8.2 NETWORK INTERCONNECTION

8.2.1 DESIGN BASIS

The 500 kV switchyard is designed to be the interconnection point between the power plant and the 500 kV network. It is designed to function reliably under all conditions of power plant operation. It will furnish service startup power to the power plant, and reliably function and isolate trouble in the power system grid under power system normal and abnormal conditions (Figures 8-7 and 8-12).

Electrical power from the 500 kV network to the switchyard is supplied by three physically independent transmission lines designed and located to minimize the likelihood of their simultaneous failure under operating, postulated accident and postulated adverse environmental conditions. Three physically independent circuits from the switchyard to the onsite electrical distribution system are also provided. The switchyard is designed with duplicate and redundant systems - e.g., two battery systems, two trip coils per breaker, two protective relay schemes, and two auxiliary AC supplies from plant emergency busses.

Load flow and stability studies were performed when the plant was licensed to indicate that the tripping of one or both fully loaded Calvert Cliffs generating units would not impair the ability of the system to supply plant service. These studies were made at the projected peak load conditions and also at minimum load conditions when the two Calvert Cliffs units were supplying the entire Baltimore system. Simultaneous loss of the units at either load period did not overstress the ability of the planned transmission grid, either from a thermal or voltage standpoint, to supply power to the area and the plant. In addition, some major transmission circuits were assumed to be out of service at the time. The spinning reserve policy of the Pennsylvania-New Jersey-Maryland (PJM) Interconnection, of which we are a member, is to maintain enough reserve capacity synchronized to the system to cover the largest single contingency in PJM.

High-speed clearing of faults and selective reclosing assure maximum availability of power and system grid stability. Transient stability under fault conditions has been verified by a digital computer study which included the interconnected systems and analyzed for various contingencies, including the failure of a 500 kV breaker to trip under a fault condition.

8.2.2 DESCRIPTION AND OPERATION OF SWITCHYARD

The switchyard is shown in Figure 8-2. Major switchyard components are described in Table 8-1.

The switchyard operates at 500 kV and the equipment is selected to have the capability of isolating system and switchyard faults with a minimum effect on the stability of the power system grid.

The switchyard is arranged in a breaker-and-one-half, as well as double breaker arrangement. The switchyard has four bays, one with four breakers, two with three breakers, and one with two breakers and connections to the generator main power transformers, the three plant service transformers, and three 500 kV lines to the 500 kV network. Each line has sufficient capacity to carry the entire output of both turbine generators.

The switchyard 500 kV power circuit breakers, the circuits from the switchyard to the generator main power transformers, and from the switchyard to the plant service transformers, (P-13000-1 and P-13000-2), are provided with Hybrid Breakers with built-in disconnect switches to permit isolating any power circuit breaker or any circuit from the switchyard while allowing the 500 kV busses to remain tied together. The P-13000-3 service transformer has been provided with two sets of double breakers and disconnect switches to permit isolating any power circuit breaker or an circuit from the switchyard.

The 500 kV lines to the 500 kV network consist of three physically independent lines designed and located to minimize the likelihood of simultaneous failure under operating, postulated accident and postulated adverse environmental conditions.

Zone relaying is provided for the circuit from the switchyard to the generator main power transformers and for the two switchyard main busses. The main bus zones include the circuit from the switchyard to the plant service transformers. New relaying has been added to the circuit from the switchyard to the plant service transformers to monitor the circuit for the existence of an open phase condition. If an open phase condition is detected an alarm is initiated to the main Control Room annunciator system to alert the operators of the event.

Conservative margins have been allowed between the maximum expected fault duty and the rating of the equipment. Reliability is assured by the switchyard arrangement which utilizes a three bay breaker-and-one-half and a fourth bay double breakers scheme. With this scheme, any breaker may be removed from service without affecting switchyard operation.

All circuits or portions of the busses and overhead lines have primary and backup relaying. The outgoing lines have two sets of high-speed relays. The circuit breakers have dual trip coils on separate isolated DC control circuits, and breaker failure relays to trip the adjacent breakers.

8.2.3 DESCRIPTION AND OPERATION OF SWITCHYARD CONTROL SYSTEM

The 480/277 - 120 Volt AC power is supplied from two 4.16 kV/480-277 Volt, 500 kVA, three-phase transformers which are located in the switchyard. The service transformers are supplied by two isolated 4.16 kV feeders from the plant. These 4.16 kV feeders are supplied from separated emergency 4.16 kV busses in the plant (4.16 kV Unit Busses 11 and 21). Each of the switchyard power transformers supplies the 60 Hertz power requirements for the switchyard. The AC load is divided between two low voltage manual changeover power panels to allow for loss of one station power transformer.

