BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In Re: Joint Petition for Determination of Need for an Electrical Power Plant in Volusia County by the Utilities Commission, City of New Smyrna Beach, Florida, and Duke Energy New Smyrna Beach Power Company Ltd., L.L.P.	)	DOCKET NO. 981042-EM FILED: SEPT. 28, 1998

DIRECT TESTIMONY

OF

KENNIE SANFORD, JR., P.E.

ON BEHALF OF

THE UTILITIES COMMISSION OF THE CITY OF NEW SMYRNA BEACH, FLORIDA

AND

DUKE ENERGY NEW SMYRNA BEACH POWER COMPANY LTD., L.L.P.

IN RE: JOINT PETITION FOR DETERMINATION OF NEED BY THE UTILITIES COMMISSION OF NEW SMYRNA BEACH AND DUKE ENERGY NEW SMYRNA BEACH POWER COMPANY, FPSC DOCKET NO. 981042-EM

DIRECT TESTIMONY OF KENNIE SANFORD, JR., P.E.

Q: Please state your name and business address.

A: My name is Kennie Sanford, Jr., and my business address is Duke/Fluor Daniel, Inc., One Fluor Daniel Drive, Sugar Land, Texas 77478.

Q: By whom are you employed and in what position?

A: I am employed by Duke/Fluor Daniel ("D/FD") as a Principal Electrical Engineer.

Q: Please describe your duties with Duke/Fluor Daniel.

A: I am responsible for the scope definition of electrical facilities to support proposals, sales, and permitting for electrical power plants. My duties and responsibilities include preparing electrical estimates, one-line diagrams, scope of work and estimate basis documents, layout of electrical equipment and substations, and preliminary electrical system analyses.

QUALIFICATIONS AND EXPERIENCE

Q: Please summarize your educational background and experience.

A: I have a Bachelor of Science degree in Mathematics and Physics from Stephen F. Austin State University and a

Bachelor of Science in Electrical Engineering degree from the University of Houston. I have completed many courses and training seminars, including training in protective relay applications, electrical system calculations, and computer applications.

Q: **What is your experience in power plant engineering, construction, operations, permitting, and licensing?**

A: I have 25 years of experience as an electrical engineer. My work experience has included preparing construction drawings, construction subcontracts, engineering and construction cost estimates, engineering schedules, specifications and protective relay coordination studies for electric power generation and power distribution for cogeneration, refinery, and petrochemical plants. In addition, I have field experience in startup of electrical systems for cogeneration facilities.

In my career, I have worked for Duke/Fluor Daniel, Inc. (1998-present), Fluor Daniel, Inc. (1996-1998), Kvaerner John Brown (1994-1996), Destec Engineering, Inc. (1986-1994), and Fluor Engineers, Inc. (1973-1986). My resume' is included as Exhibit ____ (KS-1) to my testimony.

Q: **Are you a registered professional engineer?**

A: Yes. I am a registered professional engineer in the State of Texas.

DIRECT TESTIMONY OF KENNIE SANFORD, JR., P.E.

SUMMARY AND PURPOSE OF TESTIMONY

Q: What is the purpose of your testimony?

A: I am testifying on behalf of the Utilities Commission of the City of New Smyrna Beach, Florida ("UCNSB"), and Duke Energy New Smyrna Beach Power Company Ltd., L.L.P. ("Duke New Smyrna"), the joint applicants for the Commission's determination of need for the New Smyrna Beach Power Project ("the Project"). My testimony describes the electrical system of the Project, including the major electrical system components, startup and standby power supplies, electrical design considerations, and systems control.

Q: What are your responsibilities with respect to the New Smyrna Beach Project that is the subject of this proceeding?

A: Duke/Fluor Daniel is the engineering, procurement, and construction ("EPC") contractor for the New Smyrna Beach Project. I am working on the Project as Principal Electrical Engineer with responsibility for preliminary electrical design of the Project.

Q: Please summarize your testimony.

A: The New Smyrna Beach Power Project includes a state-of-the-art 500 MW (nominal) combined cycle power plant using advanced combustion turbine technology and the electrical interconnection facilities that will connect the power plant to the Smyrna Substation of the UCNSB. The Project features high thermal efficiency (a heat rate of approximately 6,832 Btu per kWh based on the Higher Heating Value of natural gas) and low emissions. The Project also features proven electrical systems and technologies.

Q: Are you sponsoring any exhibits to your testimony?

A: Yes. I am sponsoring the following exhibits.

KS-1. Resume' of Kennie Sanford, Jr., P.E.

KS-2. Electrical One-Line Diagram of the New Smyrna Beach Power Project.

