In addition to the contract for detailed engineering, Bechtel was awarded the contract for the project's Construction Management (CM). TEC's CM representative has worked shoulder-to-shoulder with Bechtel's Construction Manager to add TEC-specific construction experience to this effort, and transitioned to the field at the end of 1994.

Other examples of team flexibility and integration include:

- The composite TEC-Bechtel project management-engineering-procurement team which was dispatched to GEESI's offices in Lebanon, Pa. to implement a schedule recovery plan for HGCU System design and equipment procurement

- The integration of a key Bechtel engineering team member into the design group for the sulfuric acid plant in Monsanto's offices in St. Louis, Missouri.

- The composite TEC-Bechtel-Texaco team which has been, and continues to be, very active in the resolution of design and scheduling issues with MAN GHH and L&C Steinmüller in Europe

Since the project's inception, DOE/METC (Morgantown Energy Technology Center) has provided guidance and direction toward key program objectives. DOE's involvement has been a very important part of the project in several ways. The DOE Technical Design Team conducted a "40% complete" review of the engineering progress in early 1994 at the Bechtel offices in Houston, and will perform a "90% complete" design review in early 1995. Quarterly project review meetings were conducted during 1994, and the DOE Technical Design Team continues to monitor progress of the HGCU engineering work as well as of the developmental work at the HGCU pilot plant at G.E.'s Corporate Research and Development (CR&D) Laboratories in Schenectady, N.Y. Close and frequent communication between the TEC and DOE/METC Project Managers provides focus for the project and expedites the in-process adjustments necessary for a project of this type.

Additionally, alignment meetings have been held at various working levels throughout the life of the project, from Senior Management through key discipline-levels. Meetings such as these have helped to bring focus to the critical success factors necessary to make the Polk IGCC Project a technical and commercial success for all project participants, and for the electric utility industry.

Each of the major project participants has been challenged to review their traditional "business as usual" practices, and make internal adjustments at times due to the highly fluid design environment and evolving technologies that comprise this project. Tampa Electric appreciates the flexibility and spirit of teamwork that continues to be displayed by our project partners.

We fully expect the project management style utilized for this project to be an effective model for IGCC projects of the future.

VII. PROJECT COST AND SCHEDULE

Information in this section refers to the Project Cost Estimate included as Exhibit A to this report, Project-to-Date (PTD) Costs through December of 1994 shown in Exhibit B, a Project Milestone Schedule (Exhibit D), and a schedule of significant startup milestones (Exhibit E).

A. PROJECT COST ESTIMATE

Exhibit A, Project Cost Estimate, shows the costs by major plant sections for the period prior to 1994, with annual estimates thereafter through the completion of construction in 1996. The year-end 1994 estimate of total project cost to Tampa Electric for the Polk IGCC Demonstration Project is $449,804,000. DOE cost-sharing toward the project scope represented by this estimate is ($110,253,000).

B. PROJECT-TO-DATE COSTS THROUGH 1994

Exhibit B, PTD Costs through 1994, shows actual versus estimated costs, project-to-date through 1994, subdivided by expenditure type, and variance for each type in dollars and in percent. Against a PTD cost estimate of $180,815,203, actual expenditure was $184,329,821, or 1.9 percent over estimate through 1994.

C. PROJECT MILESTONE SCHEDULE

Exhibit D, Project Milestone Schedule, focuses on dates related to key milestones for contract awards, contractor mobilizations, and manufacturing completion targets during 1994, and on equipment delivery milestones, completion of detailed engineering, issuance of major construction contracts, and test program completions in 1995.

D. STARTUP SCHEDULE

Exhibit E, Startup Schedule, highlights the completion of key construction events and "first use" of major plant equipment to support the preparation for commercial operation of Polk Unit 1.

VIII. TECHNICAL PROGRESS / DETAILED ENGINEERING

This section of the report addresses detailed engineering with accomplishments for the various IGCC plant areas, from coal delivery through power generation and the processing of by-products, as listed in Table 2.

TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Process flow diagram (PFDs) were prepared and/or revised and issued for design	✓	✓	✓	✓	✓	✓				✓				✓	✓	✓
Piping and instrument diagrams (P&IDs) were issued for review, safety and operability reviews were conducted and P&IDs were issued for design and subsequently issued for construction.	✓	✓	✓	✓	✓	✓ (issued for design only)	✓	✓ (HAZOPs only conducted)		✓	✓	✓	✓	✓	✓	✓ (HAZOPs only con-ducted)
System specification and material requisition issued for purchase	✓ (Coal Handling & Coal Silo)													✓	✓	✓ (P.O. awarded to Aqua-Chem)
Area plot plans issued for construction		✓	✓				✓									
Equipment location plans issued for design and subsequently issued for construction	✓				✓		✓			✓ (Intake structure)				✓	✓	
Piping planning studies issued for review and subsequently for design	✓				✓					✓ (Intake Structure & U/G Piping)				✓	✓	
Piping isometric drawings were prepared and issued for construction	✓				✓		✓			✓ (intake structure)	✓	✓	✓	✓ (intake structure)	✓ (intake structure)	
Computer 3-D model was developed and Walkthru reviews were conducted					✓	✓	✓	✓		✓	✓	✓	✓	✓ (intake structure)	✓ (intake structure)	✓
Instrument index was prepared and issued for design	✓				✓					✓				✓	✓	
Logic diagrams were prepared, reviewed and issued for design	✓				✓ (instru-ment)					✓ (intake structure)				✓ (Control Systems)	✓	
Instrument location plans were prepared and issued for review	✓				✓		✓ (issued for const.)			✓ (issued for Const. - intake structure)				✓	✓ (issued for design)	

TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Electrical single-line diagrams were issued for design and subsequently issued for construction	✓ (design only)	✓	✓		✓		✓			✓				✓	✓	
Electrical schematic diagrams were prepared, issued for review and subsequently for construction	✓ (review only)				✓	✓ (review only)				✓				✓	✓	
Electrical wiring diagrams were prepared, issued for design and subsequently for construction										✓ (intake structure)				✓	✓	
Electrical grounding plans were prepared, issued for review and subsequently for construction	✓ (review only)				✓					✓				✓	✓	
Electrical area classifications were prepared, issued for review and subsequently for construction	✓	✓	✓		✓					✓				✓	✓	
Electrical cable tray/conduit drawings were prepared, issued for review and subsequently for construction	✓ (review only)				✓					✓				✓	✓	
Electrical cable/raceway schedules were prepared and issued for review	✓				✓					✓				✓	✓	
Equipment and structural foundation and steel drawings were issued for construction					✓	✓ (review only)	✓			✓ (intake and outfall - foundation & structural only)	✓	✓	✓		✓ (Equip. & foundation only)	
Process design basis was issued		✓	✓													
Process data sheets were issued for design		✓	✓													
Process descriptions were issued		✓	✓													
Basic design data were issued for design		✓	✓						✓ (used oil handling)							
Vendor design documents were reviewed				✓ (Process)			✓ (GE and others)									

TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Underground orthographic drawings were issued for construction										✓					✓ (sewers)	
Underground planning studies were issued for review and subsequently for design										✓					✓ (sewers)	
Plant cooling water balance was updated and issued for design										✓						
Mechanical data sheets and specifications were issued for purchase		✓	✓													
Heat and material balances were issued		✓	✓			✓										
Relief valve sizing basis was issued		✓	✓													
Equipment, catalyst, utility, and utility balances summaries were issued		✓	✓													
Review of plant design electronic model was completed		✓	✓													
Line designation tables were issued for construction		✓	✓													
Interface meetings held monthly with syngas cooler equipment suppliers			✓													
Final report on Nalco cooling water test program was issued										✓						
Syngas cooler equipment performance data was reviewed			✓													
Resized HGCU unit from 120 MW capacity to 35 MW capacity due to lower than expected absorption rate from GE pilot plant test run				✓												
GEESI conducted technology review with DOE and Tampa Electric				✓												
Equipment data sheets issued for design				✓												
Preliminary milestone schedule was issued				✓												

TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Control concept and general arrangement drawings were issued.				✓												
Drawings and material requisitions for quotations for following vessels: primary cyclone, secondary cyclone, secondary cyclone lockhopper, absorber inlet lockhopper, absorber, absorber outlet lockhopper, regenerator outlet lockhopper, regenerator sorbent lockhopper and barrier filter lockhopper				✓												
Distributed control system configuration package issued for design						✓	✓ (preparation)									
Distributed control system documentation package was issued							✓									
Loop diagrams were issued						✓		✓								✓
All major process equipment specifications were issued						✓										
Bid tabulation on main gas compressor and firetube waste heat boiler were approved						✓										
Enviro-Chem engineering/procurement schedule and quality assurance plan were issued						✓										
Instrument data sheets were issued						✓										✓
Equipment arrangement layouts were issued						✓										
Sewer system conceptual design was approved						✓										
Utility and effluent summaries were issued						✓										
Underground and aboveground piping interface points were approved						✓										

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TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Purchase orders for electrical/analyzer building, adsorber valve/piping skid, and pre-fabricated cold box area large bore pipe were issued								✓								
Purchase orders for major rotating equipment were issued																✓
Purchase Orders were issued for compressors (plus motors), heat exchangers, afterfilters, silencers, filters, lube oil skids, TSA adsorber vessels, LIN storage tank, column can enclosure, and 13.8 and 4.16 KV switchgear								✓								
Design of electrical and piping interfaces at battery limits was completed								✓								
Noise attenuation studies were completed								✓								
Piping and civil structural design effort was 95% complete								✓								
APCI site Construction Manager mobilized								✓								
Civil/underground construction contract was awarded and contractor mobilized								✓								
Mechanical testing of main air compressor was successfully completed								✓								
Design for distillation columns was issued and fabrication was begun								✓								
Cold box erection contract was issued								✓								
Large bore yard area pre-fabricated piping package issued to bid								✓								
Specification and material requisition for slag storage area and brine and hot gas clean-up solids landfills were prepared and issued for quotation									✓							

TABLE 2
VIII. TECHNICAL PROGRESS/DETAILED ENGINEERING

ACCOMPLISHMENTS	Coal Delivery Handling & Storage	Coal Grinding & Slurry Prep.	Gasifier System	Hot Gas Clean-Up System	Cold Gas Clean-Up System	Sulfuric Acid Plant	Combined Cycle Power Gener.	Air Separation Unit	By-Product Handling	Cooling/ Circ. Water & Fire Water	P.B. Closed Loop Cl. Water	Fuel Oil Storage	Compressed Air System	Water Treatment System	WW Treatment System	Brine Conc. System
Study conducted to evaluate cost of onsite versus offsite disposal of brine and HGCU solids. Offsite disposal found to be attractive.									✓							
Material selection guides, system description, and equipment lists were issued								✓								
Skid frame design calculations and preliminary foundation load data were issued																✓
ASME vessel calculations were issued																✓
Plate materials for vessels and tube sheets were purchased																✓
Fabrication of major vessels and heat exchangers was begun																✓

IX. TECHNICAL PROGRESS / SIGNIFICANT ENHANCEMENTS

A. SULFURIC ACID PLANT

- Capital cost savings in the acid plant's design have been realized in the following areas:
  - Use of low pressure 95-percent oxygen instead of atmospheric air for the catalytic converter's reaction air stream
  - Use of siliconized ductile iron piping material instead of Sandvik SX stainless steel for strong acid piping systems
  - Use of FRP piping material instead of teflon lined carbon steel for weak acid piping systems
  - Elimination of one product acid transfer pump (used on shutdowns only) and one installed product acid loading pump from the original scope of supply
  - Relaxation of certain API 617 requirements for the plant's main gas compressor (an API 617 compressor was originally scoped, which was more stringent than Monsanto Enviro-Chem's typical compressor specification).
- The above items were incorporated without impacting the acid plant's availability requirements. A separate capital cost savings will be realized by having a previously mobilized field erected tank fabricator install the product acid storage tank instead of keeping this erection in Monsanto Enviro-Chem's scope.

B. COMBINED CYCLE POWER GENERATION EQUIPMENT

- Following the resizing of the hot gas clean-up system, it was decided to delete the hot syngas piping from the gasification area to the CT including the GE-furnished valves and piping, resulting in significant savings to the project.
- Based on the operating conditions for the plant, the capacity of the fuel oil storage was reduced from three million to two million gallons.
- The area classification requirements for the accessory module, fuel oil forwarding skid and the diluent nitrogen skid were established.
- The size of the auxiliary boiler was increased to allow startup of the gasification system.

- Steel platform was added to permit CT generator rotor removal.

- One of the two boiler feedwater transfer pumps was changed to the magnetic bearing design requiring no lubricating oil. This is the first US application of this technology for this size of a pump.

C. AIR SEPARATION UNIT

- A second installed compander was added to provide additional refrigeration capacity and serve as an installed spare. This will add capacity to produce liquid nitrogen for storage and improve reliability.

- Changes were made to the design of heat exchangers served by the open loop cooling water system to improve reliability and reduce the potential for fouling. Changes to the cooling water piping system were also made to facilitate cleaning of the heat exchangers cooling water side.

D. POWER BLOCK CLOSED LOOP COOLING WATER SYSTEM

- A cooling water filter was incorporated in the open loop cooling water system to protect the open loop/closed loop heat exchanger.

E. BRINE CONCENTRATION SYSTEM

- A centrifuge was selected for dewatering the brine slurry instead of a drum dryer to improve reliability and reduce cost.

- Two multi-stage centrifugal blowers were selected for heat addition to the falling film evaporator instead of a single compressor to reduce cost with no reduction in reliability.

X. HAZOP/SAFETY REVIEWS

HAZOP/Safety reviews were conducted by Polk Power Station Unit 1 design personnel regarding process safety management of highly hazardous chemicals. Complete HAZOP/Safety reviews were conducted for all process and utility areas associated with the design of Polk Power Station Unit 1. Methodologies used to determine and evaluate the hazards of each process area are described below.

