UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 117 TO FACILITY OPERATING LICENSE NO. NPF-62

ILLINOIS POWER COMPANY

CLINTON POWER STATION, UNIT 1

DOCKET NO. 50-461

1.0 INTRODUCTION

In 1997, the licensee determined that as a result of load growth, the voltages on the offsite power sources could not be maintained above the minimum required value assuming a LOCA and unit trip with certain grid conditions. By letter dated May 4, 1998, Illinois Power (licensee)proposed to install one Static VAR Compensator (SVC) to the secondary (4.16 kV) side of the reserve auxiliary transformer (RAT) and the other SVC to the secondary (4.16 kV) side of the emergency reserve auxiliary transformer (ERAT) to correct this voltage condition. The RAT is associated with the offsite 345 kV transmission system, and the ERAT is associated with the offsite 138 kV transmission system. These two transmission systems constitute the two required offsite electrical power sources for the plant. In addition, the licensee also proposed to incorporate SVC protection system requirements under a new technical specification.

A supplemental letter dated September 23, 1998, was submitted that discussed the proposed preoperational testing of the SVCs. In that letter, there was a small editorial change to the proposed technical specification basis. This change was clarifying and did not significantly change the requested amendment or affect the staff's proposed finding of no significant hazards consideration determination.

2.0 EVALUATION

The licensee has proposed to install an SVC to the secondary (4.16 kV side) of the RAT, and another SVC to the secondary (4.16 kV side) of the ERAT to address the grid voltage problem. The SVCs are manufactured by Asea Brown Boveri (ABB). Each SVC is equipped with an internal control and protection system; however, at Clinton each SVC is also equipped with an additional (or enhanced) protection capability. The enhanced protection capability is achieved by providing each SVC with two independent and redundant subsystems which will ensure that the Class 1E buses will be adequately protected against failures of SVCs. Due to the critical role of the SVC protection system in protecting the Class 1E 4.16 kV buses, the licensee has proposed a new technical specification for incorporation into the Clinton Technical Specifications.

2.1 Static VAR Compensator

Thyristor controlled technology using SVCs is used for voltage control. SVCs are equipped with a control and protection system that includes a programmable high speed controller, thyristor monitoring circuit that provides protection for the SVC. Each SVC is rated at +28.5/-14.0 MVAR and includes a Thyristor Controlled Reactor (TCR) bank rated at 21.5 MVAR, a Thyristor Switched Capacitor (TSC) bank rated at 21.0 MVAR, and a Harmonic Filter Capacitor (FC) bank rated at 7.5 MVAR. The FC is always connected to the 4.16 kV bus and provides a capacitive 7.5 MVAR supply boosting the 4.16 kV bus voltage. If the boost provided by the FC bank raised the 4.16 kV voltage beyond its preset voltage operating point, the voltage is lowered by inserting the required inductive reactance from the TCR bank. When the 4.16 kV voltage dips below the capability of the FC bank, the TSC is inserted into the system to maintain the required voltage. The SVCs are designed to keep the voltages at preset values at their respective 4.16 kV buses by raising (adding capacitive reactance), or lowering (adding inductive reactance) the voltages, as required.

The TCR bank is a three phase, delta connected system consisting of four thyristors in series per phase. The TSC bank is a three phase, delta connected system consisting of five thyristors in series per phase. Firing pulses for the thyristors for the TCR bank or the TSC bank are sent from the SVC control, programmable high speed controller and the associated electronics via fiber optic links to the thyristor electronic unit which converts the light signal to electric pulses that are used to trigger the thyristor.

2.1.1 SVC Internal Control and Protection System

The SVCs are equipped with a control and protection system that includes a programmable high speed controller (PHSC), and valve control system. The PHSC provides the control and protection features. The valve control system links the PHSC to the thyristor valves. The SVC PHSC internal protection system protects the TSC, TCR and the filter capacitors and trips the SVC output breakers for PHSC, TCR, TSC, and FC branch failures. The PHSC provides the first line of defense for the SVC and minimizes the impact of SVC failures on the 4.16 kV system. On detection of a fault due to overcurrent (instantaneous and inverse time), voltage, thyristor failure or PHSC failure, the PHSC sends a trip signal to both trip coils of each SVC output breaker via lockout relays.

