UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322 (OL)
	)	
(Shoreham Nuclear Power Station, Unit 1)	)	
	)	

AFFIDAVIT OF DR. GLENN G. SHERWOOD,
DR. ATAMBIR S. RAO, AND MR. EUGENE C. ECKERT

Glenn G. Sherwood, Atambir S. Rao, and Eugene C. Eckert being duly sworn, depose and state as follows:

(1) My name is Glenn G. Sherwood. I am employed by the General Electric Company as Manager, Safety and Licensing Operation. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I have been employed in this position since 1976. My responsibilities include supervision of the preparation of licensing submittals for General Electric BWRs, including analyses performed in Chapter 15 of safety analysis reports. In particular, I have been involved in the supervision of licensing matters for the Shoreham Nuclear Power Station since the initial submittal of the Shoreham Final Safety Analysis Report (FSAR). In this regard, I am familiar with the analyses performed in Chapter 15 of that document. From 1974, when I joined General Electric,

to 1976, I was the Manager, Program Control Section. My responsibilities included managing engineering and manufacturing work flow for General Electric's nuclear group. I have a Bachelor of Science degree in Engineering from the U.S. Naval Academy and a Ph.D. in Engineering from the University of Michigan.

(2) My name is Atambir S. Rao. I am employed by the General Electric Company as Manager, Plant Safety Systems Engineering. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I was appointed to my present position in 1984. My responsibilities include ECCS performance analysis, containment performance response analysis, and plant safety performance evaluations, including FSAR safety analyses. I have previously held a number of positions relating to accident and transient analyses since I first joined General Electric in 1973. Earlier responsibilities have included modeling and analyzing the thermal hydraulic behavior of BWR fuel following loss of coolant accidents, assessing the implication of advances in heat transfer, fluid mechanics, thermodynamics and two-phase flow on overall BWR system response during transients and loss of coolant accidents, developing emergency operator guidelines, and assessing containment thermal hydraulic and radiological response for various

accidents and transients. I have been assigned as Manager, Emergency Core Cooling Systems (ECCS) Engineering (1979-80), and Manager, Containment and Radiological Engineering (1982-84). I received a Ph.D and a Masters degree in Mechanical Engineering from the University of California, Berkeley, and a Bachelor of Technology in Mechanical Engineering from the Indian Institute of Technology, Kanpur, India.

(3) My name is Eugene C. Eckert. I am employed by the General Electric Company as Manager, Power Transient Performing Engineering, a position I have held since 1971. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I am responsible for establishing the simulation requirements of the computer models needed to perform transient analyses, development of design procedures evaluation of BWR stability, and evaluation and specification of the functional protection systems required for reactor abnormal transient protection. Immediately upon joining General Electric Company in September 1959, I participated in assignments which included large jet engine control design, aircraft nuclear propulsion control analysis, nuclear submarine kinetics and control analysis, and industrial control simulation analysis at GE's Research and Development Center. In 1962, I joined General Electric's Nuclear Energy Division to

work on Boiling Water Reactor simulation and dynamic analysis. I have been responsible for design and licensing documentation of the dynamic analysis for several GE BWRs and have participated in initial startup testing of many of the units. I received a Bachelor of Science Degree in Electrical Engineering from Valparaiso University in Indiana in 1958. I attended Stanford University under an Oak Ridge Fellowship and received a Master of Science Degree in Engineering Science in August 1959.

(4) Chapter 15 of the Shoreham FSAR provides the results of analyses for the spectrum of accident and transient events that must be accommodated by the Shoreham plant to demonstrate compliance with the NRC's regulations. This portion of the safety analysis is performed to evaluate the ability of the plant to operate without undue risk to the health and safety of the public. The Shoreham FSAR was submitted to the NRC Staff for review and has been approved by the Staff in its Safety Evaluation Report for Shoreham (NUREG-0420).

(5) At the request of the Long Island Lighting Company, General Electric, in conjunction with cognizant LILCO and Stone & Webster personnel, has reviewed all of the events considered in Chapter 15 of the FSAR to determine the effect on public health and safety of the operation of the Shoreham plant

during fuel load, criticality testing and low power operations. Although the FSAR considers all phases of the operation of the plant from fuel load to operation at 100% power, this review was performed specifically to confirm that operation of the Shoreham plant during low power operation will pose no undue risk to public health and safety. The review of Chapter 15 was divided into three parts: (1) fuel load and precriticality testing (Phase I), (2) cold criticality testing (Phase II), and (3) low power testing up to 5% of rated power (Phases III and IV).1/ The review was based upon the same criteria and bases as the original Chapter 15 analyses. Where assumption of a loss or unavailability of offsite power was required in the original analyses, potential unavailability of the TDI diesel generators was considered in this review.

(6) The General Electric review of Chapter 15 confirms that operation during the phases identified above will not result in any undue risk to the public health and safety. In fact, the risk from any Chapter 15 event during both the fuel load and precriticality phase and the cold criticality testing phase is essentially non-existent. The risk to the

---

1/ Parts (1) and (2) correspond to Phases I and II, respectively, as described in the Affidavit of Messrs. Notaro and Gunther. Part (3) corresponds to Phases III and IV, combined, as described in that affidavit.

public health and safety from the Chapter 15 events postulated for low power testing up to 5% of rated power is small in comparison to the risks already found acceptable for 100% power operation. As already indicated, this review considered the impact of potential diesel unavailability.

Phase I: Fuel Loading and Precriticality Testing

(7) This phase of operation of the Shoreham plant includes only initial fuel loading and precriticality testing. The reactor will remain at essentially ambient temperature and atmospheric pressure. The reactor will not be taken critical. Any increase in temperature beyond ambient conditions will be due only to external heat sources such as recirculation pump heat. There will be no heat generation in the core. Details of the steps to be performed during these operations are described in the Phase I discussion in the affidavit submitted by Messrs. Notaro and Gunther.

(8) The review of the Chapter 15 analysis revealed that of the 38 accident or transient events addressed in Chapter 15, 18 of the events could not occur during Phase I because of the operating conditions of the plant. An additional 5 events could physically occur, but given the plant conditions, could not constitute events in the context of the Chapter 15

safety analysis. The remaining 15 events could possibly occur, although occurrence is highly unlikely given the plant conditions. In any event, it is readily apparent that the potential consequences of these 15 events would be trivial. Exhibit 1 below lists the category into which each Chapter 15 event falls.

(9) The 18 Chapter 15 events which could not occur during Phase I are precluded by the operating conditions of the reactor. These events all involve operating modes or component operation which are not possible during this phase. For example, during fuel loading and precriticality testing, the reactor is at essentially ambient temperature and atmospheric pressure. Accordingly, no steam is available. Thus, all events which would require pressurized conditions are precluded. Events such as turbine trip (FSAR § 15A.1.2), loss of feedwater heating (FSAR § 15A.1.8) and inadvertent opening of a safety relief valve require the generation of steam for the event to occur. Similarly, there is no steam flow to interrupt, thus precluding an MSIV closure event (FSAR § 15A.1.4). Other events are precluded by definition. Thus, events such as continuous control rod withdrawal during power range operation (FSAR § 15A.1.11) and operation of a fuel assembly in an improper location (FSAR § 15A.1.16) cannot be postulated.

(10) In addition to the 18 events which simply 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 (FSAR § 15A.1.20) and abnormal startup of an idle recirculation pump (FSAR § 15A.1.25), would be of interest only if they could affect core physics or thermal-hydraulic conditions. With no heat generation or boiling in the core, there are no pertinent phenomena (such as temperature differences or void collapses) to evaluate. Another example, the core coolant temperature increase event (FSAR § 15.A.1.26), postulates a loss of RHR cooling. Even if the RHR system was operated in Phase I, there would be no temperature increase from decay heat to evaluate should the RHR system be lost.

