NUREG-0420
Supplement No. 5

Safety Evaluation Report
related to the operation of Shoreham Nuclear Power Station, Unit No. 1

Docket No. 50-322

Long Island Lighting Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

April 1984

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ABSTRACT

Supplement 5 (SSER 5) to the Safety Evaluation Report on Long Island Lighting Company's application for a license to operate the Shoreham Nuclear Power Station, Unit 1, located in Suffolk County, New York, has been prepared by the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission. This supplement addresses several items that have been reviewed by the staff since the previous supplement was issued.

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1 INTRODUCTION AND GENERAL DISCUSSION

1.1 Introduction

The Nuclear Regulatory Commission's Safety Evaluation Report (SER) (NUREG-0420) on the application by Long Island Lighting Company (LILCO or applicant) to operate the Shoreham Nuclear Power Station was issued by the Nuclear Regulatory Commission staff (NRC staff) on April 10, 1981. Supplement 1 (SSER 1) to the Shoreham SER was issued in September 1981; SSER 2 was issued in February 1982; SSER 3 was issued in February 1983; and SSER 4 was issued in September 1983.

Each of the sections in this SSER 5 is numbered the same as the section of the SER that is being updated. The discussions in this report are supplementary to and not in lieu of the discussions in the SER, except where specifically noted.

Copies of this report are available for public inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, D.C. 20555 and at the Shoreham-Wading River Public Library, Route 25A, Shoreham, New York 11786. Copies are also available for purchase from the sources indicated on the inside front cover.

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1.7 Outstanding Issues

In Section 1.7 of the SER, the NRC staff identified 61 outstanding issues that were not resolved at the time of issuance of the SER. This report discusses subsequent supplementary information that has been received regarding the

Shoreham Security Plan and provides the staff's evaluations of the applicant's March 20, 1984 supplemental motion for a low-power license. The items identified in Section 1.7 of the SER are listed below with status of each item. If the item is discussed in this supplement, the section where the item is discussed is identified. The resolution of the remaining outstanding issues will be discussed in future supplements to the SER.

Item	Status	Section
(1) Pool Dynamic Loads	Resolved	
(2) Masonry Walls	Resolved	
(3) Piping Vibration Test Program - Small Bore Piping/Instrumentation Lines	Resolved	
(4) Piping Vibration Test Program - Safety-Related Snubbers	Resolved	
(5) LOCA Loadings on Reactor Vessel Supports and Internals	Resolved	
(6) Downcomer Fatigue Analysis	Resolved	
(7) Piping Functional Capability Criteria	Resolved	
(8) Dynamic Qualification	Partially resolved, awaiting further information	
(9) Environmental Qualification	Partially resolved, awaiting further information	
(10) Seismic and LOCA Loadings	Resolved pending confirmation	
(11) Supplemental ECCS Calculations with NUREG-0630 Model	Resolved with license condition	
(12) ODYN, Generic Letter 81-08	Resolved	
(13) NUREG-0619, Feedwater Nozzle and Control Rod Return Line Cracking Generic Letter 81-11	Resolved	
(14) Jet Pump Holddown Beam	Resolved	
(15) Inservice Testing of Pumps and Valves	Resolved	
(16) Leak Testing of Pressure Isolation Valves	Resolved	
(17) SRV Surveillance Program	Resolved	

Item	Status	Section
(18) NUREG-0313, Revision 1	Resolved	
(19) Preservice Inspection	Resolved	
(20) Appendix G - IV.A.2.a	Resolved	
(21) Appendix G - IV.A.2.c	Resolved	
(22) Appendix G - IV.A.3	Resolved	
(23) Appendix G - IV.B	Resolved	
(24) Appendix H - II.C.3b	Resolved	
(25) RCIC	Resolved	
(26) Suppression Pool Bypass	Resolved	
(27) Steam Condensation Downcomer Lateral Loads	Resolved	
(28) Steam Condensation Oscillation and Chugging Loads	Resolved	
(29) Quencher Air Clearing Load	Resolved	
(30) Drywell Pressure History	Resolved	
(31) Impact Loads on Grating	Resolved	
(32) Steam Condensation Submerged Drag Loads	Resolved	
(33) Pool Temperature Limit	Resolved	
(34) Quencher Arm and Tie-Down Loads	Resolved	
(35) Containment Isolation	Resolved	
(36) Containment Purge System	Resolved	
(37) Secondary Containment Bypass Leakage	Resolved	
(38) Fracture Prevention of Containment Pressure Boundary	Resolved	
(39) Emergency Procedures	Resolved	
(40) LOCA Analyses	Resolved	
(41) LPCI Diversion	Resolved	

Item	Status	Section
(42) Flow Meter	Resolved	
(43) Loss of Safety Function After Reset	Resolved	
(44) Level Measurement Errors	Resolved	
(45) Fire Protection	Resolved	
(46) IE Bulletin 79-27	Resolved	
(47) Control System Failures	Resolved	
(48) High Energy Line Breaks	Resolved	
(49) DC System Monitoring	Resolved	
(50) Low and/or Degraded Grid Voltage Condition	Resolved	
(51) Fracture Toughness of Steam and Feedwater Line Materials	Resolved	
(52) Management Organization	Resolved	
(53) Emergency Planning	Under review	
(54) Security	Awaiting further information	13.7
(55) Q-List	Resolved	
(56) Financial Qualification	Resolved	
(57) TMI-2 Requirements		
Shift Technical Advisor	Resolved with license condition	
Shift Supervisor Administrative Duties	Resolved	
Shift Manning	Resolved	
Upgrade Operator Training	Resolved	
Training Programs - Operators	Resolved pending confirmation	
Revise Licensing Examinations	Resolved	
Organization and Management	Resolved	

Item	Status	Section
Procedures for Transients and Accidents	Resolved	
Shift Relief and Turnover Procedures	Resolved	
Control Room Access	Resolved	
Dissemination of Operating Experiences	Resolved	
Verify Correct Performance of Operating Activities	Resolved	
Vendor Review of Procedures	Resolved	
Emergency Procedures	Resolved	
Control Room Design Review	Resolved pending confirmation	
Training During Low-Power Testing	Resolved	
Reactor Coolant System Vents	Resolved	
Plant Shielding	Resolved	
Post-Accident Sampling	Resolved with license condition	
Degraded Core Training	Resolved	
Hydrogen Control	Resolved	
Relief and Safety Valves	Resolved pending confirmation	
Valve Position Indication	Resolved	
Dedicated Hydrogen Penetrations	Resolved	
Containment Isolation Dependability	Resolved with license condition	
Accident-Monitoring Instrumentation		
Attachment 1	Resolved with post-implementation review	
Attachment 2	Resolved	
Attachment 3	Resolved	

Item	Status	Section
Attachment 4	Resolved	
Attachment 5	Resolved	
Attachment 6	Resolved	
Inadequate Core Cooling	License condition	
IE Bulletins		
Item 5	Resolved pending confirmation	
Item 10	Resolved pending confirmation	
Item 22	Resolved	
Item 23	Resolved	
Bulletins and Order Task Force		
Item 3	Resolved	
Item 13	Resolved pending confirmation	
Item 16	Resolved	
Item 17	Resolved	
Item 18	Resolved	
Item 21	Resolved	
Item 22	Resolved	
Item 24	Resolved	
Item 25	Resolved	
Item 27	Resolved	
Item 28	Resolved	
Item 30	Resolved	
Item 31	Resolved	
Item 44	Resolved	