KS-3. New Smyrna Beach Power Project, Electrical Facilities Description, which includes an electrical system overview of the Project, descriptions of the major electrical components of the Project, description of the Project's startup and standby power supplies, listing of applicable electrical design considerations (codes and standards), and description of systems controls for the Project.

THE NEW SMYRNA BEACH POWER PROJECT

Q: Please give an overview of the electrical system of the New Smyrna Beach Power Project.

A: The New Smyrna Beach Power Project is a natural gas fired combined cycle generating unit consisting of two combustion turbine generators ("CTGs"), two heat recovery steam generators ("HRSGs"), one steam turbine generator ("STG"), and a cooling tower. The Project's rated output is 500 MW (nominal); its projected summer capacity is 476 MW and its projected winter capacity is 548 MW. A step-up transformer will be provided for each generator for a 115 kV connection to the Smyrna Substation owned by the UCNSB.

The overall electrical one-line diagram for the Project is included as Exhibit ______ (KS-2).

Q: Please summarize the major components of the electrical systems of the Project.

A: The major electrical system components include the following.

1. New 115 kV Take-off Towers.
2. New 115 Transmission Conductor.
3. New 115 kV Breaker Bays at the Smyrna Substation.
4. Main Generator Step Up Transformers.
5. Isolated Phase Bus System.
6. High Current Isolated Phase Generator Circuit Breakers.
7. Switchgear.
8. Plant Motor Control Centers.
9. 120 VAC UPS Inverter.
10. 125VDC Station Service Batteries with Chargers.
11. Generators.

Please refer to Section 2.1 of Exhibit ____ (KS-3) for a more detailed description of these major electrical system components.

Q: Please summarize the starting and emergency power supplies for the Project.

A: Normal starting of the Project's combustion turbine generators will be achieved by means of a load-commutating inverter adjustable frequency drive, which uses the generator as a synchronous motor for variable speed control during startup of the CTG system. Normal starting of the STG will be accomplished by controlling the input of steam to the STG.

The Project is not designed to have black start capability. Startup power will be provided by the generating plants of the Utilities Commission of New Smyrna Beach.

Standby power requirements will be supplied by a 500 kW diesel engine driven generator for backup to the UPS ("uninterruptible power supply") system and other critical loads.

Please refer to Section 2.2 of Exhibit ____ (KS-3) for a more detailed description of the startup and standby power supplies for the Project.

Q: Please summarize the electrical design considerations applicable to the New Smyrna Beach Power Project.

A: The electrical system of the Project will be designed in accordance with the applicable provisions of the following codes and standards.

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers (IEEE).
3. National Electrical Manufacturers Association (NEMA).
4. American Society for Testing and Materials (ASTM).
5. Insulated Cable Engineers Association (ICEA).
6. National Fire Protection Association (NFPA).
7. National Electrical Safety Code (NESC).
8. National Electrical Code (NEC).
9. Illuminating Engineering Society (IES).

Q: Please give a brief description of the control systems for the New Smyrna Beach Power Project.

A: The instrumentation and control systems for the New Smyrna Beach Power Project will be designed to provide state-of-the-art monitoring and control of the plant's operations. The control system will consist of a Distributed Control System ("DCS") with microprocessor based controllers, an operator console, and an engineering console.

The DCS will provide the main control functions of the plant. The various plant subsystems will be controlled from the operator console. Control of the generators will be performed by a packaged control system, which will enable the operator to perform setpoint and monitoring functions of the CTGs and STG. Local control equipment will enable the operator to perform the following functions: start, stop, raise and lower load, raise and lower vars, and duct burner control. The circuit breakers, transformers, and switchgear will be monitored and controlled by the DCS.

Please refer to Section 4 of Exhibit ____ (KS-3) for a more detailed description of the Project's control systems.

Q: Does this conclude your direct testimony?

A: Yes, it does.

Kennie Sanford, Jr
Principal Design Engineer

EDUCATION:
B.S., Mathematics and Physics, Stephen F. Austin
B.S., Electrical Engineering, University of Houston

PROFESSIONAL LICENSE/CERTIFICATE:
Registered Professional Engineer TX NO 51296

SUMMARY OF EXPERIENCE:

Electrical Engineer with 25 years of experience preparing construction drawings, construction subcontracts, engineering and construction cost estimates, engineering schedules, specifications, calculations, and protective relay coordination for electrical power generation, distribution, lighting, grounding, generator and motor controls, and instrumentation for cogeneration, refinery, and petrochemical plants. Also, experience preparing inquiries, purchase requisitions, and technical quotation summaries and also doing factory inspections for electrical equipment and material. In addition, field experience doing checkout and startup of electrical systems for cogeneration facilities.

