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# 1996 DOE Annual Technical Report

## Annual Report
## January - December 1996

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# Disclaimer

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# SECTION I

# PROJECT DESCRIPTION

## I. PROJECT DESCRIPTION

Tampa Electric Company's Polk Power Station Unit 1 (PPS-1) Integrated Gasification Combined Cycle (IGCC) demonstration project uses a Texaco pressurized, oxygen-blown, entrained-flow coal gasifier to convert approximately 2000 tons per day of coal to syngas. The gasification plant is 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 BTUs/cf (HHV). 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 at 900°F is designed to pass through an intermittently moving bed of metal-oxide 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 simplified Block Diagram is included as exhibit C of the Appendix.

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 integrates these complex processes.

Also important to this project is the development and utilization of a valuable diagnostic and training tool in the form of a dynamic simulator. This tool was 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 was invaluable during the training program for plant operators and technical personnel.

# SECTION II

# PROJECT HIGHLIGHTS

## 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. DOE is providing more than $142,000,000 in co-funding for this Project. 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 one of the primary drivers 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 were 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 highly 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 were developed which include a dynamic simulator, a distributed control system, and an emergency shutdown system.

# SECTION III

# ENVIRONMENTAL AND PERMITTING ACTIVITIES

## III. ENVIRONMENTAL / PERMITTING

The following significant events, related to the Polk IGCC Project's Environmental and Permitting requirements, occurred in 1996.

### STATE ACTIVITIES

- Request to modify the Conceptual Plan for mine reclamation activities was submitted to DEP on February 22, 1996. In response to agency questions, additional information related to the reclamation modification proposal were provided to DEP on May 13, June 28 and October 8, 1996. Resolution of the proposal is pending.

### CONDITIONS OF CERTIFICATION SUBMITTALS

Water

- Florida DEP approval of Groundwater Monitoring Plan, submitted May 31, 1994, was effective September 7, 1995. The first DOE Quarterly Monitoring Report was submitted on May 23, 1996. Quarterly Groundwater Monitoring reports commenced in 1996.

- Florida DEP approval of the Industrial Wastewater Treatment system, submitted December 13, 1994, was effective March 15, 1995. The Sampling and Analysis Plan was submitted 1996.

- The Potable Water Treatment and Supply System was submitted to Florida DEP for approval on February 17, 1995. Approval was effective April 24, 1995. Submitted the clearance items for this system and system cleared on April 2, 1996.

- Submitted the Asbestos-free Certification for the Potable water system on October 2, 1996.

- Submitted one set of the wetland reclamation final grade and cross section drawings for the site reclamation west of SR37 October 2, 1996.

- The Sinkhole Response Plan was submitted in March 1996.

- Hydrological Analysis for Conceptual Reclamation Plan (update) was submitted in May 1996.

- The Statement of Completion and Request for Transfer to Operation Entity form was submitted for the Surface Water Management System on September 12, 1996.

- The Cooling Water Reservoir Berm Failure Flood Analysis was submitted on June 3, 1996.

- The Groundwater Monitoring Well Completion Report was submitted in 1996.
- Final Construction Report was submitted on October 30, 1996.
- Amended the National Pollutant Discharge Elimination System permit in August 1996.

Chemical Management

- Certificate of Completion for the Slag Storage area was submitted on June 19, 1996.
- The Plan for Handling and Disposal of spent Sulfuric Acid Plant Catalyst for Polk Unit 1 was submitted July 1996.
- Demonstration of Financial Assurance for the Slag Storage Area was submitted on November 12, 1996.
- Final Spill Prevention Control and Countermeasure Plan was submitted in Quarter III, 1996.

Air

- Opacity Certification Report was submitted on November 6, 1996.
- Notification of Start-up Operations were submitted on May 14, and August 12, 1996.
- Notification of Initial start up syngas flaring on August 9, 1996.
- Notification of Combustion Turbine CEM and Performance Testing on June 27, 1996.
- Submitted notification regarding performance testing of Auxiliary Boiler on June 13, 1996.
- Notification of Combustion Turbine CEM and performance testing was submitted on May 24 and 31, 1996.
- Notification of actual Start-up for the combustion turbine was submitted on April 25, 1996.
- Notification of Demonstration of CEM performance and emission performance testing for the auxiliary boiler was submitted on March 12, 1996.
- Notification of Initial Start up of combustion turbine was submitted on March 11, 1996.

- Notification of initial firing of the Auxiliary boiler on January 15, 1996.
- Ambient Air Monitoring Plan was submitted and approved in October of 1996.
- Submitted the Title V Air Permit application in June 1996.

Other

- Traffic monitoring studies were submitted to Florida DOT and Polk Count for the intersections of SR37 and CRDs 640 and 630 and CR630 and Ft. Green Road, May 1, 1995. Monitoring was conducted and report submitted on April 8,1996.
- Radioactive Material License was received during the third quarter in 1996.

# SECTION IV

# STATUS OF MAJOR CONTRACTS

## IV. STATUS OF MAJOR CONTRACTS

### A. DETAILED PROFESSIONAL ENGINEERING AND TECHNICAL SERVICES

During 1996, Bechtel's engineering support was concentrated in the field, providing support to both construction and start up. Efforts included:

- resolving contractor's questions
- providing designs to support construction and start up schedule work arounds
- supporting preparation of detailed start up, shut down and operating procedures
- providing design modifications to correct operational deficiencies

Bechtel's engineering efforts were essentially complete by the end of 1996.

### B. HOT GAS CLEAN UP SYSTEM DESIGN AND START-UP SUPPORT

General Electric Environmental Services, Inc. (GEESI) continued to support construction and start up during 1996 for the Hot Gas Clean Up (HGCU) system. By the end of 1996, GEESI's efforts had been reduced to a minimum, centering around support during the various testing phases. The HGCU is scheduled to be functionally tested in 1997.

### 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 $NO_X$ combustors capable of firing fuel oil No. 2 as well as syngas

- One 229,741 KVA hydrogen cooled generator (combustion turbine)

- One tandem compound, double flow condensing steam turbine with one uncontrolled extraction

- One 156,471 KVA hydrogen cooled generator (steam turbine)

- 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 and 50 psig saturated.

At the end of 1996 all major components of the power island had been delivered, installed, checked out and put into operation. General Electric continues to support the project with on-site technicians and engineers.

During the start-up of the unit, TEC had to resolve many issues. These issues are discussed in detail in section IX C, initial operation. Included in the operation section is a complete discussion of the highly publized 7FA fleet problems and their resolutions.

At the end of 1996, TEC had entered negotiations with GE to provide ongoing maintenance and technical support. TEC expects to conclude these negotiations in 1997.

## 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 and Chemicals, Inc. (APCI). Commissioning and start-up of the ASU began in January of 1996 and was completed in the first quarter without major incident. In April 1996, a vibration problem developed in the main air compressor (MAC) motor. The vibration problem was investigated by TEC, APCI, and the motor manufacture. The rotor was rebalanced and tested until contract vibration requirements were met. The ASU performed well throughout 1996, and all contract monies have been paid to APCI. The contract is currently opened awaiting the results of the performance test.

## E. RADIANT SYNGAS COOLING SYSTEM ENGINEERED EQUIPMENT PACKAGE

The Radiant Syngas Cooling System is designed to cool the hot syngas exiting the gasifier, generate high pressure steam, and remove coal ash from the syngas stream in the form of slag. This system was commissioned in the summer of 1996 and placed into commercial operation with the balance of the plant in October of 1996. Overall, the system has performed very well, with exit gas temperatures significantly below design numbers. In addition, this system has not contributed significantly to any unit down time in 1996.

The lower than design Radiant Syngas Cooler exit gas temperature is a result of the fouling of the heat exchange surface being significantly less than anticipated. This could be a function of the specific coal being used (only one coal was used during 1996), or could be a result of design details in the heat exchanger arrangement which improved gas flow patterns. Additional studies will be performed on this temperature in 1997, including the effects of alternate fuels.

## F. CONVECTIVE SYNGAS COOLING SYSTEM ENGINEERED EQUIPMENT PACKAGE

The Convective Syngas Cooling System is designed to cool the raw syngas exiting the radiant syngas cooler while raising high and medium pressure steam as well as exchanging energy with clean gas and nitrogen streams. This system was commissioned in the summer of 1996 and placed into commercial operation with the balance of the plant in October of 1996.

The system consists of two types of heat exchanger. There are two Convective Syngas Coolers which cool the syngas and raise high pressure steam. In addition, there are four stages of gas to gas heat exchangers which cool the raw syngas while heating either clean syngas or nitrogen. The heat exchangers are interconnected with double wall, water cooled piping which generates medium pressure steam.

The convective syngas coolers have performed well, operating generally within design guidelines while not contributing to any significant Unit downtime. However, there have been significant problems with the gas to gas exchangers. Early in the start-up and commissioning phase of the plant, these exchangers exhibited a consistent tendency to plug with ash on the tube side (raw gas side) of the exchanger. This pluggage resulted in several Unit shutdowns and significantly contributed to the overall downtime in 1996.

The ash pluggage of the gas to gas exchangers also led to a significant corrosion problem in the tubes of these exchangers. After extensive study was done on the plugging phenomenon, the problem was minimized through a combination of operating and physical modifications, primarily related to optimizing combinations of Raw Syngas Velocity and Gasifier Operating Temperature. However, the tubes had already been damaged from the corrosion attack and this could not be reduced. Plans were made in late 1996 to either bypass or replace these exchangers sometime in 1997.

## G. TURNKEY SULFURIC ACID PLANT

The contract for engineering, supply , and erection of the sulfuric acid plant, dated June 8, 1994, was awarded to Monsanto Enviro-Chem Systems, Inc. Catalyst and acid were loaded into the appropriate vessels and tanks in early July 1996. The acid plant was prepared for first syngas in July 1996 and produced the first sulfuric acid in August 1996. Operation of the acid plant is demanding on the operation staff when the gasifier is turned down and burning a lower than design sulfur coal. Full load operation has been relatively smooth. All monies have been paid to Monsanto and a letter of credit has been issued. Contract close out is proceeding and is expected to be completed in 1997.

## H. TEXACO SUPPORT SERVICES CONTRACT (REFRACTORY AND BURNERS)

Texaco provides engineering and start-up support to the Project through three separate agreements. Under the License Agreement, they continue to provide a wide variety of services. They reviewed and approved key detailed design documents, performed on-site construction inspections, and provided start-up support services. Texaco reviewed and approved the gasifier burner manufacturer's shop drawings and inspected the completed burners.

Under a separate Technical Services Agreement (TSA) they have provided a variety of specific, as-needed services. For example, a Texaco representative provided day-to-day advise during the detailed design effort in Bechtel's Houston office. They helped in defining and setting up the on-site laboratory. In 1996, they helped write the operating procedures for the gasification portion of the plant.

Texaco, through a separate contract performed the detailed design of the gasifier refractory system. The effort also included inspection of the refractory at the manufacturer's shop. In 1996 they provided oversight of the refractory system installation.

For 1997, Texaco will continue to technically support the project on an as needed basis to insure successful operation of the gasification system.

## I. DISTRIBUTED CONTROL SYSTEM

The Bailey Infi-90 Distributed Control System (DCS) has performed well during 1996. No gasifier or plant trips were caused by DCS module or I/O failures. The overall DCS availability in 1996 was 100.0 %.

Two systems associated with the DCS have also been successful: 1) the data storage, and 2) retrieval system and the operator training simulator. The Polk plant would not be running as well as it is today without these systems.

- Data storage and retrieval is done by a product called Plant Information Systems (PI) from Oil Systems Inc. Data storage has been almost 100% reliable, and retrieval is easy in several different formats (graphs, tables, spreadsheets).

Although the DCS has performed well, the required level of technical support has been higher than expected to achieve these results. A full-time team with some supplemental help worked throughout most of 1996 to address the following issues:

- DCS module infant mortality was fairly high in the Commissioning Phase, but failure rates have declined dramatically. All failed modules were replaced under warranty.

- Initially there were over 8000 possible alarms, and at times during the Commissioning Phase over 1000 of these were simultaneously active. Such information overload causes alarms to be ignored. A separate "alarm team", formed late in the Commissioning Phase, reduced the number of alarms to about 4000. Further reduction in the number of possible alarms and prioritization of the remaining alarms is still in progress.

- Conveying information which can be quickly and easily interpreted for split-second decision making is always a challenge. To meet this challenge, it has been necessary to improve plant diagnostics by adding more "first out" indications, dedicated displays, and ready lists. Graphic displays have also been modified to be more concise and easily readable. These efforts will undoubtedly continue into the foreseeable future.

- The data links between the DCS and both CT and ST Mark V control systems have been troublesome. Making changes is particularly hard. (In contrast, the data link between the DCS and the Triconex Gasifier Safety System has worked very well.) Also, working on the Mark V and GE's user interface is difficult. We must still rely more heavily on GE than we would prefer at this stage of operation. It would have been preferable to have done as many of the turbine control functions as possible directly in the DCS.

- Almost all logic and configuration errors have been eliminated, initial tuning has been done on all control loops, and some optimization has been done. However, initial operation and tuning efforts have shown that new or modified control logic will be necessary for several plant areas such as:

  -- Overall plant load control
  -- Combustion Turbine fuel transfers,
  -- pH control in water treatment,
  -- Grey Water inventory control
  -- Centrifuge control in Brine Concentration.

## J. EMERGENCY SHUTDOWN SYSTEM

The contract for engineering, design, manufacturing, assembly, and shipping of the gasifier Emergency Shutdown System (ESD), was awarded to Triconex Corporation in June 1994. 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. The ESD system chassis was shipped to Bailey Control's factory for integration testing with the DCS. Integrations with the DCS completed in April 1995 with completion of shipment to jobsite occurring in May 1995. The ESD system underwent final configuration checkout based on system start-up schedules with completion occurring in July 1996.

## K. SIMULATOR DEVELOPMENT

The Simulator is a dynamic process simulation system for the Polk Unit 1 IGCC plant. The Simulator was used for operator training, control systems check out and tuning, engineering analysis, marketing of IGCC to potential customers and potentially, to provide training and engineering analysis for others. It was determined to be necessary because of the complexity of this integrated design, and the first of a kind integrated controls system.

The Simulator contract was awarded to Bailey Controls. Bailey and their modeling sub-contractor, TRAX, began work in February 1995. During 1996, all models were completed and the models integrated to allow the Simulator to perform as a complete operating plant. Training of plant operators also was completed in 1996 in time to support the start up of the plant. Bailey and TRAX continued to modify the system to incorporate design changes developed after the start of the model development. This contract will be completed in 1997.

The operator training simulator furnished by Bailey and TRAX, Inc was installed and checked out during 1996. A copy of the actual plant control system (DCS and Triconex hardware and software) interacts with process plant models running on seven PC's. This simulator enabled plant personnel to become familiar with plant operation before start-up and correct control system and procedural errors before they occurred in the real plant. Final simulator testing and contract closeout is expected to occur in mid 1997.

## L. BRINE CONCENTRATION UNIT

### Brine Concentration Unit

The brine concentration unit began processing grey water in 1996 simultaneously with the gasification plant. The brine unit is composed of two distinct units, the falling film evaporator, and the forced circulation evaporator/crystallizer/centrifuge. The following outlines the operations of each unit during 1996.

### Falling Film Evaporator

The falling film evaporator utilizes falling film distillation technology using four stage centrifugal blowers as the heat source. During all of 1996 this unit performed without incurring a plant outage. However, due to high carryover of chlorides in the blower inlet, severe corrosion has occurred. This resulted in a rotating element failure. Due to this design problem, several studies were initiated to resolve the problem. A final solution is pending a cost analysis of the alternatives presently being considered.

**Forced Circulation Evaporator/Crystallizer/Centrifuge.**

During 1996 several problems arose with this unit. Primarily, severe and rapid corrosion was found in the forced circulation evaporator heat exchanger, resulting in several tube bundle replacements until the correct metallurgy was found. Corrosion was also found to occur in the forced evaporator overhead condenser as well.

An extensive corrosion coupon sampling program was undertaken throughout the entire brine concentration unit to evaluate the metallurgy requirements for the falling film unit as well as the forced circulation/crystallizer sections. This coupon sampling program continues in 1997.

Extensive line pluggage occurred in the forced circulation evaporator/crystallizer/centrifuge piping. This piping was redesigned to allow better flow characteristics in 1996 and will be implemented in 1997.

## M. CONSTRUCTION MANAGEMENT SERVICES

Bechtel Power Corporation provided construction management (CM) services. During 1996 major emphasis was placed on completing the construction work, and supporting start-up with manpower to complete the project.

The CM team was led by the TEC on site Construction Manager. The CM team has managed the on site construction efforts effectively in order to keep the project on schedule and within an acceptable budget.