Item	Status	Section
Item 45	Resolved	
Item 46	Resolved	
Emergency Preparedness - Short Term	Under review	
Upgrade Emergency Support Facilities	Under review	
Emergency Preparedness - Long Term	Under review	
Primary Coolant Outside Containment	Resolved	
Improved Iodine Monitoring	Resolved	
Control Room Habitability	Resolved pending confirmation	
(58) Reactor Vessel Materials Toughness	Resolved	
(59) Control of Heavy Loads - Generic Letter 81-07	Resolved	
(60) Station Blackout - Generic Letter 81-04	Resolved pending confirmation	
(61) Scram System Piping	Resolved	
(62) Remote Shutdown System	Resolved with license condition	
(63) Design Verification	Under review	
(64) Loose Parts Monitoring System	Resolved	
(65) Low-Power License Motion	Resolved with license condition	1.10, 2.3, 8.5, 13.5, 13.7, 14.1, 15, 23

1.10 Motion for a Low-Power License

On March 20, 1984, the applicant made a supplemental motion (the motion) for a low-power operating license before the Atomic Safety and Licensing Board Panel. The objective of this supplemental motion is to show that the pending diesel generator issues that are now being litigated need not be resolved to support the issuance of a low-power license. In support of this objective, the applicant has provided design information and analysis to demonstrate that even if one assumes the unavailability of all three onsite diesel generators, with a single design-basis event and the concurrent (normally postulated) loss of offsite power, there is reasonable assurance that alternate ac power can be made available in sufficient time to ensure that structures, systems, and components important to safety perform as intended at 5% power.

The NRC staff has reviewed the applicant's motion and supporting affidavits, as included in a letter to H. Denton from B. McCaffrey dated March 20, 1984. The information in that submittal was supplemented during a meeting between the staff and the applicant on March 29, 1984 (a copy of the transcript of that meeting has been placed on the Shoreham docket). In addition, by letters dated April 3, 1984 (SNRC-1033), April 6, 1984 (SNRC-1035), and April 11, 1984 (SNRC-1036), the applicant provided additional supporting information that has been considered by the staff.

The staff evaluation of the motion presented in this SER supplement has considered the following areas: meteorological (Section 2.3), electric power systems and supplies (Section 8.3.1), procedures (Section 13.5), security (Section 13.7), transients and accident analyses (Section 15), and containment systems (Section 15).

2 SITE CHARACTERISTICS

2.3 Meteorology

To provide added safety assurance with regard to the impact of severe weather on the proposed low-power operation of the Shoreham facility, the applicant has proposed to proceed immediately to cold shutdown when the U.S. National Weather Service (NWS) issues--and LILCO is notified of--forecasts of any of the following severe weather conditions for the Shoreham area:

(1) hurricane warning
(2) tornado watch
(3) severe storm watch
(4) special weather statement of significant thunderstorm
(5) winter storm watch
(6) a prediction of abnormally high tides greater than 5 feet above mean high water within 24 hours.

The evaluation below is based on the expertise and knowledge of the NRC staff reviewers, supplemented by discussions with NWS northeast regional staff located on Long Island, NY.

NWS has the ability to reliably forecast conditions that lead to advisories 1, 5, and 6 (above) several hours in advance of the event. The NWS ability to accurately forecast tornadoes and severe storms (advisories 2 and 3) for the Long Island area is relatively poor; the accuracy of these forecasts is much less than 50%. Because the forecasts of significant thunderstorms (advisory 4) are based on radar siting, the accuracy of their prediction rate is good, but only a short time is available between the forecast and onset of the storms at the site.

In spite of the limitations of the forecasting accuracy and limited advance warning time for some severe weather conditions, the actions proposed by LILCO should result in plant shutdown during a substantial part of the time when the loss of offsite power as a result of severe weather conditions is likely.

Therefore, the staff concludes that the actions proposed by the applicant are appropriate and generally consistent with the state-of-the-art in forecasting severe weather. The staff will require, as part of the Shoreham Technical Specifications, that the plant be shut down if such severe weather advisories are issued for the Shoreham area.

8 ELECTRIC POWER

8.5 Alternating Current Power System for Low Power Operation

The objective of the staff review in this area is to determine whether the alternate ac power sources meet the intended safety function and review objectives that are defined in the SER for the onsite diesel generator ac power sources. The safety function of the alternate ac power sources (assuming neither the offsite power system nor the onsite diesel generators are functioning) is to provide sufficient capacity and capability to ensure that the structures, systems, and components important to safety perform as intended for low-power operation. Thus, the objective of the review is to determine whether the alternate ac power sources have the required redundancy, meet the single failure criterion, and have the capacity, capability, and reliability to supply power to all required safety loads. It is also the objective of the staff review to determine whether the alternate ac power sources will provide reasonable assurance that ac power will be available in sufficient time after postulated design-basis events and provide a level of safety for operation at 5% of rated power at least equivalent to that required by General Design Criteria (GDC) 17 and 18 of Appendix A to Title 10 of the Code of Federal Regulations Part 50 (10 CFR 50) for full-power operation.

The applicant has proposed to use two portable "peaking units" as alternate ac power sources. These peaking units are rated at 20 MW and 10 MW, respectively.

The 20-MW 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 sources, following an appropriate loss of voltage signal. The turbine starts using compressed air to drive an air start motor. Starting air is stored at 400 to 500 psig in pressurized receivers of sufficient capacity to allow three starting attempts without recharging. An automatically controlled air compressor within the enclosure is cycled on and off, as required, to maintain the compressed air supply. The distribution system has a 150-amp-per-hour, 125-volt dc battery. A 50-amp battery charger maintains the battery charge at required levels. Power for the air compressor and battery charger comes from an auxiliary transformer that is powered from the associated distribution system (69-kV) during standby, and from the gas turbine generator during operation. Fuel is from an onsite, 1,000,000-gallon storage tank. Two fuel pumps deliver fuel under pressure to the gas turbine. One pump is powered from the 125-volt dc battery and starts automatically when the gas turbine starts. The dc pump operates until the gas turbine generator is producing power, when the ac-operated pump starts and the dc pump automatically stops. Power for the ac fuel pump is from the same source used by the air compressor and battery charger.

The 10-MW unit consists of four diesel-engine-powered generators, each rated at 2.5 MW. 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. Each starts using two 125-volt dc electric starting motors. A single, 420-amp-per-hour, 125-volt dc, lead acid battery provides power for the starting motors on all four diesel engines. This battery is in the enclosure of one of the four diesel generator power units. The diesel generators start in sequence, with the start cycle for one ending before the start cycle for another begins. A start cycle lasts 15 seconds, and the system attempts to start each diesel engine three times, assuming the engine has not started on the first or second attempt. The starting battery has more capacity than is required for 12 diesel engine start cycles (three attempts for each of the four diesel engines). The battery is maintained at full charge by a battery charger. Power for the battery charger is from an auxiliary transformer that is powered from the associated distribution system (4 kV) during standby, and from the diesel generators when they are on line. The diesel generators are designed to automatically synchronize with each other after they reach rated speed and voltage; they are connected to the load as one unit. The controls are designed to allow stable parallel operation of the four diesel generators. Connection to the load will be by manual operation.