INDUSTRIES/TECHNOLOGIES EXPERIENCE:

SIGNIFICANT EXPERIENCE:

FLUOR DANIEL, INC., Sugar Land, TX (1996 - Present)

PRINCIPAL ELECTRICAL ENGINEER

Chevron FEBPX, Chevron, Thailand, (1997 - Present)

Lead electrical engineer for the "Front End Engineering" work to establish a Lump Sum Turn Key (LSTK) contract for the detailed engineering, procurement, and construction of an aromatics plants, including a co-generation facility. Plant electrical load was estimated at 55MW. My work included preparing an estimate, developing the scope of work and one-line diagrams, layout of substations, and preliminary electrical system analysis.

Terminal Upgrade Project, Amoco, Trinidad, West Indies (1996 - 1997)

Lead electrical engineer for the replacement of the electrical facilities at an onshore crude oil processing terminal facility. My work included preparing an estimate, developing the scope of work and one-line diagrams, layout of new substations, and requisitioning of new equipment to replace the 15KV and 480V electrical distribution systems at the facility. Work also included replacement of the existing manual generator controls with new PLC automated controls.

Metaxylene No. 2 Unit, Amoco, Texas City, TX (1996 - 1997)

Engineer responsible for preparing the relay coordination, load flow analysis, and short circuit analysis, and short circuit analysis for a new process unit as well as the addition of a 25KVA, 138KV-13.8KV transformer and 145KV SF6 circuit breaker to an existing 138KV outdoor substation.

KVAERNER JOHN BROWN, Houston, TX (1994 - 1996)

PRINCIPAL ELECTRICAL ENGINEER

Lead electrical engineer for a new ethylene vinyl alcohol unit. My work included preparing an estimate, developing the scope of work, one-line diagrams, area classification, layout of new substations, and requisitioning of new 13.8KV-4.16KV transformer, new 13.8KV-480V transformer, switchgear, motor control centers, and variable speed drive-controllers for the facility.

DESTEC ENGINEERING, INC., Houston, TX (1986 - 1994)

LEAD ELECTRICAL ENGINEER

Lead electrical engineer for a 465MW cogeneration facility:
The major components of the facility consisted of (3) gas turbine/generator skids with HRB's, (1) steam turbine/generator system, and (1) utility furnished 52.5KV GIS. I prepared the generator and utility interface one-line diagrams to show relaying, metering, synchronizing schemes, and DCS interface for a Phase III engineering package.

Lead Electrical Engineer for a 424MW cogeneration facility:
The major components of the facility consisted of (3) gas turbine/generator skids, (1) steam turbine/generator system with 18KV generator breaker, (3) HRB's, (1) six bay cooling tower, water treatment system, and (3) lineups of 1500MVA, 15KV switchgear. I wrote specifications, assisted with equipment vendor selections, and checked vendor drawings. I supervised preparation of design drawings, relay coordination study, and short circuit, load flow and motor starting calculations. I spent ten months at the jobsite assisting with construction, checkout, and startup of the electrical systems, including preparing field test requirements for all equipment and generators, and evaluating construction change orders.

Lead electrical engineer for (3) 50MW congeneration facilities and associated produced water system:
The major components of each facility consisted of (2) gas turbine/generator skids, (2) HRB's and one prefabricated metal control building housing indoor electrical equipment. I issued the material requisitions for all electrical equipment, which was shop wired and shipped to the jobsite in a prefabricated building. I checked the relay coordination and the three line diagrams, prepared the short circuit and load flow studies, and assisted with checkout, startup, and utility pre-paralleling of the facilities.

FLUOR ENGINEERS, INC., Sugar Land, TX (1973 - 1986)

SENIOR ELECTRICAL ENGINEER

Standard Oil Chemical Co., Lima, Ohio (1986)

My work included revising and updating SOCC standards specifications for electric motors, electrical design and installation, prefabricated electrical equipment building, power transformers, low voltage switchgear, motor control centers, switchracks, instrument and power cable, neutral grounding resistors, uninterruptible power supplies, packaged equipment electrical requirements, electric heat tracing, cable tray, power conditioners, and automatic transfer switch; developing the inspection and testing procedure for existing electrical equipment to be used in a new service; requesting quotations for electrical equipment, preparing quotation summaries, and making technical recommendations for vendor selection; and preparing the electrical construction cost estimate

($2.7 million). The contract was postponed at approximately 20% of engineering completion.

