8/31/84

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-4 (Low Power)
(Shoreham Nuclear Power Station, Unit 1)	)	

SUFFOLK COUNTY AND STATE OF NEW YORK PROPOSED FINDINGS OF FACT

I. Relative Safety of Low Power Operation with Alternate Configuration and with Qualified Power Sources

A. Vulnerabilities to a Seismic Event

1. Several witnesses testified as to the vulnerability of LILCO's proposed alternate AC power configuration to a seismic event. Christian Meyer, Jose Roesset, and Gregory C. Minor testified on behalf of Suffolk County. Tr. 2762. John T. Christian, Ahmed E. Meligi, and Robert C. Wiesel testified on behalf of LILCO (Tr. 962), as did (to a lesser degree) William G. Schiffmacher (Tr. 480), and William J. Muselar. Tr. 554. John L. Knox and Edward B. Tomlinson testified on behalf of the NRC Staff. Tr. 2337.

2. The Suffolk County witnesses who address the seismic vulnerability of Shoreham's alternate AC power system were qualified by their education and experience to provide the opinions set forth in their testimony. Dr. Christian Meyer, currently an Associate Professor in the Department of Civil Engineering and Engineering Mechanics at Columbia University in New York, has the equivalent of a Bachelor of Science in civil engineering and a Master of Science and Doctor of Philosophy degree in structural engineering from the University of California at Berkeley. His employment experience, prior to his assuming teaching duties at Columbia University, focused on seismic analysis and design of major structures, including the analysis and design of nuclear power plant structures. His teaching duties cover structural analysis and design, and his research activities are concentrated on earthquake engineering, structural dynamics, and computer-aided analysis of structures. Tr. 2762-64, 2803-07, 2667-70 (Meyer).

3. Dr. Jose Roesset has a degree in civil engineering, and a degree of Doctor of Philosophy from the Massachusetts Institute of Technology with primary emphasis in structures, secondary emphasis in soil mechanics and in systems, and a minor in mathematics. He currently holds the position of the Paul D. and Mary Robertson Meek Centennial Professor at the University

of Texas at Austin, where he teaches courses in the general subject areas of structural analysis, structural dynamics, and earthquake engineering. Prior to that, he was Professor of Civil Engineering at the University of Texas at Austin and Professor in the Department of Civil Engineering at the Massachusetts Institute of Technology, where he taught structural engineering, dynamic analysis, and earthquake engineering. Dr Roesset has also performed consulting work in the areas of structural engineering, dynamic analysis, and earthquake engineering with respect to nuclear power plants and on non-nuclear matters. Tr. 2765-69; 2808-12; 2673-75 (Roesset).

4. Gregory C. Minor has 24 years of experience in the nuclear industry, including design and testing of systems for use in nuclear power plants. His education is in electrical engineering (with a power systems option) resulting in a Bachelor of Science degree in electrical engineering and a Master of Science degree in electrical engineering. His employment includes 16 years as a design engineer and manager of engineering design organizations with General Electric Company. His responsibilities included the design and qualification testing of safety systems to meet seismic criteria applicable to nuclear power plants. In particular, during his employment with General Electric Company, he was responsible for the seismic

qualification, including dynamic testing and analysis, of electrical equipment manufactured by General Electric for use in nuclear power plants. Tr. 2675-76; 2769; 2813-19 (Minor).

5. LILCO's witnesses Christian, Meligi, and Wiesel are also qualified by education and experience to testify as to the seismic capabilities of equipment. Dr. Christian, who has a Doctor of Philosophy degree in Civil Engineering, is a Senior Consulting Engineer with Stone & Webster Engineering Corporation, with extensive experience in consulting and teaching in the areas of geotechnical engineering, earthquake engineering, and computer application. Tr. 963-66 (Christian). Mr. Meligi, who is head of the Component Qualifications Division of Sargent & Lundy, has a Bachelor of Science degree in Aeronautical Engineering and a Master of Science degree in Engineering Mechanics. He is responsible for developing and implementing environmental and seismic qualification programs for equipment in nuclear power plants and has extensive experience relating to seismic qualification of equipment. Tr. 967-70 (Meligi). Mr. Wiesel, who is a Senior Structural Engineer with Stone & Webster Engineering Corporation, has experience in the design and seismic and structural analysis of structural elements and equipment. He holds Bachelor of Science and Master of Science degrees in Civil Engineering. Tr. 970-72 (Wiesel).

6. The methods used to perform a seismic analysis or a structural analysis do not vary depending upon the particular structure involved in the analysis. Tr. 2692 (Meyer). The training of a structural engineer involves the ability to determine the strength, stiffness, and mass properties of structures and to determine the response of structures to seismic loads. Tr. 2692 (Meyer). Therefore, whether or not a structural engineer had previously analyzed the effect of a seismic event upon a particular type of structure would be immaterial to that engineer's ability to perform a structural analysis or predict the response of such a structure.

7. Staff witnesses Tomlinson and Knox have never performed any seismic qualification of equipment for use in nuclear power plants nor have they ever reviewed equipment for the purpose of evaluating its seismic qualification. Tr. 1858-1859 (Knox, Tomlinson). In addition, neither of them has performed any analysis or review of the seismic capabilities or survivabilities of the alternate AC power configuration being proposed by LILCO. Tr. 1865 (Tomlinson, Knox). The NRC Staff has not performed any review of the seismic analysis provided by LILCO concerning the EMD diesel generators and their associated switchgear, nor has the Staff reviewed any seismic analysis of the survivability of the gas turbine and its associated switchgear. Tr. 1865, 2343 (Knox, Tomlinson).

8. Mr. William G. Schiffmacher testified on behalf of LILCO. Mr. Schiffmacher is the manager of the Electrical Engineering Department at LILCO. Tr. 480 (Schiffmacher). Mr. Schiffmacher's testimony describes the LILCO power supply system, the LILCO connections to the regional power grids, the transmission links to Shoreham, the transmission network reliability, the gas turbines at various locations offsite from Shoreham, the Shoreham 20 MW gas turbine, and the EMD diesels at Shoreham. Tr. 486-524 (Schiffmacher). See also Tr. 331-33 (Schiffmacher).

9. Until the LILCO austerity measures in early 1984, Mr. Schiffmacher held memberships in a number of societies and associations. These memberships were beneficial in his opinion because it afforded Mr. Schiffmacher an opportunity to discuss with other utilities things that are being done in the transmission area or substation area through regular mediums, and also to deal with manufacturers. Mr. Schiffmacher was forced to give up these memberships due to the austerity measures. Tr. 353-54 (Schiffmacher).

10. Mr. William Museler, LILCO's Director of the Office of Nuclear, testified regarding commitments and procedures LILCO would adhere to in Phases II-IV of LILCO's low power testing program. Tr. 554, 558 (Museler).

11. Mr. Museler has no degree in seismology. In addition, he has performed no analyses to determine whether any components or structures of the alternate AC power system will be adversely affected in the event of a design basis earthquake. Tr. 529 (Museler).

12. LILCO originally proposed to supply power to the safety loads at Shoreham in the event of an emergency as follows: via any one of three on-site emergency diesels, each fully safety-related and qualified for the SSE; via an off-site 69 KV circuit supplying power from the 69 KV switchyard through the reserve station system transformer ("RSST"); and via a 138 KV circuit supplying power from the 138 KV switchyard through the normal station system transformer ("NSST"). Under LILCO's low power proposal, however, there will be no seismically qualified on-site emergency power system. Instead, LILCO proposes to "enhance" its off-site power system by the addition of: a 20 MW gas turbine supplying power to the safety loads via a 13 KV/69 KV transformer in the 69 KV switchyard, from which it then supplies power to the safety loads via the 69 KV circuit and the RSST; and four 2.5 MW General Motors diesels which will supply their power to the safety loads via a new 4 KV line leading directly into the non-emergency switchgear room (the same room fed by the NSST and the RSST). Tr. 2771 (Minor).

13. In analyzing the seismic vulnerabilities of LILCO's enhanced off-site power system, it is not necessary to include enhancements outside of the 69 KV and 138 KV switchyards, such as the addition of black-start capability to the gas turbine at Holtsville. In a seismic event, such off-site enhancements still must supply their power to Shoreham via the 138 KV or 69 KV switchyards and/or the RSST or NSST. If there are physical components along these circuits at or within the respective switchyards which are projected to fail during an SSE, then the fact that the far off enhancements have been made would not affect the seismic reliability of the power supply because a potential failure to supply power to the safety loads would still be predicted. Tr. 2772 (Meyer, Minor).

14. In the event of a loss of offsite power induced by a seismic event, the LILCO witnesses testified that response is not dependent upon the availability of AC power. Rather, the HPCI and RCIC systems are seismically qualified and would operate automatically to ensure core cooling since these systems are steam driven and utilize DC power supplies. Tr. 310 (Rao, et al.). Assuming the availability of RCIC or HPCI, core cooling would be assured for indefinite periods. The only need for the restoration of AC power would be for containment cooling and containment and suppression cool limits would not be

exceeded for about 30 days without AC power. Tr. 311 (Rao). This LILCO testimony, however, did not address the Commission's standard in CLI-84-8 regarding whether operation of Shoreham would be as safe with the alternate AC power system as with fully qualified diesels. (See further discussion of the "as safe as" standard later in these Findings).

15. The following items, which are potential sources of single failures (i.e., an item whose failure will prevent a generating source from supplying power to the safety loads) are critical items in LILCO's enhanced AC power system because their failure could defeat the ability of portions of that system to provide power to safety loads. With respect to the four EMD diesels, the critical items of greatest importance, aside from the diesels themselves, are:

(1) the common fuel line to the main diesel and those balancing or equalizing lines supplying fuel to each of the four diesels;

(2) the battery starting system which must start all four diesels;

(3) the switchgear cubicle to which the four EMD diesels supply power and from which a single cable tray carries power to the non-emergency switchgear room;

(4) the cable tray and the cable carrying power from the switchgear cubicle to the non-emergency switchgear room; and

(5) the non-emergency switchgear room itself, particularly the masonry walls through which the 4 KV EMD diesel power lines must pass.

Tr. 2772-74 (Minor). The failure of any of the five items identified above may prevent the EMD diesels from supplying power to safety loads. Tr. 2774 (Minor).

16. With respect to the 20 MW gas turbine and the 69 KV system, the critical items of greatest importance (aside from the gas turbine itself) are:

(1) the one million gallon fuel tank which supplies fuel to the gas turbine;

(2) the fuel line from the fuel tank to the turbine;

(3) the compressor system used to start the turbine;

(4) the 13 KV multiple pothead and bus support next to the gas turbine control building;

(5) the 13 KV/69 KV transformer and the 69 KV switchyard;

(6) the buses, circuit breakers, insulators and switches related to the gas turbine and located in the 69 KV switchyard;

(7) the RSST and its associated equipment; and

(8) the non-emergency switchgear room, particularly the masonry wall through which the 69 KV/RSST power line must pass.