The following areas were considered in the staff review of these alternate ac power sources:

Capacity and Capability of 20-MW Gas Turbine

The applicant (by item 20 of the Schiffmacher affidavit, contained in the motion) stated that the 20-MW gas turbine has the ability to carry all plant emergency loads together with some selected plant nonemergency loads. To demonstrate this capacity, the applicant (by item 8 of the Museler affidavit) stated that on a biweekly basis through actual test the 20-MW gas turbine will be loaded to at least 13 MW. The 13-MW test load is slightly greater than the total of all plant loads that can be connected to safety buses, as shown on FSAR Table 8.3.1-1. The 13-MW test load does not, however, consider selected nonemergency loads. The nonemergency load is about 20% of the 20-MW capacity of the gas turbine, or 4 MW, as stated by the applicant (line 7, page 22 of the March 29, 1984 meeting transcript). The staff will require, as part of the Shoreham Technical Specification, that this 4-MW nonemergency load be included in the test load so that the gas turbine will be loaded to 20 MW as part of an operational test prior to plant operation beyond criticality testing, and to 13 MW every 2 weeks. With the imposition of this requirement, the staff concludes that the 20-MW gas turbine has sufficient capacity, provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and is acceptable.

In regard to the capability of the gas turbine to be connected to safety loads, the applicant (pages 18, 19, and 20 of the transcript) stated

(1) On loss of voltage on the 69-MW offsite power system bus, the gas turbine automatically starts; breaker number 640, shown on FSAR Figure 8.2.1-1, automatically opens, isolating the 69-kV switcnyard from the LILCO offsite grid system, and motor mechanical switches 616 and 617 on FSAR Figure 8.2.1-1 automatically open to strip off load normally connected to the 69-kV switchyard bus.

(2) All loads connected to nonsafety buses 1B and 12 on FSAR Figure 8.2.1-1 are automatically disconnected on loss of voltage except the 4-MW nonemergency load discussed above.

(3) The gas turbine is automatically connected to the 69-kV bus after it attains the correct speed.

(4) All other loads or power supplies that may be connected to (but are not automatically disconnected from) the 69-kV switchyard bus are administratively kept disconnected.

Thus, on loss of the normal 69-kV offsite circuit, a source of power is automatically reestablished in 2 to 3 minutes so that the control room operator need only, by procedure, close breakers 424, 444, or 464 on FSAR Figure 8.2.1-1 to resupply power to safety loads (lines 7 to 13, page 26 of the transcript). To demonstrate this capability, the applicant (lines 19, 20 and 21, page 24 of the transcript) stated that a test would be performed once a month to ensure that the gas turbine will start automatically on loss of grid voltage and isolate from the grid.

As part of the Shoreham Technical Specifications, the staff will require that this monthly test be performed with the following functions verified:

(1) that loads normally connected to the 69-kV and 4.16-kV buses are automatically disconnected

(2) that the gas turbine automatically connects to the 69-kV bus within 2 to 3 minutes

The staff will also require, as part of the Technical Specifications, the periodic verification, once every 12 hours, that loads or power supplies normally disconnected to the 69-kV bus are in fact disconnected.

With respect to the capability to close breakers numbered 424, 444, or 464 so that power can be supplied to actual loads, the applicant (lines 15 through 20, page 25, and lines 1 through 7, page 29 of the transcript) indicated that this capability would be demonstrated by operational testing before plant operation in Phases III and IV and will require 5 to 10 minutes for the control room operator to complete. In addition to this operational test, the staff will require that proper operation of the gas turbine be demonstrated by loading it to its design load requirement (which includes safety loads as well as nonsafety loads on 480-V busses 12A, 12B, 12C, and 12D), with verification that voltage and frequency are maintained within required limits. The staff also will require, as part of the Shoreham Technical Specifications, that the capability to connect to actual safety loads also be demonstrated once every 6 months while the unit is shut down. With the imposition of these requirements, the staff concludes that there is sufficient capability to ensure that the gas turbine can be connected to safety loads and can supply power to permit functioning of required safety loads, that it provides a level of safety for 5% rated power operation at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable.

Capacity and Capability of the Four Mobile Diesel Generators

In regard to the capacity of the four mobile diesel generators, the applicant (lines 7 through 10, page 10 of the transcript) stated that one of the four 2.5-MW mobile diesel generators has adequate power to mitigate the worst case accident. To demonstrate this capacity, the applicant, by letter dated April 3, 1984, stated that on a biweekly basis through actual test the four 2.5-MW diesel generators will be loaded to a minimum of 50% of rated load or to at least 1.25 MW per diesel generator. Because this minimum test load of 1.25 MW does not equal the minimum required capacity of 2.5 MW to mitigate the worst case accident, the staff will require, as part of the Shoreham Technical Specifications, that each diesel generator be loaded to 2.5 MW or that all four mobile diesel generators be loaded to 10 MW every 2 weeks. With the imposition of this requirement, the staff concludes that each of the four mobile diesel generators has sufficient capacity, provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and is acceptable.

In regard to the capability of the four mobile diesel generators to be connected to safety loads, the applicant (pages 11 through 18 of the transcript) indicated that

(1) On loss of power the diesel generators would automatically start.

(2) A field operator would be dispatched to establish the availability and status of the diesel generators.

(3) The control room operator, by procedure, would manually open disconnect switches to isolate the offsite power grid system from the four mobile diesel generators.

(4) All loads connected to non-safety bus 11 shown on FSAR Figure 8.2.1-1 are automatically disconnected except for nonemergency loads on buses 11A, 11B, 11C, and 11D.

(5) The control room operator, by procedure, will ensure that these nonemergency loads connected to bus 11 are in fact disconnected by manually opening their supply breaker.

(6) The field operator, by procedure, manually closes a breaker so that ac power from the four mobile diesel generators is connected to 4.16-kV bus 11 shown on FSAR Figure 8.2.1-1.

(7) The control room operator, by procedure, closes breakers numbered 415, 435, or 455 shown on FSAR Figure 8.2.1-1 to resupply power to safety loads.

With respect to the capability of the four mobile diesel generators to be connected to safety loads, the applicant (lines 9 through 22, page 31 of the transcript) indicated that the capability would be demonstrated as part of operational testing before Phases III and IV and will require 30 minutes for the control room and field operators to complete. As part of this test, the staff will require that the applicant demonstrate proper operation of the four mobile diesel generators by loading each diesel generator to its design load requirements for 1 hour and verifying that voltage and frequency are maintained within required limits. In addition to these preoperational tests, the staff will require, as part of the Shoreham Technical Specifications, that the above described capability to connect the four mobile diesel generators to safety loads be demonstrated once every 6 months while the unit is shut down. With respect to the capability of the diesel generators to automatically start on loss of voltage, the applicant (by item 8e of the Museler affidavit) stated that the generators would be tested (on a biweekly basis) to demonstrate that at least three of the four mobile diesel generators can be manually started and operated at rated speed. As part of this periodic test, the staff will require, as part of the Shoreham Technical Specifications, that the diesel generators be started on a simulated loss of offsite power signal with ac power disconnected from all diesel generator auxiliary equipment (such as ac power to the starting battery through the battery charger). Also as part of these preoperational and 6-month periodic tests, the staff will require that

(1) the battery charger be demonstrated capable of recharging the battery to at least 95% of full charge within 8 hours.