Amoco Oil Co., Texas City, TX (1985)

I participated in the following: performing a field survey of instrumentation presently in operation, updating of process and instrument diagrams to reflect field survey, revising P&ID's to incorporate a Foxboro Distributed Control System, preparing an instrument index on the IBM PC (using Dbase III), and preparing specifications for differential transmitters, temperature transmitters, thermocouples, and RTD's, pressure switches, solenoid valves, current switches, transducers (I/P, I/I, & E/I), level controllers (pneumatic) and local indicators.

Texaco, Inc., Convent, LA (1983 - 1984)

Systems included: new 13.8KV, 1000MVA Main Substation No. 3 and 18 new area substations (4160V, 2400V, and 480V); tow 13.8K, 3000A distribution lines from the L.P.&L. Bagatelle Substation to Main Substation No. 3 to 23 new area substations (both offsites and onsites), modifications to existing Main Substation No. 2 and 8 existing area substations; one new 480V, 1050KW and one new 480V, 1200KW standby generator systems; one new control house designed for a distributed control system, modifications to add process computers to one existing control house, employee/gate house, addition to existing lab building, firehouse, tank farms, pipeways, blending and treating unit, loading docks, cooling towers, instrument air compressor, export fuel gas compressor, sour water disposal area, general waste water treating area, clarifier, flare, maintenance office, equipment storage room, Texaco office building, and electric heat tracing for piping in Pipeway 21. Total cost of the offsites portion of the project was $171 million.

Work included: preparing a feasibility and cost study for determining voltage distribution level for routing power from Louisiana Power and Light's substation to Texaco's Main Substation No. 3; preparing a feasibility and cost study to add capacitors at main Substation No. 3 for power factor correction; specifying, requisitioning, and inspecting switchgear, motor control centers, power transformers, switchracks, power cables, variable speed drive controllers, reactors, capacitors, electric heat tracing, and generators; preparing protective relay coordination study, short circuit calculations, motor starting calculations, cable derating calculations for cable installed underground, sag and tension calculations for overhead distribution lines, cable pulling calculations, and maximum allowable control circuit length calculations; preparing detailed estimate for engineering and material cost (electrical totaling $10.3 million); and reviewing and approving approximately 1100 electrical plan drawings, details, and wiring diagrams. I supervised (10) electrical engineers and (30) designers who performed the above listed work. Engineering was completed approximately (6) months ahead of the original schedule and within budget.

Gulf Science and Technology, Baytown, TX (1982)

My work included: writing specifications for electric motors, general electrical, electrical requirements for packaged mechanical equipment, and oil-immersed transformers; recommending limits for classifications of hazardous areas; and preparing the construction cost estimate. The project was postponed at approximately 10% engineering completion.

Shell Oil Co., Martinez, CA (1981 - 1982)

My work included: supervision of (5) electrical engineers who specified and requisitioned power transformers, bus duct, motor control centers, power and control cable, instrument cable, variable speed drive controllers, and UPS systems; preparation of detailed construction cost estimate (electrical totaling $6.0 million); checking vendor drawings, factory inspections for a 250KW, 480V steam turbine generator set, and (4) 50KVA, 120V, single phase output UPS's, reviewing and approving approximately 600 electrical plan drawings, details, and wiring diagrams; and calculating maximum allowable run length of 120VAC control wiring for remote control of 480V starters to confirm that no voltage drop problems existed for lengths less than 1700 feet. Engineering was completed on schedule and within budget.

Imperial Chemical Industries Americas, Inc., Baton Rouge, LA (1980)

The subprojects were: (a) a clarified water make-up system including the installation of two 40HP cooling water pumps (estimated electrical cost was $10,000); (b) the uprating of (4) existing 600VDC rectifier systems (estimated electrical cost was $650,000); and (c) the rehabilitation of a cell renewal building so that ICI cells could be renewed. My work included: preparing a work description for each subproject; preparing the electrical requirements for packaged equipment and 480V motor control centers; and specifying and requisitioning 480V outdoor starts, diodes and fuses for rectifiers, Halmar DC metering system, control panels, and motor control centers.

I was reassigned as the Lead Electrical Engineer for the upgrading of the existing chlorine production facility. Work included: reviewing engineering and design of a new 230KV substation (estimated cost of $4.1 million); approving design drawings for modification of bus duct (estimated cost of $0.5 million); checking and approving the 60,000 amperes shorting switches for use during change-out of ICI cells. Total indicated cost of the project was $34 million. The plant was sold by ICI after engineering completion. Construction was never started.

Arco/Polymers, Inc., Port Arthur, TX (1979)

My work included: revising and updating ARCO standard specifications for electrical motors, general electrical, electric grounding, instrument electrical, electrical testing and inspection, and outdoor power transformer; requisitioning electrical equipment and material; compiling office man-hour and construction cost estimates; reviewing and approving approximately (75) detailed design drawings for grounding, power, lighting, and instrumentation; and preparing detailed description of work for the electrical subcontract, then making technical recommendations for subcontractor selection. Electrical construction cost was approximately $900,000, including labor, equipment, and material. Engineering was completed on schedule and within budget.