(11) The remaining 15 events addressed in Chapter 15 could possibly occur. However, our review established that all are trivial events which have no potential to impact public health and safety. Prior to initial criticality, there are no fission products in the core and no decay heat exists. It follows that core cooling is not required. In addition, with no fission product inventory, there are no fission product releases possible. Thus, for reactor events such as a control

rod removal error (FSAR § 15A.1.13) and a control rod drop (FSAR § 15.1.33) and for non-reactor events such as a fuel handling accident (FSAR § 15.1.36) or a liquid radwaste tank rupture (FSAR § 15.1.32), there could be no radiological consequences. Therefore, there is no risk to public health and safety.

(12) Even a loss of coolant accident (FSAR § 15.1.34) could have no radiological consequences during Phase I. No core cooling is required. No fission product release is possible. The fuel simply could not be challenged by a complete draindown of the reactor vessel for an unlimited period of time.

(13) In summary, the review of Chapter 15 events for fuel loading and precriticality testing indicates that many Chapter 15 events simply cannot occur, and for those that can, there can be no radiological consequences. Therefore, there is no possible risk to the public health and safety. This conclusion is not affected by any postulated diesel generator unavailability because it is in no way dependent on the availability or unavailability of any AC power.

Phase II: Cold Criticality Testing

(14) This phase of low power testing of the Shoreham

plant will include cold criticality testing of the plant at essentially ambient temperature and atmospheric pressure. The power level during this phase of testing will be in the range of .0001% to .001% of rated power. Details of the testing to be performed during this phase are described in the Notaro Affidavit.

(15) The review of Chapter 15 revealed that of the 38 accident or transient events included there, 15 of the events could not occur because of the operating conditions of the plant during Phase I. See Exhibit 2. A number of these events are not possible because the reactor will be at essentially ambient temperature and pressure and no steam will be generated. For example, the generator load rejection event (FSAR § 15A.1.1) could not occur during this testing phase because steam is needed to drive the main turbine generator to permit connecting it to the LILCO transmission system. Another example, the loss of condenser vacuum event (FSAR § 15A.1.21), could not occur because it assumes that steam is available to draw a vacuum in the main condenser. A third example, the inadvertent HPCI pump start event (FSAR § 15A.1.10), could not occur because there will be no steam available to power the HPCI pump, a steam driven ECCS pump. Other Chapter 15 events could not occur because they are precluded by the configuration

of the plant during this phase of low power testing. An example of this type of event is the MSIV closure (FSAR § 15A.1.4). The MSIVs will normally be closed throughout all of the operations conducted during this phase of low power testing. In any event, there is no steam generated by the reactor to flow through the steam lines.

(16) In addition to the 15 events that could not occur during Phase I, many of the 23 events remaining in the Chapter 15 analysis are far less likely to occur during low power testing than during normal operations. For example, the recirculation pump trip (FSAR § 15A.1.20), the recirculation pump seizure (FSAR § 15A.1.22), the recirculation flow control failures (FSAR § 15A.1.23 and 24) and the abnormal startup of idle recirculation pump (FSAR § 15A.1.25) events, although physically possible, are not as likely to occur because the recirculation pumps are used for only limited periods of time during this phase of the testing program. Similarly, the loss of feedwater event (FSAR § 15A.1.18) is very unlikely because little, if any, make-up water will have to be supplied to the reactor. Moreover, make-up water would not normally be supplied by the feedwater system under these conditions. Other very unlikely events include miscellaneous small releases outside primary containment (FSAR § 15.1.29), off design

operational transient as a consequence of instrument line failure (FSAR § 15.1.30), and feedwater system piping break (FSAR § 15.1.37). Thus, many of the Chapter 15 events that are physically possible during Phase II remain very unlikely in light of the plant conditions that will then exist.

(17) Nonetheless, all 23 possible events contained in Chapter 15 were reviewed to reaffirm that the consequences of these events, should one occur during Phase I of low power testing, would be bounded by the consequences analyzed for the event considered in the FSAR. A discussion of some of the 23 possible events contained in Chapter 15 illustrates the basis for this conclusion. The continuous control rod withdrawal during startup event (FSAR § 15A.1.12) is applicable to operation in the power, source and/or intermediate range of operation. During cold functional criticality testing, the reactor will operate in the source and intermediate ranges and therefore the conclusions contained in Chapter 15 are applicable to this event should it occur during this phase of low power testing. As the FSAR indicates, this event would not result in any release of radioactive material from the fuel at any power level. Another example is the fuel handling accident (FSAR § 15.1.36). As stated in the FSAR, the most severe fuel handling accident from a radiological viewpoint is a dropping

of the fuel assembly onto the top of the core. The FSAR analysis assumes that the fuel contains a fission product inventory equivalent to operation of 1000 days at full rated power. This assumption results in an equilibrium fission product concentration at the time the reactor is shut down. But as already noted, the fission product inventories in the core will be significantly less during Phase II low power testing than the inventories analyzed in the FSAR because of the extremely low power levels (.0001% to .001% of rated power) achieved during this testing. Thus, even if a handling accident took place and fuel damage did occur, there would be significantly less fission products to be released from the core than those that have already been analyzed and found acceptable in the FSAR. A third example is the liquid radwaste tank rupture event (FSAR § 15.1.32). This event assumes the rupture of a radwaste tank that contains a substantial amount of contaminated liquids generated during the operation of the reactor. But again, since Phase II low power testing results in insignificant power levels in the reactor, there will be little, if any, radioactive liquids in the radwaste tank should such a rupture occur. Thus, even the minimal consequences already described in the FSAR for the design basis event would be further reduced under these low power testing conditions. For each of these events, the review concluded that the consequences are significantly

less severe for any event occurring during the cold functional criticality testing than for the event analyzed in Chapter 15. To summarize, because of the extremely low power levels reached during this testing phase, fission product inventory in the core will be only a small fraction of that assumed for the Chapter 15 analyses. As indicated above, the FSAR assumes operation at 100% power for 1000 days in calculating fission product inventory; the inventory during Phase II low power testing will be less than one one-hundred-thousandth (.00001) of the fission product inventory assumed in the FSAR. Consequently, none of the events analyzed in Chapter 15 could result in a release of radioactivity during cold criticality testing that would harm the public health and safety.

(18) The review of Chapter 15 events for Phase II testing and the conclusions reached are unaffected by any unavailability of the TDI diesels. Of the 23 possible Chapter 15 events reviewed, 20 of the events in the FSAR do not require the assumption of loss or unavailability of offsite AC power. See Exhibit 2. Thus, our conclusions for these 20 of the 23 possible events are independent of the status of the diesels.

(19) The three events that do assume loss or unavailability of offsite AC power are (1) pipe breaks inside the primary containment (LOCA) (FSAR § 15.1.34), (2) feedwater

system piping break (FSAR § 15.1.37), and (3) the loss of AC power event (FSAR § 15A.1.19). With respect to these events, the LOCA would be the most limiting event. The review has shown that if a LOCA did occur during the cold criticality testing phase, however remote that possibility, there would be time on the order of months available to restore make-up water for core cooling. At the power levels achieved during Phase II, fission product inventory is very low. At most, decay heat will, on the average, be a fraction of a watt per rod, with no single rod exceeding approximately 2 watts. This is less, roughly, than the heat output of a Christmas tree bulb. It follows that the fuel cladding temperature would not exceed the limits of 10 CFR § 50.46 and Appendix K even after months without cooling and without any source of AC power.