(2) a battery service test be performed in accordance with the guidelines of Standard 450-1980 of the Institute of Electrical and Electronics Engineers (IEEE) to a load test profile equal to 12 full 15-second engine start cycles. With the imposition of these requirements, the staff concludes that there is sufficient capability and capacity to ensure that the four mobile diesel generators can be connected to safety loads and can supply power to permit functioning of required safety loads, provide a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and are acceptable.

Independence and Compliance with the Single Failure Criterion

With regard to electrical independence of the 20-MW gas turbine from the four mobile alternate power supplies and their circuits, the staff was concerned that the electrical cross connections (shown on FSAR Figure 8.2.1-1) between the two alternate sources could cause their common failure. Concerning the interconnections through 4.16-kV buses 1A, 1B, 11, and 12, the applicant (line 25 of page 20, and lines 1 through 7 of page 26 of the transcript) stated that breakers numbered 420, 430, 460, and 470 on FSAR Figure 8.2.1-1 are normally open. Regarding the interconnection between 480-V buses 11A and 12A, 11B and 12B, 11C and 12C, and 11D and 12D shown on FSAR Figure 8.2.1-1, the applicant (lines 21 and 23 of page 22 of the transcript) also stated that the breaker interconnecting each of these buses is normally open. As part of the Technical Specifications for Shoreham, the staff will require verification, once every 12 hours, that each of these normally open breakers remains open. As to the remaining interconnections through the 4.16-kV emergency buses numbered 101, 102, and 103, the applicant (lines 13 through 16 of page 36 of the transcript) indicated that plant procedures would prevent such interconnection. Procedure directs that one of the two supply breakers to each of these buses normally would be kept open, while the other breaker normally is kept closed. During the March 29, 1984 meeting, the staff (pages 36 through 41 of the transcript) expressed the concern that because these breakers included an automatic transfer capability between the two breakers, some event or single failure could cause failure of both sources of alternate power. To preclude this occurrence, the staff will require that the transfer capability be removed, and the staff will so condition the low-power license. With the imposition of this requirement, the staff considers this item resolved. The Shoreham Technical Specifications will be changed to reflect that testing of this automatic transfer will not be required during low-power operation but will be required for the full-power license.

In regard to the physical independence between the 20-MW gas turbine and the four mobile diesel generators alternate power supplies and their circuits, the applicant (page 82 of the transcript) provided a description of the physical separation of these circuits. This description indicated that the gas turbine is located in the 69-kV switchyard, with its circuits entering the switchgear room as shown on FSAR Figures 8.2.1-3A and 8.2.1-8A. These circuits are part of the circuits associated with the reserve station transformer. The four mobile diesel generators are in a physically separate location next to the southwest corner of the reactor building with the circuits entering the same switchgear room shown on FSAR Figure 8.2.1-8A. These circuits enter approximately 40 feet east on the same side of the switchgear room (as those circuits associated with the gas turbine).

On the basis of this description, the staff concludes

(1) The gas turbine and mobile diesel generators are separated by approximately 300 feet.

(2) The four mobile diesel generators are separated from the reserve station service transformer by approximately 150 feet and the control and auxiliary boiler building.

(3) The circuits associated with the gas turbine are routed in underground concrete enclosed raceway approximately 75 feet from to the location of the four mobile diesel generators.

(4) The circuits associated with each of the alternate ac sources located in the 69-kV switchgear room shown on FSAR Figure 8.2.1-8A are routed in physically separate cable bus duct, raceway, or switchgear.

(5) The circuits associated with each alternate ac source are routed between the switchgear room and the safety buses in raceways encased in the concrete floor, as shown on FSAR Figure 8.2.1-8B.

(6) The preceding separation provides sufficient independence so that failure of one alternate source will not cause loss of the other source.

This separation provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and is acceptable with the following exception: because the staff is concerned that failure of either the reserve station service transformer or the normal station service transformer as a result of fire may cause failure of the circuits associated with the four mobile diesel generators, the staff will require that these circuits be located no closer than 50 feet from either transformer, or adequate fire barrier separation must be provided. The staff will so condition the low-power license. With the imposition of this requirement, the staff considers this item resolved.

The applicant has not provided any information regarding the quality and design standards to which the alternate ac power supplies and their associated circuits were designed. Because of the importance of these items to the safe operation of the plant during low-power operation, the staff will require they be subject to a quality assurance program commensurate with their importance to safety for 5% rated power operation. This program shall include all pertinent and past history (inspection reports, mill certifications, manufacturer certification, etc.) as available. Current and future documentation shall be all inclusive and be available at the site. With the imposition of this requirement as a condition to the Shoreham low-power license, the staff considers this item resolved.

In regard to protection from natural phenomena and postulated accidents the staff has concluded

(1) Environmental conditions associated with postulated loss-of-coolant or pipe break accidents are confined to the reactor containment or plant auxiliary building. Thus, the alternate ac power system is sufficiently isolated or removed so that the accident environment will have no effect on the capability of the alternate ac power system to perform its safety function. The staff concludes that there is reasonable assurance that ac power will be available for these environmental conditions, that the system provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable in this regard.

(2) For low-power operation, the main turbine generator is not operating. Thus, the only source of missiles that need to be considered would be from outside the plant building and that would be from a tornado. For tornados, the applicant, by letter dated April 3, 1984, stated that the plant would be immediately shut down if the NWS issues a tornado watch for the Shoreham area. The staff will require, as part of the Shoreham Technical Specifications, the immediate shut down of the plant given this condition. With the imposition of this requirement, the staff concludes that more than 30 days will be available before ac power is needed, thus,there is reasonable assurance that ac power will be available, that the system provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable in this regard.

(3) In regard to hurricanes, the applicant (item 7a of the Museler affidavit) stated that the plant would be immediately shut down if NWS issues a hurricane warning for the Shoreham area. The staff will require, as part of the Shoreham Technical Specifications, the immediate shut down of the plant given this condition. With the imposition of this requirement, the staff concludes that more than 30 days will be availble before ac power is needed. Thus, the staff concludes that there is reasonable assurance that ac power will be available, that the system provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable in this regard.

(4) In regard to a seismic event, the applicant (item 7e of the Museler affidavit) stated that the plant would be immediately shut down if there is an indication of seismic activity of 0.01g on the Shoreham seismic monitors.

In addition, the applicant (item 23 of the Schiffmacher affidavit) provided the manufacturer's assurance that the gas turbine would remain structurally sound during a design-basis seismic event at Shoreham and would be available after the event to perform its design function. As part of the Shoreham Technical Specifications, the staff will require the immediate shut down of the plant if there should be such an indication of seismic activity.

In case of a seismic event, it is the staff's opinion that the alternate ac sources will be available after the event because

(a) A period of 30 days is available before the alternate ac power sources are needed for any mitigating function.