PRELIMINARY HAZARD ANALYSIS

A Preliminary Hazard Analysis (PreHA) study was conducted to identify any items in the project design that could result in unsafe operating conditions or present unsafe environmental conditions due to the use of hazardous materials. The objectives of the PreHA were as follows:

- Identify hazard scenarios that could result in:
  - Serious injury to employees
  - Physical exposure or emotional impact to the public
  - Environmental impact
  - Service property losses
  - Significant business interruption
- Qualitatively estimate their consequences and likelihood
- Rank the risk of each hazard and hazard scenario
- Suggest approaches to risk reduction
- Separate P&IDs into three groups for further analysis as follows:
  - No further analysis required because there is no perceived risk
  - Minimal analysis using what if? questions or a checklist
  - Detailed analysis required using HAZOP, Failure Mode and Effects Analysis or Fault Tree techniques

The PreHA team ranked each hazard according to the risk posed by each potential hazard scenario. Consequences were rated according to severity, frequency, and the potential exposure to the public, plant personnel, the environment, and plant equipment.

Recommended changes to improve safety or mitigate consequences were noted. The results of these analyses were recorded on forms specially designed for this process. A responsible individual was identified for each item to take necessary actions to resolve the issues.

"WHAT-IF" HAZARD ASSESSMENT ANALYSIS

The Process Hazards Analysis (PHA) study was conducted to identify any items in the project design could result in unsafe conditions or unexpected operational or mechanical difficulties. The PHA was conducted using the "What If?" technique. This method involves asking and answering a number of questions starting with "What if...," to identify unexpected hazards or problems. Areas of interest were hazards to the public, plant personnel, the environment, and/or equipment.

The team discussed the potential causes and consequences of each item/question, including human error conditions, and the findings were recorded in the CAUSE and CONSEQUENCE columns, respectively. If the team decided that a change was warranted to improve safety or operability, it was noted in the RECOMMENDATIONS column.

HAZOP

The Hazards and Operability (HAZOP) study for the Polk Power Station, Unit 1 was conducted to identify any items in the project design that could result in unsafe operating conditions or unexpected operational difficulties. The "Guide Word" HAZOP technique was selected for this project, which is an analysis in which guide words are combined with process parameters to examine deviations from design intent at selected locations in the process flow. The guide words used include **no, more** (higher), **less** (lower), **other than**, etc. Process parameters examined include **flow, temperature, pressure, level**, and **composition.**

The HAZOP study is a disciplined method of providing a PHA team with the means to visualize the ways a plant, process, or piece of equipment can fail, malfunction, or be improperly operated. Within the HAZOP, the process under investigation is systematically questioned to determine the consequences (hazards) of deviations from the design intent. The premise of the HAZOP technique is that a problem can exist if the process deviates from the design intent.

The PHA team examined the process deviations at the selected nodes on the piping and instrumentation diagrams. When a deviation was identified which would cause unsafe conditions or operating problems, possible causes and consequences were discussed and recorded in the CAUSE and CONSEQUENCE columns, respectively. Changes to improve safety or operability were entered in the ACTION column.

CLOSEOUT OF HAZOP AND SAFETY REVIEW ACTIONS

The individual(s) identified to take action investigated the issues and implemented agreed-upon modifications to the P&IDs. The resolutions were documented on the special forms for record.

XI. 3-D MODEL REVIEWS

Detailed design of Polk Power Station Unit 1 was performed using Bechtel's 3DM system. This is a three-dimensional computer model of the plant which presents the following features of the plant design:

- Equipment and buildings
- Piping, valves and significant pipe supports
- Civil foundations and structures
- Structural steel
- Ladders, platforms, stairways and hand rails
- Instruments
- Electrical cable trays
- Access and pull spaces

The 3-D model was used by many project participants through the course of the project. Initially, its main purpose was to identify and eliminate interferences. On the Polk Project, the 3-D model was reviewed using the WALKTHRU program. The reviews were conducted in two stages; Stage 1 was conducted when all the equipment and large bore piping was modeled and Stage 2 was performed when the model was complete with all small bore piping. Each review stage is normally conducted in two steps: first an internal review by design disciplines, then a joint review with TEC's operations and maintenance personnel. A partial list of the issues that were resolved during the model review is listed below:

- Verified that valve locations and orientations provided for access to the handwheel operators. In cases where immediate accessibility was not required, chain pulls for the handwheels were installed.
- Reviewed walkways at grade and on platforms to assure adequate side and head clearance for plant personnel.
- Reviewed equipment arrangements for maintenance and inspection accessibility.
- Verified that there is adequate space and access for removing or installing equipment. This means that provisions have to be made for special maintenance equipment such as forklifts, mobile cranes, hoists, bundle pullers, etc.

- Reviewed the locations of instrument sensors, transmitters, and local readouts to verify adequate access by plant maintenance and operating personnel.

- Ensured that appropriate plant utilities (service air and water, low pressure steam, and nitrogen) were provided at convenient locations.

- Studied arrangements of equipment handling flammable or hazardous materials to determine that no undue safety hazards existed and that adequate protective measures (such as emergency escape routes and safety showers) were included.

After the model was reviewed, the model was checked for interferences and piping isometric drawings and other documents were generated and used to procure material. After these tasks were completed, the model was used by Construction for planning and walkdown purposes. Examples of 3-D model Walkthru drawings are attached.

The use of the 3-D model has many benefits. Probably the greatest advantage is elimination of much of the field rework which has occurred with previous work methods.

XII. CONSTRUCTION MANAGEMENT

A. CONSTRUCTION PLAN AND PROJECT PHILOSOPHY

The project philosophy established by Tampa Electric was to award major contracts based on areas rather than by discipline or commodity. It is the Construction Manager's (CM) responsibility to monitor and enforce compliance with those contracts. The following is a list of major contracts to be awarded by the CM team:

	Area	Contractor
1.	Mechanical Contract for Gasification Area	Undetermined
2.	Mechanical Contract for the Power Block	Undetermined
3.	Sulfuric Acid Plant	Monsanto Enviro-Chem Systems, Inc.
4.	Two Site Work Construction Contracts	Johnson Brothers Corporation
5.	Control Building	Hennessey Construction Services
6.	Warehouse and Maintenance Buildings	C. A. Oakes Construction Company
7.	Fire Protection	Undetermined
8.	Field Erected Tanks	Tampa Tank
9.	Coal Silos	American Marietta

Additionally, the CM will be involved in the procurement of testing services, security, trash disposal, construction utilities, minor foundations and other services. The CM will manage the site activities of all contractors. As the construction plan is developed and executed, any additional contracts will be similarly the responsibility of the CM.