(20) The loss of AC power event (FSAR § 15A.1.19) and the feedwater system piping break (FSAR § 15.1.37) under cold criticality testing conditions do not rely on the diesel generators for mitigation of the event. For these events, since no loss of coolant occurs and the decay heat is minimal, core cooling is achieved, without AC power, using the existing core water inventory and heat losses to ambient, for essentially unlimited periods of time. In any event, as demonstrated in the Schiffmacher Affidavit, AC power sources can and will be

readily supplied to the Shoreham plant even if one assumes the simultaneous loss of all three emergency diesel generators.

(21) In addition to our conclusions that the limiting LOCA event could not approach the limits of 10 CFR § 50.46 and Appendix K during Phase II low power testing, there are other reasons why our findings with respect to the three events that assume loss of AC power are independent of the availability of the TDI diesels. The LOCA (pipe break inside containment) and the feedwater system piping break postulate the double ended rupture of a piping system. Because the reactor will be at essentially ambient temperature and atmospheric pressure during Phase II, it is extremely unlikely that such a pipe break would ever occur. In fact, the NRC Staff does not require double ended ruptures to be postulated for low temperature and low pressure systems in safety analyses. Thus, these events are much less likely during cold criticality testing than during normal operation.

(22) The review of Chapter 15 events for cold criticality testing indicates that performance of these activities at Shoreham involves essentially no risk to the public health and safety. This conclusion is not affected by any postulated diesel unavailability. In fact, even if AC power were not available for extended periods of time, fuel design limits and

design conditions of the reactor coolant pressure boundary would not be approached or exceeded as a result of anticipated operational occurrences, and the core would be adequately cooled in the unlikely event of a postulated accident.

Phases III and IV:
<u>Low Power Testing Up To 5% of Rated Power</u>

(23) These aspects of low power testing will include operation of the plant at power levels up to 5% of rated power. Details of the testing to be performed during this phase of operation are described as Phases III and IV in the Notaro Affidavit.

(24) The review of the 38 Chapter 15 events for these phases of low power testing operations revealed that two of the events in Chapter 15, generator load rejection (FSAR § 15A.1.1) and turbine trip with generator breaker failure (FSAR § 15.1.2) cannot occur because the generator will not be connected to the grid during these phases of testing. A third event, the cask drop, is precluded by design as stated in FSAR § 15.1.28. See Exhibit 3.

(25) Of the remaining 35 events that can occur during this phase of operation, 31 of the events do not assume loss or unavailability of AC power. For each of these 31 events,

operation of the plant up to 5% of rated power will be bounded by the Chapter 15 analysis. Since the Chapter 15 analysis considers all possible phases of plant operation, it follows that operation at 5% can result in consequences less severe than those analyzed in Chapter 15. For example, the turbine trip event (FSAR § 15A.1.2) assumes 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. FSAR § 15A.1.2 specifically notes that turbine trips at power levels less than 30% of rated power are bounded by the limiting analysis. Another example is the loss of feedwater heating event (FSAR § 15A.1.8). This event assumes 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. Since these analyses are not required to assume the absence of AC power, potential unavailability of the TDI diesels has no effect on the assessment of these events.

(26) Not only are the results of these 31 events bounded by the Chapter 15 analysis, the consequences of these events are also less than the consequences stated in the FSAR.

First, the power limitations during 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 fact, because of the intermittant type of operations conducted during low power testing, equilibrium fission product inventory for even 5% power is unlikely to be achieved. This low fission product inventory reduces risk in two ways: (a) the amount of decay heat present in the core following shutdown is substantially reduced, and (b) the amount of radioactivity that could be released upon fuel failure is substantially reduced.

(27) The second factor contributing to the significantly lower risk 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 mean that it takes longer for the plant to reach setpoints and limits. For example, on loss of feedwater (FSAR § 15A.1.18), the water level in the reactor will decrease at a slower rate than if the event occured at 100% power. This gives the operator more time to act manually to restore feedwater before an automatic action takes place. Similarly, in the loss of condenser vacuum event (FSAR § 15.A.1.21), 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, feedpump trip or main steam isolation occur. Another example is the main steam isolation valve closure event (FSAR § 15A.1.4). At five percent power, the amount of heat produced upon isolation of the reactor vessel (which is followed by a reactor scram) 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.

(28) The third factor contributing to the significantly lower risk 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.

(29) As already noted, only four of the events analyzed in Chapter 15 require the assumption of the

unavailability of offsite AC power for operation during Phases III and IV. Of these four events, the loss of coolant accident is the most limiting event. The Chapter 15 LOCA analysis assumes the unavailability of offsite AC power. This is a conservative licensing assumption. In fact, as described in detail in the Schiffmacher Affidavit, there are multiple sources of AC power available to the Shoreham site (e.g., emergency diesel generators, two normal sources of offsite power, blackstart gas turbines at Holtsville, Southhold, and East Hampton, a blackstart gas turbine on the Shoreham site, and mobile diesel generators). Thus, AC power will be available at Shoreham to mitigate a loss of coolant accident during low power operations up to 5% rated power. In the unlikely event offsite AC power is lost, it can be restored within sufficient time to prevent exceeding the limits of 10 CFR § 50.46 and Appendix K. GE has determined that for 5% power so long as reflooding of the core has occurred within approximately one hour, § 50.46 criteria will be met.2/ As the Schiffmacher Affidavit demonstrates, power can be restored to Shoreham within minutes. An evaluation has been performed to assure the adequacy of containment isolation in the event AC power sources

---

2/ As shown in the Exhibit 4 below, lower power levels will result in more time to restore power and core cooling for a postulated LOCA. Thus, for 1% power approximately 5 hours are available.

cannot provide immediate isolation in a LOCA. Based upon the results of this evaluation, we have concluded that through the use of appropriate manual action, containment isolation can be accomplished in a timely manner.

(30) For the other three events, (1) loss of AC power (FSAR § 15A.1.19), (2) pipe break outside containment (PBOC) (steam line break accident) (FSAR § 15.1.35) and (3) feedwater system piping break (FSAR § 15.1.37), the reactor would automatically isolate. This isolation is not dependent upon the availability of AC power. For all three events, both HPCI and RCIC would be available to provide reactor coolant makeup. Given the heat capacity of passive heat sinks such as structural steel, suppression pool cooling would not be required for about 30 days. Therefore, there is ample time for AC power to be restored. Furthermore, assuming loss of offsite power in the context of pipe breaks outside containment (main steam line break accident and feedwater system break accident) is a conservatism which stems from the PBOC analysis methodology. That methodology requires the assumption of a loss of offsite power for pipe breaks which result directly in a plant trip of the turbine generator system or reactor protection system. Notwithstanding grid stability analyses, it is assumed that plant trips could cause perturbations of the grid, resulting in the

loss of offsite power. For operation at 5% power or less, however, the turbine generator is not connected to the grid, and therefore any assumption of induced perturbation to the offsite grid is not valid.

(31) Based on our review of Chapter 15, operation of the plant during low power testing up to levels of 5% of rated power poses no undue risk to the public health and safety. In fact, any risk is substantially less than that already found to be acceptable by the NRC Staff in its review of Chapter 15. Even if the Shoreham TDI diesels are assumed to be unavailable, there is ample assurance that fuel design limits and design conditions of the reactor coolant pressure boundary will not be exceeded as a result of anticipated operational occurrences, and that the core will be cooled and containment integrity and other vital functions will be maintained in the event of any postulated accident.

Glenn G. Sherwood

Atambir S. Rao

Atambir S. Rao

Eugene C. Eckert

STATE OF New York)
) To-wit:
COUNTY OF Westchester)

Subscribed to before me this 22nd day of March, 1984.