(b) The manufacturer has provided assurance that the gas turbine will be structurally sound after a seismic event.

(c) Diesel generators similar to those being used at Shoreham have been used in marine and locomotive applications.

(d) Operating experience during seismic events has demonstrated the capability of equipment similar to that being used at Shoreham to survive a seismic event and to perform its design function after the seismic event.

The staff, therefore, concludes that there is reasonable assurance that ac power will be available following a seismic event, that the system provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable in this regard.

(5) Concerning other natural phenomena, the applicant (item 7 of the Museler affidavit and by letter dated April 3, 1984) stated that the plant would be immediately shut down in case of (1) a severe storm watch for the Shoreham area issued by NWS, (2) a prediction by NWS for the Shoreham area of abnormally high tides greater than 5 feet above mean high water within 24 hours, (3) the outage of two of the four LILCO interconnections to Consolidated Edison and to the New England Power Grid, and (4) a low electrical frequency condition that causes an alarm on the LILCO transmission system. The staff will require, as part of the Shoreham Technical Specifications, that the plant be immediately shut down for each of these conditions. With the imposition of this requirement, the staff concludes that more than 30 days will be available before ac power is needed. Thus, there is reasonable assurance that ac power will be available when required, that the system provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and that it is acceptable in this regard.

(6) The applicant has provided no evaluation of a design-basis event fire in the nonsafety switchgear room through which both alternate ac power circuits pass. The staff will, therefore, require--and so condition the low-power license--that these circuits either be protected in accordance with the requirements of Appendix R to 10 CFR 50 or that a procedure be developed so that ac power can be re-established around the switchgear room

from one of the alternate ac power sources to the safety loads within 30 days. With the imposition of this requirement, the staff concludes that the design provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and is acceptable.

Reliability

The gas turbine generator is powered by a Pratt and Whitney gas turbine. This turbine generator is designed so that the power section of the turbine is not connected to the compressor section. In this design, the starting motor does not have to turn the mass of the generator during starting, thereby making starting faster, easier, and more reliable. Operating history for gas turbine generator identical to that used at Shoreham (as presented by the applicant in a letter dated April 11, 1984) shows 2 failures out of 84 start attempts or 97.6% reliability. The staff concludes that this reliability is well within the 92 to 99% reliability currently being demonstrated by typical onsite power system diesel generators located at operating nuclear power plants, provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full-power operation, and is acceptable.

Each of the four mobile diesel generators is powered by 20-cylinder, EMD series 645 turbocharged diesel engines. These engines have widespread application in power generation, marine systems, and locomotives, and miscellaneous other industrial applications. This series of EMD diesel engines has an excellent reputation for inservice reliability in all types of applications. The operating history (pages 7 through 11 of the transcript) for the four mobile diesel generators shows that on a per-diesel-generator basis there were 4 failures out of 279 start attempts or 98.6% reliability per diesel. When four diesel generators are considered (rather than one), the reliability of the four mobile diesel generators (for the Shoreham application where only one is needed to supply minimum required safety loads) approaches 100%.

Evaluation Findings

The review of the alternate ac power sources proposed by the applicant for low-power operation at Shoreham covered single-line diagrams, station layout drawings, schematic diagrams, descriptive information and a confirmatory site inspection. The basis for acceptance of the alternate ac power sources was conformance with the intent of the GDC for the low-power mode of plant operation. The staff concludes that the alternate ac power source design will provide reasonable assurance that ac power will be available within 55 minutes following a design-basis event LOCA and within 30 days following a design-basis event (seismic) with loss of normal offsite power. The design provides a level of safety for 5% rated power operations at least equivalent to that required by GDC 17 and 18 for full power operation, and is acceptable, as described above.

13 CONDUCT OF OPERATIONS

13.5 Plant Procedures

13.5.1 Procedures for Augmentation of Electrical Power

The measures that the applicant has taken to augment electrical power include

(1) installation of additional power sources, such as a gas-turbine-driven electrical generator and four diesel-driven electrical generators

(2) prioritizing available LILCO system power for Shoreham

(3) placing the plant in cold shutdown when natural occurrences may significantly threaten available offsite power

These measures also include the use of written procedures to detail and control actions by operators to start up, operate, shut down, and test the additional power sources. Procedures will also be used to change the electrical breaker and switch positions to connect and disconnect power sources to buses supplying power to equipment important to plant safety when this equipment is needed for emergency operations and for testing. In addition, procedures will be used

(1) to prescribe the LILCO electrical system operators methods for prioritizing LILCO system power for Shoreham

(2) for the system operator to obtain and relay important weather information to the Shoreham watch engineer

(3) for followup action by the plant staff to place the plant in cold shutdown, if necessary

During the March 29, 1984, meeting, the applicant described the methods for use of the procedures, training of operators to perform the procedural actions, and measures to be taken to ensure the technical validity of each procedure. The applicant stated that procedural training will be provided in the requalification training program, a part of which includes evaluation of operator knowledge. Also, operators will walk through the procedures as part of their training and to establish that the procedures are technically correct and useable.

The operations described are typically performed by plant operators and prescribed in plant procedures. Based on a review of the affidavits supplied in the motion for a low-power license and the information obtained in the March 29, 1984, meeting, the staff concludes that acceptable procedures can be written to prescribe operator actions for connecting available electrical power sources to equipment important to safety and for placing the plant in cold shutdown when natural occurrences threaten continuity of offsite power.

13.7 Security

13.7.1 Protection Requirements for Low-Power Operation

13.7.1.1 Background

The purpose of this section of the SSER is to examine to what extent security requirements could be relaxed if operation were limited to 5% power, or alternately, what substitute measures would be acceptable. The specific items of concern are the protection of emergency power sources required for safe shutdown and the availability of emergency power for operation of the security system.

13.7.1.2 Discussion

NRC regulations require, among other things, that each applicant for a license to operate a nuclear power reactor pursuant to 10 CFR 50 establish, before receiving a license, a physical protection system designed to protect the facility against radiological sabotage by a specified design-basis threat. There are no provisions in the regulations for relaxation of security requirements during periods of low-power operation, and there are no precedents for such relief. (In certain cases, temporary compensatory measures are employed to satisfy a specific requirement if the planned element is not operating.) Nevertheless, this would seem to be a reasonable course of action if it could be shown that the public safety would not be adversely affected. Accordingly, it is necessary to examine the effect of reduced power operation on sabotage consequence potential, and the safeguards effectiveness of proposed substitute measures. These topics are discussed in the following paragraphs.

Sabotage Risks During Low-Power Operation

After sustained operation at 5% power, sufficient decay heat is produced to cause core damage in the absence of reactor coolant. Fuel overheating would begin in about 1 hour after complete loss of coolant, and in about 4 days if the coolant inventory is allowed to boil off and is not replaced. Even though this results in increased reaction time compared to full-power operation, and even though the attendant risk would be correspondingly reduced, it would nevertheless seem to be prudent to provide full-scale protection of (1) the reactor coolant pressure boundary to prevent a sabotage-induced LOCA, and (2) either the reactor core isolation cooling or high pressure coolant injection system to ensure there is capability to reflood the core. Once it has been determined that protection is required, all elements of the security program are needed to protect against the design-basis threat; otherwise, an undefined risk of failure is introduced. In this regard, there is no method currently available that would permit the staff to determine the equality of the reduced sabotage consequence risk compared to the increased risk of safeguards failure. Accordingly, the staff concludes that the relaxation of safeguards requirements during low-power operation might increase the risk of sabotage.

