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

ENCLOSURE 1

SAFETY EVALUATION OF THE REQUEST TO OPERATE THE SHOREHAM NUCLEAR POWER STATION AT 25 PERCENT POWER SYSTEM AND PROCEDURES FOR ACCIDENT MITIGATION

1.0 INTRODUCTION

To support its request for authorization to operate the Shoreham Nuclear Power Station at 25 percent power, LILCO submitted an analysis to demonstrate that risk and consequences of accidents at 25 percent power are reduced compared with the full power operation. In the analysis, LILCO is taking credit for several physical and procedural modifications which had not been analyzed when the 5 percent power license was i[illegible]ed in July 1985. In this Safety Evaluation, the staff examines th[illegible]ceptability of these hardware and procedural modifications taken credit for in LILCO's analysis.

2.0 EVALUATION

2.1 Principal Characteristics Identified for 25 Percent Power Operation

For 25 percent power operation, the fission product inventory in the core will be less than the inventory that w[illegible]ld be obtained by 10C percent power operation. The fuel burn-up during the low-power operation also will be less than that for 100 percent power operation. This low fuel burn-up reduces the amount of radioactivity that could be released upon fuel failure.

One factor contributing to larger safety margin during low-power operation is the increased time available for preventive or mitigating action should such action be deemed desirable by the operator. Longer time is available because the limited power levels means that it takes longer for the plant to reach setpoints and limits. One example is the main steam isolation valve closure event. At twenty five percent power, the amount of heat produced upon isolation of the reactor vessel (which is followed by a reactor trip) results in a slower pressure and temperature increase than would be experienced at 100 percent power. This gives the operator more time to manually initiate reactor cooling before automatic action occurs. In effect, the operator may end the transient before there is any substantial impact on the plant.

Another factor contributing to larger safety margin during lower power operation is the reduction in the required capacity for mitigating systems. Because of the lower levels of decay heat present following operation at 25 percent power, the demand for core cooling and auxiliary systems is reduced, requiring the operation of fewer systems and components to mitigate any event.

2.2 Transients and Design Basis Accidents Analysis

At the request of LILCO, General Electric Company (GE) has reviewed all of the Design Basis Accidents (DBA) considered in Chapter 15 of the FSAR to evaluate their potential radiological dose consequences beyond the exclusion area boundary at 25 percent of rated power. The review was based upon the same criteria and bases as the original Chapter 15 analyses. The review confirmed that of the 38 accidents and transients addressed in Chapter 15, all of the events, if they occurred at 25 percent power, would be bounded by the same DBAs at 100 percent power. The DBAs would not result in offsite radiological consequences that would require evacuations.

To assure that the fuel cladding integrity safety limit Minimum Critical Power Ratio (MCPR) is not exceeded during any abnormal operation event, LILCO evaluated a spectrum of transients. The analysis verified that there is no change in the limiting transient. The limiting transient is the loss of feedwater heating as in the original analysis. The licensee has verified that the Critical Power Ratio (CPR) remains above the safety limit of 1.06 MCPR for this event.

For all designated control rod patterns and recirculation flow rates which may be employed at thermal power levels equal to or less than 25 percent, operating plant experience indicates that the resulting CPR values are in excess of requirements by a larger margin (nearly twice the operating limit CPR) under all conditions. Although some abnormal transients initiated at 25 percent power or less can have large CPR reductions, their larger initial thermal margins prevent them from having a closer approach to the safety limit MCPR (1.06) than by the limiting rated power transients. None of the transient events result in fuel failure, thereby having no offsite radiological impact.

2.3 Physical and Procedural Changes Taken Credit by LILCO in the Shoreham PRA

2.3.1 Diesel Fire Pump as a Cooling Source for the Residual Heat Removal (RHR) Heat Exchanger in the Steam Condensing Mode

The Emergency Procedure Guidelines (EPGs) guide the operator to make use of the "last resort" systems such as diesel fire pumps if all Emergency Core Cooling SystemS (ECCS) fail during an accident. LILCO's plan to use the diesel fire pumps for the RHR heat exchanger in the steam condensing mode is acceptable because the staff assessments of the EPGs have confirmed the value of the diesel fire pumps to prevent severe damage in the event of loss of all ECCS.

2.3.2 Use of ADS Inhibit Switch

LILCO modified the Automatic Depressurization System (ADS) logic by deleting high drywell pressure permissive and adding a manual inhibit switch. LILCO installed the modification ahead of schedule, even though TMI action plan II.K.3.18 required installation only after the first refueling outage. The staff has previously approved the ADS modification and the Shoreham emergency operating procedures addresses the use of the manual inhibit switch as allowed in the EPG. LILCO's plan to take credit for the use of ADS switch in the PRA is acceptable.