Jose M. Tejada

Notary Public

My commission expires:

JOSE M. TEJADA
Notary Public, State of New York
No. 03-4727173
Qualified in Bronx County
Cert. Filed in Westchester Co
Commission Expires March 30, 1984

Exhibit 1

FUEL LOAD AND PRECRITICALITY TESTING

	Chapter 15 Event	Event Category
1.	Generator Load Rejection	*
2.	Turbine Trip	*
3.	Turbine Trip with Failure of Generator Breakers to Open	*
4.	MSIV Closure	*
5.	Pressure Regulator Failure - Open	*
6.	Pressure Regulator Failure - Closed	*
7.	Feedwater Controller Failure - Maximum Demand	***
8.	Loss of Feedwater Heating	*
9.	Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	***
10.	Inadvertent HPCI Pump Start	*
11.	Continuous Control Rod Withdrawal During Power Range Operation	*

---

* Event not possible.

** Component operation possible but Chapter 15 phenomena cannot occur.

*** Event possible but no consequences.

12.	Continuous Rod Withdrawal During Reactor Startup	***
13.	Control Rod Removal Error During Refueling	***
14.	Fuel Assembly Insertion Error During Refueling	***
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly into an Improper Location	*
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	*
17.	Inadvertent Opening of a Safety/Relief Valve	*
18.	Loss of Feedwater Flow	***
19.	Loss of AC Power	***
20.	Recirculation Pump Trip	**
21.	Loss of Condenser Vacuum	*
22.	Recirculation Pump Seizure	**
23.	Recirculation Flow Control Failure - Decreasing Flow	**
24.	Recirculation Flow Control Failure With Increasing Flow	**
25.	Abnormal Startup of Idle Recirculation Pump	**
26.	Core Coolant Temperature Increase	***
27.	Anticipated Transients Without SCRAM (ATWS)	*
28.	Cask Drop Accident	*
29.	Miscellaneous Small Releases Outside Primary Containment	***

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	***
31.	Main Condenser Gas Treatment System Failure	*
32.	Liquid Radwaste Tank Rupture	***
33.	Control Rod Drop Accident	***
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	***
35.	Pipe Breaks Outside Primary Containment (Steam Line Break Accident)	*
36.	Fuel Handling Accident	***
37.	Feedwater System Piping Break	***
38.	Failure of Air Ejector Lines	*

COLD CRITICALITY TESTING

	Chapter 15 Event	Event Category	Assumes Unavailability of Offsite AC
1.	Generator Load Rejection	*	N/A
2.	Turbine Trip	*	N/A
3.	Turbine Trip with Failure of Generator Breakers to Open	*	N/A
4.	MSIV Closures	*	N/A
5.	Pressure Regulator Failure - Open	*	N/A
6.	Pressure Regulator Failure - Closed	*	N/A
7.	Feedwater Controller Failure - Maximum Demand	**	No
8.	Loss of Feedwater Heating	*	N/A
9.	Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	**	No
10.	Inadvertent HPCI Pump Start	*	N/A
11.	Continuous Control Rod Withdrawal During Power Range Operation	*	N/A

---

* Event not possible.

** Event possible but essentially no consequences.

12.	Continuous Rod Withdrawal During Reactor Startup	**	No
13.	Control Rod Removal Error During Refueling	**	No
14.	Fuel Assembly Insertion Error During Refueling	**	No
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly into an Improper Location	**	No
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	**	No
17.	Inadvertent Opening of a Safety/Relief Valve	*	N/A
18.	Loss of Feedwater Flow	**	No
19.	Loss of AC Power	**	Yes
20.	Recirculation Pump Trip	**	No
21.	Loss of Condenser Vacuum	*	N/A
22.	Recirculation Pump Seizure	**	No
23.	Recirculation Flow Control Failure - Decreasing Flow	**	No
24.	Recirculation Flow Control Failure With Increasing Flow	**	No
25.	Abnormal Startup of Idle Recirculation Pump	**	No
26.	Core Coolant Temperature Increase	**	No
27.	Anticipated Transients Without SCRAM (ATWS)	**	No
28.	Cask Drop Accident	*	N/A
29.	Miscellaneous Small Releases Outside Primary Containment	**	No

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	**	No
31.	Main Condenser Gas Treatment System Failure	*	N/A
32.	Liquid Radwate Tank Rupture	**	No
33.	Control Rod Drop Accident	**	No
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	**	Yes
35.	Pipe Breaks Outside Primary Containment (steam line break accident)	*	N/A
36.	Fuel Handling Accident	**	No
37.	Feedwater System Piping Break	**	Yes
38.	Failure of Air Ejector Lines	*	N/A

Exhibit 3

5% POWER

	Chapter 15 Event	Event Category	Assumes Unavailability of Offsite AC
1.	Generator Load Rejection	*	N/A
2.	Turbine Trip	**	No
3.	Turbine Trip with Failure of Generator Breakers to Open	*	N/A
4.	MSIV Closures	**	No
5.	Pressure Regulator Failure - Open	**	No
6.	Pressure Regulator Failure - Closed	**	No
7.	Feedwater Controller Failure - Maximum Demand	**	No
8.	Loss of Feedwater Heating	**	No
9.	Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	**	No
10.	Inadvertent HPCI Pump Start	**	No
11.	Continuous Control Rod Withdrawal During Power Range Operation	**	No

---

* Event cannot occur.

** Bounded by same event at higher power level per FSAR Chapter 15.

12.	Continuous Rod Withdrawal During Reactor Startup	**	No
13.	Control Rod Removal Error During Refueling	**	No
14.	Fuel Assembly Insertion Error During Refueling	**	No
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly Into an Improper Location	**	No
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	**	No
17.	Inadvertent Opening of a Safety/Relief Valve	**	No
18.	Loss of Feedwater Flow	**	No
19.	Loss of AC Power	**	Yes
20.	Recirculation Pump Trip	**	No
21.	Loss of Condenser Vacuum	**	No
22.	Recirculation Pump Seizure	**	No
23.	Recirculation Flow Control Failure - Decreasing Flow	**	No
24.	Recirculation Flow Control Failure - With Increasing Flow	**	No
25.	Abnormal Startup of Idle Recirculation Pump	**	No
26.	Core Coolant Temperature Increase	**	No
27.	Anticipated Transients Without SCRAM (ATWS)	**	No
28.	Cask Drop Accident	*	N/A
29.	Miscellaneous Small Releases Outside Primary Containment	**	No

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	**	No
31.	Main Condenser Gas Treatment System Failure	**	No
32.	Liquid Radwaste Tank Rupture	**	No
33.	Control Rod Drop Accident	**	No
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	**	Yes
35.	Pipe Breaks Outside Primary Containment (Steam Line Break Accident)	**	Yes
36.	Fuel Handling Accident	**	No
37.	Feedwater System Piping Break	**	Yes
38.	Failure of Air Ejector Lines	**	No

ECCS LOCA EVALUATIONS

Core Avg. Power (% of rated)	Peak Rod MAPLHGR (KW/ft)	Time to 10 CFR § 50.46 Limits (min)	10 CFR § 50.46 Limits: PCT (F°) (Limit 2200°)	10 CFR § 50.46 Limits: Local Oxidation (Limit 17%)	10 CFR § 50.46 Limits: Core Wide Oxidation (Limit 1%)
5.0	1.34	55	2200	6.5	less than 0.9
2.5	0.67	124	2200	8.4	less than 1.0
1.25	0.34	285	2100	9.0	1.0
.5	0.13	700	2000	9.0	1.0

ASSUMPTIONS: 10 CFR 50 Appendix K (Standard FSAR Basis)
Initial Conditions Based on Equivalent Core at Designated Core Average Power

Exhibit 4

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322 (OL)
	)	
(Shoreham Nuclear Power Station, Unit 1)	)	
	)	

AFFIDAVIT OF DR. GLENN G. SHERWOOD, DR. ATAMBIR S. RAO, AND MR. EUGENE C. ECKERT

Glenn G. Sherwood, Atambir S. Rao, and Eugene C. Eckert being duly sworn, depose and state as follows:

(1) My name is Glenn G. Sherwood. I am employed by the General Electric Company as Manager, Safety and Licensing Operation. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I have been employed in this position since 1976. My responsibilities include supervision of the preparation of licensing submittals for General Electric BWRs, including analyses performed in Chapter 15 of safety analysis reports. In particular, I have been involved in the supervision of licensing matters for the Shoreham Nuclear Power Station since the initial submittal of the Shoreham Final Safety Analysis Report (FSAR). In this regard, I am familiar with the analyses performed in Chapter 15 of that document. From 1974, when I joined General Electric,

to 1976, I was the Manager, Program Control Section. My responsibilities included managing engineering and manufacturing work flow for General Electric's nuclear group. I have a Bachelor of Science degree in Engineering from the U.S. Naval Academy and a Ph.D. in Engineering from the University of Michigan.