If any of the eight items listed above is severely damaged by a seismic event, power may not be supplied to the safety loads. Tr. 2774-75 (Minor).

17. There is a bypass line on the 69 KV system which permits operators to direct off-site power to the RSST via a 69 KV line without use of the 69 KV switchyard. This bypass line, which takes several hours to be manually activated, is an additional part of the 69 KV circuit; however, it is only a possible backup source rather than an initial power source, and it is vulnerable to failures of the RSST and masonry wall in the non-emergency switch room. Tr. 2775 (Minor); 371-73 (Schiffmacher).

18. With respect to the 138 KV system, the critical items of greatest importance are:

(1) buses, circuit breakers, insulators and switches in the 138 KV switchyard;

(2) the transmission towers between the switchyard and the NSST;

(3) the NSST and its associated equipment; and

(4) the non-emergency switchgear room itself, particularly the masonry walls through which the 138 KV/NSST power line must pass. Tr. 2775-76 (Minor).

19. A seismic event can cause damage to electrical and mechanical equipment such as that which is critical to the operation of the elements of LILCO's proposed alternative AC power configuration as a result of ground motions which cause structures and equipment to vibrate. Damage to electrical and mechanical equipment during an earthquake may result from one or more of the following causes:

(1) The stresses and various elements due to the inertia forces from the vibration of the equipment may exceed their strength. This is often the cause of damage or failure to buildings, tanks and other structures.

(2) Sliding, rocking, or even overturning of pieces of equipment not properly anchored or attached to their supporting structure may occur. Cases of sliding, rocking or overturning of equipment at substations have often been recorded, particularly with respect to transformers.

(3) Elements connecting separate structures or pieces of equipment with different vibrational characteristics will be subject to differential motions. These elements may fail if they are not flexible enough to accommodate these relative displacements or strong enough to force the two components to vibrate together. This is typically the case for tight or taut cables and will also affect connection elements such as insulators.

(4) The soil or foundations under the structure supporting the equipment may fail or experience differential settlements. This problem may be aggravated if there is a potential for soil liquefaction. Embankments or slopes may also become unstable due to ground motion and may endanger nearby structures. Tr. 2776-77 (Meyer, Roesset).

20. Experience from past earthquakes indicates that structures and components made out of brittle materials are particularly vulnerable to damage because they cannot sustain

the deformations induced by the seismic disturbance without breaking. Examples of brittle materials are unreinforced masonry, glass, and ceramics. Tr. 2777 (Meyer, Roesset).

1. Vulnerability of the Alternate AC Power Configuration to Soil Liquefaction

21. Soil liquefaction is the reduction of shear strength in a saturated soil due to increase in pore water pressure under cyclic loading without drainage. Tr. 2778 (Roesset). When granular soils, sands in particular, are shaken by an earthquake, the pressure in the pore fluids increases as a result of the cyclic loads. The pore pressures can become so large that there is no longer any effective contact stress between the particles, in which case the soil becomes, literally, a very dense liquid. Tr. 959 (Christian) In addition, because the excess pressures must be released, "sand boils" are commonly observed for a period as much as half an hour after the earthquake has occurred. Sand boils are the result of water coming to the surface, carrying particles of sand and silt, and spewing up like a a geyser until the sand falls out forming a cone like a volcano on the surface. Tr. 959-60 (Christian).

22. The potential for soil liquefaction is of particular concern in areas with loose, saturated sand. The results of soil liquefaction may range, depending on the extent of liquefaction and the size of the area affected, from sand boils and cracks at the surface to extensive landslides. For a small to moderate amount of liquefaction at some depth, one would expect at least some differential motions at the surface. Tr. 2778 (Roesset).

23. The soils in the Shoreham area are of a sandy variety which is conducive to liquefaction. Tr. 2779 (Roesset).

24. Stone and Webster performed for LILCO an assessment of the potential for soil liquefaction in the area in which the EMD diesel generators are located. Tr. 992-95 (Christian). The results of the Stone and Webster calculations indicate that the soil in that area probably can withstand up to 0.13 g without liquefaction. Tr. 995 (Christian).

25. Although Stone and Webster predicts that liquefaction will not occur in earthquakes up to 0.13 g, Stone and Webster cannot predict with confidence that liquefaction will not occur at accelerations above 0.13 g. Tr. 995 (Christian).

26. In the area surrounding the EMD diesels and the EMD switchgear building, there is a clear risk of soil liquefaction if there is a peak ground acceleration of 0.2 g, which is the SSE level for Shoreham. Tr. 2779 (Roesset); 989 (Wiesel).

27. A number of procedures are available to reduce the potential for liquefaction. Each procedure has as its main goal an increase in the density of the soil. Procedures commonly used include excavating the soil and replacing it, compacting it as the fill is placed; compacting or densifying the soil by vibroflotation; and drilling vertical or inclined holes in the ground in a specified pattern and pumping grout into the ground. Tr. 2784-85 (Roesset).

28. According to FSAR §§ 2.5.4.5 and 2.5.4.12, the potential for soil liquefaction has been detected under the main building and other areas of the Shoreham site. Tr. 2779-80 (Roesset). However, measures have been taken to improve the subsurface conditions under seismic Category I structures, such as the major plant buildings, and in the vicinity of the service water system and the diesel fuel oil tanks. Tr. 2780 (Roesset).

29. Densification has not been undertaken in other areas of the Shoreham site where liquefaction is a potential problem,

such as the area in which the EMD diesels are located and the 69 and 138 KV switchyards. Tr. 2780 (Roesset) If densification techniques were employed at those locations, the potential for soil liquefaction would be greatly reduced. Tr. 2785 (Roesset). If a seismic event occurred, different seismic motions would result in the areas where densification has been performed and those which have not been so improved. Tr. 2780-81 (Roesset).

30. If a small to moderate amount of liquefaction occurred at some depth in the area of the EMDs, the 69 KV or 138 KV switchyards, both horizontal and vertical differential motions would be expected. They could result in tilting of foundations, poles and transmission towers. In addition, the stability of the embankment located behind the EMD diesels could be impaired and could impact the EMD diesel fuel line and the cable tray related to the EMD diesels. Tr. 2781 (Roesset).

31. LILCO's witness Dr. Christian testified that soil liquefaction can cause different kinds of motions. He testified that although it is very difficult to predict exactly what would happen if there were soil liquefaction in the area around the EMD diesels, the diesels could sink or they could be skewed in some dimension. Tr. 959-60 (Christian). Estimates

of movements from several inches to several feet, depending on the extent of the liquefaction, are not unreasonable. Tr. 2781 (Roesset).

32. If soil liquefaction occurred and resulted in a movement of several inches of key components in the alternate power configuration, many failures would be expected. Tr. 2782 (Meyer).

33. The fuel line feeding the EMD diesels does not have sufficient flexibility to withstand several inches of relative displacement without failure. Tr. 2782 (Meyer).

34. The cable connections on the roof of the EMD switchgear cubicle could fail as a result of large displacements from soil liquefaction. The cables themselves could also fail, depending upon their flexibility. Tr. 2782 (Meyer).

35. The fuel line feeding the 20 MW gas turbine does not have sufficient flexibility to withstand several inches of relative displacement without failure. Tr. 2783 (Meyer).

36. In both the 69 KV and 138 KV switchyards, there are various multiple pothead and bus support structures and circuit breakers, which have relatively rigid connections which are very vulnerable to differential motions. They would not be

able to experience several inches of relative displacement without failure. Tr. 2783 (Meyer).

2. Failures Resulting from an SSE

37. Leaving aside potential failures resulting from soil liquefaction, if the SSE were to occur at or near Shoreham, resulting in accelerations of 0.2 g horizontal and 0.13 g vertical, there are several structures, components and equipment essential to the functioning of LILCO's enhanced AC power configuration which are likely to suffer damage. Tr. 2785 (Meyer, Roesset).

a. Vulnerabilities of Gas Turbine and 69 KV Line

38. The stone ring wall foundation of the one million gallon fuel tank for the 20 MW gas turbine will fail in an SSE, leading also to a failure of the tank itself. Tr. 2785-86 (Roesset); SC LP Ex. 53.

39. The hydrodynamic forces created by the horizontal and vertical accelerations in the SSE could also cause elephant foot buckling of the fuel tank. LILCO has apparently not conducted any dynamic analysis of the fuel tank to determine the potential of such a failure. Tr. 2786 (Roesset).

40. The stability of the million gallon fuel tank and its foundation may be further impaired if the soil underneath has not been densified and is subject to soil liquefaction. Tr. 2786 (Roesset).

41. Therefore, there is a definite potential for the SSE to cause a failure of the million gallon fuel tank, particularly if full, thus rendering the 20 MW gas turbine inoperable at least until a new fuel source is installed. Tr. 2786 (Roesset).

42. Failure of the 4-inch buried pipe between the fuel oil tank and the fuel pump and filter for the 20 MW gas turbine is expected to occur at the tank and pump connections in the event of an SSE. In addition, the 2 inch pipe above grade which feeds the gas turbine is expected to fail at the pump connection. The piping system (valves, filters, meters) in the fuel oil piping station for the gas turbine is expected to fail as a result of the non-seismic qualification and design of the components. Tr. 2787 (Meyer); SC LP Ex. 53. Therefore, there is a substantial probability of failure of the 20 MW gas turbine fuel line in the event of an SSE. Tr. 2787 (Meyer).

43. Although the gas turbine itself is probably capable of withstanding the loads involved in the SSE, there is no evidence that LILCO has analyzed the strength of the support pins or the turbine's support frame. Tr. 2787 (Meyer).

44. There is a substantial likelihood that the short, rigid link which connects the air tank and the compressor motor which comprise the air starting unit for the gas turbine will fail in the SSE, thus rendering the starter system inoperable. The two components of the air starting unit are not likely to have the same natural frequency, and the link connecting them does not appear to be flexible enough to accommodate this relative motion nor strong enough to force both components to vibrate together. There is no evidence that LILCO has quantitatively evaluated the likelihood of failure of this link. Tr. 2788 (Meyer).

45. The gas turbine switchgear cubicle is connected by buses and insulators to a structure which supports potheads and buses. The buses and insulators are unlikely to have the necessary flexibility to accommodate the relative displacement resulting from the vibration amplitude of the supporting structure and the switchgear cubicle. This link which is essential to the provision of power by the 20 MW gas turbine may also fail in the SSE. Tr. 2788-89 (Meyer).