2.3.3 Procedural Changes to HPCI System

The EPG allows defeating of High Pressure Coolant Injection (HPCI) automatic suction transfer to the suppression pool and allows the operator to switch suction back to the condensate storage tank if the suppression pool temperature is high. We reviewed the Shoreham Emergency Operating Procedure, SP.29.024.01, Rev. 4D and find the procedure acceptable. Hence LILCO's plan to take credit in the PRA for defeating the HPCI suction transfer logic is acceptable.

2.3.4 Emergency Procedures Throttling Low Pressure ECCS and Condensate

During an Anticipated Transient Without Scram (ATWS), the EPG allows the operator to decrease core power by reducing core flow through lowering the water level and thus reducing the natural circulation driving head. LILCO Emergency Operating Procedure, SP.29.024.01, Rev. 4D incorporates the operator actions during an ATWS. The operator lowers Reactor Pressure Vessel (RPV) water level by terminating and preventing all injection into the RPV except boron injection systems and Control Rod Drive (CRD) until either:

(a) Reactor power drops below 5 percent,
(b) RPV water level reaches -158 inches, Top of Active Fuel (TAF), and
(c) All Safety/Relief Valves (SRVs) remain closed and drywell pressure remains below the high drywell pressure scram setpoint of 1.69 psig.

Control of the RPV water level is at TAF. Lowering the water level to reduce power is necessary to minimize pool heatup because HPCI and RCIC are used to keep the water level above TAF. HPCI and RCIC turbines exhaust to the suppression pool thereby increasing the pool temperature. Emergency RPV depressurization will be required to prevent exceeding the heat capacity temperature limit of the suppression pool.

The operator is instructed to control reactor water level using condensate or CRD or Low Pressure Coolant Injection (LPCI) when RCIC/HPCI systems are stopped because of high suppression pool temperature. Control of the water level is at top of active fuel if possible. Following boron injection, which will mitigate the ATWS, the operator is instructed to recover and raise water level to enhance boron mixing. LILCO is following the EPG guidelines in their plant emergency operating procedures. LILCO's plan to take credit for the level control procedures during the ATWS is acceptable.

2.3.5 Anticipated Transients Without Scram (ATWS)

ATWS events, anticipated transients coupled with a failure to scram, were investigated for their potential to lead to core damage. The transient types include turbine trip, loss of feedwater, MSIV closure, loss of condenser vacuum, loss of offsite power and Inadvertent Opening of a Relief Valve (IORV). The majority of anticipated transient initiators for BWR's result from or lead to turbine trips and Shoreham is no exception. However, given the 25 percent power limitation, availability of the main condenser as a viable heat sink becomes an important consideration in the mitigation of these transients. The Shoreham turbine bypass system is designed to bypass a 25 percent power steam rate. This bypass capability and the use of highly enriched boron in the Shoreham Standby Liquid Control System (SLCS) lead to reductions in ATWS contributions to the total core damage frequency.

LILCO is taking credit for Alternate Rod Injection (ARI), Recirculation Pump Trip (RPT) and SLCS for mitigation of ATWS. As part of the 25 percent power evaluation, the staff has completed the ARI and RPT systems design review to verify that Shoreham meets the ATWS rule 10 CFR 50.62. The staff evaluation was forwarded to Project Directorate I-2 (Ref. 1). In that SER it was concluded that LILCO was in general compliance with the ATWS rule.

In Amendment No. 6, dated May 18, 1987 (Ref. 2), the staff approved the licensee's plan to enrich the boron in the sodium pentaborate in the Standby Liquid Control System (SLCS) tank to 85 atom percent boron-10. The current minimum SLCS parameters (41.2 gpm, 9.8 percent concentration of 85 atom percent boron-10 enrichment) will ensure an equivalent injection capacity that is 200 percent of the ATWS rule requirement for Shoreham. The use of higher enrichment allows additional time for SLCS initiation because less time is required for injection of the amount (weight) of sodium pentaborate necessary to achieve a hot shutdown condition. This results in a decrease in the human error probability estimate for SLCS injection, and to a lesser extent, reduction in the ATWS core melt frequency. LILCO's plan to take credit for the increased Boron enrichment in the PRA is acceptable.

2.3.6 Corium Ring

A recent design modification to the Shoreham containment is the installation of a "corium ring" which surrounds the control rod drive (CRD) room floor inside the pedestal area. This ring is made of concrete and is intended to prevent core debris (corium) from flowing out of the pedestal access manways and air vents into the outer drywell floor during a postulated severe core damage accident. There are four downcomers located in this area. The lips of the downcomers are flush with the floor so that molten corium released from the vessel in the event of a postulated meltdown, can flow directly into the suppression pool.