Construction was 100% complete at the end of 1996. This represented an approximate gain of 25% during 1996. All major milestones were completed on time.

Significant achievements were reached with respect to site safety;

- The project had only 3 lost time accidents in 3.4 million man-hours worked
- Continuous streaks of 650,000 man-hours, 1,741,321 man-hours and 1,237,118 man-hours without disabling injuries
- The project received the prestigious Stag Award from the Hartford Insurance Company for excellence in safety on a construction project
- The OSHA recordable rate of 1.90 was well below the industry average of over 10.0 for this type of project

This remarkable achievement was possible through good cooperation of the site zero-accident philosophy plan implemented by all contractors.

Key construction management highlights during 1996 were:

- Completion of all construction activities
- Closeout of most major construction contracts
- Completion of environmental mitigation work.
- Completion of start-up support activities

# SECTION V

# PROCESS DESCRIPTION

# 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 26-ton payload, with a total of about 80 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 and fines recovered from Black & Grey Water Systems. 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 can also be 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 hydrogen sulfide ($H_2S$) 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 feed injector. 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 (H), Carbon Monoxide (CO), water vapor, and Carbon Dioxide ($CO_2$ ), with small amounts of Hydrogen Sulfide ($H_2S$), methane ($CH_4$), argon (Ar), and nitrogen ($N_2$). 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 saturated 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 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. Eventually it is expected that this brine will be sold as a marketable produce to the local fertilizer industry. 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 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 Amonia ($NH_3$) water 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 sent 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. Plans call for developing a marketable use for these solids.

A large fraction of any remaining particulate matter entering the absorber is captured by the 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 sorbent. 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.

Another economic factor which will be investigated is the attrition of sorbent pellets. The amount of damage done to the pellets during the mechanical process of sorbent cycling will be a critical success factor for determining the HGCU technical and commercial viability.

Sulfide 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 (CTG), Heat Recovery Steam Generator (HRSG), and Steam Turbine-Generator (STG).

### 1. Combustion Turbine-Generator

The CT is a GE 7FA, designed for low-$NO_x$ emissions firing syngas, with low sulfur fuel oil for start-up 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 BFW systems has two (2) 100% feed pumps. One of these pumps is a developmental magnetic bearing design.

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 start-up 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 121 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 start-up 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 start-up, 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 13.8KV 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 after cooler and fed to the molecular sieve absorbers. 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. The ASU consumes significant electric power with mac motor. This is partially recovered via the CT with $N_2$ injection (150 on oil vs. 192 on syngas).

## G. SLAG BY-PRODUCT HANDLING

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 dewatering bins. 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 lockhopper inlet valve is opened for a new cycle.

Solids from the lockhopper are dumped onto a concrete 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 temporary 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 has been classified by EPA 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.

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 was 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 includes 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 are lined with a synthetic material or other materials with similar low permeability characteristics. The runoff basin is designed to contain runoff water volumes equivalent to 1.5 times the 25-year, 24-hour storm event. Water collected in the runoff basin is 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 $SO_3$ are 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 was 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.

# SECTION VI

# PROJECT MANAGEMENT

## 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. Although no formal group meetings were held in 1995 or 1996, informal discussion among the participants did occur. There will be a final closeout meeting to discuss results of the Polk Power Project among the participants.

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 prevailed. Early in 1995 the Engineering team transitioned back to Tampa, Florida to support construction. This lent continuity to project activities from engineering to construction particularly with the ASU, the Sulfuric Acid Plant and the Gasification Plant. Both of the Bechtel contracts were structured heavily with performance incentives. These incentives helped align both companie's interest.

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 transitioned to the field to provide continuity and assist with material receipt, while other team members completed the required tasks in Houston. By the end of 1995, all procurement activities had been relocated to a site field office.

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 subsequently competitively bid and 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 in July of 1994, and the Bechtel construction manager mobilized in Tampa in January 1995. The Bechtel and Tampa Electric project managers mobilized at the project site in April of 1995. This allowed for close coordination of all project activities from one central location. All of the assigned field personnel were demobilized in 1996.

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 a "90% complete" design review in early 1995. Quarterly project review meetings were conducted during 1994, 1995 and 1996 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.

## SECTION VII

## PROJECT COST

## VII. PROJECT COST

Information in this section summarizes the current forecast of costs associated with Budget Periods I & II. This forecast includes all capitalized costs except AFUDC (interest) for the development, engineering, construction and start-up of the Polk IGCC Demonstration project. Also included are the costs associated with the new switchyard, transmission and distribution lines, the coal transloader at Big Bend Station, non-capitalized Polk start-up fuel and warehoused inventory.

Exhibit A, Project Cost Estimate, summarizes the costs by major plant sections for the periods prior to 1994,1994,1995 and 1996 and an estimate for 1997. The current estimate of total Budget Period I & II costs, excluding AFUDC, to Tampa Electric for the IGCC demonstration project is $485 million. Projected DOE cost-sharing toward the project scope represented by this estimate is $123 million.

**EXHIBIT A**
**TAMPA ELECTRIC COMPANY**
**POLK POWER STATION**
**PROJECT COST ESTIMATE**
**($ X 1,000)**

| Excludes AFUDC | | | | Proj_Mgmt:\doe96ptr | | |
|---|---|---|---|---|---|---|
| | PRIOR TO 1994 | TOTAL 1994 | TOTAL 1995 | TOTAL 1996 | TOTAL 1997 (Projected) | Current Forecast |
| COMMON & GENERAL | 23,744 | 20,313 | 27,603 | 33,359 | (763) | 104,257 |
| HOT GAS CLEANUP | 1,671 | 2,888 | 14,514 | 3,444 | 19 | 22,536 |
| COLD GAS CLEANUP | 993 | 9,704 | 17,096 | 4,890 | 84 | 32,767 |
| GASIFICATION PLANT | 13,283 | 32,824 | 90,734 | 28,970 | 1,286 | 167,097 |
| POWER GENERATION | 33,473 | 23,012 | 20,909 | 2,505 | 88 | 79,986 |
| HEAT RECOVERY (HRSG) | 8,766 | 10,960 | 22,403 | 6,773 | 101 | 49,003 |
| PLANT ELECTRICAL | 38 | 4,365 | 16,699 | (1,974) | 8 | 19,135 |
| SITE DEVELOPMENT & BUILDINGS | 20,447 | 17,189 | 21,830 | 11,608 | 1,033 | 72,106 |
| PLANT UTILITIES | 557 | 3,281 | 20,446 | 10,896 | 815 | 35,994 |
| POLK TRANSMISSION & DISTRIBUTION | 141 | 1,444 | 5,881 | 2,272 | 0 | 9,738 |
| POLK COAL TRANSLOADING FACILITY | 0 | 0 | 2,431 | 967 | 0 | 3,398 |
| POLK START-UP FUEL & INVENTORY | 0 | 0 | 0 | 11,860 | 0 | 11,860 |
| DOE COST SHARING | (15,550) | (27,628) | (53,453) | (25,814) | (422) | (122,867) |
| CURRENT 12/96 PROJECT ESTIMATE | 87,563 | 98,352 | 207,092 | 89,754 | 2,250 | 485,011 |

NOTE : Project Cost Estimate based on Current Reforecast

# SECTION VIII

# CONSTRUCTION MANAGEMENT

## VIII. 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. The philosophy was to focus on contractors that had previously demonstrated successful completion of similar projects. This was done to assure the on time completion of a budget critical project. It is the Construction Manager's (CM) responsibility to monitor and enforce compliance with those contracts. The following is a list of major contracts awarded by the CM team:

| Area | Contractor |
| --- | --- |
| 1. Site Development and Earthwork | Johnson Bros |
| 2. Civil Foundations | Johnson Bros |
| 3. Mechanical/Electrical for Power Block Area | H.B. Zachary Co |
| 4. Mechanical/Electrical for Gasification Area | The Industrial Co |
| 5. Mechanical/Electrical for Gasification Waste Processing | The Industrial Co |
| 6. Sulfuric Acid Plant | Monsanto Enviro-Chem Systems, Inc. |
| 7. Control Building | Hennessey Construction Services |
| 8. Warehouse and Maintenance Building | C.A. Oakes Construction Co |
| 9. Fire Protection | F.E. Moran |
| 10. Coal Silos | American Marietta |
| 11. Field Erected Tanks | Tampa Tank |
| 12. Final Site Grading & Paving | Bulger Corporation |
| 13. Site Reclamation Work West of SR37 | Johnson Bros |
| 14. Air Separation Unit | Air Products |

There were a number of smaller contracts awarded at the Polk Site by CM team including:

| Area | Contractor |
|---|---|
| 1. Site Rail | R.W. Summers |
| 2. Site Well Drilling | Diversified Drilling |
| 3. RSC Transportation/Erection | Davenport Mammoet |
| 4. Transport of HRSG Modules | Beyel Bros |
| 5. Chemical Storage & Waste Transfer Building Construction | Kalemaris Construction |
| 6. Gasification Elevator | Montgomery Elevator |
| 7. Slag Storage Pond | EMCON Southeast |

Additionally, the CM was involved in the procurement of testing services, security surveying, trash disposal, construction utilities, temporary facilities construction, and other services. The CM managed the site activities of all contractors.

CM Services at Polk Power were divided into two phases. The first phase took place in Houston Texas. Key members of the CM Team worked with the Engineer to optimize design through constructability planning. The second phase of CM Services took place once the Project mobilized in the field.

The following describes services performed in each phase of the job:

The Phase I Construction Services

- Provided information to allow Tampa Electric to assess construction options.
- Planning and Scheduling of pre-construction and construction activities
- Developed Project Specific Project controls systems
- Completed development of Tampa Electric's proposed contracting strategy
- Prepared a comprehensive environmental compliance plan for the project.
- Prepared construction bid documents and solicited construction bids
- Developed a system for controlling quality by adherence to codes, standards and provisions of the technical specifications
- Prepared plans for construction facilities

- Developed and implemented a plan for construction safety
- Assisted Tampa Electric and the Engineer in development of a program for plant test and start-up
- Reviewed plant drawings and specifications for Constructability, format, content and completeness
- Advised and made recommendations to design documents with respect to construction feasibility, economics, availability and utilization of materials and labor, time requirements for procurement and construction
- Developed written administrative procedures to be followed in managing the construction activities
- Prepared written pre-qualification criteria for bidders and developed contractor interest in the project to insure only prominently qualified bidders were considered

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

- Coordinated activities of all site contractors for lay down and fabrication as well as plant construction activities
- Provided site security, construction utilities, support services, housekeeping and cleanliness, construction photography, surveying and quality control/testing services on a subcontracted cost basis
- Provided construction scheduling, progress tracking, and analysis for all construction activities
- Provided construction contract administration
- Assess quality; adherence to codes, standards and construction specifications; and initiate corrective action to monitor and enforce compliance to specifications by construction contractors
- Performed administrative tasks related to construction including monthly reporting and maintenance of construction accounting records
- Manage activities in conjunction with Engineer's start-up plan
- Prepare the project completion report

## KEY ACTIVITIES ACCOMPLISHED DURING 1996

- By the end of 1996 the construction percent complete was 100% compared to 100% scheduled.
- Over 3.5 million manhours worked on the project.

- The Project experienced an OSHA Recordable rate of 2.28 and 2 OSHA Recordable Cases through the end of 1995. The Project worked 1.1 Million Man Hours during 1996 before experiencing its third lost time in June 1996.
- Completed all construction and released all start-up systems to the project start-up team.
- Construction of the Polk Power Station was concluded in 1996. This section chronicles the highlights of the construction activities over the life of the project.

## B. CHRONOLOGY OF EVENTS

The Construction Management Team arrived at the Polk Power Jobsite in January 1994. The first Contractor was mobilized in March 1994. However, a Stop-Work-Order was issued by the Army Corps of Engineers on March 22, 1994 due to a delay in receiving Environmental Permits. This order was released July 18, 1994 with the issue of the 404 Permit from the Army Corp of Engineers.

The following is a complete chronology of events:

SEPTEMBER 1993

- Submitted plan to start work in Jan. 1994 when SCA (Site Certification Application) approved

OCTOBER 1993

- Issued the Construction Schedule Barchart, Manpower, and Listings (Rev. 0). Schedule was based on start of Site Development 07-Jan-94 and Plant Completion on 01-Jul-96.

FEBRUARY 1994

- Submitted detail plan and schedule of site development activities to SWFWMD in and effort to facilitate commencement of site development.
- Contract with Johnson Brothers signed Feb. 7, 1994.

MARCH 1994

- Mobilized Johnson Brothers on site.
- Completed barrier fence installation along wetland areas.
- Commenced non-jurisdictional area tree clearing, and temporary roads.
- USACE issued a stop work directive for non-jurisdiction work areas B&C. USACE instructional letter of March 8, 1994 and subsequent teleconference of March 22, 1994 resulted in confusion on what could be worked. Therefore, the project issued a STOP WORK ORDER on March 22, 1994.
- Established temporary facilities on site.

APRIL 1994

- An updated permit for dewatering and mitigation was approved by SWFSMD on April 27, 1994. This allowed JBC to commence reclamation and dewatering work.
- Issued authorization to JBC on April 28, 1994 to commence work in "A" areas. All other areas remained on hold.
- Cleared and grubbed approx. 80 acres.

MAY 1994

- Started construction of temporary berms.
- Installed erosion control silt fencing to address additional runoff areas of concern.

JUNE 1994

- Permits for tie-in to SR37 by FDOT received.
- Continued reclamation of A2 and accessible areas in A1.
- Completed mass dewatering in Area A2

JULY 1994

- Received Record of Decision from the Department of Environmental Protection on 14-Jul-94.
- Received 404 Permit from the Army Corp. of Engineers on 18-Jul-94 which allowed construction to proceed in the main plant areas.
- Continued reclamation in Areas A1, A2, and A3.
- Commenced B1 draw down.
- Commenced clear and grub of Power Block after 18-Jul-94 COE permit

SEPTEMBER 1994

- Johnson Bros. Continued to maintain drawdown in Area A2 and completed drawdown in Area B1.
- Railroad Construction commenced site work with track being laid along Road "C."
- Awarded contract for CP-10A Control Building.

OCTOBER 1994

- Completed clearing and grading the Power Block Area.
- Commenced installation of underground pipe for storm, cooling and circ water system.
- Awarded contract for CP-008 Main Civil Installation Contract to Johnson Bros.

NOVEMBER 1994

- Mobilized CP-008 Main Civil Contractor - Johnson Brothers
- Mobilized CP-010A Admin/Control Building - Hennessey Construction Services
- Mobilized R-001 Warehouse and Maintenance Buildings - C.A. Oakes
- Commenced Foundations for Combustion Turbine, Outfall Structure, Fuel Oil Tank and Pipe rack

DECEMBER 1994

- Commenced foundations for Steam Turbine and HRSG.
- Placed foundations and tilt walls for Control Room Buildings
- Placed foundations and started erection of warehouse and maintenance buildings.
- Mobilized field engineering at the jobsite.
- Mobilized V-004 Air Separation Unit - Air Products.
- Started receipt of the HRSG modules at jobsite.
- Started installation of fire protection pipe.

JANUARY 1995

- Placed first concrete for intake structure, piperack, steam turbine, GSU transformer, flare, and tank foundations.
- Started excavation and underground utilities for the Air Separation Unit.
- Completed underground Circ. Water and cooling water piping.
- Completed ballast installation for Railroad.
- Started underground utilities, electricals, waste oily water, storm, and waste water piping

FEBRUARY 1995

- Completed installation of underground pipe for storm, cooling, and circ. water systems.
- Formed and placed concrete for gasification structure and steam turbine pedestals.
- Completed construction of railroad now ready to receive rail shipments.
- Mobilized D-001 for Field Fab Tanks - Tampa Tank, Inc. and started installation of ring walls on Tanks
- Air Products placed concrete for Main Air Compressor.
- Awarded Contract CP-012 Power Block and Plant Utilities Mechanical & Electrical to H.B. Zachary.

MARCH 1995

- Mobilized T-013 Coal Silos - American Marietta and placed concrete for silo foundation.
- Formed and placed concrete for HGCU structure, Rod Mill, Water Treatment, substation foundations, piperack and tank foundations
- Completed the civil and underground work in the Air Separation Unit.
- Received 1st shipment of Gasifier structural Steel on 23-Mar-95.
- Completed setting of the Combustion Turbine and Auxiliary Transformer.
- Commenced installation of the Steam Turbine Condenser.
- Received Distillation Column for Air Separation Unit

APRIL 1995

- Commenced construction of dragline path west of SR37.
- Erected first tier of steel in gasification structure.
- Set the Combustion Turbine and Generator Power block equipment.