ELECTRICAL ENGINEER

Cities Service Company, Lake Charles, LA (1978)

Electrical Engineer for the design and construction of a single train unit (K-Line) for a low density polyethylene plant. My work included: checking the one-line diagrams; preparing the electrical construction cost estimate (totaling $1.1 million for material and equipment, and $1.1 million for labor); and requisitioning the extruder driver, fly knife cutter motor, switchgear, motor control centers, transformers, and lighting panelboards.

National Petrochemical Co. of Iran, Bandar Shahpur, Iran (1978)

Electrical Engineer for preparing an electrical base engineering package for an NGL fractionation facility. My work included: writing specifications for hermetically sealed transformers, industrial and flameproof motors, high voltage switchgear, general electrical, 400V switchgear, neutral grounding resistor, generator control benchboard, UPS system, and electrical generators; prepared area classification recommendations based on IEC standards, and designed the electrical distribution system which included four 10000KW, 11KV gas turbine generators. Distribution level was recommended at 11KV with utilization voltages at 3.3KV and 380KV. System was designed using IEC standard voltage levels. All substations were double-ended for reliability to maintain operation of critical loads.

Marathon FCCU Addition, Garyville, LA (1977)

Electrical Engineer for checking the design of a 230KV substation of two 40MVA, 230-13.8KV transformers and a line-up of 13.8KV switchgear located inside a Powell power control room (PCR) type building.

Union Texas Petroleum, Rayne, LA (1977)

Lead Electrical Engineer for a $5.6 million expansion of an NGL fractionation facility. My work included reviewing the general electrical specification and 480V motor control center specification; writing specification for electrical requirements for packaged mechanical equipment; scheduling, requisitioning, expediting all electrical equipment and material (totaling $80,000); reviewing and approving approximately 50 electrical plans, details, schematics, and wiring diagrams; calculating load requirements for the new unit and recommending addition of 1500 KVA at 480V more capacity; compiling schedule for completion of design drawings; compiling engineering man-hour estimate and construction cost estimate; checking motor control schematics for motors ranging in size from 3HP to 200HP.

Arco/Polymers, Inc., Port Arthur, TX (1976 - 1977)

Lead Electrical Engineer for the design and construction of a high density polyethylene plant, HDPE-3 (totaling $34 million). Electrical system consisted of an incoming 69KV, 10MVA substation with a 4160V secondary and (3) 1000KVA, 4160 - 480/277V substations. My work include: reviewing ARCO specifications; revising the 4000HP extruder motor specification to ensure compatibility with a Werner-Pfleidereer extruder; writing and issuing specifications for a 69KV outdoor substation, cathodic construction estimate (totaling $2.1 million); preparing area classification study for approval by ARCO; technical evaluation subcontracts evaluating quotations and issuing purchase requisitions; preparing detailed description of work for electrical subcontracts and evaluating quotations and change orders; reviewing and approving approximately 275 electrical design drawings; factory inspections of all major equipment; calculating short circuits of system, performing relay coordination study, and tabulating relay settings.

My work at the jobsite included: performing checkout of all control circuits, performing run-in test of motors, and performing electrical functional check of the deluge and gas detection systems. Engineering and construction was completed on schedule and under budget.

ASSOCIATE ELECTRICAL ENGINEER

Union Carbide Corporation, Taft, LA (1975)

Electrical engineer acting as coordinator between design and engineering for the "Energy System" phase of the project. System included a 230KV overhead line looped throughout the plant with (4) main substations for stepping down to the utilization voltages of 2400V and 480V. My work included: reviewing the design of the 230KV substations (design by Commonwealth Associates); requisitioning transmission line material; checking all motor control schematics for process and utility pumps; checking approximately (15) 480KV one-line diagrams, and (4) overall plant distribution one-line diagrams; and checking vendor drawings.

ASSISTANT ELECTRICAL ENGINEER

Union Carbide Corporation, Taft, LA (1975)

Electrical Engineer for modification of the acrylics unit. My work included: specifying and requisitioning additional components for 480V starters for reuse in a new service; reviewing all electrical specifications and evaluating comments on specifications; and preparing the electrical estimate (project totaling $3.6 million).

St. Croix Petrochemical Co., St. Croix, Virgin Islands (1974)

Acting design supervisor for designing and drafting of connection diagrams for installing all process instruments, and performing field checkout of the electrical controls for the Erie City boilers at St. Croix.