(2) My name is Atambir S. Rao. I am employed by the General Electric Company as Manager, Plant Safety Systems Engineering. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I was appointed to my present position in 1984. My responsibilities include ECCS performance analysis, containment performance response analysis, and plant safety performance evaluations, including FSAR safety analyses. I have previously held a number of positions relating to accident and transient analyses since I first joined General Electric in 1973. Earlier responsibilities have included modeling and analyzing the thermal hydraulic behavior of BWR fuel following loss of coolant accidents, assessing the implication of advances in heat transfer, fluid mechanics, thermodynamics and two-phase flow on overall BWR system response during transients and loss of coolant accidents, developing emergency operator guidelines, and assessing containment thermal hydraulic and radiological response for various

accidents and transients. I have been assigned as Manager, Emergency Core Cooling Systems (ECCS) Engineering (1979-80), and Manager, Containment and Radiological Engineering (1982-84). I received a Ph.D and a Masters degree in Mechanical Engineering from the University of California, Berkeley, and a Bachelor of Technology in Mechanical Engineering from the Indian Institute of Technology, Kanpur, India.

(3) My name is Eugene C. Eckert. I am employed by the General Electric Company as Manager, Power Transient Performing Engineering, a position I have held since 1971. My business address is General Electric Company, 175 Curtner Avenue, San Jose, California 95125. I am responsible for establishing the simulation requirements of the computer models needed to perform transient analyses, development of design procedures evaluation of BWR stability, and evaluation and specification of the functional protection systems required for reactor abnormal transient protection. Immediately upon joining General Electric Company in September 1959, I participated in assignments which included large jet engine control design, aircraft nuclear propulsion control analysis, nuclear submarine kinetics and control analysis, and industrial control simulation analysis at GE's Research and Development Center. In 1962, I joined General Electric's Nuclear Energy Division to

work on Boiling Water Reactor simulation and dynamic analysis. I have been responsible for design and licensing documentation of the dynamic analysis for several GE BWRs and have participated in initial startup testing of many of the units. I received a Bachelor of Science Degree in Electrical Engineering from Valparaiso University in Indiana in 1958. I attended Stanford University under an Oak Ridge Fellowship and received a Master of Science Degree in Engineering Science in August 1959.

(4) Chapter 15 of the Shoreham FSAR provides the results of analyses for the spectrum of accident and transient events that must be accommodated by the Shoreham plant to demonstrate compliance with the NRC's regulations. This portion of the safety analysis is performed to evaluate the ability of the plant to operate without undue risk to the health and safety of the public. The Shoreham FSAR was submitted to the NRC Staff for review and has been approved by the Staff in its Safety Evaluation Report for Shoreham (NUREG-0420).

(5) At the request of the Long Island Lighting Company, General Electric, in conjunction with cognizant LILCO and Stone & Webster personnel, has reviewed all of the events considered in Chapter 15 of the FSAR to determine the effect on public health and safety of the operation of the Shoreham plant

during fuel load, criticality testing and low power operations. Although the FSAR considers all phases of the operation of the plant from fuel load to operation at 100% power, this review was performed specifically to confirm that operation of the Shoreham plant during low power operation will pose no undue risk to public health and safety. The review of Chapter 15 was divided into three parts: (1) fuel load and precriticality testing (Phase I), (2) cold criticality testing (Phase II), and (3) low power testing up to 5% of rated power (Phases III and IV).1/ The review was based upon the same criteria and bases as the original Chapter 15 analyses. Where assumption of a loss or unavailability of offsite power was required in the original analyses, potential unavailability of the TDI diesel generators was considered in this review.

(6) The General Electric review of Chapter 15 confirms that operation during the phases identified above will not result in any undue risk to the public health and safety. In fact, the risk from any Chapter 15 event during both the fuel load and precriticality phase and the cold criticality testing phase is essentially non-existent. The risk to the

---

1/ Parts (1) and (2) correspond to Phases I and II, respectively, as described in the Affidavit of Messrs. Notaro and Gunther. Part (3) corresponds to Phases III and IV, combined, as described in that affidavit.

public health and safety from the Chapter 15 events postulated for low power testing up to 5% of rated power is small in comparison to the risks already found acceptable for 100% power operation. As already indicated, this review considered the impact of potential diesel unavailability.

Phase I: Fuel Loading and Precriticality Testing

(7) This phase of operation of the Shoreham plant includes only initial fuel loading and precriticality testing. The reactor will remain at essentially ambient temperature and atmospheric pressure. The reactor will not be taken critical. Any increase in temperature beyond ambient conditions will be due only to external heat sources such as recirculation pump heat. There will be no heat generation in the core. Details of the steps to be performed during these operations are described in the Phase I discussion in the affidavit submitted by Messrs. Notaro and Gunther.

(8) The review of the Chapter 15 analysis revealed that of the 38 accident or transient events addressed in Chapter 15, 18 of the events could not occur during Phase I because of the operating conditions of the plant. An additional 5 events could physically occur, but given the plant conditions, could not constitute events in the context of the Chapter 15

safety analysis. The remaining 15 events could possibly occur, although occurrence is highly unlikely given the plant conditions. In any event, it is readily apparent that the potential consequences of these 15 events would be trivial. Exhibit 1 below lists the category into which each Chapter 15 event falls.

(9) The 18 Chapter 15 events which could not occur during Phase I are precluded by the operating conditions of the reactor. These events all involve operating modes or component operation which are not possible during this phase. For example, during fuel loading and precriticality testing, the reactor is at essentially ambient temperature and atmospheric pressure. Accordingly, no steam is available. Thus, all events which would require pressurized conditions are precluded. Events such as turbine trip (FSAR § 15A.1.2), loss of feedwater heating (FSAR § 15A.1.8) and inadvertent opening of a safety relief valve require the generation of steam for the event to occur. Similarly, there is no steam flow to interrupt, thus precluding an MSIV closure event (FSAR § 15A.1.4). Other events are precluded by definition. Thus, events such as continuous control rod withdrawal during power range operation (FSAR § 15A.1.11) and operation of a fuel assembly in an improper location (FSAR § 15A.1.16) cannot be postulated.

(10) In addition to the 18 events which simply 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 (FSAR § 15A.1.20) and abnormal startup of an idle recirculation pump (FSAR § 15A.1.25), would be of interest only if they could affect core physics or thermal-hydraulic conditions. With no heat generation or boiling in the core, there are no pertinent phenomena (such as temperature differences or void collapses) to evaluate. Another example, the core coolant temperature increase event (FSAR § 15.A.1.26), postulates a loss of RHR cooling. Even if the RHR system was operated in Phase I, there would be no temperature increase from decay heat to evaluate should the RHR system be lost.