- Started setting the HRSG Modules.
  Completed erection of Fuel Oil, Demin Water and Service Water Tanks.
  Completed and Turned Over Warehouse.

MAY 1995

- Completed A1 and A2 Cooling Reservoir grading.
- Completed foundations for Rod Mill, Waste Treatment.
- Commence truck dump foundations.
- Mobilized CP-011 Gasification - The Industrial Company (TIC)
- Mobilized equipment for erection of Gasification Structure.
- Completed setting of ASU Transformers
- Commenced setting of Steam Turbine and Generator
- Completed erection of Amine and Grey Water Tanks
- Completed and Turnover Maintenance Building.

JUNE 1995

- Mobilized the Project Management Team and the Resident Engineering Team on site.
- Completed erection of the second tier of steel in the gasification structure.
- Set the balance of substations.
- Completed setting the HRSG Modules and Steam Drums.
- Completed the Steam Turbine Condenser.
- Completed test lift of the Gottwald crane for the RSC lift
- Set the Radiant Syngas Cooler on 28-Jun-95.
- Completed Gasifier sequence B structural steel.
- Set Steam Turbine Generator.
- Commenced setting the DCS equipment.
- Completed field erection of the brine tank.
- Completed the South Silo and North Silo walls.
- Set the distillate
- on column, the heat exchanger, and subcooler for Air Separation Unit.

JULY 1995

- Energized the plant on 27-Jul-95.
- Completed the Control Building for turnover and occupancy.
- Set the Steam Turbine
- Commenced structural steel erection for the Coal Grinding Building.

AUGUST 1995

- Completed Control Room HVAC test and balance. Demobilize Hennessey from jobsite. Set the Ammonia Stripper Column, Soot blowing Drum, and Flare.
- Set the Cooling and Circulating water pumps at the Intake Structure.
- Commenced setting the Brine System Equipment
- Completed HGCU Tier 1 main framing.

- Commenced setting HGCU equipment.
- Turned-over the DCS system
- Began erection of the Intake Structure gantry crane.

SEPTEMBER 1995

- Flooded the Intake Structure Reservoir and removed the temporary coffer dam.
- Started setting the Stenmuller equipment in the Gasifier Structure East and West wings.
- Erected the Main Conveyer Sections from the Truck Unloading Hoppers to the Coal Silos.
- Completed installation of the ASU Main Air Compressor.
- Started Fire Protection Deluge Piping for the Main Transformers.

OCTOBER 1995

- Started the dike removal for the Intake Structure Reservoir.
- Obtained approval to begin construction of slag storage area.
- Commenced erection of ASU Cold Box.
- Started 2nd floor concrete in the Coal Grinding/Slurry structure.
- Monsanto completed placement of structural steel.
- Air Products completed insulation

NOVEMBER 1995

- Completed setting the Stenmuller equipment in the Gasifier Structure.
- Completed erection of the ASU Cold Box.
- Commenced wetlands reclamation work west of SR 37.
- Commenced excavation for the Slag Storage area.
- Completed erection of the HRSG stack wing walls.
- Completed Auxiliary Boiler Installation

DECEMBER 1995

- Installed LP diaphragms and bearings in the Steam Turbine.
- Completed erection of structural steel for the Brine Area.
- Completed rough set of major HGCU equipment.
- Completed excavation for the Slag Storage area and commenced liner installation.
- Completed erection of Sulfuric Acid Plant.
- Montgomery Elevator mobilized for the gasifier structure elevator (T-008.)

JANUARY 1996

- Completed testing, boilout, and first fire of the Auxiliary Boiler.
- Completed installation of the primary liners for the Slag Storage pond.
- Completed installation of Coal Handling Conveyors.
- Completed installation of the primary liners for the Slag Storage Pond.

- Complete installation of the HRSG Large Bore Piping.
- Completed Acid Plant Erection and Checkout.
- Started installation of the refractory in the HGCU Absorber.

FEBRUARY 1996

- Completed HRSG Hydrotests.
- Completed HGCU Absorber and Regenerator vessel refractory and internals installation.
- Commenced RSC/Gasifier refractory installation.
- Completed GE 2-3 Spaced cutback and combustor change-out.

MARCH 1996

- Completed assembly of Steam Turbine lube oil flushing piping.
- Completed assembly of the Steam Turbine.
- Completed assembly of Hot Gas Cleanup regenerator.
- Continued RSC/Gasifier Refractory installation.
- Completed chemical flushing of the HRSG.
- Loaded first coal into silo on 29-Mar-96.

APRIL 1996

- Completed Slag Handling/Leachate collection ponds.
- Completed assembly of Steam Turbine.
- Complete siding for the Coal Handling building.
- Completed fire protection in the Power Block.
- Complete Steam Turbine lube oil flush.

MAY 1996

- Awarded CP-014, Final Paving, Grading, Landscaping, and Fencing
- Completed RSC refractory installation.
- Commenced installation of surface temperature monitoring system on gasifier.
- Completed gasification structure fireproofing.
- Complete replacement of "A" bellows on HRSG.
- The Aux Boiler CEMS Certification was completed.
- The CT first power to the grid was on May 4, 1996.
- Air Products removed the Main Air Compressor motor to align and balance.
- Placed the Steam Turbine on turning gear and completed first fire with steam.
- Completed chemical cleaning of the RSC high and medium pressure steam systems.

JUNE 1996

- Synchronized the Steam Turbine to the grid on 01-Jun-96.
- Completed successful performance test of the Power Block on distillate.
- Completed loading of the coal silos and settlement survey tests.
- Completed initial pressure test for the syngas piping system.
- Started second HRSG Bellows replacement outage for the "B" and "C" Bellows.
- Completed curing of the RSC refractory.

JULY 1996

- Completed the HRSG CEMS Rata and Drift Testing on fuel oil.
- Completed the "B" and "C" HRSG Bellows repair work.
- Received approval from Polk County HRS to place potable water system in service.
- Completed plant Gas Detection System installation.
- Completed site paving.
- Demobilized contracts CP-022 (Johnson Bros.) and CP-012 (Zachry.)
- Fired 1st Syngas on 19-Jul-96 firing continuously for 13 hours.

## C. CONTRACT SUMMARIES

Work Execution Plan

The CM construction execution philosophy for the project, was to award contracts based on the major plant areas (Intake Structure, Power Block, Fuel Oil Storage, Gasification, Coal Handling, Industrial Waste Treatment, Make-up Water Treatment, Substation Switchyard, Wetland Reclaimation, Sulfuric Acid Plant and Air Separation Plant) rather than by discipline. The cost of bidding, managing and administrating these contracts was minimized by combining areas into large contracts, thus minimizing interface points, and by targeting qualified contractors with the resources, project control, quality and safety processes necessary to meet the project requirements at a competitive price. Individual contract milestone dates were based on deliveries of major equipment and bulk materials, engineering release dates and the plant start-up activities and durations.

Contracts were issued as construction contract packages (CP), Engineering turn key packages (A,D,N;R,T) and CM service subcontracts (SC). The area contract philosophy provided each major contractor with the greatest flexibility to schedule and control work sequencing and to realize savings from combined lifting equipment and scaffold usage. It also makes the contractor responsible for damage in common areas, reduces the number of CM personnel required to manage interface and mitigate exposure to claims due to interferences with other contractors.

The following section provides a short summary of the construction performed at Polk Power Station.

### 1. A-015 -FIRE PROTECTION (F.E. Moran):

A) Contract Description

All of the above ground Fire Protection systems (foam, sprinkler piping and fire detection) for the project were combined into a single lump sum contract. The contract included the design, procurement, construction and start-up of the various systems. This contract was issued by Bechtel Engineering.

B) The scope of work includes:

- Design and procurement services for the plant fire protection systems based on criteria provided by Bechtel Engineering.

- Installation of local control panels and sprinkler piping.

- Installation of TECO furnished hose reels.

- Tie-in to underground fire protection installed by CP-008 contractor.

- System integration with turnkey Sulfuric Acid and Air Separation plants into overall monitoring panel in Control building

- Checkout and coordination of permitting

- Final testing and start-up of Fire Protection and Gas Detection Systems

C) Chronology

This contract was awarded to F.E. Moran on May 10, 1995 and was completed in October 1996. The contractor performed well and cooperated with other contractors on the Project. Schedule performance was in accordance the Project Schedule. Manufacturing problems with the Gas Detection System required a two week schedule extension to resolve.

| Major schedule milestones | Planned | Actual |
|---|---|---|
| Release Main Fire Control Panel | 11/22/95 | 11/20/95A |
| Release Fuel Oil Foam Systems | 11/29/95 | 11/20/95A |
| Release Coal Handling Area | 03/27/96 | 03/11/96A |
| Release Power Block Area | 04/26/96 | 04/29/96A |
| Release Standpipe Systems | 05/08/96 | 05/08/96A |
| Demobilize from Project Site | 05/22/96 | 06/17/96A |
| Revised Site demobilization | 06/05/96 | 06/17/96A |

D) Special Topics

The Fire protection portion of the contract was successful from design engineering through installation, start-up and functional testing. The gas detection portion of the system was designed and installed by AFT (a subcontractor to F. E. Moran).

As of June 1996, the contractor worked 12,000 Man-hours without a first aid case, OSHA recordable or lost work day case.

## 2. CP-001 -SITE DEVELOPMENT (Johnson Bros. Corp.)

A) Contract Description

This was the first contract issued for the project. It was for the major earthmoving scope that transformed the jobsite from a former phosphate unreclaimed strip mine consisting of a series of water filled trenches to the current configuration.

B) The scope of work included:

- Site clearing and grubbing, earthwork, reclamation of wetlands East of State Road (SR) 37.
- Installation of underground piping including 60" and smaller Reinforced Concrete stormwater pipe, 72" concrete pressure pipe for the circulating water system and 36", 42" and 48" ductile iron cooling water pipe.
- Soil erosion control.
- Clearing, grubbing, site dewatering and cut and fill for land areas.
- Construction of temporary and permanent berms, cooling water ponds, ditches, trenches and culverts.
- Layout and survey of work areas.
- Installation of base material for roads and asphalt base course
- Construction of temporary parking areas, laydown areas and railroad subgrade.
- Slope stabilization of berms, trenches and ditches
- Initial site revegetation
- Installation of coal delivery ramps

C) Chronology

This contract was awarded to Johnson Bros. Construction (JBC) on February 7, 1994. The contractor is scheduled to finish work in June 1996. The contractor worked a double shift for over a year to maintain the schedule.

| Major Schedule Milestone | Planned | Actual |
|---|---|---|
| Site available | 02/14/94 | 02/07/94A |
| Railroad spur to Power Block complete | 10/03/94 | 12/18/94A |
| Cut and fill Power Block complete | 08/01/94 | 10/28/94A |
| Cooling Water reservoir at Intake Structure complete | 10/03/94 | 01/12/95A |
| Cooling Water reservoir complete | 08/18/95 | 10/15/95A |
| Wetlands reclamation complete | 02/29/95 | 06/01/96A |

D) Special Topics

The Contractor worked 617,719 Man-hours and experienced the following Safety Record through May 1996:

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Through May 1996 | 92 | 31 | 9 | 0 | 2.91 |

3. **CP-003 - RAILROAD (R.W. Summers):**

A) Description of Contract

This contract was issued to provide for all site railroad work. The contract was bid on a lump sum basis from the Houston office.

B) The contract scope includes:

- Signalization at Fort Green Road
- Furnish materials, survey and labor
- Installation of crossing at Fort Green Road and Plant Road "C"
- Installation of railroad bedding, track, rail ties, switches and ballast for spur from CSX track located adjacent to Fort Green Road to the Sulfuric Acid loading area.

C) Chronology

This contract was awarded to R.W. Summers on July 14, 1994. The Contractor completed his scope of work during the month of March 1995 and demobilized from the site. The work was completed within the original schedule durations.

D) Special Topics

The Contractor worked 8,252 total Man-hours and did not have any first aid cases, OSHA recordable cases or lost time accidents during the execution of its work.

## 4. CP-008 CIVIL AND UNDERGROUND PIPE (Johnson Brothers Construction):

A) Contract Description

This contract is the main civil contract for the Polk Power Project. The contractor installed the majority of the site foundations and underground piping in all plant areas, as well as the pipe rack structural steel.

B) The contract scope included installation of the following::

- Earthwork associated with foundation installation, tank foundations and liners for 9 plant field erected storage tanks
- All underground electrical ductbank
- Fuel oil storage tank area earthwork and concrete dike
- Plant Instrument Air compressor foundations
- Cooling water intake structure concrete (incl dewatering)
- Underground pipe for utilities and process water (except where included in the CP-001 site development contract)
- Grounding grid
- Power block equipment foundations
- Pipe rack foundations and steel erection
- Flare foundations
- Hot Gas Clean-Up foundation
- Gasification structure foundation and structural steel erection to 85 feet above grade. The concrete placement for the Gasification structure foundation included embedding the main structural columns in the concrete. Engineering provided a design for this work that ensured the columns could be set and held plumb through the concrete pour.

In order to make the schedule RSC equipment erection dates, the Gasification structure had to be started before the CP-011 contract was awarded. This was accomplished by incorporating the erection of the Gasification structure to elevation 185 into the CP-008 contract. Late steel deliveries caused the plan to change and JBC only erected half of the steel below 185 with the remainder being added to the CP-011 contract after award.

- Coal handling and coal grinding area foundations

C) Chronology

This Contract was awarded to Johnson Bros. Construction (JBC) on October 14, 1994. Due to late design changes and steel deliveries, the Contractor completed his work scope during the month of November 1995 and demobilized from the Project Site.

| Major Schedule Milestones | Planned | Actual |
|---|---|---|
| Mobilize | 11/03/94 | 11/03/94A |
| Fuel Oil tank foundation complete | 01/01/95 | 01/10/95A |
| All power block foundations complete | 03/07/95 | 03/10/95A |
| All substation foundations complete | 03/23/95 | 04/05/95A |
| Intake and discharge structure complete | 03/30/95 | 03/15/95A |
| Gasification structure complete to 185' | 05/12/95 | 06/20/95A |
| All underground piping complete | 05/15/95 | 06/10/95A |

D) Special topics

JBC's recordable rate was the highest on the project and they suffered from a lost time accident when a carpenter accidentally cut off 2 fingers. The CM team worked with their personnel throughout the contract to improve their safety performance.

The Contractor worked 241,194 Man-hours and experienced the following Safety record:

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Total Contract | 78 | 15 | 10 | 1 | 8.29 |

## 5. CP-010A -CONTROL BUILDING (Hennessey Construction):

A) Contract Description

This was a design/build contract for all architectural, civil, electrical and mechanical work associated with the Polk Power Station Control building. It was bid on a lump sum basis.

B) The contract scope includes:

- Underground electrical, plumbing, water and fire protection within 5 feet of the building perimeter

- Foundations and area grading

- Above ground civil, architectural, interior finishes, electrical power, plumbing, lighting, HVAC, fire protection, lightning protection, security and communication

- Installation of lab furnishings, fixtures and control room build-out

C) Chronology

This contract was awarded to Hennessey Construction Services on October 13, 1994. The contractor completed his scope of work in August 19, 1995.

D) Special Topics

The contractor worked 55,792 Man-hours and experienced one first aid case and no OSHA recordables or lost work time accidents

## 6. CP-011-GASIFICATION/COAL HANDLING (The Industrial Company - TIC):

A) Contract Description

The contract scope of work included area paving, mechanical, electrical and instrumentation work in the Gasification and Coal Handling areas.

B) The scope of work includes:

- Gasification area- This area includes the Grey Water and Black Water, Acid Gas Removal, Low Temperature Cooling process areas. The work in these areas includes structural steel erection, piping, electrical, instrumentation in the Gasification structure, Amine structure, Ammonia structure and the Gasification piperack. Piping work in the Gasification structure was worked on a 58 hours per week basis during the bulk installation period.

  Early in the project, it was recognized that the critical path of the project would run through the Gasification structural steel, equipment erection, piping and electrical work. An early critical project milestone was setting of the Radiant Syngas Cooler (RSC) equipment in the Gasification structure at the 185 foot elevation on June 30, 1995. In order to meet this date, the design for the Gasification structure was split in half, with the portion below elevation 185 designed early and the erection started by the CP-008 contractor approximately 2 months before the CP-011 contract was awarded. The portion above 185 foot was erected by TIC.

  In addition to splitting the Gasification structure between 2 contractors, the portion of the steel above 185 foot had to be split again to accommodate the crane used to set the RSC (at 185') and the High Pressure Steam Drum (set at 316'). The north and west sections of the upper Gasifier structure were installed with temporary bracing to allow the safe setting of the HP Steam Drum at the same time the RSC was set at the lower elevation.