The Phase I Construction Services being provided by Bechtel are as listed below:

- Provide information to allow Tampa Electric to assess construction options
- Planning and scheduling of pre-construction and construction activities
- Project controls systems

- Review and complete development of Tampa Electric's proposed contracting strategy
- Prepare a comprehensive environmental compliance plan for the project
- Prepare construction bid documents and solicit construction bids
- Develop a system for controlling quality by adherence to codes, standards and provisions of the technical specifications
- Consult, advise and assist Tampa Electric with all aspects of site planning and construction facilities planning
- Develop and implement a plan for construction safety
- Assist Tampa Electric and the Engineer in development of a program for plant test and startup
- Review plant drawings and specifications for constructability, format, content and completeness
- Advise and make written recommendations to design documents with respect to construction feasibility, economics, availability and utilization of materials and labor, time requirements for procurement and construction
- Develop written administrative procedures to be followed in managing the construction activities
- Prepare written pre-qualification criteria for bidders and develop contractor interest in the project

Phase II Construction Services being provided by Bechtel are as listed below:

- Coordinate activities of all site contractors for laydown and fabrication as well as plant construction activities
- Provide security, construction utilities, support services, housekeeping and cleanliness, construction photography, surveying and quality control/testing services on a subcontracted cost basis
- Provide construction scheduling, progress tracking, and analysis for all construction activities
- Provide construction contract administration
- Assess quality; adherence to codes, standards and construction specifications; and initiate corrective action to monitor and enforce compliance to specifications

- Perform administrative tasks related to construction including monthly reporting and maintenance of construction accounting records
- Manage activities in conjunction with Engineer's startup plan
- Prepare the project completion report

B. CONSTRUCTION CONTRACTS AWARDED

<u>CP-001, Site Development:</u>

The contract for site development includes the following:

- Install underground piping including stormwater pipe to MH No.8, circulating water pipe, and 36-, 42-, and 48-inch cooling water pipe
- Soil erosion control
- Perform clearing, grubbing, site dewatering and cut and fill for land areas
- Construct temporary and permanent berms, water ponds, ditches, trenches, and culverts
- Perform layout and survey of work areas
- Install base material for roads and asphalt base course
- Construct temporary parking areas, laydown areas and railroad subgrade
- Provide slope stabilization of berms, trenches and ditches
- Perform initial site revegetation
- Install coal delivery ramps

This contract was awarded to Johnson Brothers Corporation (JBC) on February 7, 1994. Major areas worked during the year included:

- Clearing, grubbing and site drainage structures
- Site roads, parking and material laydown areas
- Underground stormwater, circulating and cooling water systems
- Cooling water basins

By the end of 1994, JBC had completed 48 percent of this work versus 50 percent of the scheduled work.

CP-003, Railroad:

The railroad contract included furnishing of materials and installing ballast, rail ties, switches and track for plant rail spur (commencing at termination of CSX-installed track) and constructing road-crossing. This contract was awarded to Summers Brothers.

CP-008, Main Civil/Structural:

The contract for civil/structural site construction included:

- Earthwork associated with foundation installation, tank foundations and liners for plant storage tanks
- All underground ductbank (except for cable)
- All fuel oil storage tank area concrete and earthwork
- Instrument air compressor foundations
- Cooling water intake structure concrete
- Grounding and underground pipe
- Power Block equipment foundations
- Pipe rack foundations and steel erection
- Flare foundation
- Underground piping not included in the site development contract
- Gasification structure foundation and structural steel erection to 85 feet above grade
- Coal handling and coal grinding area foundations
- Wastewater treatment area civil and underground electrical and utilities

This contract was awarded to Johnson Brothers Corporation (JBC) on October 14, 1994.

D001, Field Erected Tanks:

The field erected tanks contract includes design, supply and erection of atmospheric pressure tanks and vessels including condensate storage, amine storage, slurry run tank, chemical cleaning, service water, demineralized water, fuel oil storage, brine storage, evaporator storage, and grey water storage tanks; hydrotesting; cleanup of tank interiors; blasting of tank interiors and exteriors; and application of coatings, painting, cathodic protection and post-weld heat treatment. Foundation work will be performed in package CP-008. This contract was awarded to Tampa Tank on April 15, 1994.

CP-010A, Control Building:

The contract for the control building includes all civil, architectural, interior finishes, fire protection, electrical power and lighting, plumbing, HVAC (including startup testing and balancing), control wiring and communications systems needed for construction of Control Building; foundations, underground utilities, and setting of emergency generator and associated fuel tank at Control Building; lightning protection; security system; computer access floor; laboratory fixtures and equipment (exhaust hoods, tables, sinks, piping, etc.); kitchen and all appliances. This contract was awarded to Hennessey Construction Services on October 13, 1994.

R-001, Warehouse and Maintenance Buildings:

The contract for the warehouse and maintenance buildings includes design, furnishing of materials, and erection; civil, architectural; interior finishes; electrical power and lighting; fire protection; plumbing; HVAC (including startup testing and balancing); control wiring; underground utilities; foundations and communications systems; lightning protection; and all appliances. This contract was awarded to C.A. Oakes Construction Company.

CP-015, Well Drilling:

This contract includes installation of permanent site wells and includes sampling, logging, pumps and motors and was awarded to Diversified Drilling on August 25, 1994.

V-014, Sulfuric Acid Plant:

This turnkey contract to erect the sulfuric acid plant including tanks, foundations, columns, structural steel, pumps, equipment, instrumentation, electrical insulation, painting, startup, testing and operator training was awarded to Monsanto Enviro-Chem on May 10, 1994.

CP-017, Heavy Haul and Transport for Radiant Syngas Cooler:

This contract to provide ocean transportation of the radiant syngas cooler and components from port of fabrication to Tampa, Florida, surface transportation to jobsite, and erection of equipment in the gasification structure was awarded to Davenport Mammoet Heavy Transport, Inc. on May 9, 1994.

T-013, Coal Silos:

This contract includes design, furnishing of materials, and installation of coal storage silos (including foundation) and was awarded to American Marietta on May 19, 1994.

Miscellaneous Service Contracts:

Miscellaneous service contracts were awarded between January 20 and September 6, 1994.

C. CONSTRUCTION ACHIEVEMENTS

- Contract bidding packages for major contracts for mechanical/electrical installation for the Power Block and plant utilities, and the gasifier and coal handling areas were prepared
- Construction management team mobilized into construction office complex near Power Block
- Construction of railroad nearly complete
- Drilling of production water wells was well underway by year's end
- Coordinated the development of a separate contract package for reclamation work west of SR-37
- Implemented Constructability Program
- Provided technical support and interface with Engineering
- Commenced construction of underground facilities, site foundations, site buildings, and cooling pond structures

XIII. TECHNICAL PAPERS/CONFERENCE PRESENTATIONS

During 1994, Tampa Electric and TPS Project Management representatives participated in major conferences to deliver technical papers targeted toward the advancement of IGCC Technology in Utility Applications. The summary below lists the key conferences attended and the technical papers presented.

February: Stephen D. Jenkins of TPS and Deputy Project Manager for the Polk IGCC Project, presented a paper on the "Tampa Electric Company Polk Power Station IGCC Project" at the Conference on Comparative Economics of Emerging Clean Coal Technologies III in Washington, D.C.

June: Donald E. Pless, Director of Advanced Technology for TPS and Project Manager for the Polk IGCC Project, made a technical presentation at the Polk Power Station Site to a delegation of Utility and Governmental representatives from the Peoples Republic of China on "Polk Power Station Unit No. 1".

September: Donald E. Pless delivered his paper on the "Tampa Electric Company Integrated Gasification Combined Cycle System" at the Third Annual Clean Coal Technology Conference in Chicago, Illinois, sponsored by the U.S. Department of Energy, Pittsburgh, Pennsylvania.