The corium ring consists of a curb of precast concrete blocks which is two feet 6-inches wide by two feet high. The blocks are held in place by 3/4-inch thick plates along the top and inside face of the blocks. The air ducts have been modified by the addition of removable precast reinforced concrete slabs around the existing shear wall opening, creating a concrete air shaft which extends from the inside edge of the reactor support pedestal into the CRD room (pedestal region). The concrete slab installed in front of the existing shear wall air opening raises the duct off the floor level, thus preventing the exit of corium in the event of a postulated meltdown. The air flow is directed to the CRD room in a Z pattern through the concrete air shaft by means of two turning vanes installed inside the air shaft.

The corium ring is a passive safety-related structure. The concrete blocks and turning vanes are seismically supported to ensure they stay in place and do not damage safety-related equipment.

We have reviewed the design and the installation of the corium ring to assure that its placement will not impact the safety function of other safety systems and that containment functions remain unaffected. Specifically, we have reviewed the containment design for possible interference related to the downcomers and their ability to respond to the local transients and any change to the vent flow area as it relates to the subcompartment pressure analysis. On the basis of our review, we concluded that the corium ring does not impact the previously calculated and approved short and long term drywell and suppression chamber pressure and temperature analysis. In addition, there is no change in the subcompartment pressure analysis for the annulus formed by the reactor vessel and the sacrificial shield. Thus, the corium ring does not adversely affect the containment's response to design basis accidents. Therefore, the staff's conclusions reached in the original Shoreham Safety Evaluation Report (NUREG-0420) are unchanged due to the installation of the corium ring.

2.3.7 Alternating Current Power Systems

The Alternating Current (AC) power system at the Shoreham plant site consists of an onsite and offsite system required by 10 CFR Part 50 and three additional supplies of AC electric power. The offsite system consists of two physically independent circuits. These circuits supply electric power from the LILCO transmission network to the Shoreham station onsite electric distribution system. The onsite system consists of three independent emergency diesel generators manufactured by Transamerica Delaval, Inc. (TDI). These TDI diesel generators supply electric power to the onsite electric distribution system after a loss of offsite power. The onsite and offsite systems have been designed and constructed in accordance with NRC regulatory requirements. The staff has reviewed these designs and concluded that they meet applicable General Design Criteria (Appendix A to 10 CFR Part 50), recommendations and guidelines of regulatory guides, branch technical positions, and industry standards as described in Section 8.0 of the staff's Safety Evaluation Report (SER) related to the operation of Shoreham Nuclear Power Station, Unit No. 1 (NUREG-0420) and Supplement No. 9 to the SER.

In addition to the offsite and onsite AC power supply systems required by 10 CFR Part 50, the licensee has designed and constructed three additional supplies of AC electric power. These supplies, located at the Shoreham site, include units rated at 20MW, 10MW, and 4.15MW. The 20MW unit consists of a single gas-turbine-powered generator. The generator, gas turbine, and all electrical and mechanical controls are contained within a weather-resistant enclosure. The gas turbine is designed for "deadline" start capability: i.e., the gas turbine is capable of starting, accelerating to rated speed and voltage. and connecting to a power distribution system using only self-contained control systems and power supplies.

The licensee, as part of their request to operate Shoreham at 25 percent power, indicated that this unit would be available and can be manually connected to the onsite distribution system through the 69KV switchyard if needed. Also, the licensee, by letter dated May 8, 1987, indicated that test and maintenance of this unit would include:

A. A monthly operational test at base load,
b. An annual blackstart test,
c. An annual overspeed test,
d. Weekly inspections of the turbine and generator enclosures and also checking the unit of oil and fuel leakage,
e. Inspection of the turbine hot section every 7000 hours of operation, and
f. Inspections of the generator internals every five years.

The 10MW unit consists of four diesel-engine-powered generators, each rated at 2.5MW. Each generator with its associated diesel engine, electrical and mechanical components and controls is in an independent, weather-resistant enclosure. Each diesel generator is designed for "dead-line" start capability: i.e., the diesel generators are capable of starting, accelerating to rated speed and voltage, automatically synchronizing with each other, and operating in a stable parallel configuration using only self-contained control systems and power supplies. The licensee, as part of their request to operate Shoreham at 25 percent power, indicated that this unit would be available and can be manually connected to the onsite distribution system if needed. Also, the licensee, by letter dated May 8, 1987, indicated that test and maintenance of this unit would include:

a. Preventive maintenance and inspections consistent with the manufacturer's recommendations,
b. Start and idle test on each of the 2.5MW units every three months, and
c. Load test each of the 2.5MW units every refueling outage.