46. Numerous structures in the 69 KV switchyard, including bus structures, fuse and switch structures, pothead structures, battery racks, and lightening arresters, have very

low natural frequencies. Although recommendations were made to LILCO to stiffen these structures in order to reduce the dynamic amplification of ground motion, those recommendations have not been carried out by LILCO. Tr. 2789 (Meyer); SC LP Ex. 55.

47. The recommendation that these structures be stiffened was made because the 69 KV switchyard is predicted to fail in the SSE. Tr. 2789 (Meyer); SC LP Ex. 56; SC LP Ex. 1. There is at least a 50 percent probability that the 69 KV switchyard would fail in an SSE. Tr. 2790 (Meyer).

48. Neither the NSST or the RSST or the spare transformers onsite are bolted down. Tr. 475-77 (Schiffmacher).

49. A horizontal force due to an earthquake of intensity 0.14 g is sufficient to topple over the 13 KV/69 KV transformer in the 69 KV switchyard, if the force were applied statically. An 0.2 g earthquake is likely to rock the transformer on its base sufficiently to damage vital components, such as the relatively brittle ceramic insulators. Although anchoring transformers to foundations is good standard practice and has been recommended to LILCO (SC LP Exs. 55, 57), and rocking and overturning of transformers have been observed in many earthquakes, LILCO has not anchored the 13 KV/69 KV transformer to its foundation. Tr. 2790-91 (Meyer).

50. The RSST transformer has the same potential for rocking on its foundation or outright toppling over as the 13 KV/69 KV transformer, because the RSST is not bolted to its foundation. Thus, the RSST and its attached components may experience failure in the event of an SSE. Tr. 2791 (Meyer).

51. Mr. Schiffmacher did not know the seismic qualification of the RSST. Tr. 340-41 (Schiffmacher). The parties stipulated that the RSST was not designed to seismic qualifications. Tr. 341 (Stipulation).

52. The 69 KV system, from the RSST out to the Wildwood Substation is not designed for any specific seismic event. Tr. 342 (Schiffmacher).

53. All of the offsite power generating stations referenced in Mr. Schiffmacher's testimony, such as the Holtsville gas turbines, the Southhold gas turbines, and the Port Jefferson gas turbines, feed their power to the plant either through the 69 KV or the 138 KV circuits. Tr. 359 (Schiffmacher).

54. Mr. Schiffmacher testified that LILCO can restore a mile of 69 KV transmission facility within 24 hours. By this statement, he meant basically the pole line and this does not

include transformers if any would be involved. Tr. 376 (Schiffmacher). If the NSST or RSST were damaged and needed to be replaced, it would take on the order of several days in order to replace them, even though there are spare transformers at the Shoreham site. Tr. 377-78 (Schiffmacher). If the insulators on a transformer were damaged, they could probably be replaced in 4-6 hours. Tr. 457-58 (Schiffmacher).

b. Vulnerabilities of 138 KV System

55. The 138 KV switchyard has a median capacity level of 0.2 g. Therefore, in an SSE, there is at least a 50 percent probability that the 138 KV switchyard will incur failure. Tr. 2791-92 (Meyer); SC LP Ex. 56.

56. The NSST has the potential of rocking on its foundation or outright overturning because it is not bolted to its foundation. Tr. 2792 (Meyer).

57. The transmission towers which hold the transmission lines from the 138 KV switchyard to the NSST may vibrate in response to ground motion from an SSE. If soil liquefaction were to occur and lead to tilting of the transmission towers, this aggravating circumstance could cause the brittle insulators on the transmission towers to fail. Tr. 2792 (Meyer).

c. Seismic Vulnerabilities of the EMD Diesel Generators

58. LILCO's testimony concerning the seismic survivability of the EMD engines is based upon a combination of analysis and test results. Tr. 981 (Meligi). Although Mr. Meligi described certain tests that were performed by the U.S. Navy on certain General Motors EMD diesels, he was unable to state when the engines that were the subject of the Navy tests had been manufactured or when the EMDs at Shoreham had been manufactured or installed. He was unable to state whether the Navy tests were performed before or after the Shoreham EMDs had been manufactured. Tr. 934, 937 (Meligi).

59. Mr. Meligi's testimony concerning a walk down to be conducted to inspect the EMD diesels, and the similarity between them and machines Sargent & Lundy has seismically qualified in the past, does not address the question whether the results of the Navy shock tests upon which he relies in his testimony are applicable to the Shoreham EMDs. Tr. 956-57 (Meligi).

60. In addition, the analysis performed by General Motors of EMD diesels, which is discussed by Mr. Meligi in his testimony, was performed in the middle or late 1970s. Mr. Meligi

did not know when the components that were the subject of that analysis were manufactured. Tr. 938-39 (Meligi).

61. The EMD diesels themselves probably have the capability of being operable during or at least after a SSE. In addition, the EMD diesels themselves do not seem likely to slide on their railroad tie foundations. Tr. 2793 (Meyer).

62. There is a strong possiblity that the fuel line which supplies fuel to all four EMD diesels would fail in an SSE. Tr. 2792-93 (Meyer). An evaluation by Stone and Webster of the ability of the diesel fuel oil line to withstand earthquake effects resulted in a recommendation to bury that fuel line pipe. Tr. 991-92 (Wiesel). There is no evidence that this recommendation has been implemented by LILCO.

63. The LILCO witnesses performed an analysis of the potential for sliding or overturning of the EMD switchgear cubicle. They concluded that there is an adequate factor of safety to prevent sliding or overturning for a minimum ground input of 0.13 g. Tr. 991 (Wiesel). However, Mr. Wiesel could not say with the same degree of confidence that an adequate factor of safety exists to prevent sliding or overturning for a ground input of 0.2 g. Tr. 942 (Wiesel). The Safe Shutdown Earthquake (SSE) for Shoreham is 0.2 g. Tr. 989 (Wiesel).

64. Although it is sound engineering practice to tie down a structure such as the EMD switchgear building to its foundation, and LILCO drawing No. F-50268-1 calls for anchor bolts, there are no such anchor bolts in place. Tr. 2794 (Meyer); 2699-2700 (Meyer).

65. The rigid connection detail for the power outlet on top of the roof of the EMD switchgear cubicle is potentially vulnerable to failure in an SSE as a result of differential motion between the cubicle itself and the timber supports carrying part of the cable tray. Tr. 2794 (Meyer).

66. LILCO has not qualified the EMD diesels for a seismic event. Tr. 349 (Schiffmacher).

67. The cable tray carrying the power from the EMDs to the nonemergency switchgear room is supported on wooden timbers at intervals of about 8-10 feet. The wooden timbers are not seismically qualified. Tr. 352 (Schiffmacher).

68. Mr. Schiffmacher testified that he understands industry experience with respect to transmission lines and earthquakes to have been that there has been little significant or extensive damage to transmission lines due to earthquakes. Tr. 444 (Schiffmacher). Mr. Schiffmacher's testimony in this

regard was strictly limited to transmission lines. He had no knowledge as to whether transformers might have been damaged or experienced damage in seismic events. Tr. 442 (Schiffmacher).

d. Vulnerability of Non-Emergency Switchgear Room

69. The three power sources being relied upon by LILCO (i.e., 69 KV/gas turbine, 138 KV, and 4 KV EMD diesel output) are brought together, each at a 4 KV voltage, to permit switching between sources in the non-emergency switchgear room. This room has masonry block walls up to 25 feet of unsupported height on the south side. A failure of this wall which causes failure of one or more incoming lines could render the affected AC power source unavailable. Tr. 2795 (Minor).

70. The wall in the nonemergency switchgear room which is identified in calculations performed by Stone and Webster for LILCO as "SS-20-6," has a high probability of failing in the SSE. Falling concrete blocks from such a failure may hit the cable tray from the EMD diesels. Tr. 2795-97 (Meyer, Roesset); SC LP Exs. 58, 59. LILCO's witness, Mr. Wiesel, indicated that the seismic capability of this wall was as low as 0.02 g in terms of ground acceleration, and other calculations performed by Stone and Webster show allowable ground motions of 0.11 g and 0.13 g. Id.

71. Similarly, walls SS-20-7 and SS-20-4, also in the nonemergency switchgear room, were calculated by Stone and Webster to have allowable accelerations which would indicate damage resulting from ground accelerations at about the SSE level of 0.2 g. Tr. 2797 (Meyer, Roesset).

e. LILCO's Shutdown Proposal

72. LILCO has stated that if during low power operation a 0.01 g acceleration is recorded at the Shoreham site, the plant will be shut down. Tr. 570 (Museler). Mr. Museler testified that by committing to shut the plant down in the event of a recorded acceleration of 0.01 g, LILCO has decreased the likelihood that a loss of offsite power will occur while the plant is operating, and has increased the time available to restore AC power in the event of a loss of offsite power from a seismic event, thereby increasing the safety of its proposed low power operations. Tr. 558, 571, 572 (Museler).

73. Mr. Museler has not performed any studies to determine how long in advance of the SSE LILCO would predict there would be some sort of precursor event with a recording of 0.01 g. Instead, Mr. Museler asked geotechnical engineers at Stone & Webster to perform such a study. Their answer was that such precursors did happen occasionally, citing the New

Brunswick earthquake of 1982 where an initial tremor was first felt nine hours before the major shock and an additional tremor was felt one hour prior to the largest shock. Stone & Webster informed LILCO that such things do not happen in all cases, but do happen occasionally, and on that basis LILCO decided to commit to commence shutdown when any such precursor event occurred. Tr. 532-33 (Museler).

74. If a 0.01 g acceleration occurs as part of the main shock of an SSE, the time between the occurrence of a 0.01 g acceleration and the peak of 0.2 g will be a matter of a few seconds. Although the maximum duration of the earthquake may be on the order of 20 to 40 seconds, the interval between the triggering of the seismic monitor and the peak ground motion will be considerably less. Tr. 2798 (Meyer, Roesset).

75. A warning of several seconds will not permit shutdown of the plant prior to experiencing the SSE. The 0.01 g seismic shutdown proposed by LILCO is a manual process which will probably require an instrument reading, conferring among shift personnel, and the action of shutting down the plant. These actions may be decided upon and started within a few seconds, but the plant would not likely be shut down by the time the full seismic acceleration was reached. Thus the plant is likely

still to be operating or going through transitions in equipment operating status and electrical loading during the earthquake peak. Tr. 2798-99 (Minor).

76. If the 0.01 g acceleration is associated with a foreshock before a SSE, there may be hours or days between that event and the main shock. It is extremely difficult to predict the number of foreshocks that may precede an SSE or the time interval between their occurrence. Thus, despite LILCO's testimony that the plant will not be restarted until LILCO consults with the NRC (Tr. 572 (Museler)), the plant may be operating again when the main earthquake hits. Therefore, the reliability and effectiveness of LILCO's proposal to shut down the plant in the event of an acceleration of 0.01 g is questionable. Tr. 2798 (Meyer, Roesset).