October: At the Eleventh Worldwide TEXACO Gasification Licensee Symposium held in White Plains, New York, Stephen D. Jenkins delivered his paper entitled "Polk Power Station Syngas Cooling System".

October: Charles A Shelnut, General Manager of Polk Power Station presented his paper on "Tampa Electric's 250 MW IGCC Project Status" at the Thirteenth Annual EPRI Coal Gasification Power Plants Conference in San Francisco, California.

October: Charles R. Black, Vice President-Project Management, delivered his paper entitled "Financing IGCC Projects - Tampa Electric's Perspective," at the Thirteenth Annual EPRI Coal Gasification Power Plants Conference in San Francisco, California.

November: At the International Sulfur Conference held in Tampa Florida, Charles Shelnut, General Manager for the Polk IGCC Project, and Jim Shafer, Project Manager for Monsanto Enviro-Chem, delivered a paper entitled "Tampa Electric Company's Polk Power Station IGCC Project." The authors of the paper were Steve Jenkins of TPS and Deputy Project Manager for the Polk IGCC Project, and Jim Shafer, noted above.

December: At the Power-Gen Americas '94 Conference held in Orlando, Florida, Stephen D. Jenkins and Lee A. Schmoe of Bechtel Power Corporation delivered a paper on the "Tampa Electric Company Polk Power Station IGCC Project".

December: Donald E. Pless delivered a presentation to the National Rural Electric Cooperative Association in Tampa, Florida entitled "Polk Power Station Unit No. 1".

XIV. PROJECTIONS FOR 1995

Detailed engineering will be complete for the various plant systems by mid-year.

The two major mechanical/electrical/instrumentation construction contracts will be awarded early in 1995.

Site development work for the plant area east of State Road 37 will be approximately 90 percent complete, with reclamation work west of State Road 37 well underway.

Manufacturing/fabrication of all major plant equipment will be complete, with equipment delivered to the Polk County site from facilities all over North America and Europe.

Installation of concrete foundations, underground utilities, structural steel, and setting of all major mechanical and electrical equipment will be complete.

Installation of piping systems and electrical wiring and instrumentation work will be in full swing.

Several significant testing and development milestones will have been achieved; such as:

- Combuster Test Program completion for the G.E. 7F CT to be fired on syngas
- Factory Acceptance Testing (FAT) of the Distributed Control System (DCS) for plant controls integration
- Hot Gas Clean Up system pilot plant test program completion

The 230 KV power transmission system linking Polk Power Station to the rest of the Tampa Electric system, and the onsite 230 KV switchyard will be complete and energized.

All major buildings, roads, and communication systems will be complete and in service.

The Startup Team will be assembled and preparation for functional testing and commissioning of plant systems will be in progress.

Staffing of plant operating personnel will be complete and intensive training will be underway.

XV. SUMMARY

The emphasis during 1994 centered around detailed engineering and procurement, with those activities standing at 83 percent and 85 percent complete, respectively, at year's end. All major permitting is in place to allow construction to move forward, with the two primary construction contracts for equipment installation targeted for award early in 1995.

The ground-breaking ceremony held on November 2, 1994, marked the beginning of the shift from design and procurement to construction activity onsite in Polk County, Florida.

Major project participants at the beginning of 1994 included:

- Air Products and Chemicals, Inc.
- Bechtel Power Corporation
- Electric Power Research Institute
- General Electric Company
- General Electric Environmental Services, Inc.
- MAN Gutehoffnungshütte AG
- L&C Steinmüller GmbH
- Tampa Electric Company
- TECO Power Services, Inc.
- TEXACO
- U.S. Department of Energy - Morgantown

The Polk IGCC Team grew in 1994 to include:

- Aqua-Chem, Inc.
- Bailey Controls Company
- Johnson Brothers Corporation
- Monsanto Enviro-Chem Systems, Inc.
- Triconex Corporation

Our project participants continue to look for, and find, ways to control cost and maintain an aggressive schedule. This team of expert companies has melded into an effective unit dedicated to the success of this landmark IGCC demonstration project.

The Technical Advisory Committee assembled by Tampa Electric early in the life of the project, and described in Section VI of this report, continues to be a valuable resource for gasification and power systems expertise.

Of special note is the recognition Tampa Electric Company received in 1994 for its innovation in the creation of the Power Plant Siting Task Force, described more fully in Section II of this report. Tampa Electric became the first private sector organization ever named to receive the State of Florida's top award for dispute resolution. This honor was bestowed by the Florida Growth Management Conflict Resolution Consortium, comprised of statewide environmental leaders and growth management officials.

Early in 1994, armed with the latest results from hot gas clean up (HGCU) system pilot plant tests, a project team decision was made to resize the Polk IGCC Project's HGCU system to process 10 percent of gasifier syngas output instead of the originally planned 50 percent stream. This design change required amendments to the DOE-TEC Cooperative Agreement and to the Contract for HGCU system design, both of which were near completion at year's end. The resultant demonstration HGCU system will provide valuable operating data for this developmental technology, and is expected to confirm its technical and commercial viability.

The schedule for the Polk IGCC Demonstration Project continues to support the completion of construction and commercial operation in the latter half of 1996.

In closing, Tampa Electric is pleased with the progress made in 1994, and appreciates the support, contributions, and flexibility of our team members. We eagerly look forward to the shift from engineering and procurement to construction and startup as we move into 1995. The hard work and dedication toward the fulfillment of project goals and objectives will soon take shape in the form of the environmentally superior, high performance IGCC power plant that is Polk Power Station Unit No. 1.

XVI. APPENDIX

Exhibit A - Project Cost Estimate

Exhibit B - Project-to-Date Costs Through 1994

Exhibit C - Polk Power Station Block Flow Diagram

Exhibit D - Project Milestone Schedule

Exhibit E - Startup Schedule

Exhibit F - Artist's Rendering of Polk Power Station

Exhibit G - Site Plot Plan

Exhibit H - Construction Progress Curve

Exhibit I - Site Photographs, Aerials and Selected Photographs at Grade

Exhibit A

POLK POWER STATION
PROJECT COST ESTIMATE
($ x 1,000)