Protection of Emergency Power Sources

Diesel generators and dc power sources are normally protected as vital equipment. In the case of Shoreham, the onsite emergency diesels are considered to be not operable, and the applicant has proposed to rely on offsite power for safe operation of the reactor. (This includes the commercial ac power grid, a

20-MW gas turbine generator, and four 2.5-MW diesel generators located inside the protected area near containment.) All dc power sources are understood to be initially available and operating.

The ac power requirement for the ECCS with all components operating simultaneously is about 10 MW. However, in the absence of a sabotage-induced LOCA (which can be prevented by protecting the entire reactor coolant pressure boundary, including power-operated relief and isolation valves), it is only necessary to provide the power for mitigating the effects of an induced transient. The limiting case for a sabotage-induced transient would be the isolation of the plant from the electrical power grid and the corresponding loss of feedwater flow. The components needed to achieve and maintain safe operation under this condition would be

- the RCIC or HPIC pumps (inside containment)
- makeup water (suppression pool)
- dc power source for instruments and valves (located inside vital areas)

Because the RCIC and HPIC pumps are steam turbine driven, no ac power would be required to maintain the reactor in a safe condition. Furthermore, with no loss of coolant other than that resulting from boil off, a single refill of the core within 4 days of the loss of feedwater flow would be sufficient to maintain a safe condition indefinitely. The dc power needed for valve control and instruments would be supplied by the plant's emergency battery bank, which has a 24-hour capacity without recharging. Considering the above, there is no identifiable need to protect the offsite power sources as vital equipment. Accordingly, the staff finds

(1) adequate dc power is available for 24 hours of emergency operation with non-essential loads dropped (protected as vital equipment)

(2) the steam-driven RCIC or HPIC pumps maintain the core in a safe condition (assuming no sabotage-induced LOCA) (protected as vital equipment)

(3) there is no technical reason to protect the temporary diesels and the gas-turbine generator as vital equipment because they are not required for safe shutdown* (in the absence of a LOCA)

Availability of Emergency Power for the Security System

In regard to emergency power for the intrusion alarm, security communications, access control, and closed circuit television systems, a 6-hour supply is available from the security-related backup battery and uninterruptible power supply (UPS). Power for recharge would be available from the mobile diesels on the gas turbine generator (or from any other ac source brought on site).

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*NUREG-0992 recommends that the emergency power source be protected as vital equipment (even though no site specific need has been identified). This is not a formal requirement at this time. However, a proposed rule is presently before the Commission that, if adopted, would require the protection of onsite ac and dc emergency power sources as independent vital islands.

Accordingly, the staff finds that the plant's capability to supply emergency power to the security system is adequate.

13.7.1.3 Conclusion

On the basis of the preceding discussion, the staff concludes that, for operation up to 5% of rated power

(1) Full-scale protection of the permanently installed equipment in the plant is necessary because the trade off in risks is not calculable.

(2) Safe shutdown can be achieved without offsite power (in the absence of a LOCA).

(3) An adequate supply of emergency power for the security system is available from the security-related backup battery system (with recharge within 6 hours from the mobile diesels or the gas turbine generator).

The staff notes, however, that there exists some uncertainty regarding the commitment of local law enforcement authorities to respond to safeguards emergencies at the site. This matter must be resolved before licensing, and will be addressed in a subsequent SSER.

14 INITIAL TEST PROGRAM

14.1 Fuel Loading and Low-Power Testing Activities

The affidavit of Jack A. Notaro and William E. Gunther in the motion contained a description of the activities to be performed during fuel loading and the low-power phase of initial plant operation. In reviewing the affidavit, the staff compared the information provided with descriptions of activities in startup reports of similar previously licensed facilities and with FSAR descriptions of fuel loading and the low-power testing programs. The staff concludes that the affidavit describes activities typically performed at boiling water reactors during fuel loading and zero and low-power testing, with repetitive testing provided for operator training. The staff estimates that these activities will require 2 to 3 months to complete.

15 TRANSIENT AND ACCIDENT ANALYSES

The alternate ac power supplies at the site consist of one 20-MW gas turbine and four 2.5-MW mobile diesel generators. According to the applicant, the gas turbine can restore power to the emergency core cooling system (ECCS) pumps within 10 minutes, and the mobile diesels can restore power to the ECCS pumps within 30 minutes. During a loss of offsite power and loss of the gas turbine, only one of the four mobile diesels is required to mitigate the most limiting accident (a loss-of-coolant accident, LOCA). Restoration of power to one of the three divisions will ensure power to at least one of the two ECCS pumps. A detailed evaluation of electrical systems is in Section 8.3.1 of this SSER.

In its March 20, 1984, motion the applicant requested NRC approval for the following activities:

(1) Phase I: fuel load and precriticality testing

(2) Phase II: cold criticality testing

(3) Phase III: heatup and low-power testing to rated pressure/temperature conditions (approximately 1% rated power)

(4) Phase IV: low-power testing (1 to 5% rated power)

These phases are distinct; each consists of a separate set of operations and testing. Together they include the full sequence of activities associated with fuel loading and low-power testing up to 5% of rated power.

The staff has reviewed all of the events considered in FSAR Chapter 15 to determine the effect on public health and safety of operation of the Shoreham plant during the four phases. The staff has also reviewed the applicant's analyses in the motion for low-power operation. The evaluation was based on the availability of alternate ac power supplies provided by LILCO, with no credit assumed for the permanently installed diesel generators. The staff finds the applicant's submittal acceptable. A detailed evaluation of the four phases of operation is given below.

(1) Phase I: Fuel Load And Precriticality Testing

This phase includes only initial fuel loading and precriticality testing. The reactor will remain at essentially ambient temperature and atmospheric pressure. The reactor will not become critical. Any increase in temperature beyond ambient conditions will be from external heat sources such as recirculation pump heat. There will be no heat generation in the core.

The review of the FSAR Chapter 15 analyses showed that of the 38 accident or transient events addressed, 22 of the events could not occur during Phase I because of the operating conditions of the reactor. These 22 events involve operational modes or component operations that are not possible during this phase. Because no steam is available, all events that would require pressurized conditions are precluded. Other events are precluded by definition (e.g., control rod removal error during refueling, fuel assembly insertion error during refueling. A fuel insertion error during initial loading would be of no consequence because of the absence of decay heat). In addition to the 22 events that cannot occur, there are 5 events for which the component operation evaluated in Chapter 15 could occur, but the phenomena of interest in Chapter 15 could not exist.

All recirculation pump events--such as recirculation pump trip and abnormal startup of an idle recirculation pump--would be of interest only if they could affect core physics or thermal hydraulic conditions. With no nuclear heat generation in the core, there are no pertinent phenomena to evaluate.