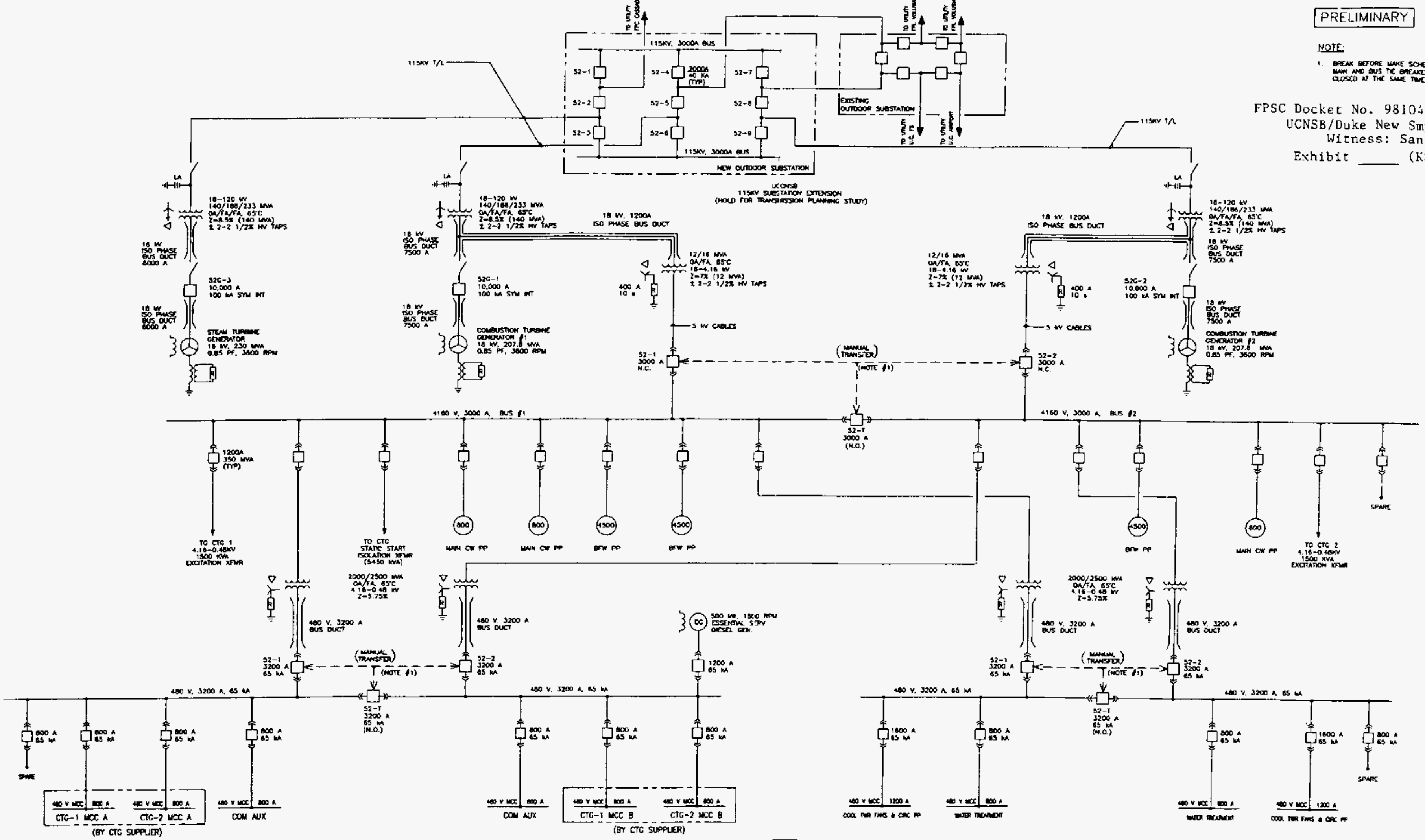
ELECTRICAL DESIGNER

St. Croix Petrochemical Co., St. Croix, Virgin Islands (1973 - 1974)

PRELIMINARY

NOTE:
1. BREAK BEFORE MAKE SCHEME. MAIN AND BUS TIE BREAKERS SHALL NOT BE CLOSED AT THE SAME TIME.