(11) The remaining 15 events addressed in Chapter 15 could possibly occur. However, our review established that all are trivial events which have no potential to impact public health and safety. Prior to initial criticality, there are no fission products in the core and no decay heat exists. It follows that core cooling is not required. In addition, with no fission product inventory, there are no fission product releases possible. Thus, for reactor events such as a control

rod removal error (FSAR § 15A.1.13) and a control rod drop (FSAR § 15.1.33) and for non-reactor events such as a fuel handling accident (FSAR § 15.1.36) or a liquid radwaste tank rupture (FSAR § 15.1.32), there could be no radiological consequences. Therefore, there is no risk to public health and safety.

(12) Even a loss of coolant accident (FSAR § 15.1.34) could have no radiological consequences during Phase I. No core cooling is required. No fission product release is possible. The fuel simply could not be challenged by a complete draindown of the reactor vessel for an unlimited period of time.

(13) In summary, the review of Chapter 15 events for fuel loading and precriticality testing indicates that many Chapter 15 events simply cannot occur, and for those that can, there can be no radiological consequences. Therefore, there is no possible risk to the public health and safety. This conclusion is not affected by any postulated diesel generator unavailability because it is in no way dependent on the availability or unavailability of any AC power.

Phase II: Cold Criticality Testing

(14) This phase of low power testing of the Shoreham

plant will include cold criticality testing of the plant at essentially ambient temperature and atmospheric pressure. The power level during this phase of testing will be in the range of .0001% to .001% of rated power. Details of the testing to be performed during this phase are described in the Notaro Affidavit.

(15) The review of Chapter 15 revealed that of the 38 accident or transient events included there, 15 of the events could not occur because of the operating conditions of the plant during Phase I. See Exhibit 2. A number of these events are not possible because the reactor will be at essentially ambient temperature and pressure and no steam will be generated. For example, the generator load rejection event (FSAR § 15A.1.1) could not occur during this testing phase because steam is needed to drive the main turbine generator to permit connecting it to the LILCO transmission system. Another example, the loss of condenser vacuum event (FSAR § 15A.1.21), could not occur because it assumes that steam is available to draw a vacuum in the main condenser. A third example, the inadvertent HPCI pump start event (FSAR § 15A.1.10), could not occur because there will be no steam available to power the HPCI pump, a steam driven ECCS pump. Other Chapter 15 events could not occur because they are precluded by the configuration

of the plant during this phase of low power testing. An example of this type of event is the MSIV closure (FSAR § 15A.1.4). The MSIVs will normally be closed throughout all of the operations conducted during this phase of low power testing. In any event, there is no steam generated by the reactor to flow through the steam lines.

(16) In addition to the 15 events that could not occur during Phase I, many of the 23 events remaining in the Chapter 15 analysis are far less likely to occur during low power testing than during normal operations. For example, the recirculation pump trip (FSAR § 15A.1.20), the recirculation pump seizure (FSAR § 15A.1.22), the recirculation flow control failures (FSAR § 15A.1.23 and 24) and the abnormal startup of idle recirculation pump (FSAR § 15A.1.25) events, although physically possible, are not as likely to occur because the recirculation pumps are used for only limited periods of time during this phase of the testing program. Similarly, the loss of feedwater event (FSAR § 15A.1.18) is very unlikely because little, if any, make-up water will have to be supplied to the reactor. Moreover, make-up water would not normally be supplied by the feedwater system under these conditions. Other very unlikely events include miscellaneous small releases outside primary containment (FSAR § 15.1.29), off design

operational transient as a consequence of instrument line failure (FSAR § 15.1.30), and feedwater system piping break (FSAR § 15.1.37). Thus, many of the Chapter 15 events that are physically possible during Phase II remain very unlikely in light of the plant conditions that will then exist.

(17) Nonetheless, all 23 possible events contained in Chapter 15 were reviewed to reaffirm that the consequences of these events, should one occur during Phase I of low power testing, would be bounded by the consequences analyzed for the event considered in the FSAR. A discussion of some of the 23 possible events contained in Chapter 15 illustrates the basis for this conclusion. The continuous control rod withdrawal during startup event (FSAR § 15A.1.12) is applicable to operation in the power, source and/or intermediate range of operation. During cold functional criticality testing, the reactor will operate in the source and intermediate ranges and therefore the conclusions contained in Chapter 15 are applicable to this event should it occur during this phase of low power testing. As the FSAR indicates, this event would not result in any release of radioactive material from the fuel at any power level. Another example is the fuel handling accident (FSAR § 15.1.36). As stated in the FSAR, the most severe fuel handling accident from a radiological viewpoint is a dropping

of the fuel assembly onto the top of the core. The FSAR analysis assumes that the fuel contains a fission product inventory equivalent to operation of 1000 days at full rated power. This assumption results in an equilibrium fission product concentration at the time the reactor is shut down. But as already noted, the fission product inventories in the core will be significantly less during Phase II low power testing than the inventories analyzed in the FSAR because of the extremely low power levels (.0001% to .001% of rated power) achieved during this testing. Thus, even if a handling accident took place and fuel damage did occur, there would be significantly less fission products to be released from the core than those that have already been analyzed and found acceptable in the FSAR. A third example is the liquid radwaste tank rupture event (FSAR § 15.1.32). This event assumes the rupture of a radwaste tank that contains a substantial amount of contaminated liquids generated during the operation of the reactor. But again, since Phase II low power testing results in insignificant power levels in the reactor, there will be little, if any, radioactive liquids in the radwaste tank should such a rupture occur. Thus, even the minimal consequences already described in the FSAR for the design basis event would be further reduced under these low power testing conditions. For each of these events, the review concluded that the consequences are significantly

less severe for any event occurring during the cold functional criticality testing than for the event analyzed in Chapter 15. To summarize, because of the extremely low power levels reached during this testing phase, fission product inventory in the core will be only a small fraction of that assumed for the Chapter 15 analyses. As indicated above, the FSAR assumes operation at 100% power for 1000 days in calculating fission product inventory; the inventory during Phase II low power testing will be less than one one-hundred-thousandth (.00001) of the fission product inventory assumed in the FSAR. Consequently, none of the events analyzed in Chapter 15 could result in a release of radioactivity during cold criticality testing that would harm the public health and safety.

(18) The review of Chapter 15 events for Phase II testing and the conclusions reached are unaffected by any unavailability of the TDI diesels. Of the 23 possible Chapter 15 events reviewed, 20 of the events in the FSAR do not require the assumption of loss or unavailability of offsite AC power. See Exhibit 2. Thus, our conclusions for these 20 of the 23 possible events are independent of the status of the diesels.

(19) The three events that do assume loss or unavailability of offsite AC power are (1) pipe breaks inside the primary containment (LOCA) (FSAR § 15.1.34), (2) feedwater

system piping break (FSAR § 15.1.37), and (3) the loss of AC power event (FSAR § 15A.1.19). With respect to these events, the LOCA would be the most limiting event. The review has shown that if a LOCA did occur during the cold criticality testing phase, however remote that possibility, there would be time on the order of months available to restore make-up water for core cooling. At the power levels achieved during Phase II, fission product inventory is very low. At most, decay heat will, on the average, be a fraction of a watt per rod, with no single rod exceeding approximately 2 watts. This is less, roughly, than the heat output of a Christmas tree bulb. It follows that the fuel cladding temperature would not exceed the limits of 10 CFR § 50.46 and Appendix K even after months without cooling and without any source of AC power.