- All foundations (except those on the north side of the Gasification structure) were placed by the CP-008 contractor. The remaining foundations were included with the CP-011 contract to allow the maximum flexibility to schedule cranes and structural steel laydown areas needed to erect the Gasification structure. These foundations were part of the critical path because they included the interconnecting pipe rack that tied the Gasification structure to the main pipe rack. This rack needed to be complete to meet early start-up system turnover dates.

- Coal Handling area- This area includes the installation of all the structural steel erection, piping, siding, equipment, electrical and instrumentation associated with the Coal Unloading building, Coal Conveyors and Coal Grinding building. The conveyor galleries and support bents were assembled by the vendor at a local fabrication shop and shipped out to the site in 125 foot sections. TIC installed the electrical and piping on the galleries prior to setting on the bents.

  The structural steel erection was coordinated with the D-001 tank erection contractor to allow for maximum ground fabrication of the two large field erected slurry run tanks and shared use of the steel erection crane.

- Thermal Oxidizer - This work includes all piping, electrical and instrumentation.

- Interconnecting Pipe Racks - The work includes installation of random pipe and supports, insulation and touch up painting.

- Industrial Waste Treatment - All work except foundations.

- Flare - All work other than the Flare foundations.

- Electrical work for the various areas includes Closed Circuit TV, Gaitronics, grounding, lighting, lightning protection, heat tracing, power and instrument wiring.

- Start-up support- Specific start-up support work (loop checks, instrument calibration, steam blow prep, flushing) was included in the contract on a lump sum basis

- TIC subcontracted the following work: HVAC, plumbing, conveyor belt vulcanizing, metal building siding, painting, insulation, fireproofing, refractory and refractory curing.

C) Chronology

This CP-011 contract was awarded to The Industrial Company (TIC) on April 21, 1995. In July, 1995, the CP-011A contract was awarded to TIC as a separate contract with common non-manual staff. The contractor mechanically completed his scheduled work by the project end date of August 1, 1996. TIC worked 48 hours per week as their standard week. Piping work in the Gasifier was worked on a 6-10 basis for most of the contract. TIC worked 7-10s during the erection of the structural steel needed to support the RSC erection schedule.

| Milestone schedule | Planned | Actual |
|---|---|---|
| Gasification Structure complete to elev 310 (N&W walls only) | 6/29/95 | 06/29/95A |
| Complete RSC internal hydrotest (prior to erection) | 7 days after release to TIC | 07/04/95A |
| Final GAS system turnover | 6/1/96 | 07/08/96A |
| Mechanical completion all work | 8/1/96 | 07/08/96A |
| Final acceptance of all work | 9/1/96 | 11/30/96A |

D) Special Topics

The Contractor's dedication to safety was excellent. As of May 1996, TIC worked a combined 969,843 manhours between the two contracts (CP011 & CPO11A). The Contractor experienced the following Safety record through April, 1996:

| Polk Power Contractor Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Combined CP-011/11A through May 1996 | 303 | 44 | 6 | 1 | 1.24 |

## 7. CP-011A -GASIFICATION WASTE PROCESSING (The Industrial Company - TIC):

A) Contract Description

This contract includes the area paving, structural steel, and mechanical-electrical and instrumentation work for Hot-Gas Clean up process systems.

B) The contract scope includes:

- Slag Handling/Fines Handling - All work south of the Gasification structure, piping systems to a tie in point at the rack south of Gasification structure.
- Grey Water - All work in the Grey Water area south of the Gasification structure.

- Brine Concentration - All work except foundations (which were included in CP-008 contract).

- Thermal Oxidizer - Setting equipment and Main Pipe supports. The piping, electrical and instrumentation was included in the CP-011 contract.

- Hot Gas Clean-up - All work except foundations. Contractor used an approved Subcontractor (Reintjes of the South) for Vessel Refractory.

C) Chronology

This contract was awarded to The Industrial Company (TIC) on July 6, 1995. The Contractor was completed by November 31,1996.

| Milestone schedule | Planned | Actual |
|---|---|---|
| Last 2 systems (HBF and HEG) | 07/01/96 | 06/13/96A |
| Mechanical Completion of all work | 07/01/96 | 06/13/96A |
| Final acceptance of all work | 08/01/96 | 09/30/96A |

D) Special Topics

The hours worked by the Contractor and Safety statistics for this TIC contract are included with the TIC contract for Gasification/Coal Handling.

## 8. CP-012 -POWER BLOCK AND PLANT UTILITIES (H.B.Zachry):

A) Contract Description

This contract includes the area paving, mechanical, electrical and instrumentation work in the Power Block and Plant Water and Air plants. It also provided for installation of all of the project high voltage power distribution system.

B) The contract scope of work includes:

- Power Block - The work included structural steel erection, mechanical and electrical work associated with the installation of all equipment including the GE supplied Steam and Combustion Turbine Generators and VOGT supplied Heat Recovery Steam Generator. A Continuous Emissions Monitoring System for the HRSG stack was installed in the Power Block.

- Make-up Water Treatment, Fuel Oil Storage, Auxiliary Boiler, Instrument Air Plant, Intake Structure - H.B.Zachry performed all equipment, piping, electrical and instrumentation work.

- All foundations and field erected tanks were installed by other contractors.

- Electrical work- In order to meet the start-up milestones, all project power distribution from main switch gear to all local MCC's was included in this contract, including all pipe rack cable trays and substation erection.

- Interconnecting Pipe Racks -The work includes installation of random pipe and supports, insulation, touch up painting.

- In order to avoid interference between contractors, area paving for the Power Block was transferred from the CP-008 contract to the H.B.Zachry scope of work.

- Electrical work for the various areas includes Closed Circuit TV, Gaitronics, grounding, lighting, lightning protection, heat tracing, fiber optic cable, DCS, local power from the MCCs to the equipment and instrument wiring.

- Start-up support- Specific start-up support work (loop checks, instrument calibration, steam blow prep, flushing) was included in the contract on a lump sum basis

- The contract was bid with a provision to allow GE the option to self install the Combustion Turbine Generator and associated equipment and electrical work. This option was not exercised by GE.

C) Chronology

This contract was awarded to H.B.Zachry Company on February 17, 1995. Work was completed by May, 1996.

| Milestone Schedule | Planned | Actual |
|---|---|---|
| EHA system (First High Voltage Bus) | 06/01/96 | 06/01/96 |
| DCS system (Distributed Control bldgs) | 07/01/96 | 07/01/96 |
| Avg 8 systems over 8 months | Varies | +/- 1 week |
| Last systems | 03/01/96 | 04/01/96 |
| Mechanical completion of all work | 04/01/96 | 07/01/96 |
| Final acceptance of all work | 05/15/96 | 08/01/96 |

D) Special Topics

The Contractor's dedication to safety was excellent. Through May 1996 the contractor worked 702,761 Man-hours with the following Safety record:

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Through May 1996 | 339 | 49 | 3 | 0 | 0.85 |

## 9. CP-014 -FINAL GRADING/FENCING (Bulger Construction):

A) Contract Description

The scope of this contract includes the complete site grading, paving of the interior roads and installation of the plant perimeter fencing.

B) The contract scope includes the installation of the following:

- Site perimeter fencing
- Completion of any site grading, asphalt paving and reseeding not in the CP-001 contract.
- Stone covering of the plant areas.
- Installation of cement stabilized soil on the drainage ditch slopes
- Coordination with other site contractors to avoid the possibility of having to rework pavement on roads.

C) Chronology

This contract was awarded to Bulger Construction in May 1996 and the contractor mobilized in June. The contract was completed by September 30,1996.

D) Special Topics

There is no safety record for the contractor at the time of this report.

## 10. CP-015 -WELL DRILLING (Diversified Drilling):

A) Contract Description

This contract was issued to install all of the permanent plant site wells

B) The contract scope includes the following:

- Setting of 4 permanent site wells, pumps and motors
- Sampling and logging of samples to meet State and Federal regulations

C) Chronology

This contract was awarded to Diversified Drilling on August 25, 1994. The Contractor completed his scope of work in June 1995.

D) Special Topics

The Contractor worked a total of 3,891 Man-hours and had 3 first aid cases during the period of execution of his work. There were no OSHA recordable or Lost work day cases.

## 11. CP-017 -RSC TRANSPORTATION/ERECTION (Davenport/Mammoet):

A) Contract Description

The contract scope includes the heavy haul and erection of the large equipment in the Gasification structure.

B) The scope of work for this contract includes the following:

- Ocean Transport of RSC, HP and MP Steam Drum from the Belleli shop in Italy to the Port of Manatee
- Over road heavy-haul transport of vessel from the Port of Manatee to jobsite
- Erection of equipment into structure
- Provision of all permits and bonds for road transportation
- Deciding the best method and routing for overland transportation route.

C) Chronology

This contract was awarded to Davenport Mammoet Heavy Transport Inc., on May 9, 1994. The contractor completed setting of the equipment in July 1995.

D) Special Topics

The contractor worked 4,740 Man-hours without a first aid or OSHA recordable case.

## 12. CP-021 HRSG HEAVY HAUL (Bevel Brothers):

A) Contract Description

The contract scope of work includes the heavy haul of the HRSG modules from the rail siding to the jobsite. It was awarded on a lump sum basis.

B) The scope of work includes the following:

- Unloading of the HRSG modules (up to 150 tons ea) from rail cars at the CSX siding using a lifting frame
- Overland transport to the site on heavy haul trailers and offloading near the Power Block

C) Chronology

This contract was awarded to Beyel Bros in November 1994. All work was completed by February 1995.

D) Special Topics

The contractor worked 1350 manhours without a first aid case and demobilized from the project in January 1995.

**13. CP-022 RECLAMATION WEST OF SR 37 (Johnson Brothers Construction):**

A) Contract Description

This contract was issued to reclaim property on the property across SR 37 from the jobsite. This property was included in the land purchase when TECO obtained the project site land from IMC. TECO also obtained the obligation to restore the land from mining operations. There were no facilities constructed on the site.

B) The scope of this contract includes the following:

- Restoration of the strip mined property West of State Road 37
- Reseeding and planting of the wetlands

C) Chronology

This contract was awarded to Johnson Bros Construction on November 8, 1995. The contractor mobilized and commenced dewatering and earthwork on November 13, 1995. The contract was completed in August of 1996.

D) Special Topics

As of May 1996, the contractor worked 128,041 Man-hours with 18 first aid cases and 1 OSHA recordable. Their OSHA incident rate is 1.56.

**14. CP-023 -CHEMICAL & LUBE OIL STORAGE and BRINE & HOT GAS WASTE TRANSFER BUILDINGS (Kalemeris Construction) :**

A) Contract Description

This contract was issued for the construction of the Brine/Hot Gas Transfer building and renovation of the Chemical/Lube Oil building.

B) The scope of this contract includes the following:

- Design and construction of a new brine and hot gas clean-up waster transfer building

- Renovation of an existing building for use as a chemical and waste oil storage facility.

- Tie in to existing utilities up to 5' outside the buildings

- Providing stamped engineered drawings for the work

C) Chronology

This contract was awarded to Kalemeris Construction Co. on March 7, 1996. Work commenced April 1996 and was completed in August of 1996.

D) Special Topics

The contractor has worked 1515 Manhours with 1 first aid case and no OSHA recordables as.of May 1996.

15. **D-001 -FIELD ERECTED TANKS (Tampa Tank):**

A) Contract Description

The contract scope included the field erection of 13 large storage tanks.

B) The contract included the following:

- Design, supply and erection of atmospheric pressure tanks including Condensate Storage, Amine Storage, 2 ea elevated Slurry Run, Chemical Cleaning, Service Water, Demineralized Water, Fuel Oil Storage, Brine Storage, Evaporator Storage and Grey Water Storage tanks. The Slurry Run tanks are located 30 foot above grade in the Coal Grinding building and Tampa Tank coordinated the erection of the tank with the CP-011 contractor to maximize crane usage and tank prefabrication.

- NDE and hydro testing of the tanks

- Sandblasting and application of interior and exterior coatings

- Cathodic protection and post-weld heat treatment

- Foundation work was performed by the CP-008

C) Chronology

This contract was awarded on a lump sum basis to Tampa Tank on April 15, 1994 with mobilization set for January 1995. The contractor completed his scope of work in December 1995. One key factor in the success of this contract was Tampa Tank's ability to adjust his schedule to work with other contractor's changing priorities.

D) Special Topics

The contractor worked 19,894 Man-hours and experienced 6 first aid cases during the execution of his work. There were no OSHA recordables or lost work day cases.

## 16. N-003 - GASIFIER REFRACTORY INSTALLATION (Texaco)

A) Contract Description

This contract was issued to provide technical direction required for the inspection of the quality of the Gasifier refractory. The installation contract was issued with CP-011.

B) The contract scope of work included the following:

- Provision of complete refractory installation procedures for the Gasifer.
- Continuous inspection of the refractory lining of the Gasifier
- Monitoring of the curing process
- Technical assistance to resolve design problems in the field.
- Final acceptance of the refractory installation.

C) The contract was awarded to Texaco in 1995 and completed with the final curing of the Gasifier refractory in June 1996.

D) - As of April 1996, the contractor worked 500 hours with no first aid cases or OHSA recordable or lost time accidents.

## 17. R-001 -WAREHOUSE AND MAINTENANCE BUILDINGS (C.A.Oaks):

A) Contract Description

This contract was issued for the design and construction of the two 20,000 sf permanent prefabricated metal buildings for the plant warehouse and maintenance facilities.

B) The contract scope included the following:

- Design services for the Warehouse and Maintenance buildings
- All construction work for the buildings including civil, architectural, interior finishes, fire protection, electrical power and lighting, plumbing, HVAC, test and balancing, communication systems, foundations and underground utilities

C) Chronology

This contract was awarded to C.A. Oakes Construction Company on May 9, 1994. The contractor completed his scope of work in July 1, 1995. C.A.Oakes experienced numerous problems and delays due to its subcontractors not being able to mobilize when needed. The contractor was able to complete the Warehouse on time, but was late in completing the Maintenance building.

D) Special Topics

The contractor worked 46,752 Man-hours and experienced the following Safety record during the execution of his work.

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Total contract | 4 | 2 | 1 | 0 | 4.28 |

## 18. T-008 -GASIFICATION ELEVATOR (Montgomery Elevator):

A) Contract Description

This contract was issued to provide for the design and construction of elevator in the gasification structure.

B) The scope of the contract included the following:

- Design and construction of the elevator, cab, doors and controls
- State inspection certification

C) Chronology

This contract was awarded to Montgomery Elevator on June 1, 1994 and the work completed in May 1996 with 2 first aid cases and no OSHA recordables. The original schedule called for a 52 week schedule. This was changed to a 40 week schedule during the award negotiations. After working overtime for several weeks and deleting 25% of the landings, the actual duration of the work was 23 weeks.

D) Special Topics

The contractor worked 3,632 hours through May 1996, with 2 first aid cases and no OSHA recordables.

## 19. T-013 -COAL SILOS (American Marietta):

A) Contract Description

The contract scope of work includes the design, supply and installation of coal storage silos and foundations

B) The scope of work for this contract included the following:

- Design and construction of two concrete coal silo storage facilities
- Foundations, interior steel plating, ladders and conveyor embedments in the silo roof.

C) Chronology

This contract was awarded to American Marietta on May 19, 1994. The contractor completed the erection of Coal Silos in September 1995.

D) Special Topics

The contractor worked 21,742 Man-hours and experienced 3 first aid cases during the execution of his work. There were no OSHA recordables or lost time days.

## 20. V-004 -AIR SEPARATION UNIT (Air Products and Chemicals - APCI):

A) Description of Contract

A contract was negotiated and signed with Air Products and Chemicals, Inc (APCI) to provide an air separation unit (ASU) capable of producing 2020 standard tons per day (STPD) of 95% pure oxygen, 6,037 STPD of 99% pure nitrogen and 401 STPD of 99.99% pure nitrogen. The ASU provides oxygen and nitrogen to an integrated gasification combined cycle power plant with a nominal rating of 250 MW.

The contract was signed as a lump sum turnkey contract in which APCI provided engineering, procurement and construction activities for the ASU. The contract required APCI to guarantee purity and flow rates for both oxygen and nitrogen as well as power consumption. In addition to this, an availability guarantee of 98% was required for the first two years of operation.

B) The contract included the following;

The industrial gas industry is specialized and requires specific knowledge of cryogenic and handling of oxygen. For this reason, it was decided that the request for proposal would be formatted as a process specification in which the design would produce required product flowrates at given pressure, temperature, etc. The proposal requested bids ranging from engineering and procurement to a total turnkey lump sum package.