FPSC Docket No. 981042-EM
UCNSB/Duke New Smyrna
Witness: Sanford
Exhibit _____ (KS-2)



REV.	DATE	REVISION DESCRIPTION	CHK.
A	1/98	ISSUED FOR INT. REVIEW	DB
B	2/98	ISSUED FOR INFORMATION	DB
C	4/98	ISSUED FOR INFORMATION	DB
D	6/98	ADDED AUX. DIESEL GENERATOR	DB
E	7/98	UPDATED GEN. RATINGS PER REF. PLANT	DB

DUKE FLUOR DANIEL

POWER ENGINEERING • CONSTRUCTION • OPERATIONS & MAINTENANCE

NEW SMYRNA BEACH POWER PROJECT
OVERALL ONE LINE DIAGRAM

06877401-6-603A REV. E

CAD DRAWING No. 00603AE.DWG

*DATE*TIME* MANUAL CHANGES MADE - YES ☐ NO ☐ DWG. FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

NEW SMYRNA BEACH POWER PROJECT

Project Electrical Facilities Description

1 PROJECT ELECTRICAL SYSTEM OVERVIEW

The project is a natural gas fired combined cycle facility consisting of two (2) Combustion Turbine Generators (CTGs), two (2) Heat Recovery Steam Generators (HRSGs), one (1) Steam Turbine Generator (STG), and cooling towers with a nominal output of 500 MW (514 MW at ISO temperature and humidity conditions). Plant electrical generation will be at 18kV. A step-up transformer will be provided for each generator for connection to new 115 kV transmission lines. Three 115kV overhead transmission lines will connect the new power plant facility to the "Interconnection Point" at the load side of the 115kV New Smyrna Beach Substation. Additions, modifications, and/or upgrades to the existing transmission networks, are described in the Results of Power Flow Studies prepared by Resource Management International Inc., dated July 2, 1998.

2 ELECTRICAL SYSTEM DESCRIPTION

The electrical system for the facility as described below is required for operating and interconnecting of the CTGs and STG to the 115kV transmission grid.

2.1 Electrical System Major Components

- New 115kV Take-off Towers

  New 115kV take-off towers for the step-up transformers and disconnect switches will be installed next to the power plant. The main step-up transformers will be connected to the 115kV grid using 115kV disconnect switches and one take off tower located next to each transformer. New metering and relaying panels for the new plant switchyard will be housed in a new control building.

- New Overhead 115kV Transmission Lines.

  Approximately 150 feet of new overhead 115kV transmission line for each generator. The 115kV transmission line will be installed for interconnecting the generation unit step-up transformers with a new 115kV substation (furnished and installed by New Smyrna Beach Utilities Commission).

- New breaker bays at the new 115kV Utility Substation.

  New substation will consist of new breaker bays (breaker and half scheme) for each new 115kV transmission line, including surge arresters, bus support structures, and disconnect switches for connection to the existing 115kV transmission network. New metering and relaying panels for each new 115kV transmission line will be housed in a new substation relay room.

- Main Generator Step UP (GSU) Transformers.

  The main generator step-up transformers will be oil filled, two winding transformers each sized for the maximum output rating of each combustion turbine and steam turbine. GSU transformers will be provided with NLTC and surge arresters for each generator.

- Isolated phase bus (IPB) system.

  The IPB will connect each generator with the main step-up transformer, the generator circuit breaker (where applicable), the static frequency converter, and the auxiliary transformers.

- High Current Isolated Phase Generator Circuit Breakers

  Circuit breakers will be installed on all the CTGs and STG to allow for start up power to be back fed from the 115kV system through the GSU Transformer to the Station Auxiliary Transformers.

- Station Auxiliary Transformers with NLTC.

  Transformers rated 18-4.16kV will be connected to 5kV switchgear in a secondary-selective radial configuration.

- 5kV and 600V switchgear.

  5kV switchgear will provide auxiliary power to the CTGs and STG starting system, 4kV motors, and 4.16-48kV auxiliary transformers. 600V switchgear will provide auxiliary power to the 480V motor control centers, 460V motor loads, and miscellaneous low voltage power, lighting, and electric heat tracing loads.

- Plant unit 480V motor control centers ("MCCs").

  The CTGs and STG 480V MCCs will be supplied with the CTG and STG package. The plant unit 480V MCCs will be used to feed the balance of plant unit loads, i.e., water treatment loads, cooling tower loads, and other miscellaneous loads.

- 120VAC UPS Inverter feed from the unit 125VDC system.

  Each unit will be provided with one 120VASC UPS inverter feed from the unit 125 VDC system to provide reliable power to the DCS and other critical instrumentation and power supply loads. UPS power will be provided for all DCS components, CTG controllers, STG controllers, JRSG burner management system, CEM analyzers and all critical instrumentation. Provision for alternate power to the UPS will be included in the design. UPS malfunctions will be alarmed at the operator station.

- 125 VDC Station Service Batteries with redundant Battery Chargers.