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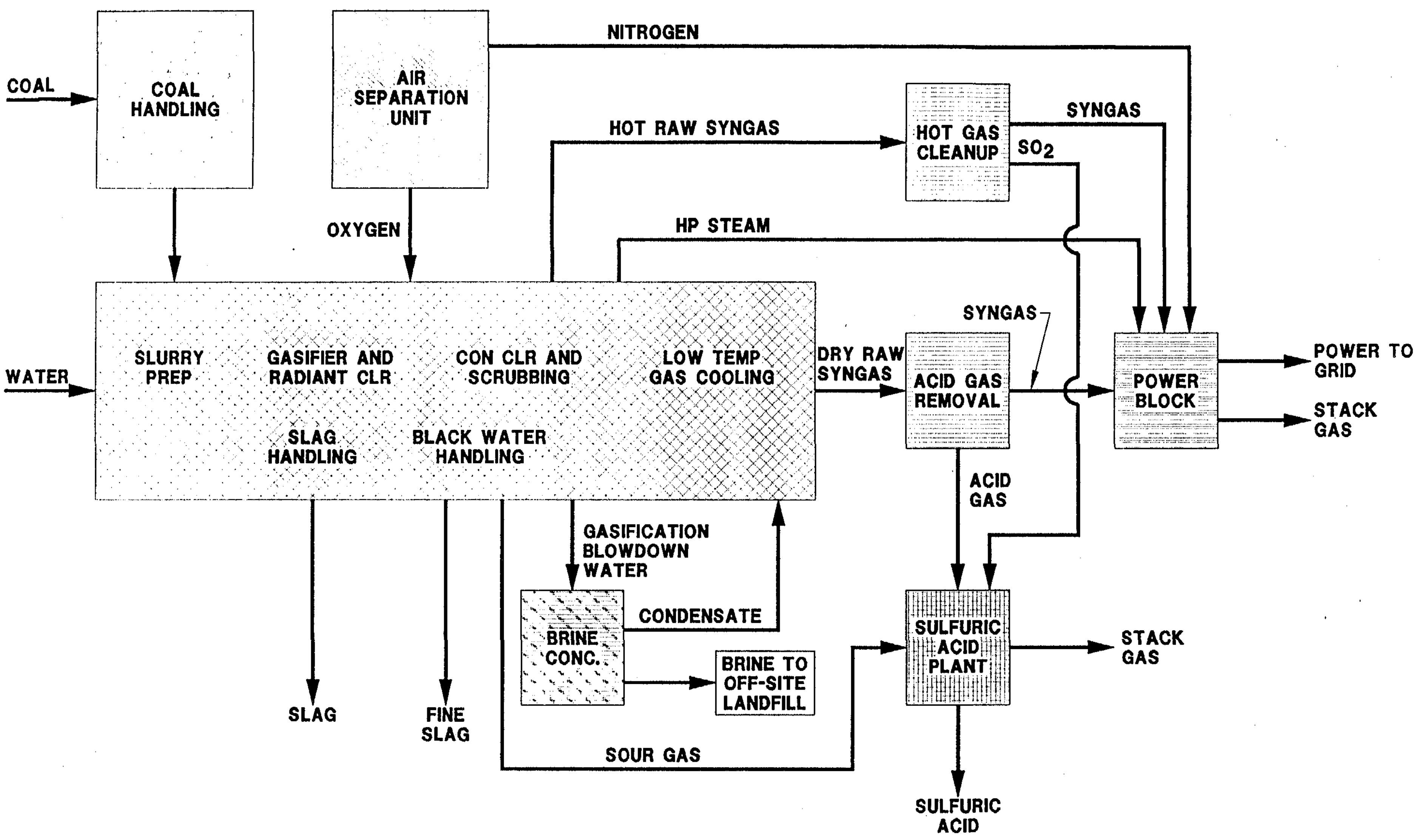
	PRIOR TO 1994	TOTAL 1994	TOTAL 1995	TOTAL 1996	TOTAL PROJECT
COMMON & GENERAL	23,776	20,081	28,025	28,518	100,400
HOT GAS CLEANUP	1,671	2,301	13,203	2,994	20,169
COLD GAS CLEANUP	993	9,326	19,613	4,271	34,203
GASIFICATION PLANT	13,283	33,913	85,031	16,128	148,356
POWER GENERATION	33,473	21,203	21,612	1,782	78,070
HEAT RECOVERY (HRSG)	8,766	10,285	28,174	4,215	51,440
PLANT ELECTRICAL	38	1,446	19,040	2,161	22,685
SITE DEVELOPMENT & BUILDINGS	20,414	17,994	22,816	10,785	72,009
PLANT UTILITIES	557	3,669	21,727	6,773	32,726
DOE COST SHARING	(15,550)	(26,824)	(54,329)	(13,550)	(110,253)
CURRENT 12/94 PROJECT ESTIMATE	87,422	93,394	204,911	64,078	449,804

Exhibit B

POLK POWER STATION
PTD COSTS THROUGH DECEMBER 1994

EXPENDITURE TYPE	PTD 12/94 BECHTEL ESTIMATE 2	PTD 12/94 ACTUAL EXPEND.	PTD 12/94 $ VARIANCE	PTD 12/94 % VARIANCE
AFUDC (Specifically Excluded)	0	0	0	N/A
A&G	2,232,781	2,338,719	105,939	4.7%
PERMITTING (RS 03 ONLY)	2,327,738	2,215,610	(112,127)	−4.8%
EIS PERMITTING (RS 03 ONLY)	715,937	716,015	78	0.0%
LAND COSTS	19,836,461	19,839,151	2,690	0.0%
SITEWORK	17,766,138	17,296,701	(469,438)	−2.6%
TECO ENERGY	1,415,098	1,377,737	(37,361)	−2.6%
MOBILIZATION	361,127	255,805	(105,321)	−29.2%
INVENTORIES	12,522	12,522	0	0.0%
LEGAL	519,425	513,510	(5,916)	−1.1%
ENGINEERING	44,090,260	44,535,930	445,670	1.0%
IGCC FACILITIES	118,293,615	122,676,302	4,382,686	4.0%
TAMPA ELECTRIC (IN−HOUSE $)	7,881,060	7,992,842	111,782	1.4%
PREVIOUS to 6/92 COSTS	7,736,966	7,736,966	0	0.0%
DOE REIMBURSEMENTS	(42,373,925)	(43,177,989)	(804,064)	1.9%
TOTAL POLK PROJECT −−>	180,815,203	184,329,821	3,514,617	1.9%



POLK POWER STATION UNIT #1
BLOCK FLOW DIAGRAM

Exhibit C

Exhibit D

POLK POWER STATION UNIT NO. 1
MILESTONE SCHEDULE
FOR THE PERIOD 1994 AND 1995

Manufacturing complete on Combustion Turbine (CT)	04/94
Manufacturing complete on Combustion Turbine Generator (CTG)	04/94
Mobilization of Site Development Contractor	04/94
Contract for Heavy Haul and Erection of Radiant Syngas Cooler (RSC) Vessel and Tube Bundle awarded	05/94
Turnkey Sulfuric Acid Plant Contract awarded	05/94
Emergency Shutdown System Design Contract awarded	06/94
Engineering/Procurement Contract awarded for Brine Concentration System	06/94
Mobilization of Railroad Construction Contractor	07/94
Purchase Order for Structural Steel Supply and Fabrication awarded	09/94
Construction Substation energized	11/94
Ground Breaking Ceremony for PPS-1	11/94
Mobilization of Civil/Structural Contractor to begin concrete foundations and site underground utilities work	11/94
Telecommunications available to the Site	11/94
First Heat Recovery Steam Generator (HRSG) Modules received	12/94
Manufacturing complete on Generator Step Up (GSU) Transformers	12/94
Air Separation Unit (ASU) Distillation Column delivery	02/95
Combustion Turbine delivery	03/95
Combustion Turbine Generator delivery	03/95
Delivery of last HRSG Modules	03/95
Construction Contract for Power Block Mechanical/Electrical/ Instrumentation Work awarded	03/95