The RFP contained standard specifications for electrical, instrumentation, and small packaged equipment. These criteria were used to attempt to standardize areas of the facility, yet allow the expertise of the bidders to design a quality product. For this reason, a design package was not used and the RFP was issued as a EPC with several options.

C) Chronology

The contract was awarded to APCI in April 1993 and the engineering phase began immediately. APCI worked closely with the A/E firm performing the detailed engineering and engineering was essentially completed in July 1994. Procurement activities coincided with the design phase of the project and all the large equipment had been ordered by July 1994.

The site was readied and APCI began mobilization activities in January 1995. The civil contractor was brought on and completed work in March 1995. The mechanical contractor followed the civil contractor and completed work in November 1995. The electrical and instrumentation contractor was mobilized in May 1995 and completed the scope of work in December. The total construction phase lasted approximately 12 months.

In late December 1995, the checkout and start up of the ASU began and was scheduled to last for approximately two months. Start up was completed in early March 1995 with the ASU operating at full load conditions and the product streams being vented to atmosphere.

D) Special Topics

The scoping philosophy was to use the experience and expertise of APCI as much as possible and at the same time try to maintain common features throughout the facility. It is believed this approach would create the greatest benefit to the project by producing a high quality product and at the same time make operation and maintenance easier and less costly due to the common features.

The safety record of APCI and their subcontractors is summarized in the table below. APCI and their subcontractors worked 128,000 manhours to construct the ASU. The OSHA recordable rate for APCI was 3.13 versus the national average for construction 11.98. APCI had no lost time accidents (L.A.) and the national average for construction is 5.

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Total Project | 23 | 7 | 2 | 0 | 3.13 |

## 21. V-014 -SULFURIC ACID PLANT (Monsanto Enviro-Chem - ME-C):

A) Contract Description

A contract was signed with Monsanto Enviro-Chem (ME-C) to provide a sulfuric acid plant (SAP) capable of producing 209 tons per day (TPD) of 98% sulfuric acid. The SAP receives as its feed stock the acid gas generated in the acid gas removal section of the gasification plant. The SAP will also receive as feed gas certain gas streams from the Hot Gas Cleanup Unit.

The contract was signed as a lump sum turnkey contract with ME-C providing engineering, procurement, and construction as well as start up and commissioning services. The contract also required ME-C to meet certain availability, propane consumption, power consumption, steam production, and product quantity guarantees.

B) The contract included the following;

The request for proposals (RFP) was issued for the bidders to supply as options an engineer and procure package as well as a turnkey lump sum (engineer, procure and construct) package. The RFP also contained standard specifications for electrical, instrumentation, and packaged equipment. These design criteria were used in an attempt to standardize the SAP to the rest of the facility, yet still use the expertise of the bidders in designing, procuring and constructing a quality SAP. As in the case of the Air Separation Unit, the lump sum turnkey option was selected to capitalize on the experience and expertise of ME-C.

C) Chronology

The contract with ME-C was signed on June 8, 1994 and engineering began immediately. The engineering phase was required a compressed schedule in order to meet the construction and start up dates established by the rest of the project. Final engineering was completed in February 1995 and mobilization activities at the site began in March 1995. Civil activities were the first activities in the construction phase to be completed and this occurred in June 1995. Mechanical, electrical, and instrumentation activities continued from June 1995 to December 1995 at which time the SAP was deemed mechanically complete. Start up services will be performed during the facility start up schedule for July 1996.

D) Special Topics

ME-C subcontracted the construction of the SAP to Leonard Construction which is a wholly owned subsidiary.The project schedule required ME-C to compress their engineering schedule and complete the design to support other project dates. The compressed schedule forced ME-C to focus resources on completing the design phase which resulted in a more complete engineering design and less rework in the field. This was conveyed by both the ME-C project personnel as well as the Leonard Construction personnel.

The safety record of Leonard construction was very good. The contractor worked 128,538 manhours with the following safety record:

| **Polk Power Site Total Safety Matrix** | **Number of First Aid Cases** | **Number of Doctor Cases** | **Number of OSHA Recordable Cases** | **Number of Loss Time Incidents** | **OSHA Recordable Rate** |
|---|---|---|---|---|---|
| Total contract | 48 | 4 | 0 | 0 | 0.00 |

## Z-009 - SLAG STORAGE & BRINE LANDFILL (EMCON):

A) Contract Description

The contract scope was for turnkey design, furnish material and construction of a Slag Storage Collection Landfill and Leachate Collection Basins.

B) The scope of work for this contract included the following.

- Provide detailed engineering, material and construction of a Slag Storage Runoff Retention Basin
- Dewatering earthwork and underground piping
- Install liner and sumps for Slag Runoff Basin and Leachate Collection area
- Install berms and grass seeding of slopes

C) This contract was awarded to EMCON Southeast on January 20, 1995. The contractor completed his work in April 1996.

D) The contractor worked 11,480 manhours with the following safety record:

| Polk Power Site Total Safety Matrix | Number of First Aid Cases | Number of Doctor Cases | Number of OSHA Recordable Cases | Number of Loss Time Incidents | OSHA Recordable Rate |
|---|---|---|---|---|---|
| Total contract | 2 | 1 | 0 | 0 | 0.00 |

## Site Services Contractors

In addition to the general construction contracts, the CM is responsible for supervising several service sub-contacts including; surveying, security, civil testing and NDE services.

## SC-001 - Surveying (Landmark/EMK):

This contract provides surveying services for layout of project control points and monitoring of those points during the construction. The surveyor also audited the Contractors site survey points where necessary. The contract was awarded to Landmark Surveying and later changed to EMK Surveying after quality concerns with Landmark. Landmark worked 4,726 manhours with no first aid cases and no OSHA recordables. As of May 1996, EMK worked 4,958 manhours with no first aid cases and no OSHA recordables. The contract is based on Unit Pricing.

## SC-002 - Security (Wells Fargo):

This contract provided 24 hour security services for protection of the jobsite and facilities during the construction of the plant. It was awarded to Wells Fargo Security Services on a Unit Price basis.

As of May 1996, Wells Fargo worked 46,789 manhours with 6 first aid cases and no OSHA recordables.

**SC-003 - Civil Testing (PSI Services):**

This contract provides civil and structural testing services for soil compaction and concrete testing as well as witness inspection of painting, bolt torque and fireproofing to assure contractor compliance to the drawing and specifications. The contract was awarded to PSI Services on a Unit Price basis. As of May 1996, PSI worked 11,625 manhours with no first aid cases and no OSHA recordables.

**SC-004 - NDE services**

This contract provides non-destructive testing (X-ray, Magnetic Particle, etc) testing services as directed by the CM to assure Contractor compliance with the drawings and specifications.

**SC-005 - General Services (Harmony Construction):**

This contract provides labor, equipment, personnel and services for temporary site services. It was awarded to Harmony Construction in October 1994 and the contractor demobilized in May 1996. The award was based on Unit Pricing.

The scope of work includes

- Site cleanup, trash collection and janitorial services
- Temporary office secretarial services
- Installation of temporary site power distribution system
- Maintenance of temporary roads
- Supply, installation and maintenance of the construction phone service
- Warehouse support services
- Sanitary services

The contractor demobilized in May 1996 after working 60,177 manhours with 11 first aid cases and no OSHA recordables.

# SECTION IX

# START-UP ORGANIZATION

## START-UP ORGANIZATION

### A. START-UP PROGRAM

In a broad perspective, the start-up program involves taking scoped systems during the final stage of construction and preparing them for operation and owner acceptance. The vast array of activities include the following: initial system walk down, component and system checkout (electronically and mechanically), instrument calibration and loop checking, meter and relay calibration, system cleaning and operational checkout, integrated system testing, fine tuning of system and plant operations, and the turnover and acceptance of the facility for commercial operation by Tampa Electric.

Other functions included in the start-up scope of work include participation in TECO's dynamic simulator and development of the operating and training procedures. The simulator is a tool that is used to simulate various operating modes of the plant, including upset conditions that could occur within complex systems. The combination of the simulator and the operating/training procedures were a valuable asset during the operator's training program and initial operation of the plant.

### B. START-UP ACTIVITIES ACCOMPLISHED 1996

The work plan for 1996 consisted of completing checkout and placing in service all remaining scoped systems, completing unit shakedown, initializing power generation using syngas, and completing performance testing of the facility. The plant was released for commercial operation on September 30, 1996.

#### KEY ACTIVITIES ACCOMPLISHED IN 1996

- Provided steam, generated by the auxiliary boiler, to the air separation unit.
- Completed check out and placed in service open loop and closed loop cooling water to the gasification area.
- Completed check out and placed in service the coal unloading, grinding and slurry preparation systems.
- Completed lube oil flushes for the gas turbine and steam turbine.
- Completed steam blows of the main steam piping that connects the HRSG to the steam turbine.
- Completed check out and test firing of the gas turbine, steam turbine and heat recovery steam generator (HRSG).
- Completed check out and performance testing of the air separation unit and sulfuric acid plant.
- Completed check out and placed in service the brine concentration system.

- Completed check out and placed in service the slag handling system.

- Completed check out and placed in service the fire water distribution, fire detection and gas detection systems.

- Completed check out of the gasification systems and produced syngas.

- Completed check out and placed in service the hot gas clean up systems.

- Developed and issued the operating and training procedures.

- Participated in the review and operation of the simulator training program.

## C. INITIAL OPERATION

The highlight of 1996 was the initial operation of Polk Power Station. The following discuss some of the details associated with achieving this milestone.

Most new units start at a low percent load and take some time starting up the unit and increasing load from 0 to 100%. However due to the particulars of this technology and TEC's persistence, the overall unit commissioning went from first gasifier light off to full gasifier production within days. In addition, once syngas was admitted to the CT, full load (192MW) was achieved in less than three (3) months.

Bringing the plant on-line after a shutdown is a longer than normal process. After the plant has been shut down for an extended period of time it takes 2 days to bring the unit back to full load capability. First the air separation unit (ASU) must be started and cooled down to operating temperature. This takes about 2 days. Concurrent to the ASU being started up, the refractory in the gasifier must be heated to operating temperature required to install the process burner. The timing of all unit start-up activities is critical in order to bring the unit on line within a 40 to 48 hour time frame.

The emissions from Polk Unit #1 have generally been as expected. $NO_x$ limits are routinely and easily controlled to the 25ppm limit. Sulfur capture is 95 +%. Although there are still issues to be solved with the brine system, Polk has not had an unpermitted water discharge. Slag disposal remains a problem to be solved. The Polk Unit has between 6-12 months temporary on site slag storage. Work is currently underway with several potential buyers to refine the slag production and handling to a form desirable by the buyers.

Each section below discusses specific operations issues by plant area.

## POWER GENERATION

## 1. COMBUSTION TURBINE MODIFICATIONS

During the checkout and start up of the General Electric Supplied combustion turbine (CT), modifications were made to correct issues discovered during the checkout of similar machines that had been put in service prior to Polk turbine being made ready for service. The corrections discussed below were all made by General Electric and paid for by General

Electric. No Impact to the overall Plant start-up schedule occurred. All of the design changes made were done in cooperation with Tampa Electric's integrated start-up and operations team.

A) **2-3 Spacer Modification** - During the installation of the turbine a modification was required to the spacer between the 2nd and 3rd stage turbine wheels to prevent the third stage wheel from rubbing against the spacer plate during operation. The modification was made in place and has resulted in error free operation.

B) **3rd Stage Bolts** - During the second combustion turbine syngas run, Tampa Electric had to shut down the turbine on Sunday Morning October 13, 1996, due to changing vibration readings. Tampa Electric had been cautioned that cracking of the 3rd stage connector bolts had been observed on similar units and that a change in vibration vectors would be indicative of the bolt(s) beginning to shear. Upon inspection of the bolts after shut down one significant crack was observed and the bolts were replaced with higher strength material. Subsequent runs of the machine have indicated the problem has been corrected. Tampa Electric will continue to monitor vibration as well as continue inspections as needed during outages to insure no further problems will occur.

C) **Exhaust Temperature Spread** - Due to an uneven distribution of syngas and nitrogen to the fuel nozzles, the combustion temperatures and hence exhaust temperatures were not consistent in the turbine. To correct the problem, orifices were placed in both distribution headers. This resulted in a more balanced flow to the fuel nozzles and hence a more consistent firing temperature. Tampa Electric continues to monitor the temperature spread to insure the modified flow distribution is adequate. There is concern that particulates are forming in the syngas between the gasifier and the CT as a result of chemical phenonenum not yet fully understood. This particulate appears to be plugging the fuel nozzle and further complicating the exhaust temperature spray. GE, Texaco and TEC continue to investigate the full impact of this phenonenum.

D) **Purge Nitrogen** - High Pressure nitrogen is suppled to the Combustion Turbine Syngas Control Valve Skid for two (2) reasons. (1) Nitrogen is utilized to purge the syngas lines when transferring from one fuel to the other. (2) Nitrogen maintains a buffer between the syngas and the compressor discharge air, when the CT is on distillate fuel. Due to problems with supplying adequate volumes of purge nitrogen, modifications were performed to provide a consistent volume of nitrogen. In addition with an adequate supply of purge nitrogen available the flow switches would consistently clog preventing a transfer. The flow switches have been relocated and transfers will continue to be monitored closely to insure the problems have been resolved.

In starting up the CT, there is a time when the turbine must burn distillate fuel in preparation for transferring to syngas. During this point in operation, it is vital that the syngas fuel and compressor discharge air do not mix. To maintain this separation a buffer of nitrogen is provided between the closed speed ratio valve and the closed syngas control valve. The Nitrogen pressure has been difficult to maintain because of leakage within the syngas control valves. The seat clearances have been adjusted by the manufacturer but these valves continue to be a problem. GE and the valve manufacturer continue to work on these problems.

E) **Diluent Nitrogen Injection Control Valve** - Upon initial syngas operation, it was discovered the nitrogen control valve was undersized and the required volume of nitrogen required for $NO_x$ control could not be achieved. A new valve was installed during the late February 97 outage. Since this outage, full load has been achieved and NOx values have been within compliance.

F) **Generator Core Vibration** - During the initial start-up & testing, the generator made a loud 3600-hertz noise as a result of resonant condition on the stator core. Belly bands were installed around the stator core and the problem was corrected.

G) **HRSG Fouling** - During the December 1996, & January 1997 syngas runs, fouling occurred in the L.P. Economizer of the HRSG. The fouling appeared to be from condensing sulfur compounds even though the exit gas temperatures were above the dew point. The operating procedure has been revised to raise the incoming L.P. Economizer inlet water temperature. At the same time the exit gas temperature has been raised slightly. The fouling appears to be arrested in the latest operating runs. We will however, continue to observe the relationships between fuel quality, exit gas temperature, and fouling in order to maximize plant efficiency without sacrificing future availability.

H) **End Covers/Fuel Nozzles** - During initial testing of the turbine, we were notified by General Electric that there was a potential problem with the brazed joints that separate the syngas from the atomizing air within the end cover. Inspections verified that a problem did exist and the end cover inserts were rebrazed, correcting this deficiency. However, during the first syngas run, syngas and atomizing air did in fact mix in several end covers due to a design deficiency. This problem was expediently resolved by the manufacture and no other problems have occurred since the repairs were completed.

## GASIFICATION

### 1. GASIFIER REFRACTORY WEAR

The original refractory liner placed in the Polk gasifier is considered a "start-up" liner. This liner was installed with slightly lower grade, less expensive bricks with the concept being that it would last through the start-up period where there is a higher risk of excursions that would damage any type of liner. Original estimates were that this liner would last approximately one year under the conditions expected for a "normal" start-up (ie. Several start-up and shut-down cycles, temperature excursions, etc.).

Inspections have been performed at periodic times throughout the start-up and early operation period. The data collected is summarized below. In general, the refractory has held up well and could be expected to last the 1 year elapsed time as projected. However, due to other considerations (ie. outage scheduling), we will replace this start-up liner in April 1997.

Replacement plans call for upgrading the refractory in areas of observed high wear. TEC will put less expensive bricks in areas that have exhibited lower wear rates. Goals in partitioning the gasifier in this manner are to minimize cost and to have an entire liner that wears uniformly and will need to be replaced at the same time. The estimated life for the liner to be used for this replacement is 2 years.

## 2. RSC OUTLET TEMPERATURE

The radiant syngas cooler (RSC) outlet temperature is a function of several factors including inlet temperature, gas flow and composition, heat exchange surface area, steam conditions and gas side fouling factor. The outlet temperature in operation has been significantly below the design outlet temperature. This is a result of several of the factors listed, but primarily due to lower than design gas side fouling.

The start-up coal at Polk, Pittsburgh #8, has not fouled the heat exchange surface in the RSC as expected. Testing on alternate coals will be conducted in early 1997. This testing will provide significant information on RSC performance that can be used to optimize the outlet temperature based on performance and capabilities of downstream equipment. Until this testing is completed, no action to modify RSC outlet temperature is planned. The process configuration has enough flexibility to allow continued operation at this reduced temperature with only minor downstream effects.