The Asea Brown Boveri, Inc. (ABB) Type 550 gas circuit breakers are installed in the 500 kV switchyard. The ABB Type 550 gas circuit breaker is a motor- and spring-operated breaker that uses SF6 gas as the interrupting medium.

The 125 Volt DC auxiliary power is supplied from two 59-cell batteries which are located in the switchyard. Each can supply the switchyard DC power requirements for eight hours without recharging. Two battery chargers are supplied to keep the batteries fully charged and, under normal conditions, to supply the 125 Volt DC power requirement. A battery switch and fuse are used to isolate the battery from the DC power panels in the event of a battery fault. The power panels can then be energized by their respective battery chargers. Each battery charger is fed from a separate 480 Volt, 60 Hertz power panel. The DC load is divided between two power panels such that the loss of one power panel will not disrupt the 125 Volt DC auxiliary power feeds necessary to maintain switchyard operation.

The monitoring of battery charger operation and battery voltage for each battery system is provided by individual alarms in the switchyard control house plus a general alarm monitored in the plant Control Room.

Normal Operation - The switchyard normally operates energized with all breakers closed. Opening and closing of the breakers can be accomplished locally in the switchyard control house or remotely from the plant Control Room and a Human Machine Interface (HMI). Indicating lamps in the plant Control Room indicate circuit breaker status.

Testing - The power circuit breakers may be removed from service and tested. Individual components and partial circuit tests may be carried out while the circuit breakers are carrying load.

The relays are supplied with test switches that will permit the removal from service of one relay of the two independent sets of protective relays for maintenance.

8.2.4 DESCRIPTION AND OPERATION OF SMECO LINE

8.2.4.1 Design Basis

The SMECO power source has the capability to supply the power necessary to maintain Unit 1 and Unit 2 in a safe shutdown condition. The SMECO system can be used to energize 13 kV Service Bus 23 that then can be used to supply either 13 kV Bus 11 or 21 as required. Once 13 kV Service Bus 23 is energized from SMECO, it could then be held in this "ready" state as required. The switchyard power source will then be used to operate both Units 1 and 2 auxiliary loads. Upon loss of the switchyard power source, the SMECO system could then be used to supply any two 4.16 kV ESF busses, one for each Unit (Section 8.3.2), through either 13 kV Service Bus 11 or 21.

A manual Engineered Safety Feature Actuation System (ESFAS) LOCI and shutdown sequencer actuation is provided in the Control Room to ensure that the SMECO system is loaded in an orderly manner to minimize system transients.

8.2.4.2 Description and Operation

The SMECO system is shown on Figures 7-10 Sh. 1, 7-22 Sh. 1, 8-1, and 8-9. The SMECO System is also described in Table 8-1A. It consists of a single, direct buried cable from the SMECO substation to 13 kV Service Bus 23 via a manual load break switch which can be used to supply warehouse power during normal operation. When the SMECO line is used as one of the independent offsite circuits, the warehouse feed will be disconnected and 13 kV Service Bus 23 and either Bus 11 or 21 will be energized. The SMECO system will have a capability at all times of 5000 kW. Electrical indication is provided in the Control Room for bus voltage, bus current and power usage.

TABLE 8-1

RATINGS AND CONSTRUCTION OF MAJOR SWITCHYARD COMPONENTS

Breakers	-	500 kV nominal
	-	3,000 A continuous
	-	36,370 MVA interrupting
Insulators	-	1,800 kV BIL
Main Bus	-	2,500 A
Bay Bus	-	2,500 A
Disconnect Switches	-	3,000 A continuous
	-	70,000 A momentary

TABLE 8-1A

RATINGS AND CONSTRUCTION OF SMECO SYSTEM

SMECO	-	5000 kW, 69/13.2 kV, regulated to 13.8kV within ± 5% voltage variation, 3-phase, 60 Hz, 328A continuous
Cable	-	500 MCM, N-TRIPLEX, Kerite, 15 kV direct burial (from SMECO STA to WHSE)
	-	750 MCM, CU TRIPLEX, Kerite (from WHSE to Bus 23)
Load Break Switch	-	13.8 kV nominal, 200 Amp, 300 MVA interrupting, manually operated