The remaining 11 events addressed in Chapter 15 could occur. However, for events such as continuous rod withdrawal during startup and a control rod drop accident or a liquid radwaste tank rupture, there could be no radiological consequences because there are no fission products.

In Phase I, because the reactor will not become critical, there will be no heat generation in the core and no fission products. Because there will have been no power generation and, consequently, no decay heat, there will be no need for cooling systems to remove decay heat. Availability of ac power is not a safety concern during Phase I because there can be no radiological consequences regardless of whether or not ac power is available. Therefore, there is no risk to the public health and safety.

The staff finds the applicant's discussion of Phase I acceptable.

(2) Phase II: Cold Criticality Testing

This phase of operation includes cold criticality testing and very low power testing at essentially ambient temperature and atmospheric pressure. The power level during this phase of testing will be in the range of 0.0001% to 0.001% of rated power.

The review of FSAR Chapter 15 for Phase II operation indicates that most of the transients are not possible for the same reasons described in the Phase I evaluation. Because the fission product inventories in the core will be significantly less during Phase II operation than for conditions analyzed in the FSAR, the radiological impact for such transients as continuous control rod withdrawal during startup event, a fuel handling accident, and liquid radwaste tank rupture are significantly less severe than those that have already been analyzed and found acceptable in the FSAR.

Because of the low pressure condition, it is not reasonable to postulate a LOCA during Phases I and II. The NRC staff normally postulates breaks only in high energy lines; for Phases I and II, there are no high energy lines because the reactor system is at atmospheric pressure. However, even if a LOCA should occur during Phase II, there is sufficient time available for restoring offsite power should onsite power not be available.

If a LOCA should occur during Phase II testing, the applicant states that there would be time--on the order of months--available to restore makeup water for core cooling. At the decay heat levels that would exist under these conditions, heat transfer to the environment would remove a significant fraction of the decay heat. Realistic calculations would be expected to show that the temperature never exceeds 2200°F. However, even if no heat transfer from the fuel rods and equilibrium fission products are assumed (i.e., infinite operation at 0.001% power), this bounding analysis shows that more than 30 days is available to restore cooling before a temperature of 2200°F is exceeded. Therefore, even assuming the unavailability of onsite power sources, there is a high probability of restoring ac power and cooling the core.

Availability of ac power is not a safety concern during Phase II because many of the transients cannot occur, and, for those that can, it is very unlikely that fuel failure could occur. Even if it did, there can be no significant radiological consequences because the fission product inventory is very low. Therefore, there is no significant risk to the public health and safety.

The staff has reviewed the applicant's discussion of the safety significance of Phase II operation and finds it acceptable.

(3) Phases III and IV: Low-Power Testing Up to 5% of Rated Power

This phase of operation includes reactor heatup and pressurization. The power level is taken in progressive steps to 1% of rated power. After the required physics tests and other preoperational tests have been completed, the power level is taken in progressive steps from 1% to 5% of rated thermal power. All safety systems and their support systems--especially the automatic depressurization system (ADS), high pressure coolant injection (HPCI) system, reactor core isolation cooling (RCIC) system, core spray system, residual heat removal (RHR) system, and the remote shutdown system--will be operational during both phases of operation.

The staff review of the FSAR Chapter 15 analyses shows that of the 38 accident or transient events addressed, 5 cannot occur during Phase II. Generator load rejection and turbine trip with failure of generator breakers to open events are not possible because the generator will not be connected to the grid. Control rod removal error during refueling and fuel assembly insertion error during refueling are precluded by definition. A cask drop accident is precluded by design; hence it is not postulated in the analyses. The remaining 33 events are considered.

For all of the events, operation of the plant up to 5% of rated power will be bounded by the Chapter 15 analyses. For example, the turbine trip event is analyzed with the assumption that the limiting event occurs with the reactor operating at 105% of rated steam flow coupled with failure of the turbine bypass valves to open. Even this limiting event does not result in any fuel failures. The FSAR specifically notes that turbine trips at power levels less than 30% of rated power are bounded by the limiting analyses. Another example is the loss-of-feedwater-heating event. This event is analyzed with the assumption of continuous operation of the feedwater system and the most severe possible loss of feedwater heating, resulting in the injection of colder feedwater. For operation at power levels less than 5%, the impact of lost feedwater heating is minimal because of the low feedwater flow.

For low-power testing up to 5% power, the fission product inventory in the core will not exceed 5% of the values assumed in the FSAR. In a letter dated April 11, 1984, the applicant estimated that the fuel burnup during low-power testing will be less than 200 MWD/MTU. This low fuel burnup enhances safety in three ways: (1) the amount of decay heat present in the core following shutdown is substantially reduced resulting in reduced cooling system requirements; (2) the amount of radioactivity that could be released upon fuel failure is substantially reduced; and (3) if additional failures were postulated, the operator will have longer to take corrective actions.

For example, on loss of feedwater, the water level in the reactor will decrease at a slower rate than if the event occurred at 100% power. If HPCI or RCIC systems operate at least once during the first 4 days to restore normal water level, no additional make up will be required to prevent core uncovery as a result of boil-off. Similarly, in a loss-of-condenser-vacuum event, the operator will have more time to identify the decreasing vacuum and to take steps to remedy the situation before automatic actions--such as turbine trip, feed pump trip, or main steam isolation--occur. Another example is the main steam isolation valve closure event. At 5% power, the amount of heat produced upon isolation of the reactor vessel (which is followed by a reactor trip) results in a much slower pressure and temperature increase than would be experienced at 100% power. This gives the operator more time to manually initiate reactor cooling rather than relying on automatic action. In effect, the operator may end the transient before there is any substantial impact on the plant.

Another factor contributing to the enhanced safety during low-power testing is the reduction in the required capacity for mitigating systems. Because of the lower levels of decay heat present following operation at 5% power, the demand for core cooling and auxiliary systems is substantially reduced, permitting the operation of fewer systems and components to mitigate any event. It follows that the ac power requirements for event mitigation are substantially reduced for 5% power operation as compared to 100% power operation. (Five minutes after shutdown, about 42 gpm makeup is required to compensate for boil-off; after 8 hours, 12 gpm is required.)

For the fuel handling accident, the limiting consequences case would result from assuming an equilibrium concentration of fission products in fuel elements as a result of continuous operation at a 5% power level. Because the operation will result in very little fuel burn up, it is very unlikely that fuel assemblies will be removed from the Shoreham vessel during the low-power license period. However, assuming that an irradiated fuel assembly were removed from the core and dropped, the staff calculated consequences to the thyroid approximately equal to those given in the SER (16 and 2 rem for the thyroid and whole body, respectively, at the exclusion area boundary, and less than 1.0 rem for both the thyroid and whole body at the low population zone). The reason for this is that the fuel handling accident analyzed in the SER assumed that the accident occurred following full power operation (a factor of 20 higher than at 5%) and that the filter efficiency of the standby gas treatment system (SGTS) was 95% (reduction in the iodine releases by a factor of 20). Assuming that a loss of power eliminated the use of the SGTS, the two factors would cancel each other and the doses would be the same. The whole body doses, on the other hand, would be about a factor of 20 less than those reported in the SER because of the assumed low power level. The analysis considered a fission product inventory produced through continuous reactor operation at 5% power for 3 years. It is very unlikely that Shoreham will operate this way for 3 years, and the fission product inventory may be less than assumed. The 3-year fission product activity was assumed because it demonstrated that even given the most pessimistic design-basis accident fission product and dose assumption, operation would be acceptable.