The 4150KW unit consists of any one of three diesel-engine-powered generator sets manufactured by Colt Industries. At an April 30, 1987 meeting, the licensee indicated that these diesel generator sets are designed and being installed to meet regulatory guidelines and requirements for an onsite safety-related AC power system. Thus, they have been located in a seismic category I structure and have been physically separated from each other such that failure of one set should not cause loss of availability of the remaining two sets. In addition, the licensee indicated that these diesel generator sets are operational and can be started, run, and connected (one at a time) to the onsite electrical distribution system via a temporary 4KV overhead transmission line and the Shoreham station 69KV switchyard and station service transformer No. 2. For 25 percent power operation, the licensee, by letter dated May 8, 1987, indicated that at least one of the three diesel-engine-powered generator sets will be available and that test and maintenance of this unit would include:

1. Preventive maintenance in accordance with manufacturer's recommendations, and
2. Load test every three months.

The objective of the following staff evaluation was to assess the added effectiveness of an AC power system that incorporates, as part of its design, the availability of the above described additional AC power supplies. In accordance with this objective, the impact that these additional supplies may have on the likelihood of recovery from a station blackout event (i.e., loss of offsite power followed by loss of all onsite AC power supplies) was assessed.

The purpose of the above described additional AC power supplies, as confirmed by the licensee at our April 30, 1987 meeting, is to use them only after a station blackout event and after it is determined that neither of the required offsite circuits can be reestablished. Thus, for any one of these additional AC power supplies to be needed, one must first assume (a) loss of offsite power, (b) failure of all three required onsite TDI diesel generators, and (c) loss of both offsite circuits such that they cannot be reestablished.

It is the staff's judgement that the AC power system at Shoreham (which meets the requirements of criterion 17 of Appendix A to 10 CFR Part 50 without the additional AC power supplies) provides reasonable assurance that AC power will be available when required and is acceptable. The additional AC power supplies which are available at the Shoreham plant site, as discussed above, provide a significant capability beyond that presently required by the regulations for recovery of AC power following a station blackout event. The staff concludes that LILCO's plan to take credit in the PRA for these additional AC power supplies is reasonable.

3.0 CONCLUSION

We find 25 percent power operation to be acceptable because:

- The fission product inventory is less than during full-power operation.
- The system-success criteria are significantly improved for the 25 percent power cases.
- The time available for the operator to take action to prevent core vulnerable states from occurring is longer than would be the case for full power, resulting in a greater probability that the operator will correctly diagnose and implement necessary action.
- The capacities of the mitigating systems required to perform safety functions are greater than required for the 25 percent power case.

- The main condenser is effective as a heat sink for turbine trip ATWS cases in which it can be maintained.

LILCO has made procedural changes at Shoreham since the issuance of 5 percent power approval. These procedural changes include:

- Procedures for using the diesel fire pumps as a cooling source for the Residual Heat Removal (RHR) System heat exchanger when utilized with the Reactor Core Isolation Cooling (RCIC) System in the steam condensing mode;
- An Automatic Depressurization System (ADS) inhibit switch to provide an easy means for the operator to prevent ADS when it could make the accident more difficult to control;
- A jumping provision added to the High Pressure Coolant Injection (HPCI) System to allow the operator to switch (HPCI) System suction back to the Condensate Storage Tank (CST) if suppression pool temperatures are high;
- Emergency procedures allowing throttling of low pressure Emergency Core Cooling System (ECCS) and condensate during ATWS events.
- Highly enriched boron to be used in the Standby Liquid Control (SLC) System to increase the allowable time for successful initiation for ATWS mitigation.

In addition, LILCO has made physical changes at Shoreham since the issuance of 5 percent power approval:

- Additional onsite AC power Systems, and
- A corium ring located within the reactor pedestal region.

The staff has reviewed the LILCO submittal for 25 percent power operation of the Shoreham plant. We find the improvements in procedures and equipment to be acceptable for taking credit in the PRA. In addition, our review has determined that operation at 25 percent power poses no undue risk to the public.

4.0 REFERENCE

1. Memorandum dated June 5, 1987, Jerry Mauck, Acting Branch Chief, Instrumentation and Control Systems Branch, DEST, to W. R. Butler, Director, Project Directorate I-2, Division of Reactor Projects I/II.

2. Licensing Amendment No. 6 dated May 18, 1987 to Facility Operating License No. NPF-36 for Shoreham Nuclear Power Station, Long Island Lighting Company.

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