77. LILCO's originally proposed fully qualified onsite power source, the TDI diesel generators, are supposed to be fully qualified for the SSE. Accordingly, by definition, the TDI diesels would withstand the SSE and remain operable even after a 0.2 g acceleration. Tr. 2800 (Minor).

3. Conclusion

78. There is a significant potential that as a result of the SSE, the 138 KV system and the 69 KV system (even as enhanced with the 20 MW gas turbine) will suffer failure. This would occur even with three fully qualified on-site diesel generators. However, if there were three fully qualified diesel generators onsite, they, by definition, would not be predicted to fail in an SSE. Therefore, after an SSE which knocked out the 138 KV and 69 KV systems, und r LILCO's originally proposed qualified source of AC power configuration, there still would be three independent 3.5 MW power sources available, any one of which could meet low power safety load needs. In contrast, under LILCO's proposed alternate AC configuration, Shoreham would be left after the SSE (assuming failure of the 138 and 69 KV systems) with only the EMD diesels, which supply the safety loads via a single cable tray as contrasted with the three independent means of supplying power to the safety loads via the TDI diesel generators. Tr. 2801-02 (Meyer, Roesset, Minor).

79. The EMD diesels also present a potential of failure during the SSE, resulting from their fuel line, the potential for soil liquefaction, and the potential for failure of the

non-emergency switchgear room walls. Tr. 2802 (Meyer, Roesset, Minor).

80. Therefore, as a result of the seismic vulnerabilities of LILCO's proposed alternate AC power configuration, operation of Shoreham at low power with the alternate configuration would not be as safe as low power operation with three fully qualified diesels. Tr. 2801-02 (Meyer, Roesset, Minor).

B. Reliability of EMD Diesels and Gas Turbine Compared to Qualified Diesel Generators

81. Suffolk County presented testimony concerning the realiability of the EMD diesels and the 20 MW gas turbine by G. Dennis Eley, C. John Smith, Gregory C. Minor and Dale G. Bridenbaugh. Tr. 2572.

82. Mr. Eley is a Technical Manager with Ocean Fleets Consulting Service, Ltd. Tr. 2572 (Eley). He began his career with a four year apprenticeship with George Clark and Northeast Marine, a company engaged in building diesel engines. While employed by that company, Mr. Eley worked in the machine shop, fittings shop and directing shop, participating in the manufacture of diesel engine components and the engines, and worked for departments involved in the installation of manufactured engines into ships, both as propulsion units and diesel

generator units. Mr. Eley was responsible for testing the engines, analyzing available data, and ascertaining whether engines were built to standards and were suitable for the purpose for which they were intended. Mr. Eley also developed a facility to test diesel engines up to 40,000 shaft horsepower. Tr. 2404-05 (Eley).

83. Subsequently, while working for the company of Austin and Pickersgill, Mr. Eley was responsible for determining whether machinery that would be aboard vessels was suited for the purpose for which it was intended. Included in the machinery were the main engine propulsion units, diesel generator sets, pumps, compressors and all other items of machinery intended to be onboard vessels. Tr. 2405 (Eley).

84. For the next twelve years Mr. Eley worked as a marine engineer with Ocean Transport and Trading, a European shipping company engaged in the carriage of cargo worldwide. He held all the engineer positions aboard vessels, from junior engineer through chief engineer. In these positions Mr. Eley was responsible for the overhaul and maintenance of equipment onboard vessels, the efficient operation of the equipment, and determining that the engines were suitably balanced and that they were running efficiently. Tr. 2408-09 (Eley). Mr. Eley

has also taken and passed fire fighting courses relating to the prevention and mitigation of fires onboard ships. Tr. 2411-12 (Tley).

85. Mr. Smith began his career as an engineer cadet. During his five year cadetship, he spent two years engaged in college-level study of mechanical engineering, two years at sea obtaining a basic understanding of the operation of the engineering department and all related machinery, and a year in the machine shop for engine maintenance, a chemical testing laboratory, and a drawing office. Tr. 2412 (Smith). His work in the drawing office included the design and preparation of drawings for the modification of engine systems, fuel processing plants, and diesel generators. Tr. 2413 (Smith).

86. Mr. Smith's experience also includes 16 years as an engineer onboard ships. During that time, he had experience in the operation, maintenance, inspection, testing and repair of a wide variety of makes of diesel generators. Tr. 2573, 2413 (Smith). For several years, Mr. Smith was the sole person responsible for operating the engine rooms onboard ships, and thus he was responsible for the operation and maintenance of diesel engines and diesel generators. Tr. 2413-14 (Smith). His experience includes working with diesel generators with deadline blackstart capabilities. Tr. 2415 (Smith).

87. Mr. Smith has also attended two recognized fire fighting courses, which were run by local fire departments pursuant to government outlines. His fire-related training includes courses on the science of fire and fire fighting, and the management and safety of fire fighting parties. Approximately fifty percent of his fire fighting training consisted of actually and physically fighting fires. Tr. 2416 (Smith).

88. In the course of their careers, Messrs. Eley and Smith have operated many different makes of diesel generators which differ only in minor and superficial ways. They all have crankshafts, pistons, camrods, cylinder heads and turbochargers. In addition, Mr. Eley testified that each time an engineer goes onboard a new ship, unless it is a class of ship similar to the one he has sailed before, it is likely that the diesel generating equipment will be slightly different. Under those circumstances, if the engineer had not seen that particular equipment before, he refers to instruction manuals, prior test results and running parameters, in order to ascertain from those materials how to run the generating plant effectively. Tr. 2436-38 (Eley); 2573 (Smith).

89. The differences between diesel generators in marine applications and diesel generators in land based applications

are very small and not of a nature that would affect the conclusions in the testimony of Messrs. Smith and Eley. Tr. 2443-44 (Eley). The major components are very similar and the overall engine is similar. Tr. 2444 (Eley). Moreover, electrical generators are used onboard vessels for exactly the same purpose as are electrical generators on land. Marine generators are started, run, checked, loaded, run up to speed, paralleled, synchronized, and load shared in a manner similar to that of land based diesel generators, and the operating procedures, maintenance procedures, blackout procedures and emergency generating procedures for diesel generators aboard vessels are very similar to those based on land. Tr. 2445-46 (Eley). Most diesel generators, including EMDs, are used in both marine and land based installations. Tr. 2446 (Smith).

90. During Mr. Minor's 24 years of experience in the nuclear industry (see Proposed Finding 4 above), his responsibilities included equipment and system design, equipment qualification, seismic and environmental qualification testing, and pre-operational testing. His work in the areas of system and equipment design was largely with safety-related equipment, safety systems and control systems for boiling water reactors in nuclear power plants built by General Electric, including Shoreham. He also participated in the start-up and check-out of several nuclear reactors. Tr. 2400; 2574 (Minor).

91. Mr. Minor's experience includes design work to achieve the necessary redundancy, diversity and freedom from single failure to meet the regulations, including the general design criteria, that apply to safety-related equipment. In addition, in performing analyses of the systems and components to assure that they comply with applicable regulations, Mr. Minor has performed failure modes and effects analyses, in which the effects of postulated failures on system performance were examined and an assessment made of whether the likelihood of postulated failures was large enough to be of concern or warrant the need for design work to prevent the failure. Tr. 2401 (Minor).

92. While with MHB Technical Associates, Mr. Minor has performed many reviews and assessments of safety systems, of reactor systems in general, and of the overall performance of nuclear power plant system for both safety and control purposes. An underlying concern of all of these analyses is the ability of the plant in question to meet the regulations which apply to it. Tr. 2401 (Minor).

93. Mr. Minor has a Bachelor of Science degree in Electrical Engineering from the University of California at Berkeley. In obtaining that degree from he pursued a power

system option, dealing with utility systems and power generation system.. He also has a Master of Science degree in Electrical Engineering from Stanford University. Tr. 2402 (Minor).

94. Mr. Bridenbaugh is President of MHB Technical Associates, and serves as a Principal Consultant with that firm. He is a mechanical engineer by education, having received a Bachelor of Science degree in Mechanical Engineering in 1953. He is a registered professional nuclear engineer in the State of California. Tr. 2575 (Bridenbaugh).

95. Mr. Bridenbaugh has more than 30 years experience in the engineering field, primarily in the areas of power plant analysis, construction, maintenance, and operations. A substantial portion of his experience was as a field engineer supervising the installation, operation, and maintenance of central station power plant equipment, including steam turbines, gas turbines, and emergency power generators. Tr. 2575 (Bridenbaugh).

96. During his employment with General Electric Company from 1953 to 1976, Mr. Bridenbaugh was involved in the design, production and testing of aircraft gas turbines, locomotives utilizing diesel drives, and gas turbine drives, large steam

turbine generators. Tr. 2162 (Bridenbaugh). He also was a field engineer and field engineering supervisor and as such worked primarily on steam turbines and generators as well as gas turbines. His responsibilities included operator training, test procedure development, supervision of installation, operational testing, maintenance, start-up testing and trouble shooting in central station power plants, nuclear and fossil, and in industrial plants. Tr. 2163-64 (Bridenbaugh).

97. Mr. Bridenbaugh worked in the General Electric Nuclear Energy Division for 13 years as Manager of Warranty Service, Manager of Product Service, and Manager of Performance Evaluation and Improvement, providing operating service to utilities, and project management for contract completion at commercial nuclear power plants. Tr. 2164 (Bridenbaugh). He was responsible for tracking the reliability of nuclear plants in the U.S. and developing a performance improvement plan for General Electric to improve the reliability of nuclear equipment. Tr. 2166, 2403 (Bridenbaugh). He also worked as a start-up engineer in at least two nuclear plants. Tr. 2177-79 (Bridenbaugh).

98. LILCO presented testimony concerning the reliability of the EMD diesel generators by Thomas W. Iannuzzi and Kenneth

A. Lewis. Tr. 1160, 1165. Both Mr. Iannuzzi and Mr. Lewis are employed by Morrison-Knudsen Company, Mr. Iannuzzi as Manager of Engineering of the Power Systems Division (PSD), and Mr. Lewis as Technical Services Manager of PSD. Tr. 1160, 1163 (Iannuzzi, Lewis). PSD serviced the EMD diesels while they were owned by New England Power Company (NEPCO), and PSD also provides service to LILCO with respect to those machines. Tr. 1169 (Lewis).

99. Mr. William Gunther testified on behalf of LILCO. He is the plant operating engineer, having held that position for one year. He is responsible for day-to-day operations at Shoreham. Prior to becoming plant operating engineer, he was the instrument control engineer for eight years at Shoreham. He holds a Bachelor of Science and a Master of Science degree in electrical engineering from Northeastern University. Tr. 153 (Gunther).