(20) The loss of AC power event (FSAR § 15A.1.19) and the feedwater system piping break (FSAR § 15.1.37) under cold criticality testing conditions do not rely on the diesel generators for mitigation of the event. For these events, since no loss of coolant occurs and the decay heat is minimal, core cooling is achieved, without AC power, using the existing core water inventory and heat losses to ambient, for essentially unlimited periods of time. In any event, as demonstrated in the Schiffmacher Affidavit, AC power sources can and will be

readily supplied to the Shoreham plant even if one assumes the simultaneous loss of all three emergency diesel generators.

(21) In addition to our conclusions that the limiting LOCA event could not approach the limits of 10 CFR § 50.46 and Appendix K during Phase II low power testing, there are other reasons why our findings with respect to the three events that assume loss of AC power are independent of the availability of the TDI diesels. The LOCA (pipe break inside containment) and the feedwater system piping break postulate the double ended rupture of a piping system. Because the reactor will be at essentially ambient temperature and atmospheric pressure during Phase II, it is extremely unlikely that such a pipe break would ever occur. In fact, the NRC Staff does not require double ended ruptures to be postulated for low temperature and low pressure systems in safety analyses. Thus, these events are much less likely during cold criticality testing than during normal operation.

(22) The review of Chapter 15 events for cold criticality testing indicates that performance of these activities at Shoreham involves essentially no risk to the public health and safety. This conclusion is not affected by any postulated diesel unavailability. In fact, even if AC power were not available for extended periods of time, fuel design limits and

design conditions of the reactor coolant pressure boundary would not be approached or exceeded as a result of anticipated operational occurrences, and the core would be adequately cooled in the unlikely event of a postulated accident.

Phases III and IV:
Low Power Testing Up To 5% of Rated Power

(23) These aspects of low power testing will include operation of the plant at power levels up to 5% of rated power. Details of the testing to be performed during this phase of operation are described as Phases III and IV in the Notaro Affidavit.

(24) The review of the 38 Chapter 15 events for these phases of low power testing operations revealed that two of the events in Chapter 15, generator load rejection (FSAR § 15A.1.1) and turbine trip with generator breaker failure (FSAR § 15.1.2) cannot occur because the generator will not be connected to the grid during these phases of testing. A third event, the cask drop, is precluded by design as stated in FSAR § 15.1.28. See Exhibit 3.

(25) Of the remaining 35 events that can occur during this phase of operation, 31 of the events do not assume loss or unavailability of AC power. For each of these 31 events,

operation of the plant up to 5% of rated power will be bounded by the Chapter 15 analysis. Since the Chapter 15 analysis considers all possible phases of plant operation, it follows that operation at 5% can result in consequences less severe than those analyzed in Chapter 15. For example, the turbine trip event (FSAR § 15A.1.2) assumes 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. FSAR § 15A.1.2 specifically notes that turbine trips at power levels less than 30% of rated power are bounded by the limiting analysis. Another example is the loss of feedwater heating event (FSAR § 15A.1.8). This event assumes 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. Since these analyses are not required to assume the absence of AC power, potential unavailability of the TDI diesels has no effect on the assessment of these events.

(26) Not only are the results of these 31 events bounded by the Chapter 15 analysis, the consequences of these events are also less than the consequences stated in the FSAR.

First, the power limitations during 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 fact, because of the intermittant type of operations conducted during low power testing, equilibrium fission product inventory for even 5% power is unlikely to be achieved. This low fission product inventory reduces risk in two ways: (a) the amount of decay heat present in the core following shutdown is substantially reduced, and (b) the amount of radioactivity that could be released upon fuel failure is substantially reduced.

(27) The second factor contributing to the significantly lower risk 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 mean that it takes longer for the plant to reach setpoints and limits. For example, on loss of feedwater (FSAR § 15A.1.18), the water level in the reactor will decrease at a slower rate than if the event occured at 100% power. This gives the operator more time to act manually to restore feedwater before an automatic action takes place. Similarly, in the loss of condenser vacuum event (FSAR § 15.A.1.21), 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, feedpump trip or main steam isolation occur. Another example is the main steam isolation valve closure event (FSAR § 15A.1.4). At five percent power, the amount of heat produced upon isolation of the reactor vessel (which is followed by a reactor scram) 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.

(28) The third factor contributing to the significantly lower risk 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.

(29) As already noted, only four of the events analyzed in Chapter 15 require the assumption of the

unavailability of offsite AC power for operation during Phases III and IV. Of these four events, the loss of coolant accident is the most limiting event. The Chapter 15 LOCA analysis assumes the unavailability of offsite AC power. This is a conservative licensing assumption. In fact, as described in detail in the Schiffmacher Affidavit, there are multiple sources of AC power available to the Shoreham site (e.g., emergency diesel generators, two normal sources of offsite power, blackstart gas turbines at Holtsville, Southhold, and East Hampton, a blackstart gas turbine on the Shoreham site, and mobile diesel generators). Thus, AC power will be available at Shoreham to mitigate a loss of coolant accident during low power operations up to 5% rated power. In the unlikely event offsite AC power is lost, it can be restored within sufficient time to prevent exceeding the limits of 10 CFR § 50.46 and Appendix K. GE has determined that for 5% power so long as reflooding of the core has occurred within approximately one hour, § 50.46 criteria will be met.2/ As the Schiffmacher Affidavit demonstrates, power can be restored to Shoreham within minutes. An evaluation has been performed to assure the adequacy of containment isolation in the event AC power sources

---

2/ As shown in the Exhibit 4 below, lower power levels will result in more time to restore power and core cooling for a postulated LOCA. Thus, for 1% power approximately 5 hours are available.

cannot provide immediate isolation in a LOCA. Based upon the results of this evaluation, we have concluded that through the use of appropriate manual action, containment isolation can be accomplished in a timely manner.

(30) For the other three events, (1) loss of AC power (FSAR § 15A.1.19), (2) pipe break outside containment (PBOC) (steam line break accident) (FSAR § 15.1.35) and (3) feedwater system piping break (FSAR § 15.1.37), the reactor would automatically isolate. This isolation is not dependent upon the availability of AC power. For all three events, both HPCI and RCIC would be available to provide reactor coolant makeup. Given the heat capacity of passive heat sinks such as structural steel, suppression pool cooling would not be required for about 30 days. Therefore, there is ample time for AC power to be restored. Furthermore, assuming loss of offsite power in the context of pipe breaks outside containment (main steam line break accident and feedwater system break accident) is a conservatism which stems from the PBOC analysis methodology. That methodology requires the assumption of a loss of offsite power for pipe breaks which result directly in a plant trip of the turbine generator system or reactor protection system. Notwithstanding grid stability analyses, it is assumed that plant trips could cause perturbations of the grid, resulting in the

loss of offsite power. For operation at 5% power or less, however, the turbine generator is not connected to the grid, and therefore any assumption of induced perturbation to the offsite grid is not valid.

(31) Based on our review of Chapter 15, operation of the plant during low power testing up to levels of 5% of rated power poses no undue risk to the public health and safety. In fact, any risk is substantially less than that already found to be acceptable by the NRC Staff in its review of Chapter 15. Even if the Shoreham TDI diesels are assumed to be unavailable, there is ample assurance that fuel design limits and design conditions of the reactor coolant pressure boundary will not be exceeded as a result of anticipated operational occurrences, and that the core will be cooled and containment integrity and other vital functions will be maintained in the event of any postulated accident.