<u>RSC outlet temperature (deg F)</u>

| | |
|---|---|
| Expected Temp. Design Case | 1400 |
| Expected Temp. Normal Operating Case | 1300 |
| Actual Operation | 1040* |

*The actual temperature listed is an average temperature of 4 thermocouples located at the exit of the RSC. This temperature varies with run duration and the number presented is typical for a "normal" run.

## 3. CONVECTIVE SYNGAS COOLING SYSTEM

The Convective Syngas Cooling System (CSC) consists of a total of 6 heat exchangers and interconnecting piping. All six of the exchangers are fire-tube type shell and tube heat exchangers. Each wing of the gasifier has one convective cooler which has hot, raw syngas on the tube side and raises high pressure steam on the shell side. Next, the gas passes to a two stage gas to gas type exchanger with hot, raw syngas on the tube side and either clean gas or nitrogen on the shell side. Each wing of the gasifier has the three exchangers in the arrangement discussed above to form the entire convective syngas cooling system.

From a process standpoint, this cooling system has performed well in the early phases of operation. The gas temperature at the inlet to this system (the same gas that is at the RSC exit) has been significantly below the design estimates. The tube side fouling factors estimated for design purposes have also been lower than expected. This results in the need to partially bypass these exchangers during operation in order to maintain temperatures above dew point at the exit of the system. However, because of the overall process relationship of the system, the bypass operation has only a minor effect on the overall plant efficiency.

The most serious problem experienced in this area of the plant has been ash plugging in the tubes of the gas to gas exchangers during the early phases of plant operation. This ash pluggage resulted in several shutdowns and required extensive clean-up procedures. TEC held several discussions with the equipment supplier and performed extensive analysis of the ash material and tube configuration. Based on this work, it was determined that TEC had to increase the velocity of the gas in this section of the plant. In addition, it was found that there was a correlation in the operating characteristics of the gasifier (ie. operating temperature) and the plugging characteristics of the ash. To increase the gas velocity, several tubes in the exchanger were blocked or plugged. This did decrease the duty available in these exchangers. However, as discussed above, there was significant margin in these exchangers due to lower than expected inlet temperatures.

Another area of concern in the design phase was erosion from the ash laden gas in the tubes of these heat exchangers. The increase in gas velocity to prevent pluggage increased the concerns for erosion damage. The inlet side of all six exchangers have "ferrules" that serve to direct the gas into the tubes and to protect the tubesheet and tube inlets. These ferrules are designed to be replaceable and are considered "sacrificial" in the sense that they are expected to erode over time and be replaced. Based on early results of inspections, we have estimated that the ferrules that are currently being used will last approximately 1 to 1 ½ years.

Another area of significant problems that have been experienced in the gas to gas exchangers has been with tube side corrosion. TEC has seen significant pitting damage in the tubes of all four stages of the gas to gas exchangers. This pitting damage has been determined to be a result of "down time" corrosion associated with chloride attack on the stainless steel heat exchanger tubes. As a temporary solution, TEC has taken steps to minimize the potential for continued attack by maintaining high temperatures in this area during plant shutdowns and by performing extensive cleaning procedures when cool down is required.

## 4. BLACK WATER SYSTEM OPERATION

Several issues concerning the operation of the Black Water system were resolved during the initial testing and start up of the unit. The key issues are discussed below;

A) The slag dewatering return line to the vacuum flash drum continually plugged during initial operation. The high content of slag remaining in the black water caused handling problems. To correct the situation the vacuum drum was bypassed and this portion of black water was sent directly to the gravity settler. The operation of the unit is only slightly affected. The primary concern is related to the higher levels of air/oxygen in the black water leading to advanced rates of corrosion in the piping and equipment. Tampa Electric continues to monitor the situation to insure adequate operation of the system.

B) In order to enhance the settling capability of the gravity settler, flocculent is added to the blackwater. Upon initial operation it was found additional flocculent was needed in the system. Additional injection points were installed at minimal cost and satisfactory operation was achieved.

C) Due to the higher than expected ash content and lower carbon conversion ratios, the black water system is running at maximum capacity. Any upset condition with the coal supply resulting in higher ash content can lead to a trip condition. An acceptable margin of 5% to 10% is needed to increase the reliability of the plant. Tampa Electric continues to evaluate solutions to this problem.

D) The actual velocities and flows being encountered in the black water system near control valves are leading to higher than expected erosion rates in the system. Tampa Electric expects to solve the problem by replacing affected areas with erosion resistant materials.

## 5. GREY WATER SYSTEM OPERATION

The grey water system operation is producing more grey water than the plant can use within the normal internal loops. Higher than expected purge flows are producing more black water than expected, in turn overloading the grey water system. The Plant currently recycles the additional grey water to the slurry preparation system to maintain the grey water inventory . This is only a temporary solution until a permanent fix is implemented to reduce/reuse the grey water.

## 6. BRINE SYSTEM OPERATION

The Brine system is part of the new technology being demonstrated at Polk Power Station. Tampa Electric is currently evaluating alternatives to resolve numerous problems in this system. Options being considered include replacing the existing brine unit with different technology versus increasing the capacity of the existing unit and remaining with the same technology.

Carryover into the falling film evaporator blowers is causing significant corrosion. Modifications are being made to the existing system to help minimize this problem. However, further major modifications may require including new compressors and inlet piping, along with an additional vapor separator.

Severe corrosion has been experienced in the forced circulation system. Metallurgy changes are underway that apprear to minimize this corrosion on the present fuel.

Major piping and control modifications are being made to the crystallization system to allow operability and availability of the system.

## HOT GAS CLEANUP STATUS REPORT

The HGCU system has been functionally checked out and is ready to proceed as described below. The change in schedule for the HGCU testing has not impacted the operation of the balance of the plant.

## 1. INLET EXPANSION JOINT

The inlet expansion joint failed during initial operation and was found to have had a fabrication problem and was partly due to the materials used. The material was upgraded and the repaired joint is on site. Installation is pending due to pluggage in the gas/gas exchanger, determination of the causes for the lower than expected syngas temperatures coming from the RSC, and a confirmed recommendation for a long term sorbent material.

## 2. CONTROL LOGIC PROBLEMS

During the testing of the sorbent transfer sequence prior to commencing the attrition test, the following problems occurred:

A) It was determined that the skip hoist was under sized based on the current logic that assumes two full loads to empty the regenerator sorbent lockhopper. In order to correct the problem the rotary feeder was calibrated to determine a speed versus flowrate curve which can be used to calculate the volume of sorbent transferred in a given amount of time.

B) There were mechanical problems with several valves and incorrect control logic for the pressurization and depressurization of the sorbent vessels. The valves will be repaired and the logic modified and tuned to assure the purges are properly completed.

C) The nuclear level switches need to be recalibrated, some were too sensitive and others not sensitive enough.

The Attrition test scheduled for 1996 has been postponed due to operational and control logic problems that were encountered during the sorbent transfer sequences as noted above. The attrition test will resume in 1997 pending resolution of the above mentioned problems.

## AIR SEPERATION UNIT

## 1. START-UP CONCERN - MAIN AIR COMPRESSOR

The start up of the Main Air Compressor (MAC) went smoothly with the exception of vibration levels higher than contract requirements for the MAC motor. The motor rotates at 1200 rpm and the contract required vibration to be 2.0 mils or less peak to peak. Data on the distributed control system (DCS) indicated vibration levels as high as 4 to 4.5 mils on the motor bearings. The motor was monitored for any change in vibration and the issue discussed with both Air Products and Chemicals, Inc. as well as the motor manufacturer GE - Canada.

With the vibration levels not meeting contract requirements, it was decided to remove the motor rotor and inspect for possible causes. Rotor straightness and pole face hardness testing was done which showed that the rotor had a bow of approximately 6 mils and there were significant differences in the pole face hardness readings. It was decided to rebalance the rotor to account for the bow and reinstall the rotor.

The machine was placed back into service and vibration readings were taken. The vibration levels after the balancing did meet the contract requirements and have been monitored since. The cost of the removal and balancing was covered as a warranty item and did not have any impact on project costs. An extended warranty for an additional seven years was requested and received from Air Products on the motor rotor.

## 2. AUXILIARY LOAD LEVELS

The auxiliary load of the ASU has a significant effect on overall plant heat rate and net output. The power consumption of the ASU is slightly more than design, but tuning of the advanced controls have reduced this amount some. The power consumption will be recorded as part of the ASU performance test to be conducted in early 1997.

## SULFURIC ACID PLANT

The Sulfuric Acid plant has worked well during the initial start up. Changes associated with the initial start up of the plant are detailed below.

## 1. LOW INLET SULFUR

The Pittsburgh #8 coal currently being burned is approximately 2.5% sulfur and the sulfuric acid plant is designed for a 3.5% sulfur coal. Analysis of the incoming coal has indicated than sulfur content is running slightly lower than 2.5% as well. The lower sulfur content of the coal forces the acid plant to run in a turned down mode which has operational implications. It was difficult at times during start-up and early operation to maintain proper temperatures in the converter and the decomposition furnace. Supplemental firing of propane was required to maintain temperatures in the equipment. The lower than designed sulfur content of the coal currently being burned has reduced the output of sulfuric acid generated as a by-product. It is anticipated that the sulfuric acid plant will be able to accommodate a 3.5% sulfur coal without any operational problems.

## SUPPORT FACILITIES

Immediately after gasifier start-up, raw syngas is routed from a point directly downstream of the syngas scrubbers through the raw gas flare valves. It then flows directly to the flare knockout (KO) drum where it was to bubble through a water pool which was to form a water seal, preventing air intrusion into the flare headers when the gas flow stopped. From the flare KO drum, it flows directly to the Flare. Soon thereafter in the start-up sequence, the syngas is routed downstream through low temperature gas cooling and acid gas removal. It is reheated in the Raw Gas/Clean Gas Exchanger and flows through the clean gas flare valve to a different part of the flare system. The flare KO drum, main flare header, and flare itself are only designed for 500°F, but the gas from the Raw Gas/Clean Gas Exchanger was expected to be 650°F. So first it is cooled with a direct water spray, then introduced into another water pool in the flare quench drum to assure it is sufficiently cooled in the event of failure of the water spray system and/or associated controls before entering the flare KO drum. Meanwhile, acid gas from acid gas removal and Ammonia Stripper off gas are being generated. These streams must be flared until the sulfuric acid plant is brought on line. These two streams flow through a separate acid gas flare header to the Flare KO Drum. The Ammonia Stripper off-gas is the last stream to be introduced into the acid plant, so it is flared the longest. Described below are design modifications that had to be implemented during the unit start up.

## 1. ACID GAS ABSORBER

Foaming in the Acid Gas Absorber was encountered. The foaming was determined to be in the Acid Gas Absorber due to the following: High Column Differential Pressure, Level indications in the Clean Gas Knockout Drum, and Poor $H_2S$ Absorption with Lean Amine. To correct the problem a defoamer injection system was implemented. Defoamer was added to the system to remove the foaming. Dose and continuous injection methods are being tried to find the appropriate technique to ensure amine tray froth without foaming. No noticeable foaming indicators have appeared in the Acid Gas Absorber since defoamer dosing and continuous addition testing were begun. The Clean Gas Knockout Drum has remained empty.

The initial system operated with an Activated Carbon Filter for amine cleaning but no defoamer addition. The addition of the defoamer injection caused the unit to have a more efficient running capacity since. Causes of foaming(other than hydrocarbons) could be found while the unit is still running. With the previous system(no defoamer addition) the system was protected against hydrocarbon and particulate foaming through filtration, but other nonfilterable agents could have caused foaming.

## 2. HIGH $H_2S$ LEVELS IN CLEAN SYNGAS

The percent of sulfur capture in AGR unit went down as high levels of Heat Stable Salts (HSS) were formed. This resulted in higher $H_2S$ levels in the clean syngas. Caustic dosing was implemented. The caustic dosing frees the MDEA from the Heat Stable Salts that form. Also, a mobile Amine Reclamation unit is being utilized on site to extract the Heat Stable Salts from the MDEA. A permanent hookup has been established within the AGR system for reclamation. This reclamation method can be utilized whether the AGR system is online or offline. The caustic addition allows us to extend the period before reclamation. Also, the amine is free to work at nearly full(i.e. 50% solution) strength. The MDEA reclamation removes the $H_2S$. This frees the amine once $H_2S$ content have become high enough to make the caustic addition treatment ineffectual in reducing system corrosivity.

Together the Caustic addition and the MDEA reclaiming increase the normal amine life and provide a cost effective way to retain previously amine purchased amine. Also, both implementations are used online, therefore the syngas would stay online during the amine cleaning.

The original system design required offsite amine reclaiming and purchase of fresh amine for refill to continue AGR operation. The AGR system would be taken offline during this process, therefore the syngas would be unclean and stay offline.

Polk's design for the sulfur removal system was based on Cool Water data, previously the largest Texaco IGCC plant utilizing Polk's general configuration. With the expected 99.5%+ $H_2S$ removal promised by solvent vendors and only 2.5% of the coal's sulfur in the form of COS, Polk could meet present and future emission requirements without removing any COS, so this became the plant's design basis.

Although, TEC can meet current emissions restrictions under these conditions with 2.5% sulfur coal, Polk is not producing the quality of fuel which GE expected for the turbine, and Polk may not be able to meet future emissions restrictions if these conditions persist, particularly with less expensive higher sulfur feedstocks.

TEC is making some minor piping modifications to maintain quality of our sulfur removal solvent and investigating the effects of operating parameters such as solvent to gas ratio, solvent introduction point into the Absorber, and solvent stripping rate to improve the $H_2S$ removal efficiency. Ultimately, however, the key to low sulfur emissions is the reduction or removal of COS. The Cool Water data upon which the Polk design was based was taken on four different coals, so there is a reasonable chance that the current high COS production from the Pittsburgh #8 coal being gasified at Polk is an anomaly. The alternate feedstock tests will hopefully show significantly less COS production. If not, concepts such as conventional COS hydrolysis, partial COS removal with modified amine solvents, or some other novel approaches to COS reduction and removal will be aggressively pursued. TEC will continue to update the DOE on any further modifications.

## 3. SLAG HANDLING MODIFICATIONS

The following table shows that although some aspects of the gasifier's performance at recent operating conditions approach "Design" values, they are far from "Commercially Expected" values.

**Slag Characteristics and Refractory Liner Life**

| | Recent Full Load Operation (Before Changes) | Design Value (Design Case) | Commercial Expectation (Normal Operating Case) |
|---|---|---|---|
| Slag Carbon Content (Weight % Dry Basis) | 34 | 28 | 14 |
| Slag Quantity (Dry Tons/Day) | 250 | 215 | 185 |
| Heating Value Lost To Slag (MMBTU/Hr HHV) | 70 | 50 | 20 |
| Refractory Liner Life (Years at 85% On-Stream Factor) | ¾ | 2 | 2 |

Carbon conversion can be increased at the expense of refractory liner life, and vice-versa, by adjusting gasifier temperature. However, as can be seen from the table, there is little available to sacrifice on either parameter. The higher than expected carbon content of the slag creates handling problems and makes it a less desirable byproduct for many applications. It also increases the mass and volume of the material we must handle, making our slag and fines handling areas extremely labor intensive. Furthermore, the heating value of the carbon lost with the slag increases net plant heat rate by 75 to 200 BTU/KWH. The current "start-up" gasifier refractory liner is less expensive with reduced slag resistance compared to the material we expect to use long-term. Our first liner replacement is scheduled for April, 1997. It will be a more slag-resistant material, so at current operating conditions, it may approach our commercial expectations of a 2 year liner life. However, feed injector adjustments to improve carbon conversion at less severe reactor conditions are still required for us to realize our commercial expectations for liner life, heat rate, and slag quantity/quality.

## 4. FLARE SYSTEM CHANGES

Changes made to the flare system are discussed below;

### A) Flare Drum Sizing / Water Carryover / Flooding

Both the Flare KO Drum and Quench Drum were not large enough to permit the gas to bubble through their water pools. Instead, the water literally blew out of the drums into the downstream equipment even at relatively low start-up rates. Water from the Flare Quench Drum blew into the Flare KO Drum. From there, the water from the KO Drum blew into the flare stack itself. Relatively small amounts of particulates and Acid Gas Removal Solvent carryover into the drums during early operation caused foaming in the drums and made carryover worse. We were concerned that pressure dynamics (water hammer) associated with the conveyor could mechanically damage the Flare Stack itself at a time when it was most needed.