100. The first portion of Mr. Gunther's testimony describes the steps involved in the proposed LILCO low power testing program, Phases I-IV. Tr. 158, 162 (Gunther). Phase I consists primarily of moving the fuel into the reactor core. In Phase II, actual criticality testing is performed, at which time the control rods are withdrawn systematically until a

reaction is obtained. This is cold criticality testing, which is conducted with the reactor head still removed from the reactor vessel. In Phase III, the entire vessel internals are installed, including the vessel head, and there is preparation for heatup and pressurization of the pressure vessel. In Phase III, the reactor is brought up to rated pressure of approximately 1000 lbs. and a temperature of 503 degrees Fahrenheit is achieved. In Phase IV, there is a continuation of Phase III in the sense that it includes heatup of the reactor vessel and taking the reactor to 5 percent power. Tr. 164-66 (Gunther).

101. Mr. Gunther also testified regarding the procedures that will be utilized to restore AC power to the plant in the event of a loss of offsite power. Tr. 167 (Gunther).

102. The NRC Staff submitted testimony by John L. Knox and Edward B. Tomlinson concerning the reliability of the EMD diesels and the 20 MW gas turbine. Tr. 2337. Mr. Knox is a Senior Electrical Engineer (Reactor Systems) in the Power Systems Branch in the Office of Nuclear Reactor Regulation, and Mr. Tomlinson is a Mechanical Engineer (Reactor Systems) in the Power Systems Branch in the Office of Nuclear Reactor Regulation. Tr. 2337 (Knox); 2339 (Tomlinson).

103. Low power operation of the Shoreham plant relying on LILCO's proposed alternate AC power system would not be as safe as low power operation with onsite emergency AC power sources that were fully qualified and satisfied all applicable regulatory requirements because the EMDs and the 20 MW gas turbine are not as reliable as the latter. Tr. 2440 (Bridenbaugh), 2578 (Eley, Smith, Minor, Bridenbaugh),[1] 2580 (Minor, Bridenbaugh).

1. <u>The EMD Diesels</u>

a. <u>Vulnerability to Single Failures</u>.

104. Unlike fully qualified diesel generators, the four EMDs are vulnerable to single failures. Tr. 2578 (Eley at al.). They have a number of common critical components such as a single electrical output circuit, a single starter system, and a single fuel supply system, and all the breakers connecting the individual EMD generators to their common bus are located in the single EMD control cubicle. A failure in any of these systems has the potential to disable the entire four-unit system and there are a number of such failure possibilities. Tr. 2581 (Eley et al.).

1/ Hereinafter, testimony jointly sponsored by Messrs. Eley, Smith, Minor and Bridenbaugh will be cited as "Eley et al."

105. Although Staff Witness Tomlinson testified that the EMD diesel generators "are capable of operating totally independent of each other," he admitted that the four diesel generators share one control cubicle, one fuel line, one equalizing line, one set of batteries and one power cable coming out to the 4 KV bus. Tr. 1882, 2348 (Tomlinson).

(i) Single Electrical Output of EMDs

106. The electrical output of each EMD diesel is carried by buried cable to the EMD control cubicle, where it is connected through an electrical breaker to a single three phase bus. The output of all four EMDs is then carried by two three-conductor cables in a single raceway, which runs approximately 100 yards from the control cubicle to the non-emergency switchgear room. A quarter of the length of this raceway is proposed to be covered by sand and stucco. Tr. 2581-82 (Eley et al.).

107. By contrast, the power output of the three qualified diesel generators originally intended to be provided at Shoreham are completely separate and independent. The diesel generators themselves are housed in separate compartments designed to withstand all design basis loads and phenomena, and each generator also is provided with all necessary auxiliaries

and controls for independent operation. The power generated by each of the units is distributed by electrical systems provided with "physical and electrical separation of bus sections, switchgear, interconnections, feeders, load centers, motor control centers, and other system components." FSAR § 8.3.1.1.1; Tr. 2582 (Eley et al.).

108. If the single output circuit for the EMDs became inoperable due, for example, to any electrical malfunctions or mechanical failure in the control cubicle, it would be impossible to transmit power from any of the EMDs to the plant. Tr. 2583 (Eley at al.). However, because the power produced by each of the three qualified diesels is transmitted independently, the failure of one output line would affect only one generator. The other two would remain capable of generating and transmitting power. Tr. 2583 (Eley et al.).

109. The EMDs are less reliable than a qualified set of onsite AC generators, because the single failure in the output line would make all four EMDs unable to supply emergency AC power. Tr. 2583 (Eley et al.).

(ii) Common Starting System for EMDs

110. The common starting system for the Shoreham EMDs consists of a number of components. Included is a battery array, housed in EMD 402, which consists of a number of individual lead acid batteries connected in series, which provide a total available voltage of 125. The battery array is connected to a stepping switch located in the EMD control cubicle. The stepping switch is necessary, because the battery array is capable of starting only one EMD at a time. The stepping switch directs battery power to one EMD at a time, moving to the next machine when the first machine starts or fails to start after 15 seconds. Also included in the starting system is a battery charger located in EMD 402. Tr. 2583-84 (Eley et al.).

111. There are two electric starter motors on each of the EMDs. The two electric starter motors are not redundant, however; both starter motors on each of the EMDs are required to start that EMD. Tr. 2541 (Eley).

112. By contrast, each qualified diesel generator originally intended to be provided at Shoreham, as described in the FSAR, was equipped with two independent, redundant air starting systems. The air storage tanks, piping between tanks, and air start distributors were designed to ASME Boiler and Pressure

Vessel Code Section III, Class 3. Each independent, redundant air starting system for qualified diesel generators is a sufficient volume to be capable of cranking the engine for a minimum of five starts without recharging the tanks. Tr. 2584-85 (Eley et al.).

113. Unlike the three qualified emergency diesel generators, the failure of the single starter system for the package of four EMDs could make it impossible to start any of the EMDs. Tr. 2585-86 (Eley et al.).

114. For example, the failure of the battery array and/or charger could render the EMD starting system inoperable. Tr. 2586 (Eley et al.). Or, a single failure in the EMD electrical equipment, such as a failure of the stepping switch, could prevent all four EMDs from starting. Tr. 2468 (Eley). Similarly, if the starter control mechanism in the EMD control cubicle failed, although electricity would be available to power the EMD starter motors, that electricity would not be transmitted to the starter motors, and none of the EMDs would be started. Tr. 2586 (Eley et al.).

115. Although the EMDs could be started individually manually, there is no evidence in the record that a failure in the stepping switch can be overridden through manual operation.

Tr. 2468-69 (Eley). Furthermore, LILCO's procedures do not call for operators to be at the EMD units during their operation. Tr. 2604 (Eley et al.).

116. Because each fully qualified diesel generator is provided with two independent, redundant starting systems, the failure of one starting system would not incapacitate even one qualified diesel generator, and the failure of two systems could only prevent the starting of one generator. Tr. 2586 (Eley et al.). By contrast, the failure of one starter component could prevent the entire EMD set from starting and from transmitting any power at all to the plant. Tr. 2586 (Eley et al.).

(iii) Fuel System for EMDs

117. Each individual EMD has a 130 gallon "day tank." The day tanks of the four EMDs are joined together by an equalizing pipe. Fuel from all four day tanks flows through the equalizing pipes in a manner which keeps the fuel in all four day tanks at the same level. Fuel is supplied to the day tanks by two transfer pumps located in EMD 402. These pumps draw fuel through a single above ground pipeline. This pipe runs next to the EMDs at the foot of a steep embankment. The fuel supply pipe passes under a temporary ramp constructed to allow

vehicles to drive up the embankment, and ends at a fueling station. Tr. 2587 (Eley et al.). At that point the pipeline is connected to a flexible hose which, in turn, is connected to a 9,000 gallon tank truck. Tr. 2587 (Eley et al.).

118. By contrast, each of the three TDI diesel generators described in the FSAR has its own fuel system, which is physically isolated from the fuel systems for the other two generators. Each system consists of a completely buried tank and two fuel supply pumps housed in their own concrete block house. All components are designed to withstand credible seismic events that may occur. Each system also has its own fuel supply line which is buried. The tanks, pumps and supply lines are protected from common fires and missile events. Each generator also has its own day tank, which is isolated from the other generators' day tanks. Tr. 2588 (Eley et al.).

119. If a failure rendered the fuel system for one of the qualified diesel generators inoperable, only one of the three generators would be affected because each qualified generator has an independent fuel supply system; the other two generators could continue to produce power. Tr. 2588-89 (Eley et al.). In contrast, if the EMD fuel supply system failed, all four EMDs would be affected because they all receive their fuel through that single system. Tr. 2589 (Eley et al.).

120. Because the fuel for all the EMDs flows through the pump and the day tank in EMD 402, an interruption of the fuel supply in that unit would interrupt the flow of fuel to all four EMDs. Thus, if a fire occurred in EMD 402, or if the pumps or float switches in EMD 402 failed, fuel would not be transferred from the single supply pipe to the day tanks of any of the EMDs. Tr. 2589 (Eley et al.).

121. Because all the day tanks are interconnected by the equalizing line, any single failure, such as a rupture due to a seismic event, could adversely affect operation of all four EMDs. Tr. 2589 (Eley et al.). If a failure occurred in the equalizing line before the isolating valve in that line, that would be a common failure that would affect operation of all four EMDs. Tr. 2476 (Eley).

122. If there were a rupture in the day tank for any one of the EMDs, that tank could be isolated so that the rupture did not affect the day tanks of the other EMDs, only if someone saw or otherwise become aware of the rupture. Tr. 2475 (Smith). Similarly, if there were a rupture in the fuel supply line feeding the EMDs, the EMDs could be fueled through an alternate fill on EMD 402 only if LILCO personnel became aware of the rupture. Tr. 2476 (Smith).

123. LILCO's procedures do not provide for operators to be in the EMD units during their operation. Tr. 2604 (Eley et al.).

124. The ground on which the EMDs are located is crushed rock which would absorb a large amount of fuel before anyone became aware of it. Tr. 2477 (Smith). There is no evidence that there is emergency lighting in the area of the EMDs that would be available after a loss of offsite power. Tr. 2477 (Smith). Thus, on a dark night, the EMDs could reach the point of fuel starvation before anyone realized that something had gone wrong. Tr. 2476 (Smith).

125. Fuel for the EMDs is transferred from the tank truck into the supply line through a hose running from the truck. This hose apparently just lies on the ground as it runs from the tank truck to the connection with the supply line. Tr. 2589 (Eley et al.). Because the fuel for all four EMDs flows through this single hose, damage to it could terminate the flow of fuel from the tank truck to all four EMDs. Tr. 2590 (Eley et al.).