Containment Isolation

The applicant has evaluated the response of the primary containment for the events analyzed in FSAR Chapter 15 that require the assumption of the unavailability of offsite ac power for operation during Phases III and IV. The most limiting event was found to be the LOCA. For this event, the applicant evaluated both containment isolation provisions and containment pressure-temperature response.

With respect to containment isolation, in a letter dated April 11, 1984, the applicant gave the results of an evaluation of all containment penetrations to ensure adequate isolation capability. This evaluation showed that only two 3/4-inch-diameter valves required prompt closure capability to ensure containment integrity. For these two valves, containment integrity was threatened only in the unlikely event of a breach in the reactor building closed loop cooling water system inside containment coincident with a LOCA. For all other LOCAs, containment integrity was ensured for all penetrations, including the above-mentioned valves. To ensure containment integrity in a timely manner for this condition, the applicant has committed to assign an equipment operator to the reactor building whenever the reactor vessel is pressurized during Phases III and IV.

The staff has evaluated the applicant's study of containment integrity for these events. With the applicant's commitment to station a person to ensure containment integrity for the case of a breach in the reactor building closed loop cooling water system, the staff concurs that containment integrity is ensured for all LOCAs.

The applicant has evaluated the response of the primary containment in the unlikely event of loss-of-offsite ac power, pipe break outside containment, and a feedwater line break. For all cases, the applicant found that suppression pool cooling would not be required for about 30 days to limit pressure and temperature within the containment to below design values. The staff concurs with the applicant's evaluation and finds this time more than sufficient to provide pool cooling. Therefore, the staff concludes that the containment is not threatened for the above events.

The applicant has also performed a detailed analysis of the drywell temperature response to the total loss of drywell cooling. The analysis was performed for several different values of drywell initial temperature and relative humidity, with the reactor at 100% power and 5% power. The calculated drywell response to these transients indicated that the maximum normal operating limit of 145°F will be exceeded shortly after the total loss of drywell cooling; however, the drywell temperature response is still enveloped by the environmental qualification conditions of the safety-related equipment in the primary containment.

The staff has reviewed the applicant's analyses and agrees with the conclusion that the safety-related equipment would be expected to function under the postulated loss-of-drywell cooling capability.

LOCA Analysis

Of all the transients and accidents, the LOCA is the most limiting with regard to the unavailability of ac power. Other transients and accidents are less severe. For small-break accidents, RCIC and HPCI systems will be used for mitigation. All components (other than room cooling) required for operation of RCIC and HPCI systems are completely independent of ac power. HPCI and RCIC systems use steam for motive power and dc power for initial valve operation and turbine control. No core damage is involved for small breaks because the RCIC and/or HPCI system(s) will maintain the reactor vessel water level within normal operating limits.

In the worst situation (a large-break LOCA) where the vessel pressure decreases rapidly, RCIC and HPCI systems will not be operable. Because ac-driven ECCS pumps are assumed to be unavailable, the reactor vessel level decreases rapidly, the reactor scrams, and the main steam isolation valves close. The applicant, in a letter dated April 6, 1984 (SNRC-1035), submitted a General Electric Co. (GE) analysis for the scenario described above. GE performed the analysis to determine the time to reach 10 CFR 50.46 limits. Four cases were considered:

(1) The first case uses a core thermal peaking factor of approximately 5. A peak rod maximum average planar linear heat generation rate (MAPLHGR) of 1.34 kW/ft was used. Using approved 10 CFR 50.46, Appendix K models and assumptions, GE calculated a core uncovery time for infinite reactor operation at 5% power. This case indicates that 55 minutes is required to reach the peak cladding temperature limit of 2200°F. Even at 55 minutes, no fuel failures were predicted.

(2) The second case utilizes a core thermal peaking factor of 3.38. A peak rod MAPLHGR of 0.91 kW/ft was used. Using approved 10 CFR 50.46, Appendix K models and assumptions, GE calculated core uncovery time for infinite reactor operation at 5% power. This case indicates that 86 minutes is required to reach the peak cladding temperature limit of 2200°F. No fuel failures were predicted.

(3) The third case takes into account a bound on the expected operating history of the core during the startup phase. A core thermal peaking factor of 3.38 corresponding to a peak rod MAPLHGR of 0.91 kW/ft was used. Approved 10 CFR 50.46, Appendix K models and assumptions were used. This case indicates that 110 minutes is required to reach the peak cladding temperature limit of 2200°F. No fuel failures were predicted.

(4) Finally, a LOCA analysis without the 10 CFR 50.46, Appendix K, criteria was performed. A core thermal peaking factor of 3.38 corresponding to a peak rod MAPLHGR of 0.91 kW/ft was assumed. This case takes into account a bound on the expected operating history of the core during the startup test phase. The results indicate that 3 to 4 hours would be available before the 2200°F limit was reached. No fuel failures were predicted.

It is expected that no more than 30 minutes will be needed to restore power to the ECCS pumps from alternate ac sources. The GE analysis indicates that 1 to 4 hours will be available for restoring ac power during a LOCA with simultaneous loss of offsite power. The staff finds this acceptable.

SER Table 8.1 depicts the arrangement of various safety systems. Division I supplies power to core spray pump A and LPCI pump A; Division II supplies power to core spray pump B and LPCI pump B; and Division III supplies power to LPCI pumps C and D. Prompt restoration of power to any one of the three divisions will ensure availability of ac power to at least two of the ECCS pumps. One of the four mobile diesels can supply power to one ECCS pump in one division. One of the six ECCS pumps is sufficient to provide adequate core cooling to stay within the limits of 10 CFR 50.46.

At the March 29, 1984 meeting, the applicant described the use of the procedures and training of operators to perform the procedural actions during a loss of offsite power. Because of the time available and operator training, there is a high probability of restoring power to ECCS pumps from the alternate ac power sources. Further evaluation of operator training and procedures is found in Section 13.5 of this supplement.

On the basis of its evaluation, the staff has concluded that there is reasonable assurance that the 10 CFR 50.46 criteria will not be violated. Therefore, there is no significant risk to the public health and safety.

23 CONCLUSIONS

The staff has reviewed the applicant's submittal for low-power operation of the Shoreham plant. The staff has performed scoping calculations to verify the results presented by the applicant and has considered the effect of loss of all ac power on transients and accidents. On the basis of this review and with the imposition of the special License Conditions and Technical Specifications noted in this SSER for this mode of operation, the staff finds that operation of Shoreham at power levels up to 5% of rated power without the availability of the permanently installed emergency diesel generators presents no significant risk to the public health and safety.

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Supplement No. 5 (SSER 5) to the Safety Evaluation Report on Long Island Lighting Company's application for a license to operate the Shoreham Nuclear Power Station, Unit 1, located in Suffolk County, New York, has been prepared by the Office of Nuclear Reactor Regulation of the U. S. Nuclear Regulatory Commission. This supplement addresses several items that have been reviewed by the staff since the previous supplement was issued.

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