The PHSC monitors the following parameters:

- TSC - line current, valve current, and capacitor unbalanced current
- TCR - line current, and valve current
- Transformer current
- SVC - output current, output voltage, and output breaker position

- 4.16 kV buses breaker positions
- EDG breaker position, EDG synch switch "ON" position
- Control signal to start and stop the SVC from the control room
- Plant protective relay trips

The PHSC utilizes these inputs to control the 4.16 kV bus voltage at the specified set point, to control SVC operation for parallel power source conditions, to provide a controlled startup, shutdown, and trips the SVC output breakers for PHSC, TCR, TSC and FC branch failures. The PHSC controls the SVC output voltage by determining the firing angle for the TCR and determining when the TSC thyristors should be on or off. This is accomplished by comparing the bus voltage to a set point contained in the central processor. The error signal from this comparison is used to determine the firing angle for the TCR thyristor and whether the TSC thyristor should be on or off.

2.1.2 DC and AC Power Distribution Systems

The dc power system for the SVC PHSC internal protection system and the SVC protection subsystems is composed of two independent "A" and "B" 48 Vdc subsystems. Each dc power system is designed to carry the total dc load for at least 8 hours, following a loss of ac power. Therefore, the SVC will continue to operate with the loss of a battery system or loss of ac power supply. There are no normal electrical connections between the two batteries during normal operation. However, these two batteries can manually be connected under emergency conditions. Each 48 Vdc system also provides power for Binary Inputs and 48V to 24 Vdc power supplies for the operation of the SVC PHSC. The output of the power supplies for the SVC PHSC are auctioneered. The dedicated battery charger for each of the 48 Vdc subsystems ensures that the battery has sufficient capacity to carry the load.

There are two 480 V, three phase power sources for each SVC PHSC system; one is the normal source, and the other serves as the backup source. The normal source is a dedicated 75 kVA, 4.16kV/480V transformer connected to the SVC non-Class 1E 4.16 kV bus and the backup source is from a non-Class 1E 480 V MCC off the plant electrical distribution system.

2.1.3 Disconnect Switch and Output Breakers for SVC

The SVC from the ERAT or RAT transformer can be disconnected by a manual 4,000 ampere disconnect switch. Each SVC is provided with two circuit breakers connected in series and each breaker is rated for 4,000 ampere continuously and 63 kA interrupting. Each circuit breaker has two trip coils. One trip coil is connected to battery system A and the other trip coil is connected to battery system B. Each protection system sends a trip signal to both circuit breakers. The circuit breakers are also provided with a device that will trip the circuit breakers on loss of dc power. The two power circuit breakers connected in series with each SVC will provide adequate isolation on the failure of the SVC and will not result in the degradation of the Class 1E system.

2.1.4 TCR Harmonics

The TCR generates odd harmonics depending on the firing angle of the thyristor valve. The TCR is connected in delta configuration and, therefore, harmonics of zero sequence characteristics, i.e., 3rd, 9th, 15th, etc., will circulate in the delta and will not be seen on the 4.16 kV bus. The 5th and 7th harmonic are filtered by the harmonic filter bank. The harmonic filter bank is designed to limit the THD that will be seen on the 4.16 kV bus. The licensee has performed a harmonic analysis to demonstrate that the SVC meets the recommendation presented in IEEE Std. 519-1992, "Recommended Practice and Requirements for Harmonic Control in Electrical Power System." The limits on total harmonic distortion are 5% for both voltage and current. The harmonic analysis indicates that both the RAT and ERAT SVCs meet this requirement.

2.2 Enhanced Protection System

Besides the control and protective functions provided by PHSC for each SVC, backup protection is provided by an enhanced protection system called SVC Protection Subsystem (SVCPS) to protect the 4.16 kV system from SVC failures. The SVCPS is equipped with two independent protection subsystems "A" and "B" consisting of two redundant subsystems for each SVC, either of which will isolate the SVC from the bus in response to postulated SVC failure. The SVCPS is comprised of two sets ("A" and "B") of protective relays. Each of the subsystems (powered by a battery associated with the subsystem) has relays to detect overcurrent, negative sequence, undervoltage, overvoltage, phase unbalance and harmonics and energizes an independent lockout relay and trip both breakers. Therefore, each breaker will receive two independent trip signals. One trip signal to the subsystem A trip coil and another trip signal to the subsystem B trip coil. For each SVC, the protection subsystem interface with the control system to protect the Class 1E safety buses from any SVC fault condition that could potentially damage the buses.