126. The single fuel supply line that carries fuel from the hose to EMD 402 is susceptible to failure due to both ground motion and missile impact. Tr. 2590 (Eley et al.).

127. Even if the fuel supply line to the EMDs were buried, the EMDs would still be susceptible to damage from missile impact at the point where the line came above the surface and at the point of the flexible connection. Tr. 2478 (Eley et al.).

128. Because fuel for all four EMDs flows through this pipeline, damage to it would interrupt the flow of fuel from the tank truck to all the EMDs. Tr. 2590 (Eley et al.).

(iv) Common Location of Breakers for the EMDs

129. All the breakers which connect the individual EMD generators to their common bus are located in the EMD control cubicle. Tr. 2581 (Eley et al.)

130. The reliability of the EMDs is reduced, because a single event, such as an electrical fire in the control cubicle, or missile damage, could disable all four breakers and make it impossible to transmit emergency power from the EMDs to Bus 11. Tr. 2591 (Eley et al.).

(v) Fire Detection and Mitigation for the EMDs

131. The onsite emergency generator system originally proposed for Shoreham includes both fixed fire detection and fixed fire extinguishing systems. These fire protection systems

include permanent and automatic detectors and fire suppression devices in each generator compartment, designed to activate automatically the CO_2 fire suppression systems which flood the compartments with CO_2 gas. The fire protection systems also provide immediate alarms in the main control room to assure that follow-up operator action is initiated. Because each of the three TDI diesel generators is in its own separate compartment, these systems operate independently to enhance the reliability of each unit. Tr. 2591 (Eley et al.).

132. The EMDs contain no fire detection equipment and no fixed, remotely operated fire extinguishing system. Tr. 2592 (Eley et al.). The only fire extinguishing equipment associated with the EMDs is a small number of hand-held fire extinguishers stored inside the EMD units and two fire hydrants located in their vicinity. Tr. 2592 (Eley et al.); 1183 (Iannuzzi and Lewis).

133. The lack of fixed fire detection and suppression systems makes the EMDs less reliable than the qualified onsite AC power sources. Tr. 2592 (Eley et al.).

134. It is unlikely that a fire in one of the EMDs would be discovered until it was too late to extinguish it expeditiously. Because the EMDs are not fitted with a fire detection

system, the first indication of a fire would be smoke or flames escaping from the housing of an EMD. Even then detection would only occur when someone happened to see the smoke or flames. Tr. 2592 (Eley et al.).

135. Although there are surveillance cameras which allow surveillance of the EMDs from the control room, smoke issuing from the housing of any of the EMDs could be observed on television monitors only if someone were looking at the monitors, and if the area surrounding the EMDs were lighted. Tr. 2488-89 (Smith). There is no emergency, DC-powered lighting outside buildings. Tr. 2477 (Smith).

136. If a fire occurred in one of the EMDs while it was operating, it is difficult to say when smoke would be pushed out of the engine compartment by cooling air flowing through the engine. Moreover, it is possible under some circumstances, for example if the fire were very close to the turbocharger, that the majority of the smoke would actually be drawn inside the engine and would not be visible. Tr. 2488 (Smith).

137. By the time the fire in an EMD is sufficiently well established to cause smoke or flames to issue from the housing, it may be so well established that it would be impossible to enter the EMD housing to apply an extinguishing medium to the

seat of the fire. Tr. 2592-93 (Eley et al.). Without the ability to direct hoses and extinguishers at the seat of the fire, it is very unlikely that the fire could be extinguished before the EMD was rendered inoperable. Consequently, personnel responding to the fire would have to be content with containing it. Tr. 2593 (Eley et al.).

138. The vulnerability of the EMDs to fire is increased by the fact that it is unlikely that the other three EMDs could be kept running if there were a fire in one EMD. Tr. 2593 (Eley et al.).

139. Fire fighters responding to a fire in one EMD would almost certainly want to isolate sources of fuel from the fire. This would mean stopping the flow of fuel from the tank truck as well as isolating the day tank of the burning unit. As a result, the other three EMDs would have only the fuel that was in their day tanks when the burning unit was isolated. Tr. 2593 (Eley et al.).

140. In addition, operating EMDs draw large amounts of air. Running the EMDs while a neighboring unit is burning creates the risk of drawing flames into the non-burning machine through the air intakes. Because fire fighters almost certainly would spray large amounts of water on the non-burning EMDs

to cool them, there is the risk that water could be drawn into the running EMDs through their air intakes. Tr. 2593 (Eley et al.).

141. Despite the fact that the housing for the EMDs was designed to allow the units to operate in adverse weather conditions including heavy rains, it is still highly probable that water sprayed by firefighters would be drawn inside the housing of any EMDs that remained in operation. The impact of water from a fire hose on the side of the housing in the area of the air intake would be totally different from that of rain or snow. Tr. 2540 (Smith).

142. A fire in EMDs 401 or 402 could also result in water being sprayed on the nearby EMD control cubicle. Tr. 2593 (Eley et al.). To eliminate the risk of electrical injury to fire fighters, the flow of electricity through the switchgear in the control cubicle probably would have to be stopped, thereby preventing the operation of any of the EMDs. Tr. 2594 (Eley et al.).

143. Thus, the EMDs are less reliable than qualified onsite generators because they are more vulnerable to fires. Tr. 2594 (Eley et al.). With LILCO's originally proposed diesel generators any fire would be detected quickly; indeed the

likely precursors to the fire, such as hot gases, might even be detected before th fire actually began. And, once a fire was detected in any one of the TDIs, fixed mitigation systems could quickly attempt to extinguish it. Tr. 2594 (Eley et al.). By contrast, a fire in any one EMD almost certainly would incapacitate that EMD. One of the originally proposed diesel generators would have a much better chance of surviving the fire. And, while a fire in one qualified diesel would not affect the others, a fire in one EMD would make it very difficult to continue to run the others. Tr. 2594 (Eley et al.).

144. The absence of fire detection and fixed fire suppression equipment is a serious shortcoming in any diesel configuration, because operating diesel engines always present a potential for fire. Tr. 2594 (Eley et al.). This shortcoming is especially serious with respect to the Shoreham EMDs, because they are more vulnerable to common fire damage than the diesel generator configuration originally proposed by LILCO. Tr. 2594-95 (Eley et al.).

145. Unlike a set of qualified diesel generators, the EMDs are not separated by approved, fire barrier walls. Instead the EMDs simply sit in a row, with each unit approximately eight to twelve feet from the next one. Consequently, there is a

greater potential that a fire in one EMD could spread to the other EMDs and prevent the entire set from supplying emergency power to the plant. Tr. 2595 (Eley et al.).

146. It cannot be said, based on the maintenance history of the Shoreham EMDs, that they have not suffered any fires since they have been in operation, because the maintenance records are incomplete. Tr. 2484-85 (Smith).

147. In addition, the EMD starting battery array poses a threat of explosion and fire. When the EMDs are started, the starter batteries are partially depleted, and they must be replenished by the battery charger. While they are being charged, batteries generate both oxygen and hydrogen gases. The hydrogen gas is a potential source of explosion. Tr. 2595 (Eley et al.).

148. The batteries in EMD 402 could produce about 32 cubic feet of hydrogen per hour while being charged, and because the lower explosion limit would be about 4.1 or 4.2 percent by volume, there is a possibility of fire. Tr. 2492 (Eley).

149. Safe operating practice dictates that batteries should be housed in a compartment with no potential sources of ignition, and which is ventilated to outside air either

naturally or mechanically in a manner which prevents the accumulation of explosive gases. In addition, explosion-proof fittings normally are used in the area where batteries are mounted. None of these practices has been followed with the EMDs. Tr. 2492-93, 2595 (Eley et al.).

150. The starter battery array for all four EMDs is stored beneath the floor in the engine compartment of EMD 402. Instead of ventilation that carries potential explosive gases to the outside air, gases generated by the starter battery are vented into the enclosed engine compartment of EMD 402. In the engine compartment of EMD 402 those gases are exposed to electrical devices, such as lights, light switches and relays, all of which could create sparks and ignite an explosion and possibly a fire. Tr. 2595-96 (Eley et al.).

151. An explosion or fire from the battery gases could incapacite EMD 402 and an explosion or fire could also disable the common starting system for all four EMDs by destroying the battery. An explosion or fire in EMD 402 could also incapacite the fuel supply system for all four EMDs, which runs through EMD 402. Tr. 2595-96 (Eley et al.).

152. The threat of explosion or fire resulting from the improper ventilation of the starting battery array is a

potential single failure that could prevent the operation of the entire EMD set. There is no comparable threat of explosion associated with the originally proposed diesel generators, because their starting systems utilize no batteries and therefore there is no source of hydrogen. Tr. 2596 (Eley et al.).

(vi) Alarms Relating to the EMDs

153. Inadequacies in the alarm system for the EMDs make it less likely that they will operate reliably than would a set of qualified diesel generators. Tr. 2600 (Eley et al.).

154. When qualified onsite diesels are operating, personnel in the control room are informed of deviations of the diesel systems from design parameters (e.g., cooling, fuel, lubrication) by alarm systems that are displayed in the control room. Tr. 2600 (Eley et al.).

155. Early detection of an abnormal condition gives the control room personnel the ability to take corrective action before the condition deteriorates to the point at which the diesel(s) automatically stops. The operating reliability of the qualified diesels is thus enhanced by adequate alarms. Tr. 2600 (Eley et al.).

156. If an alarm on one of the TDI generators went off while it was being used in an emergency to provide AC power to the plant's emergency cooling systems, the alarm would enable the operator to attempt to correct a problem before the problem actually shut the generator down. Tr. 2498 (Smith). For example, if a lubricating oil filter on a TDI began slowly choking up, and the alarm went off before the shut down signal were given, the operators could see the alarm, go to the generator and rectify the fault. There would be no interruption of the electrical power supplied by the TDIs. Tr. 2498 (Smith).

157. Although the EMDs have alarms, all EMD alarm signals except one ("Abnormal Fuel Tank Level") are given only when a problem becomes serious enough to initiate an engine shutdown. Thus, all but one of the EMD alarms go off only when it is too late for human intervention to correct an abnormal condition prior to shutdown. Tr. 2600-01 (Eley et al.). Thus, for example, the low lubricating oil alarm on the EMDs only goes off simultaneously with a shutdown signal. So, with respect to the EMDs, the first indication received by the operator is that the machine has actually stopped. Tr. 2498-99 (Smith).

158. Thus, with the TDIs there is a possibility of manual intervention before the machine actually shuts down, whereas

almost all the alarms on the EMDs give a shutdown signal to the machine, so that r nual intervention is less likely. Tr. 2499-2500 (Eley).

159. The description of the alarm system contained in the Shoreham FSAR sets forth the comprehensive instrumentation provided for operation and monitoring of a typical qualified onsite AC power system. Tr. 2601 (Eley et al.).