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Exhibit D (Continued)

POLK POWER STATION UNIT NO. 1
MILESTONE SCHEDULE
FOR THE PERIOD 1994 AND 1995

Delivery of GSU's	03/95
Construction Contract for Gasification Area Mechanical/Electrical/ Instrumentation Work awarded	04/95
Construction of Coal Storage Silos complete	04/95
CT Combustion System Development Test Program complete	04/95
Delivery of ASU Compressors	04/95
Delivery of ASU Main Air Compressor (MAC) Motor	04/95
Factory Acceptance Test complete on Distributed Control System (DCS)	04/95
High Pressure (HP) Steam Turbine delivery	04/95
Low Pressure (LP) Steam Turbine delivery	04/95
Steam Turbine Generator (STG) delivery	04/95
HGCU Pilot Plant Test Program complete	05/95
Delivery of Convective Syngas Coolers	05/95
DCS delivery	05/95
GEESI Detailed Engineering complete	05/95
Radiant Syngas Cooler delivery	06/95
Bechtel Detailed Engineering complete	06/95
230 KV Switchyard, Transmission System and Station Service Transformers to be energized	08/95

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Exhibit E

POLK POWER STATION UNIT NO. 1
SCHEDULE FOR SIGNIFICANT START-UP MILESTONES

DCS System installation and checkout complete	07/95
Energization of 230KV Switchyard	08/95
Open Loop Cooling Water System complete	10/95
Closed Loop Cooling Water to Power Block complete	11/95
Fuel Oil System available for unloading	12/95
Auxiliary Boiler available to produce plant steam to ASU	01/96
Plant Service Air System complete	01/96
Coal Unloading/Conveying System available to receive first coal	03/96
ASU Construction complete	03/96
First fire of Combustion Turbine on Fuel Oil	04/96
Circulation Water System for Power Block complete	04/96
Closed Loop Cooling Water to Gasification Area complete	04/96
Flare System complete	04/96
Sulfuric Acid Plant complete	04/96
Main Steam Piping complete	05/96
Completion of HRSG Steam Blows	05/96
Coal Grinding System complete	05/96
Initial roll of Steam Turbine	06/96
Gasifier installation complete	06/96
Slag Handling System complete	06/96
Brine Concentration System complete	06/96
First Syngas from Gasification Plant to Combustion Turbine	07/96
Hot Gas Clean Up System complete	07/96

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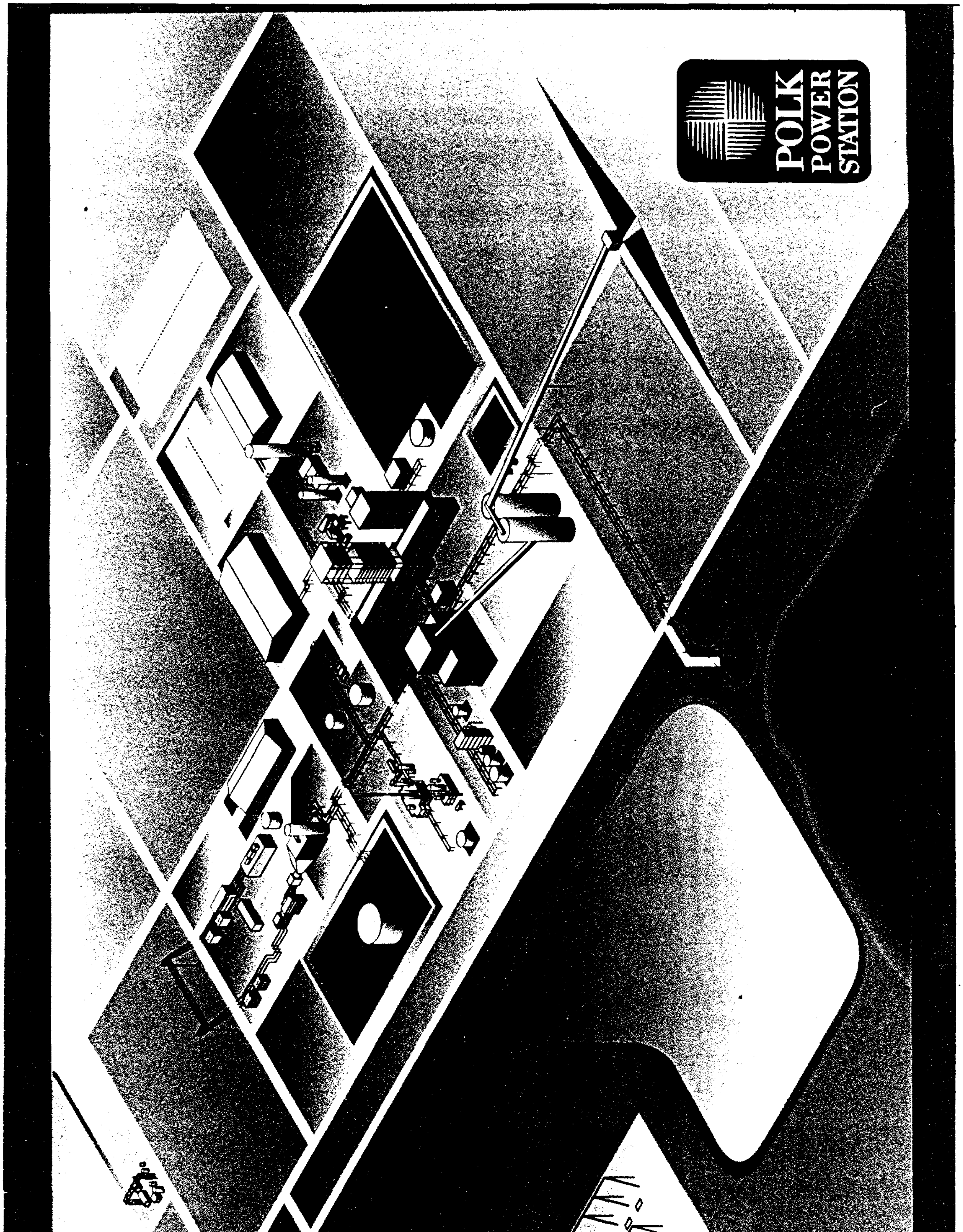