2.3 Proposed New Technical Specification for the SVCs

Since the SVC protection system is protecting the Class 1E 4.16 kV buses and equipment, the licensee proposed a new Technical Specification 3.8.11, "Static VAR Compensator (SVC) Protection Systems." The proposed changes to incorporate Limiting Condition for Operation (LCO), and surveillance requirements for the SVC protection systems ensures that the protection systems will be maintained operable as required and that appropriate action is taken in the event one or both subsystems of an SVC protection system (for an in service SVC) are determined to be inoperable. Proposed LCO 3.8.11 and its applicability would require both subsystems of an SVC protection system to be Operable whenever the associated SVC is in service. The licensee has proposed Required Actions for when one protection subsystem of a required SVC protection system is inoperable, and for when both protection subsystems of a required SVC protection system are inoperable. A Completion Time of 30 days (Condition "A") is proposed for the former and a Completion Time of 24 hours (Condition "B") to restore one SVC protection subsystem to Operable status is proposed for the latter. With either of these Required Actions not met within its required Completion Time, proposed Condition "C" is entered, wherein the associated SVC output breaker(s) must be opened to remove the SVC from service within one hour. The Completion Time of one hour permits disconnecting the SVC including assessing the impact of removing the SVC from service with respect to the offsite source(s) and its capability to provide proper voltage. The Surveillance Requirements proposed for the SVC protection system are based on the vendor's recommendations, and consideration of testing requirements for similar components/equipment. SR 3.8.11.1 is a daily system status check to ensure that the SVC protection systems are in service and identify any alarm or trouble conditions. SR 3.8.11.2 would be required to be performed at least once per 18 months consistent with other Technical Specification Surveillance Requirements for such kind of tests. The licensee has also provided the Bases in the Technical Specifications for the new SVC Protection System.

The Technical Specification Bases Sections 3.8.1 and 3.8.2 have been revised to include the use of SVCs. The licensee developed a predictor computer model which would assure adequate voltages at the Class 1E 4.16 kV buses in the event of a LOCA and unit trip. The licensee plans to use the model to assess the operability of the offsite source(s) when the associated SVC(s) is removed from service. If an offsite power source was determined to be inoperable (with an SVC removed from service), the Required Action of 3.8.1 or 3.8.2 would then apply.

2.4 Steady State, and Transient Load Flow Analyses

The licensee is performing additional steady state load flow analysis and the load flow analysis will verify that the SVC is capable of maintaining the voltage within acceptable range. The RAT SVC and ERAT SVC provide steady state, dynamic and transient voltage support to ensure that the Class 1E loads will operate as required during anticipated and postulated events. The licensee is performing a detailed short circuit analysis with the SVC to insure that all equipment is operating within allowable and interrupting rating for short circuit currents.

2.5 Failure Analysis

The licensee performed the Failure Mode and Effect Analysis and determined that the internal SVC PHSC protection system along with the two SVC subsystems "A" and "B" (enhanced SVC protection system) are designed to detect and mitigate the impacts of failures independently of each other. A failure in one system will not prevent the other system from detecting the failure and tripping the SVC. The analysis indicated that no single failure of a component due to overvoltage, undervoltage, harmonics, short circuit or overload will prevent the SVC from being disconnected from the Class 1E 4.16 kV system.

2.6 Preoperational Tests

Numerous preoperational tests will be performed on the SVCs. Many will be performed with the SVCs not connected to the plant electrical buses. Prior to performance of the integrated test for each SVC, where the SVCs will be connected to the plant electrical buses, an initial energization test will be conducted with the SVCs not connected to the plant buses. The testing will be done in accordance with vendor recommendations and the test parameters will not be outside the SVCs design capability. These tests are necessary to show acceptable SVC performance and will be performed prior to startup of the plant.

3.0 FINDINGS

We have evaluated the licensee's submittal and determined the following:

- The proposed SVC installation would improve the voltages during degraded grid conditions at the Class 1E 4.16 kV safety buses. The addition of the SVCs will help to maintain voltages at the site for both offsite electrical power sources consistent with the 'capacity and capability" requirements of GDC 17. Tripping of the SVCs in response to an SVC failure or abnormal condition does not result in a loss of power from the offsite sources, however, tripping of the SVC may result in an offsite source becoming inoperable. This is described in the Technical Specification bases for 3.8.1 and 3.8.2 regarding offsite sources.

- The regulating effect of the SVCs will support the voltage when the plant trips during normal or accident conditions. This minimizes the probability of losing electric power from the offsite supplies as a result of the loss of power generated by the nuclear unit in accordance to the requirement of GDC 17.

- The two power circuit breakers connected in series with each SVC and the associated SVC protection systems will provide adequate isolation and prevent failure of an SVC causing degradation of the Class 1E system.

- The proposed change to incorporate LCO and surveillance requirements for the SVC protection systems into the Technical Specifications ensures that the protection systems will be maintained Operable as required and that appropriate action is taken in the event one or both subsystems of an SVC protection system are determined to be inoperable.

Based on the above, we conclude that the proposed changes are acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an Environmental Assessment and Finding of No Significant Impact has been prepared and published in the Federal Register on August 13, 1998 (63 FR 43435). Accordingly, based upon the Environmental Assessment, the Commission has determined that the issuance of this amendment will not have a significant effect on the quality of the human environment.

6.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

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