160. The FSAR states that surveillance instrumentation provides continuous monitoring of the status of the emergency generators, so as to indicate their readiness to perform their intended function, and that conditions that can adversely affect performance of the emergency diesel generators are annunciated locally and in the main control room. Tr. 2601-02 (Eley et al.). The FSAR lists 38 individual, specific alarms that are fixed to the TDIs. Tr. 2603 (Eley et al.).

161. By contrast, the EMD alarm system is not sufficiently precise to facilitate the prompt diagnostic and repair actions that would be needed to restore to service a failed EMD. Four of the alarm lights on the EMD annunciator panel cover seventeen different shutdown causes. Tr. 2601 (Eley et al.).

162. For example, when the "Engine Stop" light and the "Generator Breaker" light come on simultaneously, the problem could be low engine lubricating oil pressure, low engine cooling water level, excessive crankcase pressure, engine overspeed, or an open breaker. When faced with either of those two alarms, the operators would have to check a long list of potential problems in order quickly to repair the EMD. Tr. 2601 (Eley et al.).

163. In addition, the EMD alarms are only annunciated in each individual EMD unit. The EMD alarms cannot be read from the control room. Thus, the EMD alarms can only be read if operating personnel actually monitor the individual annunciator panels in each EMD unit, and LILCO's procedures do not provide for operators to be in the EMD units during their operation. Tr. 2604 (Eley et al.).

(vii) Manual Operations Required for the EMDs

164. In United States nuclear practice there is an unwritten rule that if important safety actions need to be taken within ten minutes, and those safety actions either involve human activities which may be complex, or are so important that one does not want to risk having them performed incorrectly

during stressful periods, those safety actions are automated. This rule was applied with respect to the TDI generators. Processes by which they start, synchronize, load, distribute the load to systems which need the power the most, and isolate the systems that do not need the power are all automatic. Tr. 2534 (Minor).

165. The EMD diesels and the 20 MW Gas Turbine are important to safety, but contrary to the ten minute rule, their operation requires a great deal of human action. Tr. 2534 (Minor).

166. The amount of time that would be available in the event of a loss of offsite power during low power operation at Shoreham does not affect the comparison between LILCO's alternative proposed AC power system and a set of qualified onsite AC power sources, because in making that comparison one must postulate identical circumstances, including available time, for each situation in which you are judging the two systems. Tr. 2533 (Bridenbaugh).

167. The qualified safety-related onsite emergency AC generators are designed to have power available within 10 seconds of a loss of offsite power. Tr. 2605 (Eley et al.). The FSAR Chapter 15 analysis assumes that power would be restored within

15 seconds. Tr. 1753 (Hodges). LILCO's originally proposed onsite AC power systems were designed to meet these standards. All the starting and loading functions relating to the TDIs are to be performed automatically without operator assistance. Tr. 2605 (Eley et al.).

168. By contrast, starting and loading of the EMDs is a multiple step process involving many manual actions. Tr. 2605 (Eley et al.).

169. Although a start signal is given simultaneously to all four EMDs, because there is only one cranking battery for all four EMDs, electricity is provided to each EMD's starter motors serially. The operating manual for the Shoreham EMDs estimates that for four units to start, warm up, synchronize and become ready to receive load, it will take between two minutes twenty seconds and two minutes fifty seconds. Tr. 2605-06 (Eley et al.).

170. Although starting the EMDs is automatic, a total of at least 18 manual operations, performed by operators under the potential stress of an emergency situation, are required to connect the EMDs to the necessary electrical loads for the engineered safeguards system. Tr. 2605 (Eley et al.). Because operation of the EMDs depends on the actions of operators, the

risk of human error is greater with the EMDs than with a qualified onsite A. power system, and this additional risk reduces the reliability of the EMDs. Tr. 2607 (Eley et al.).

171. Before the breaker from the EMD bus to Bus 11 can be closed to supply power to the emergency loads, a control room operator must isolate the 4 KV buses from the RSST and the NSST by operating breakers, and must shed the loads from the 4 KV buses. Tr. 1821-22 (Clifford). Then, field operators must manually (1) remove three undervoltage program fuses in the service water pump cubicle, (2) open the gas turbine feeder breaker, the feedwater pump feeder breaker, and the 480V substation feeder breaker, in the non-emergency switchgear room, and (3) go outside to the NSST and open three disconnect switches on the low side of the NSST. Tr. 2607 (Eley et al.).

172. LILCO's procedures call for an operator to be dispatched to perform these actions. If an operator were to be dispatched from the control room, in order to complete these necessary tasks, he would have to travel nine flights of stairs, pass through approximately fifteen doors (six of which are locked security doors, and require a credit card-like key to open), and he must pass one security station. The large number of stairways and doors involved in this process

increases the chances that the operator will be unable to complete his assigned tasks in a timely manner. Tr. 2607 (Eley et al.).

173. In order to go outside to the NSST to open three disconnect switches on the low side of the NSST, the operator must leave the building, and climb over the EMD cable raceway. In order to open the switches, the operator has to use an approximately 20 foot long fiberglass pole with a hook at the end. Tr. 2608 (Eley et al.); 1830 (Clifford).

174. The difficulty involved in performing this task increases the risk of delay, and the difficulty of opening these switches under adverse weather or lighting conditions is significantly increased because there is no emergency lighting in the vicinity of the NSST. Tr. 2608 (Eley et al.).

175. The impact of human error potential in the operation of the EMDs is further increased, because it is necessary for operators manually to manage the load of the EMDs. LILCO personnel acknowledged during a July 2 demonstration of EMD operation that manual control of the loads placed on the EMDs could be necessary to ensure that the engines do not run at loads so low as to be detrimental to the machine. Tr. 2608 (Eley et al.).

176. If all four EMDs are operating and connected to the minimum load, they are connected to a very low load. Tr. 2505 (Smith). Although the Shoreham EMDs have automatic load adjusting systems, there is a big difference between balancing load among machines that are running at 50 or 75 percent load and balancing load among machines running around 5 or 10 percent load. The governors of the EMDs have a difficult time balancing or controlling the machines at very light loads, and when the machines are running at very light loads there is a risk that one of the machines will go into reverse current. This in fact occurred during the July 2 demonstration. If a machine goes into reverse current, it shuts down. That also occurred during the July 2 demonstration. Tr. 2506-07 (Smith).

177. Although if one of the EMDs tripped off due to reverse current the other EMDs might pick up the load that had been carried by the machine that tripped off, it is not certain that that would happen. Tr. 2507 (Smith).

178. Manual management of EMD loads must be done from the EMD control cubicle. This fact increases the risk of human error, especially because the EMD control cubicle contains only one set of current and power meters. This increased risk of human failure decreases the reliability of the EMDs relative to

that of fully automated power sources. Tr. 2608-09 (Eley et al.).

179. Although LILCO's witness Mr. Gunther asserted that plant procedures, including SP 29.015.02, Loss of All AC Power, have been revised to incorporate the power sources in LILCO's alternate configuration and to reflect the availability of the EMDs and the 20 MW gas turbine (Tr. 853-56 (Gunther)), there is no evidence that the Loss of All AC Power procedure, SP 29.015.02, has been modified or revised to instruct the operators to restore power by means of the alternate configuration proposed by LILCO. Tr. 793 (Gunther).

180. As of the time of the April hearing, no Shoreham control room operators had received any simulator training simulating the events, such as a loss of coolant accident, or other events that would utilize either the 20 MW gas turbine or the EMD diesels. Tr. 368 (Gunther).

181. The only testing of operator implementation of procedures discussed in the LILCO testimony was a July 2, 1984 demonstration. Tr. 856-59 (Gunther). That demonstration involved one test to start the EMDs and one test to start the gas turbine. Tr. 1846-47 (Clifford). All other testing discussed by LILCO involves testing of the functioning of the equipment. Tr. 856-60 (Gunther).

182. During the July 2 demonstration, only one of the EMD diesels was synchronized and able to carry load. Tr. 858-59 (Gunther).

183. During the demonstration on July 2, 1984, the field operators who were sent to perform the various functions required during the demonstration were in the control room at the time they were dispatched. Tr. 1834 (Clifford). There is no evidence that the July 2, 1984 demonstration or the review conducted by the Staff witnesses addressed the time necessary to perform actions set forth in LILCO procedures in the event of an actual loss of offsite power situation, and Mr. Clifford's conclusions did not relate to any particular pieces of equipment. Tr. 1840 (Clifford).

184. There is substantial uncertainty as to how much time is necessary for the EMDs actually to get load on line because of the need for human intervention. Moreover, in a real blackout situation it does not matter how many drills have been held. A real blackout would be a completely different situation because in a real blackout, especially under adverse conditions such as night or bad weather, the operator's compliance with the operating procedures might be totally different from his compliance under ideal test or drill conditions. Tr. 2504 (Smith).

185. The NRC Staff has apparently reviewed only two of the procedures discus. d by LILCO in its testimony relating to its exemption request. Those two procedures are SP 29.015.02 (Loss of All AC Power Emergency Procedure) and TP 29.015.03 (Restoration of AC Power with Onsite Mobile Generators Interim Emergency Procedure (5% Power)). Tr. 1805, 1851 (Clifford); Staff LP Ex. 2 at 13-1.

186. The review performed by the Staff witness Mr. Clifford was based upon Revision 5 of the Loss of All AC Power Emergency Procedure (SP-29.015.02), which does not include any instructions or procedures for the use of the alternate power configurations. Tr. 1805 (Clifford); 793 (Gunther).

187. The two procedures reviewed by the Staff were not acceptable to the Staff. Tr. 1835 (Clifford). If a low power license were to be issued, the Staff would insist upon five license conditions relating just to the two procedures reviewed by the Staff. Tr. 1834-35 (Clifford).

188. Although LILCO's witness Mr. Gunther stated that LILCO intends to implement the procedural changes required by the Staff (Tr. 825 (Gunther)), there is no evidence that all those changes have been made or that the Staff's concerns have been adequately addressed. See Tr. 1834-35, 1838 (Clifford).

189. In order to keep the reactor below 5 percent power, it is essentially a requirement that the number 1 bypass valve position be kept below 50 percent open. There is no procedure which directs operators to maintain the valve in that position. LILCO does not intend to have a procedure in that regard. Tr. 179-80 (Gunther). Further, there is no standing order to require operators to maintain the bypass valve in that position, although Mr. Gunther testified that he might issue such an order or a similar mechanism to ensure that the license conditions of 5 percent power are met. Tr. 180-81 (Gunther).