POLK
POWER
STATION

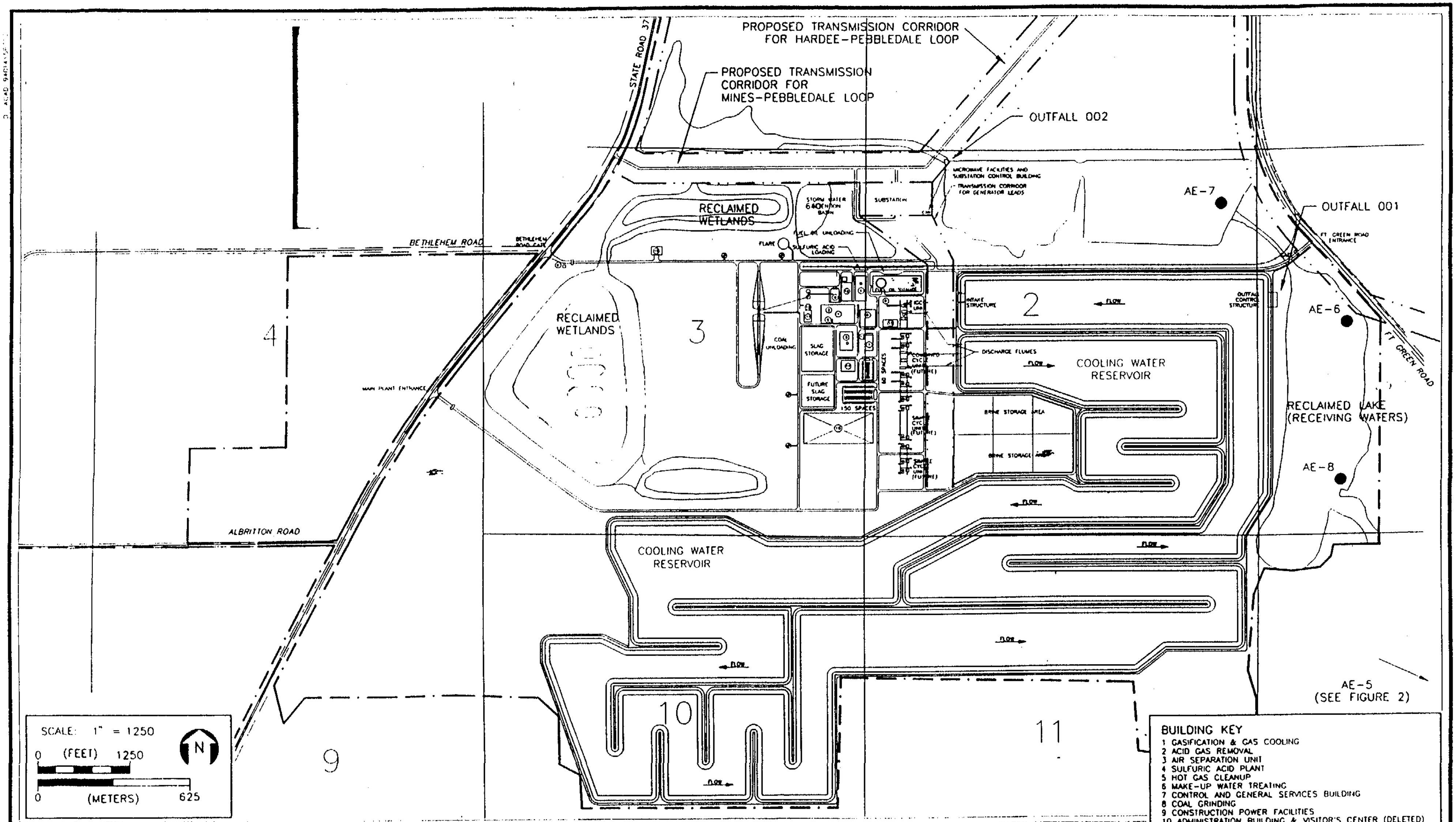
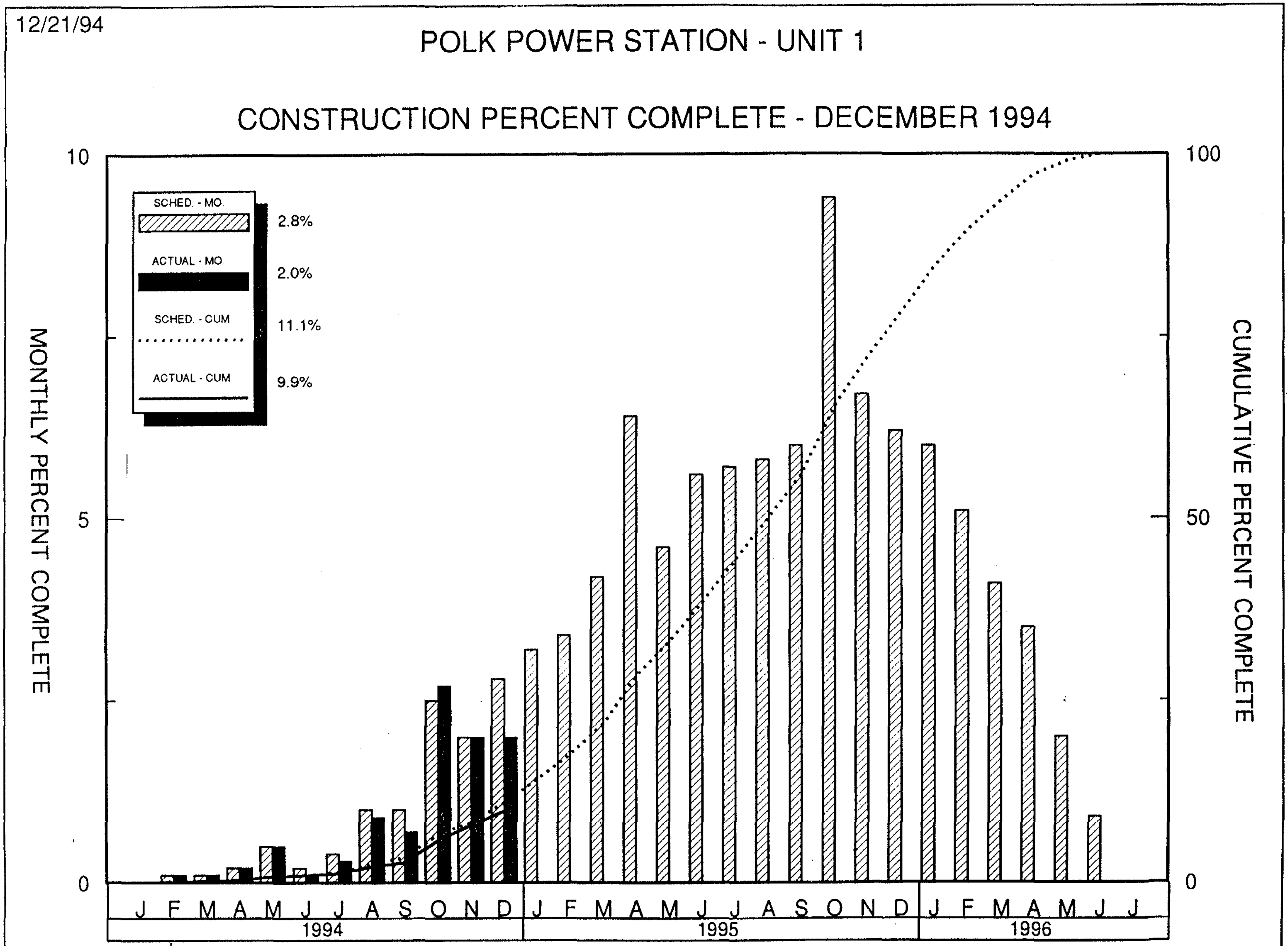


EXHIBIT G

SITE PLOT PLAN

Source: ECT, 1994.

Exhibit H



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EXCLUDES START-UP SUPPORT