To correct the problem an additional drum to accommodate excess water from the Flare KO Drum was added, the water removal piping was rerouted to permit more flow, and the flare system operating procedures were completely revised to use nitrogen purges instead of water pools in the drums to prevent air intrusion. Since the changes, dangerous situations due to excessive water in the Flare KO Drum have not occurred. TECO has thoroughly reviewed the revised operating procedures for the flare system, and are comfortable that they are adequate and safe. Nevertheless, TEC has commissioned a third party audit of the flare system and the associated operating procedures since the initial configuration was deficient and the new operating concept is dramatically different. It is possible that additional modifications will still be required. Results of this audit will be presented to DOE when it is complete.

### B) Acid Gas Flare Header

The Ammonia Stripper off gas flows with the MDEA acid gas to the Flare KO Drum through the Acid Gas Flare Header during start-up. Mixing the ammonia laden Ammonia Stripper off gas with the $CO_2$ rich acid gas formed salts which once plugged the uninsulated and untraced header, creating a potentially dangerous operating scenario.

A separate traced and insulated header will be installed from the Ammonia Stripper to the Flare KO Drum to prevent contact between the ammonia laden Stripper off gas and the $CO_2$ rich MDEA acid gas. In the mean time, occasional steam purges, heavy water flushes, and high stripper overhead operating temperatures have prevented recurrence of header plugging.

C) Ammonia Stripper Overhead Piping/Valve Sizing

The Ammonia Stripper overhead piping and valves were not sized to accommodate the ammonia in the stream, only the other minor components. Consequently, it was not possible to pass the full Stripper off gas flow to the Sulfuric Acid Plant or occasionally to the Flare without opening the control valve bypasses or lifting safety valves. Quality of the tracing of this piping was also questionable, and the overhead piping plugged with salts quite often. This also created a potentially dangerous operating scenario.

Properly sized and well traced and insulated valves and piping have been installed. The new piping and valves now comfortably handle the required flows at full rate.

## 5. SLURRY PREPARATION

The work in the slurry preparation area of the plant has focused primarily in two areas; (1) equipment problems associated mainly with the rod mills, and (2) performance issues associated with particle size distribution, fines and water recycle, and slurry viscosity.

A) Slurry Preparation Area Equipment Problems

The equipment in the slurry preparation area of the plant has performed relatively well with the exception of the rod mills which are used to grind the dry coal with water to produce a slurry suitable for pumping. During initial commissioning of the mills they exhibited unacceptable vibration. This problem was determined to be associated with the stiffness of the foundations under the rod mills (note: the mills are installed 30-40 feet above grade on concrete foundations). Additional concrete was added in two steps to eventually resolve the problem.

Another area of ongoing concern for the rod mills has been consistent leaking of the mill liner bolts. When these bolts leak, slurry builds up on the outer diameter of the mill and eventually spreads to the area and equipment surrounding the mills. TEC is still working with the mill OEM to resolve this problem. TEC has gone through several cycles of re-torquing and also double nutted all the mill liner bolts. These steps only work temporally and leaking resumes after a short amount of run time.

Other equipment problems that have been experienced in the slurry preparation area include the vibrating screens and the slurry transfer pumps. The screens experienced periodic plugging through early operation and were replaced with screens with a larger mesh opening. The slurry transfer pumps have experienced considerable wear and TEC is now trying pumps with modified clearances and liner materials.

B) Slurry Preparation Performance Issues

The performance issues associated with the slurry preparation area are primarily particle size distribution of the coal slurry from the rod mills and related pumping characteristics of the slurry. The particle size distribution of the slurry is a function of the rod charging in the mill. Rod mill motor amps are monitored to determine when to add rods and this has proven to produce consistently acceptable slurry. TEC has experienced some plugging in the slurry piping, however, this has been relatively minor. Routinely these lines are cleared after each use and don't generally experience any problems during operation. The slurry charge pump has performed extremely well with only some moderate wear of the check valve seats.

Other performance related parameters in the slurry preparation area involve the water used for feeding the rod mills and the effect of recycling carbon fines into the slurry. Both of these issues are being evaluated to determine the optimum operating configuration.

## 6. DISTRIBUTIVE CONTROL SYSTEM (DCS)

Discussed below are changes made to the DCS:

A) Data Historian

The original data historian archived control system data from the DCS to a DEC VAX. It functioned poorly and was difficult to use. Only one user at a time could use it effectively and needed to be VAX-literate. The data historian was replaced with the Oil Systems Inc. PI historian. The major value of the PI historian was its ease of use and that historic data could be trended anywhere on the Plant LAN. Making the data easily available and graphable to all station personnel speeded process problem identification, analysis and solution.

B) Control Processors

All Bailey DCS control modules (40 in all) were originally MFP02's. The nomenclature refers indirectly to the power, speed and price of the controllers, i.e. MFP02's are 'better' than MFP01's and MFP03's are 'better' than MFP02's. When the DCS was quoted, the control system design by engineering was just starting, so the controllers were 'sized' for the estimated amount of control logic plus some spare capacity. By the time the DCS was built and staged at the factory, the control logic from engineering had grown considerably and took nearly all the capacity of the MFP02's. By the end of the factory test prior to DCS shipment to the site, logic corrections and engineering changes and additions increased the loading on some of the MFP02's to the point where they were over-running. Over-running is a condition where the controller cannot finish performing all control logic within the assigned scan frequency.

C) Trends

Bailey Controls configured DCS trends to be their standard trend block which only has 30 minutes data capacity. Approx. 12 man weeks of effort was expended to change all standard trend blocks to enhanced trend blocks. Enhanced trends can hold a user selected number of data points, thus allowing plant operators to view trend data for hours to days depending on the enhanced trend block configuration.

This implementation has been so successful that operators always have the trend data they need in the time period they need to see it in.

D) Alarm state conversion

Most alarm contacts in the plant were designed as de-energized to alarm (0). The DCS was originally configured by engineering as energize to alarm (1). Over 1000 alarm states were discovered to be backward from actual field design during checkout. All were corrected on the DCS and are now working properly.

E) Alarm Management

The original configuration on the DCS had just short of 10,000 possible alarms that were possible. Only 1000 alarms at a time can be displayed on a Bailey console. The rest are discarded by the console. Even at 1000 alarms, it is not possible for an operator to pay appropriate attention to alarms that really deserve his/her attention. An alarm priority scheme was developed and implemented. Thousands of alarms were eliminated by moving the default values out of the way for Bailey analog block alarm limits for tags that were not supposed to alarm. The rest require an alarm by alarm review that has continued into 1997 and will probably continue through the end of 1997. The partial result so far is that the operator has far fewer nuisance alarms and can concentrate on the alarms that require their attention.

## D. PLANNING AND SCHEDULING

Nine start-up schedule milestones were developed from a plan that was originated on December 18, 1994. For twenty months the milestone dates remained the same and the project team was able to achieve all 9 milestones within 2 weeks of the schedule developed. Six of the nine milestones were completed within 5 days of the December schedule. This was accomplished even though the schedule had been compressed to shoot for a 1 month earlier completion date than the previous completion date of October 15, 1996. The milestones with their completion dates are listed below:

| | Schedule Date | Completion Date |
|---|---|---|
| Plant Energization | 01-Aug-95 | 27-Jul-96 |
| Utilities to ASU | 13-Nov-95 | 13-Nov-95 |
| Steam to ASU | 10-Jan-96 | 15-Jan-96 |
| First Coal | 13-Mar-96 | 29-Mar-96 |
| First Fire Gas Turbine | 9-Apr-96 | 20-Apr-96 |
| Steam Blows Complete | 30-Apr-96 | 20-Apr-96 |
| Roll Steam Turbine | 31-May-96 | 31-May-96 |
| First Syngas | 17-Jul-96 | 19-Jul-96 |
| Commercial Operation | 15-Sep-96 | 30-Sep-96 |

## E. Chronology Of Events

September 1994

The first start-up schedule was issued to the project for review on September 13, 1994, 8 months prior to mobilization of the start-up team. The schedule was developed at this time for two reasons: 1.) To provide a fully integrated logically tied EPC and start-up network, and 2.) To provide a start-up system turnover schedule that could be used to solicit lump sum bids from construction contractors.

December 1994

The start-up schedule completion date was accelerated from October 15, 1996 to September 15, 1996. Two weeks was taken out of the start-up schedule and two weeks out of the construction schedule. The first syngas date was moved from July 30 to July 17.

February 1995

The Power Scope of Work was awarded to H.B. Zachary. In the contract there were 68 start-up systems that had mechanical completion dates that had been derived from the start-up schedule. Liquidated damage figures were assigned to the turnover date of each system. H.B. Zachary provided start-up manual craft labor to perform start-up activities as identified on pages 31 to 35 of the Special Conditions Contract No. 22341-CP-012.

April 1995

The gasification scope of work was awarded to TIC- The Industrial Company. In the contract there were 54 start-up systems that had mechanical completion dates that had been derived from the start-up schedule. Liquidated damage figures were assigned to the turnover date of each system. TIC provided start-up manual craft labor to perform start-up activities as identified on pages 18 to 21 of Section IV of the Scope of Work Contract No. 22341-CP-011.

May 1995

Start-up mobilized to the site H.B. Zachary developed a detailed construction schedule and it replaced the CP-012 section of the schedule that was developed at the Houston office in December 1994.

June 1995

Zachary turned over the first start-up system to start-up. TIC developed a detailed construction schedule and it replaced the CP-011 section of the schedule that was developed at the Houston office in December 1994.

July 1995

Following Tampa Electric's completion of their Pebbledale Circuit, plant Energization of Substation SO (13.8 KV Buss A&B) was completed on July 27, 1995. Substation SO provided voltage distribution to 10 additional modular substations located throughout the plant.

September 1995

Schedule Change Notice (SCN) - 26 was issued to adjust the detail plan to accommodate a 2 to 3 month slip in steel and piping deliveries. Forty-seven system turnovers or 30 percent of the total number of start-up system turnovers were delayed anywhere from 1 to 20 weeks. The average delay was 3.5 weeks. Twelve systems (mostly utility systems) were split into subsystems in order to support the milestone dates.

December 1995

At the conclusion of 1995, start-up was 24 percent complete versus a scheduled 27 percent complete. Sixty system turnovers were received from construction versus 59 scheduled. Out of the 60 systems, start-up was able to energize 11 different substations, place in service the water plant consisting of 9 systems, and provide instrument air, cooling water and DCS communication to the Air Separation Unit.

January 1996

Zachary turned over the gas turbine system to start-up early. Start-up completed the lube oil flush and turned over the turbine to G.E. to perform the 2-3 spacer disk and combustor modifications.

February 1996

G.E. completed the 2-3 spacer disk and combustor modifications in 11 days.

March 1996

The first delivery of coal was accepted at the project site for testing of the coal unloading system. Air Products completed start-up and performance testing of the Air Separation Unit. The lump sum contract with H.B. Zachary to provide start-up craft support was converted to a time and material contract. The start-up work load began to increase significantly as 67 systems (42 percent of the total) are turned over to start-up during the months of March, April and May.

April 1996

The start-up team completed the lube oil flush on the steam turbine and completed first fire of the gas turbine on fuel oil.

May 1996

The start-up team completed steam blows of the main steam and hot and cold reheat systems. The initial roll of the steam turbine was completed. The remaining Zachary scope of start-up work was transferred over to TIC.

June 1996

The start-up team completed the first run of the coal grinding system and produced coal slurry. Vibration and amperage problems were identified with grinding mills A & B. The G.E. performance tests were conducted on fuel oil and exceeded the expectations of the project team.

July 1996

First syngas was accomplished on July 19, 1996, within 2 days of a schedule milestone that originated from a plan that was developed 19 months ago. The first run lasted 19 hours.

August 1996

The gasification plant operated for 8 runs for a combined total run time of 127 hours. The longest run was 67 hours. The plugging of the Steinmüller equipment in the east and west wing has been the leading problem contributing to the number of shutdowns of the plant.

September 1996

The gas turbine was operated on syngas for the first time on September 12, 1996. Tampa Electric officially went commercial on September 30, 1996.

October 1996

The combustion turbine reached full load on syngas on October 13, 1996.

## SECTION X

## TECHNICAL PAPERS, PRESENTATIONS AND AWARDS

## X. TECHNICAL PAPERS/CONFERENCE PRESENTATIONS/AWARDS

During 1996, 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.

September: Stephen D. Jenkins of TPS and Deputy Project Manager for the Polk Power IGCC Project, presented a paper on the "Tampa Electric Company Polk Power Station IGCC Project" at the Pittsburgh Coal Conference.

September: Donald E. Pless, Director of Advanced Technology for TPS and Project Manager for the Polk Power IGCC Project, gave a paper on "Status Update, Polk Power Station", to the Clean Coal Technology Conference in Denver, Colorado.

October: Charles R. Black, Vice-President, Project Management, Tampa Electric gave a paper on "Tampa Electric Company's Polk Power Station Construction Update to the Conference on New Power Generation Technology, sponsored by Electric Power Research Institute at the ANA Hotel in San Francisco, California.

Awards: Tampa Electric has received recognition from the following groups for the Polk Power Station:

Southeast Electric Exchange - Excellence in Engineering Award
Associated Builders and Contractors - Award of Excellence in Construction
Power Magazines - Power Plant of the Year Award
Hartford Insurance Co. - The Stag Award for Safety Excellence

## SECTION XI

## SUMMARY

## XI. SUMMARY

The emphasis during 1996 centered around start-up activities. At year's end the project was 100% complete. All major construction contractors were demobilized. All systems were checked, started and turned over to plant operations.

Safety performance on the project was outstanding and has helped keep the project participants focused on providing a safe work environment.

Major project participants on the Project included:

- Air Products and Chemicals, Inc.
- Aqua-Chem, Inc.
- Bailey Controls Company
- Bechtel Power Corporation
- General Electric Company
- General Electric Environmental Services, Inc.
- H.B. Zachry Co.
- Johnson Brothers Corporation
- MAN Gutehoffnungshütte AG
- Monsanto Enviro-Chem Systems, Inc.
- L&C Steinmüller GmbH
- Tampa Electric Company
- TECO Power Services, Inc.
- TEXACO
- The Industrial Company (TIC)
- Triconex Corporation
- U.S. Department of Energy - Morgantown

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

In closing, Tampa Electric is pleased with the progress made in 1996, and appreciates the support, contributions, and flexibility of our team members. We eagerly look forward to the shift from start-up to operations as we move into 1997. The hard work and dedication toward fulfilling project goals and objectives has resulted in a very successful completion and initial operation at Polk Power Station Unit No. 1.