Glenn G. Sherwood

Atambir S. Rao

Eugene C. Eckert

STATE OF Maryland)
) To-wit:
COUNTY OF Montgomery)

Subscribed to before me this 29th day of March, 1984.
as to Glenn G. Sherwood and Eugene C. Eckert

Karen M. Thompson
Notary Public
Karen M. Thompson

My commission expires: July 1, 1986

Exhibit 1

FUEL LOAD AND PRECRITICALITY TESTING

Chapter 15 Event	Event Category
1. Generator Load Rejection	*
2. Turbine Trip	*
3. Turbine Trip with Failure of Generator Breakers to Open	*
4. MSIV Closure	*
5. Pressure Regulator Failure - Open	*
6. Pressure Regulator Failure - Closed	*
7. Feedwater Controller Failure - Maximum Demand	***
8. Loss of Feedwater Heating	*
9. Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	***
10. Inadvertent HPCI Pump Start	*
11. Continuous Control Rod Withdrawal During Power Range Operation	*

---

* Event not possible.

** Component operation possible but Chapter 15 phenomena cannot occur.

*** Event possible but no consequences.

12.	Continuous Rod Withdrawal During Reactor Startup	***
13.	Control Rod Removal Error During Refueling	***
14.	Fuel Assembly Insertion Error During Refueling	***
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly into an Improper Location	*
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	*
17.	Inadvertent Opening of a Safety/Relief Valve	*
18.	Loss of Feedwater Flow	***
19.	Loss of AC Power	***
20.	Recirculation Pump Trip	**
21.	Loss of Condenser Vacuum	*
22.	Recirculation Pump Seizure	**
23.	Recirculation Flow Control Failure - Decreasing Flow	**
24.	Recirculation Flow Control Failure With Increasing Flow	**
25.	Abnormal Startup of Idle Recirculation Pump	**
26.	Core Coolant Temperature Increase	***
27.	Anticipated Transients Without SCRAM (ATWS)	*
28.	Cask Drop Accident	*
29.	Miscellaneous Small Releases Outside Primary Containment	***

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	***
31.	Main Condenser Gas Treatment System Failure	*
32.	Liquid Radwaste Tank Rupture	***
33.	Control Rod Drop Accident	***
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	***
35.	Pipe Breaks Outside Primary Containment (Steam Line Break Accident)	*
36.	Fuel Handling Accident	***
37.	Feedwater System Piping Break	***
38.	Failure of Air Ejector Lines	*

COLD CRITICALITY TESTING

	Chapter 15 Event	Event Category	Assumes Unavailability of Offsite AC
1.	Generator Load Rejection	*	N/A
2.	Turbine Trip	*	N/A
3.	Turbine Trip with Failure of Generator Breakers to Open	*	N/A
4.	MSIV Closures	*	N/A
5.	Pressure Regulator Failure - Open	*	N/A
6.	Pressure Regulator Failure - Closed	*	N/A
7.	Feedwater Controller Failure - Maximum Demand	**	No
8.	Loss of Feedwater Heating	*	N/A
9.	Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	**	No
10.	Inadvertent HPCI Pump Start	*	N/A
11.	Continuous Control Rod Withdrawal During Power Range Operation	*	N/A

* Event not possible.

** Event possible but essentially no consequences.

12.	Continuous Rod Withdrawal During Reactor Startup	**	No
13.	Control Rod Removal Error During Refueling	**	No
14.	Fuel Assembly Insertion Error During Refueling	**	No
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly into an Improper Location	**	No
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	**	No
17.	Inadvertent Opening of a Safety/Relief Valve	*	N/A
18.	Loss of Feedwater Flow	**	No
19.	Loss of AC Power	**	Yes
20.	Recirculation Pump Trip	**	No
21.	Loss of Condenser Vacuum	*	N/A
22.	Recirculation Pump Seizure	**	No
23.	Recirculation Flow Control Failure - Decreasing Flow	**	No
24.	Recirculation Flow Control Failure With Increasing Flow	**	No
25.	Abnormal Startup of Idle Recirculation Pump	**	No
26.	Core Coolant Temperature Increase	**	No
27.	Anticipated Transients Without SCRAM (ATWS)	**	No
28.	Cask Drop Accident	*	N/A
29.	Miscellaneous Small Releases Outside Primary Containment	**	No

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	**	No
31.	Main Condenser Gas Treatment System Failure	*	N/A
32.	Liquid Radwate Tank Rupture	**	No
33.	Control Rod Drop Accident	**	No
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	**	Yes
35.	Pipe Breaks Outside Primary Containment (steam line break accident)	*	N/A
36.	Fuel Handling Accident	**	No
37.	Feedwater System Piping Break	**	Yes
38.	Failure of Air Ejector Lines	*	N/A

Exhibit 3

5% POWER

	Chapter 15 Event	Event Category	Assumes Unavailability of Offsite AC
1.	Generator Load Rejection	*	N/A
2.	Turbine Trip	**	No
3.	Turbine Trip with Failure of Generator Breakers to Open	*	N/A
4.	MSIV Closures	**	No
5.	Pressure Regulator Failure - Open	**	No
6.	Pressure Regulator Failure - Closed	**	No
7.	Feedwater Controller Failure - Maximum Demand	**	No
8.	Loss of Feedwater Heating	**	No
9.	Shutdown Cooling (RHR) Malfunction - Decreasing Temperature	**	No
10.	Inadvertent HPCI Pump Start	**	No
11.	Continuous Control Rod Withdrawal During Power Range Operation	**	No

* Event cannot occur.

** Bounded by same event at higher power level per FSAR Chapter 15.

12.	Continuous Rod Withdrawal During Reactor Startup	**	No
13.	Control Rod Removal Error During Refueling	**	No
14.	Fuel Assembly Insertion Error During Refueling	**	No
15.	Off-Design Operational Transients Due to Inadvertent Loading of a Fuel Assembly Into an Improper Location	**	No
16.	Inadvertent Loading and Operation of a Fuel Assembly in Improper Location	**	No
17.	Inadvertent Opening of a Safety/Relief Valve	**	No
18.	Loss of Feedwater Flow	**	No
19.	Loss of AC Power	**	Yes
20.	Recirculation Pump Trip	**	No
21.	Loss of Condenser Vacuum	**	No
22.	Recirculation Pump Seizure	**	No
23.	Recirculation Flow Control Failure - Decreasing Flow	**	No
24.	Recirculation Flow Control Failure - With Increasing Flow	**	No
25.	Abnormal Startup of Idle Recirculation Pump	**	No
26.	Core Coolant Temperature Increase	**	No
27.	Anticipated Transients Without SCRAM (ATWS)	**	No
28.	Cask Drop Accident	*	N/A
29.	Miscellaneous Small Releases Outside Primary Containment	**	No

30.	Off Design Operational Transient as a Consequence of Instrument Line Failure	**	No
31.	Main Condenser Gas Treatment System Failure	**	No
32.	Liquid Radwaste Tank Rupture	**	No
33.	Control Rod Drop Accident	**	No
34.	Pipe Breaks Inside the Primary Containment (Loss of Coolant Accident)	**	Yes
35.	Pipe Breaks Outside Primary Containment (Steam Line Break Accident)	**	Yes
36.	Fuel Handling Accident	**	No
37.	Feedwater System Piping Break	**	Yes
38.	Failure of Air Ejector Lines	**	No

ECCS LOCA EVALUATIONS

Core Avg. Power (% of rated)	Peak Rod MAPLHGR (kW/ft)	Time to 10 CFR § 50.46 Limits (min)	10 CFR § 50.46 Limits: PCT (F°) (Limit 2200°)	Local Oxidation (Limit 17%)	Core Wide Oxidation (Limit 1%)
5.0	1.34	55	2200	6.5	less than 0.9
2.5	0.67	124	2200	8.4	less than 1.0
1.25	0.34	285	2100	9.0	1.0
.5	0.13	700	2000	9.0	1.0

ASSUMPTIONS: 10 CFR 50 Appendix K (Standard FSAR Basis)
Initial Conditions Based on Equivalent Core
at Designated Core Average Power

Exhibit 4