  Each unit will be furnished with 125 VDC station batteries with two battery chargers to provide 125VDC power to the switchyard equipment, MV and LV circuit breakers, and provide battery power to the UPS inverters.

- Generators

  The combustion turbines and steam turbine will drive synchronous generators. Each generator will be hydrogen cooled. Controls, excitation systems, voltage regulators, metering, and protective relays for the generators will be integrated into the combustion and steam turbine packaged control equipment.

2.2 Starting Means for the Power Plant

2.2.1 Normal Starting of CTG Single Shaft Combined Cycle Unit

Normal starting of the CTG is by a Load-Commutating Inverter (LIC) adjustable frequency drive, which uses the generator as a synchronous motor for variable speed control during start of the CTG system. The LCI start system ramps the turbine to a self sustaining speed required for purge, light-off, waterwash, etc. One LCI inverter will be supplied for two CTGs, which will prohibit simultaneous starts of the CTGs.

2.2.2 Normal Starting of STG Unit.

The turbine governor contains all functions necessary for automatic run up from standstill to nominal speed, loading and operation. The steam control valves are equipped with hydraulic servo motors and are positioned via electro-hydraulic servo valves.

2.3 Black Start Capability

No black start capability is provided for this project. Standby power for start-up of the new power facility is assumed to be available from the UCNSB. Standby power for operation of controls and operations of equipment for maintenance and preservation systems during emergency shutdowns and extended downtime of the new power facility is assumed to be available from the UCNSB.

2.4 Emergency Power Requirements

A 500 kW diesel engine driven generator is furnished for standby power for backup to the UPS system and other critical loads. Standby power is required during an unsuccessful full load rejection, when the hot units come to a complete stop and heat must be removed from the hot areas of the turbines, such as bearings. Electrical loads include seal oil pumps, cooling lube pumps, and control loads. Power to these loads is normally provided by batteries and the UPS system.

3 ELECTRICAL DESIGN CONSIDERATIONS

3.1 The electric system will be designed per the applicable provisions of the following Codes and Standards:

- American National Standards Institute (ANSI)
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA)
- American Society for Testing and Materials (ASTM)
- Insulated Cable Engineers Association (ICEA)
- National Fire Protection Association (NFPA)
- National Electrical Safety Code (NESC)
- National Electrical Code (NEC)
- Illuminating Engineering Society (IES)

4 CONTROL SYSTEMS

4.1 **Scope**

4.2 The Instrumentation and Control systems will be designed to provide state of the art monitoring and control of the operation of the plant. Optimization of the control system for a high level of automation will provide all necessary process information and operational controls for start-up, normal operation and transient or shutdown conditions of the plant operations via CRTs in the control room.

4.3 The control system will consist of a Distributed Control System (DCS) with microprocessor base controllers, Operator Console and Engineering Console.

4.4 Field instrumentation will be standardized as much as possible as to type, manufacturer and model in order to simplify the plant design and reduce spare parts.

4.5 **Control of Subsystems**

4.5.1 The DCS will provide the main control functions of the plant. The DCS will also interface with mechanical equipment controllers to provide supervisory control functions and to obtain critical operations parameters for overall plant performance monitoring.

4.5.2 The various subsystems will be controlled from the operator console. The Operator console will consist of color CRT monitors, functional keyboards, alarm panels and alarm printers. Graphic and faceplate displays will be provided to enable the operator to have full visibility and control of the process. Alarm displays and alarm print-outs will be provided to alert the operator of plant disturbances and to maintain a historical log of these disturbances. In addition, the alarm printer will document all operator initiated changes.

4.5.3 Combustion Turbine/Steam Turbine Generator (CTGs and STG).

4.5.3.1 Control of the CTGs and STG will be performed by a vendor supplied packaged control system. The packaged control equipment will e located in an enclosure adjacent to the system. Primary control will be from the CTGs and STG packaged control equipment located at the operator console. From this station the operator will be able to perform setpoint and monitoring functions of the CTGs and STG. Local CTGs and STG packaged control equipment will provide local control capability.

- Start
- Stop
- Raise load
- Lower load
- Raise vars
- Lower vars
- Load hold
- Duct burner start permissive
- Start permissive
- Ready to start

4.5.3.2 Control via the DCS will consist of hardwired signals to and from the CTGs and STG controller. These signals typically consist of the following: The DCS will also be interfaced to the CTGs and STG packaged control equipment via a datalink to obtain all operating parameters of the system. These data will be displayed on the operator console and will also be used for performance monitoring, alarming, logging, trending, etc.

4.5.4 Electrical Systems control

Status of the 4160 volt breakers, transformers and selected switchyard signals will be monitored and controlled by the DCS. These signals will be hardwired to the DCS racks.