# SECTION XII

## EXHIBITS

## XII. EXHIBITS

| | | |
|---|---|---|
| Exhibit A | - | Project Milestone Schedule |
| Exhibit B | - | Start-up Schedule |
| Exhibit C | - | Site Photographs, Aerials and Selected Photographs at Grade |

## EXHIBIT A

**Exhibit A**

# POLK POWER STATION UNIT NO. 1
# MILESTONE SCHEDULE ACHIEVEMENTS
# FOR THE PROJECT

| | |
|---|---|
| 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 |
| CT Combustion System Development Test Program complete | 01/95 |
| Air Separation Unit (ASU) Distillation Column delivery | 02/95 |
| Construction Contract for Power Block Mechanical/Electrical/Instrumentation Work awarded | 02/95 |
| Combustion Turbine delivery | 03/95 |
| Combustion Turbine Generator delivery | 03/95 |
| Delivery of GSU's | 03/95 |

## Exhibit A (Continued)

# POLK POWER STATION UNIT NO. 1 MILESTONE SCHEDULE ACHIEVEMENTS FOR THE PROJECT

| | |
|---|---|
| Delivery of last HRSG Modules | 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 | 04/95 |
| Construction Contract for Gasification Area Mechanical/Electrical/Instrumentation work awarded | 05/95 |
| Delivery of Convective Syngas Coolers | 05/95 |
| GEESI Detailed Engineering complete | 05/95 |
| DCS delivery | 06/95 |
| Radiant Syngas Cooler delivery | 06/95 |
| Bechtel Detailed Engineering complete | 06/95 |
| Construction of Coal Storage Silos complete | 08/95 |
| Cooling Reservoir Complete | 10/95 |
| Acid Plant | 01/96 |
| Complete Erection of HRSG Boiler | 02/96 |
| Complete Steam Turbine Installation | 02/96 |
| Complete Gasifier Refractory Installation | 06/96 |
| Complete Grading/Landscaping/Paving | 08/96 |

**EXHIBIT B**

## Exhibit B

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

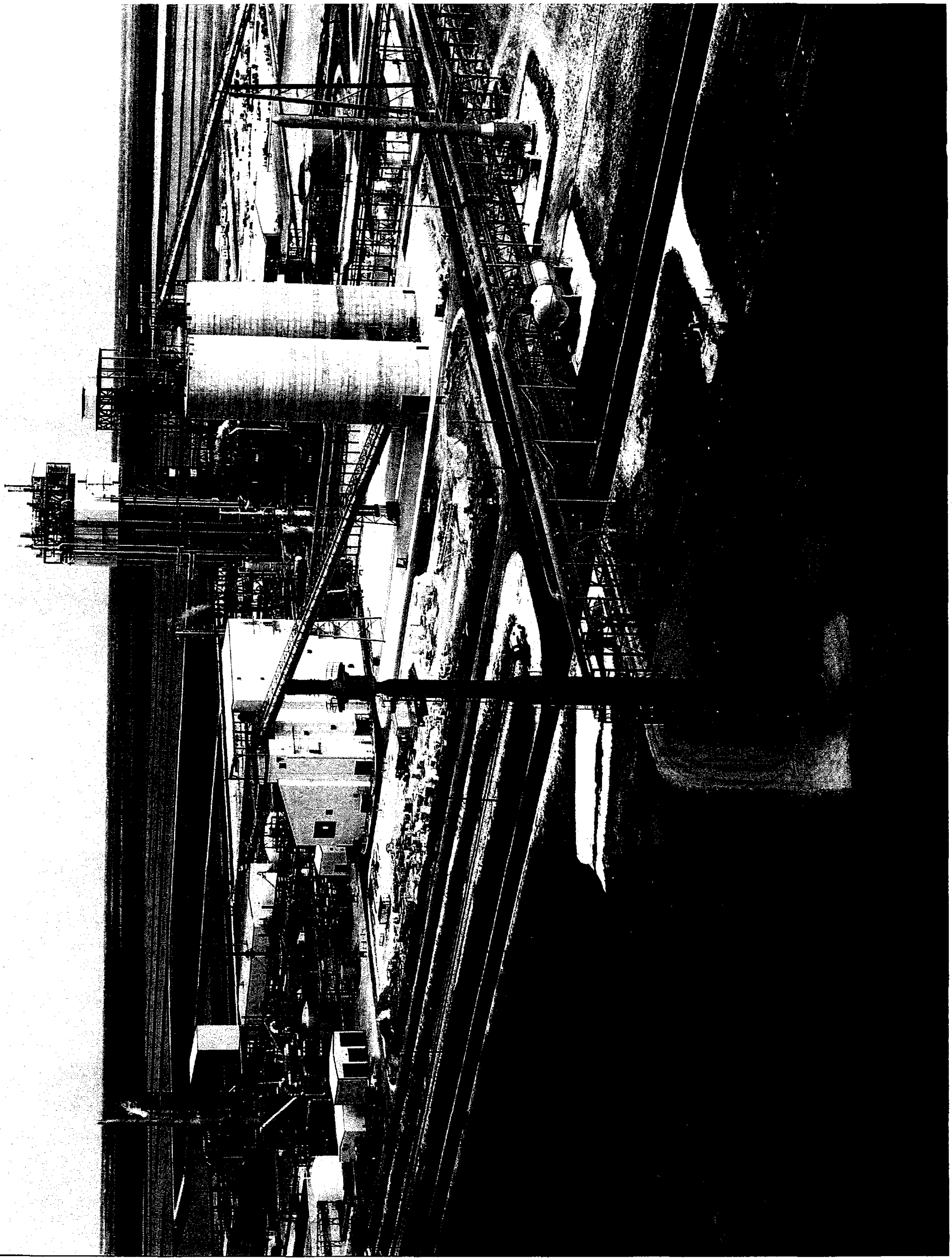
| | |
|---|---|
| DCS System installation and checkout complete | 07/95 |
| Energization of Substation S∅ (13.8KV Buss A & B | 07/95 |
| Place in services Closed Loop Cooling Water to Power Block | 12/95 |
| Place in service Demin Water System | 12/95 |
| Fuel Oil System available for unloading | 12/95 |
| Plant and Instrument Air Compressors placed in service | 12/95 |
| Place in service Open Loop Cooling Water System | 01/96 |
| Auxiliary Boiler available to produce plant steam to ASU | 01/96 |
| ASU checkout & performance tests complete | 03/96 |
| Coal Unloading/Conveying System available to receive first coal | 03/96 |
| First fire of Combustion Turbine on Fuel Oil | 04/96 |
| Circulating Water System for Power Block complete | 04/96 |
| Placed in service Closed Loop Cooling Water to Gasification Area | 04/96 |
| Placed in service Flare System | 05/96 |
| Steam Blows complete for Main Steam piping | 05/96 |
| Place in service Coal Grinding System | 05/96 |
| Initial roll of Steam Turbine | 05/96 |
| Place in service Slag Handling System | 05/96 |
| Firewater distribution & Detection complete | 05/96 |
| Place in service Sulfuric Acid Plant | 06/96 |
| Place in service Brine Concentration System | 07/96 |
| First Syngas from Gasification Plant to combustion Turbine | 07/96 |
| Hot Gas Clean Up System complete | 07/96 |
| Turnover to Plant Operations | 09/96 |

## Exhibit C

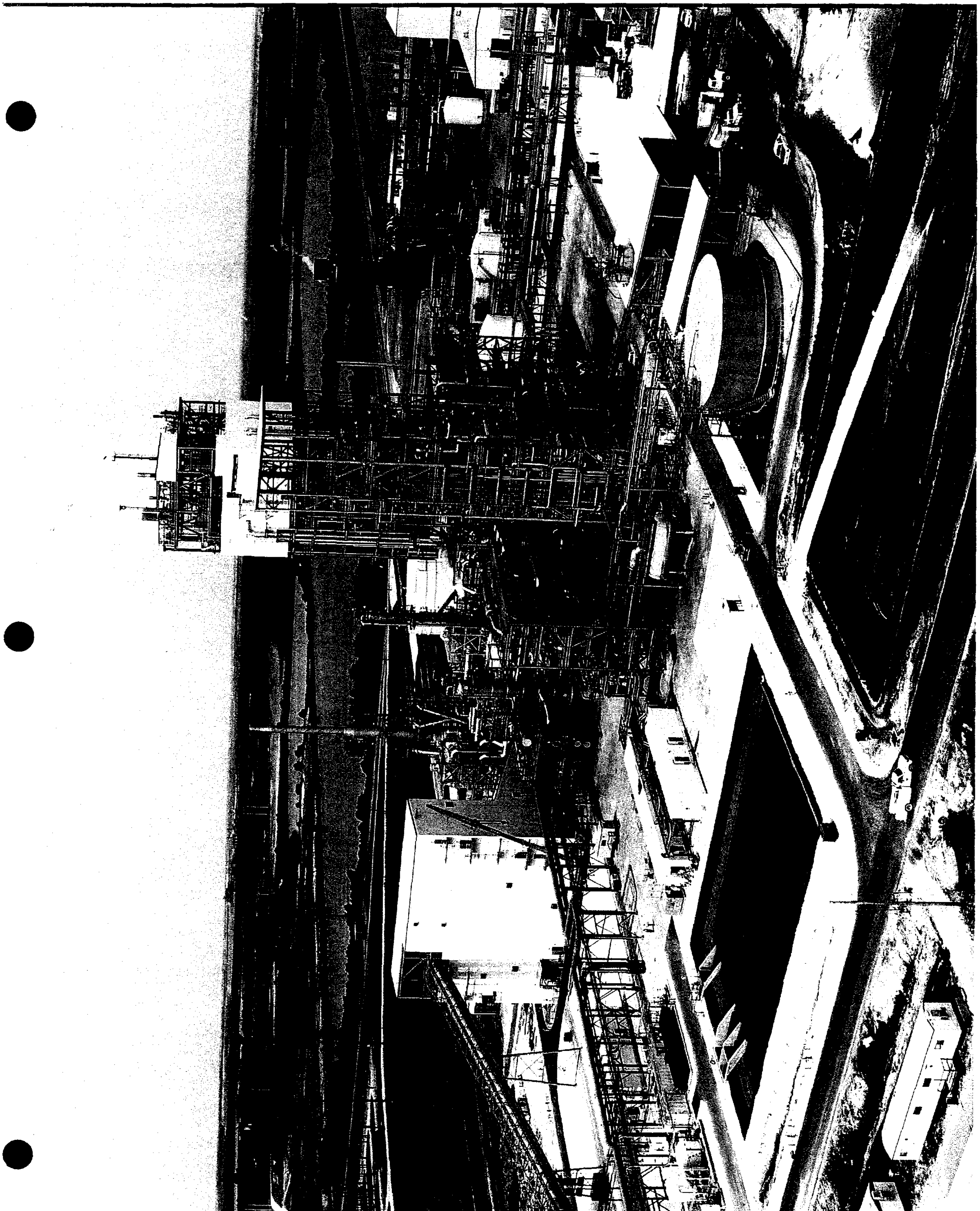
## SITE PHOTOGRAPHS, AERIALS

## AND

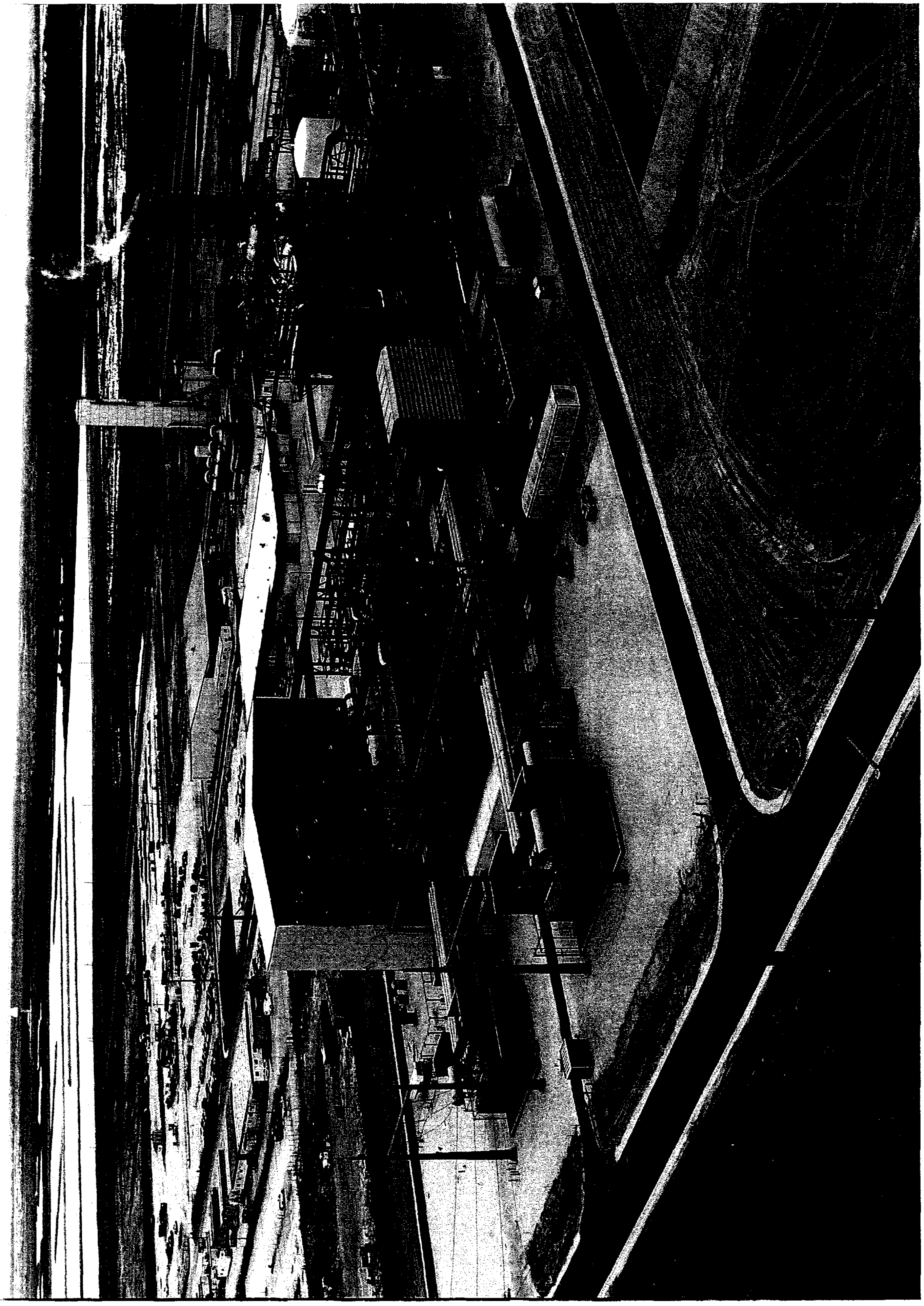
## SELECTED PHOTOGRAPHS AT GRADE



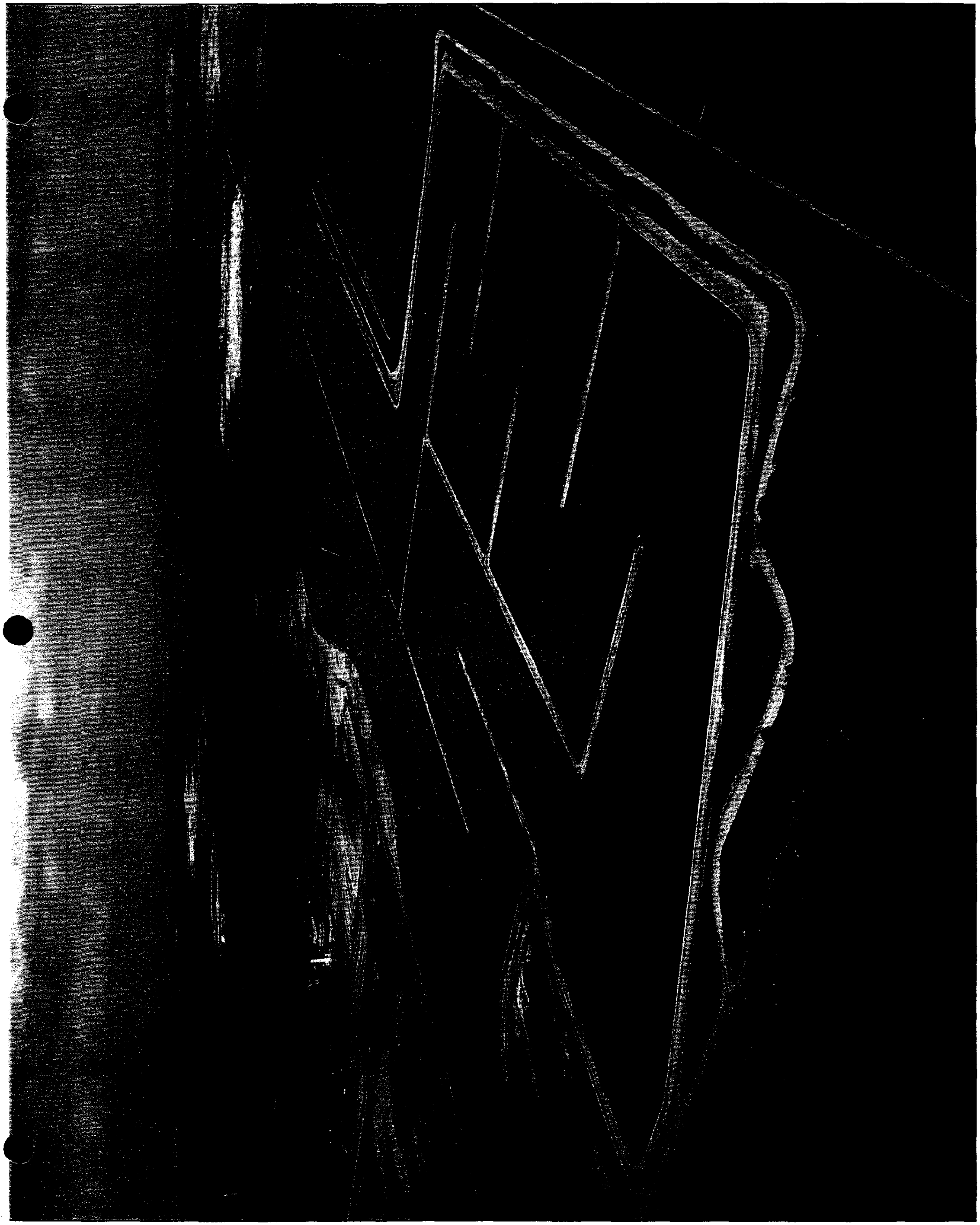
NORTHWEST VIEW OF PLANT



SOUTH VIEW OF GASIFICATION PLANT



NORTHEAST VIEW OF PLANT



VIEW OF PLANT COOLING RESERVOIR

RECLAIMED WETLAND AREA