(viii) Surveillance Test Procedures for EMDs

190. LILCO's proposed EMD surveillance test procedure does not provide for regular testing of the automatic starting, synchronizing, and load sharing mechanisms of the EMDs, as those devices would be required to operate during a loss of offsite power, loss of coolant accident. Tr. 2495 (Smith); 2597 (Eley et al.). Consequently, LILCO's proposed surveillance testing of the EMDs would not identify potential problems with key automatic elements of the EMD configuration, and as a result that testing does not provide an accurate indication of the reliability of the EMD system. Tr. 2597 (Eley et al.).

191. LILCO's proposed EMD surveillance test procedure does not provide for a visual inspection of each EMD prior to starting the engine. Such an inspection is good operating practice, because it permits the operators to ensure that the required amount of vital fluids is present, and that equipment failures or human errors have not left the engine mechanically unsound. Starting the engine without a visual inspection increases the risk that the machine will be damaged and rendered inoperable. Tr. 2598 (Eley et al.).

192. The General Motors operating manual for the Shoreham EMDs states that prelubrication of the EMD engine is a "necessary and important practice for any engine which has been inoperative for more than 48 hours." LILCO's proposed EMD surveillance test procedure does not require the "necessary and important" prelubrication. Tr. 2598 (Eley et al.).

193. Although LILCO's witness Mr. Lewis testified that in surveillance testing the EMDs at Shoreham should be run at full load approximately one hour per month (Tr. 1123 (Lewis)), LILCO's proposed EMD surveillance test procedure does not indicate how long each of the EMDs should be run once it has been started and connected to electrical loads. Thus, it is possible that the EMDs will not be run long enough at their normal

operating temperature to allow temperatures to stabilize in individual components. Stopping a diesel engine before temperatures stabilize in individual components reduces component life and operating reliability. Tr. 2598-99 (Eley et al.).

194. LILCO's proposed EMD surveillance test procedure does not call for a visual inspection of the EMDs while they are running. Such an inspection is important, because many developing mechanical problems can only be detected while the engine is running. If no one inspects the machine while it is operating, such problems could go undetected, and the operators would not have the opportunity to repair the problems before they became serious enough to make the machines inoperable. Tr. 2599 (Eley et al.).

195. LILCO's proposed EMD surveillance testing procedure does not call for a visual inspection of the EMDs after completion of the test. Thus, the LILCO procedure passes up another opportunity to discover developing problems with the machines. A post-test visual inspection also serves to verify that the soak back lube oil pump for the turbocharger is operating properly. Failing to verify that the soak back pump is functioning increases the risk of damage to the turbocharger. Tr. 2599 (Eley et al.).

196. Each of the deficiencies in LILCO's proposed EMD surveillance testing procedure results in a missed opportunity to discover developing problems in the EMDs, increased risk of damage to components, or reduced operating life of components. Consequently, all these deficiencies reduce the reliability of the EMDs. Tr. 2600 (Eley et al.).

197. There is no evidence that the NRC Staff has reviewed or approved any of the surveillance testing procedures proposed by LILCO for the alternate AC power configuration.

198. In its Safety Evaluation Report, the Staff identified seven changes to LILCO's proposed testing of the EMDs which must be made and incorporated into the Shoreham Technical Specifications or preoperational test program before the LILCO proposal is acceptable to the Staff. Staff LP Ex. 2 at 8-3 to 8-5.

199. Although LILCO's witness Mr. Gunther testified that procedures relating to testing of the EMDs had been "finalized," there is no evidence that the deficiencies identified by the County's witnesses or the NRC Staff have been adequately addressed or eliminated. Tr. 853-54 (Gunther).

200. Although LILCO's witness Mr. Gunther testified that training has been provided to operating crews covering surveillance testing of the EMD diesels and the 20 MW gas turbine, he was unable to identify what versions of such procedures were covered in the training. Tr. 855; 807, 809 (Gunther). The training and walk-throughs of procedures took place in April and May, 1984. Tr. 788-89 (Gunther). There is no evidence that the versions of surveillance procedures which LILCO intends to rely upon during low power testing have in fact been the subject of operator training.

(ix) Manufacture of the EMDs

201. Messrs. Iannuzzi and Lewis testified that evidence of proper manufacturing processes is one of the factors to be considered in evaluating the reliability of diesel generators. Tr. 1170 (Iannuzzi, Lewis).

202. The Shoreham EMDs were manufactured in 1967 and 1968. Tr. 1068 (Lewis). However, Mr. Iannuzzi did not visit the EMD manufacturing facility or observe the process by which EMD engines are made until early 1983 (Tr. 1045-46 (Iannuzzi)), and PSD did not perform quality assurance audits of the EMD manufacturing facility before 1974. Tr. 1171 (Iannuzzi, Lewis).

(x) Maintenance of the EMDs

203. Messrs. Lewis and Iannuzzi testified that the inspection and maintenance history of a specific diesel generator is a factor which allows them to assess the reliability of the generator. Tr. 1170 (Lewis, Iannuzzi).

204. Mr. Iannuzzi testified that he reviewed the maintenance records for the Shoreham EMDs from 1978 through 1983, and reports of work performed on those EMDs back to 1974. Tr. 1173 (Iannuzzi). Mr. Lewis testified that he was responsible for the units now at Shoreham since 1981 and that he had reviewed maintenance records before that. Tr. 1173 (Lewis). Mr. Iannuzzi also testified that he felt he and Mr. Lewis knew the maintenance history of the EMDs at Shoreham. Tr. 1058 (Iannuzzi).

205. The LILCO witnesses asserted that the maintenance records upon which they base their testimony consist of reports filled out by PSD field personnel each time they visited the site of the diesels, and maintenance log books for each individual EMD unit, which according to the LILCO witnesses reflected each repair and each inspection. Tr. 1049-52 (Lewis, Iannuzzi).

206. Mr. Lewis did not review the maintenance log books in detail in preparing his testimony, and Mr. Iannuzzi did not review any maintenance log books. Tr. 1052 (Lewis, Iannuzzi). In preparing his testimony, Mr. Iannuzzi reviewed only the field service reports and synopses of log books that were prepared by LILCO personnel. Tr. 1052-53 (Iannuzzi). Mr. Iannuzzi did not know how the LILCO synopses had been prepared. Tr. 1053 (Iannuzzi).

207. Messrs. Iannuzzi and Lewis testified that since 1978 the Shoreham EMDs were maintained in accordance with the PSD maintenance service contract. Tr. 1173 (Iannuzzi, Lewis). Into 1983, PSD personnel made at least twelve visits per year to the Massachusetts site at which the Shoreham EMDs were then installed. Tr. 1070-71 (Lewis).

208. However, contrary to the assertion by Messrs. Lewis and Iannuzzi, the service records relied upon by the LILCO witnesses do not contain reports of all the visits that were made by PSD personnel to the site at which the Shoreham EMDs were previously installed. Tr. 1072-74 (Lewis). Similarly, the maintenance log books for the Shoreham EMDs do not include entries for all the repair work described in the PSD reports. Tr. 1079-84 (Lewis). There are several areas where there are

discrepancies in the maintenance history of the Shoreham EMDs, and they do not provide a full history of the machines. Tr. 2442, 2470 (Smith). Mr. Lewis admitted that the maintenance records for the Shoreham EMDs should be better than they are. Tr. 1084 (Lewis).

209. Although Mr. Iannuzzi testified that he had seen no problem with parts provided by EMD that did not perform properly (Tr. 1171-72 (Iannuzzi)), he also stated that the service records for the Shoreham EMD diesels show a number of instances of cracked cylinder heads. Tr. 1174 (Iannuzzi).

210. The LILCO witnesses testified that while the EMDs were at NEPCO, there were few problems and no shutdowns for major repairs because of an operating condition. Tr. 1178 (Lewis). They also testified that they were aware of no instances in which the units shut down for repairs during operation at NEPCO. Tr. 1179 (Iannuzzi, Lewis).

211. Contrary to the assertion by the LILCO witnesses, the maintenance records relied upon by them indicate that at 10,992 hours a turbocharger failure on EMD 4 caused the engine to smoke heavily, and maintenance personnel started removing parts for changeout. Tr. 1062-63 (Lewis). A turbocharger failure could not have caused the engine to start smoking heavily if

the engine were not operating at the time of the failure, and in order for the maintenance personnel to begin removing parts for changeout the engine had to have been shut down. Tr. 1063-64 (Lewis).

212. Similarly, at 11,622 hours the turbocharger on EMD 4 was replaced because it had failed. The maintenance records relied upon by the LILCO witnesses indicate that at the same time, both aftercoolers on EMD 4 were replaced due to leaking from impact of turbo compressor parts. Tr. 1066 (Lewis). A failure of a turbocharger that resulted in parts being able to impact the aftercooler with a force sufficient to cause leaks could not have happened unless the engine was operating at the time. In order for the failed turbocharger to be replaced the engine had to be shut down. Tr. 1066-67 (Lewis).

213. An EMD diesel generator of the type installed at Shoreham would not be capable of carrying full load without an operable turbocharger. Tr. 1060-61 (Iannuzzi).

214. The maintenance records for the Shoreham EMDs also indicate that at 9,407 hours, Unit 4 experienced a dust bin blower failure, causing generator failure, and that maintenance personnel began preparation for removal of the generator and dust bin blower on Unit 4. Those removals could not have been

accomplished unless the engine was shut down. Tr. 1067-68 (Lewis). Mr. Lewis testified that without a generator a diesel generator cannot generate electricity. Tr. 1088 (Lewis).

215. Messrs. Lewis and Iannuzzi stated that they had no reason to doubt the accuracy of the maintenance records reflecting the failures of the two turbochargers and generator and dust bin blower. Tr. 1063, 1068 (Iannuzzi, Lewis).

216. Although Messrs. Iannuzzi and Lewis testified that they knew of no catastrophic failures of the pressure boundaries related to auxiliary equipment that had caused EMD diesels of the Shoreham design to shut down (Tr. 1181-82 (Iannuzzi, Lewis)), Mr. Iannuzzi clarified that it was not their testimony that there had never been any leaks or failures associated with the pressure boundary related to auxiliary equipment on EMDs with the Shoreham design. Tr. 1087 (Iannuzzi).

217. Mr. Lewis testified that PSD had no complaints from NEPCO about the operation or maintenance of the EMDs that are now at Shoreham. Tr. 1060 (Lewis).

218. Although Mr. Lewis testified that any time NEPCO had any type of problem with the EMD diesels they notified him

right away (Tr. 1118 (Lewis)), he also testified that depending on the cause of a turbocharger failure on the Shoreham EMDs while they were owned by NEPCO, the failure may not have come to his attention. Tr. 1118-19 (Lewis). He further testified that even if a turbocharger failure had been due to lack of maintenance, the failure might not have been brought to his attention. Tr. 1118-19 (Lewis).

219. Lewis testified that only two of the Shoreham EMDs have UTEX engines. Tr. 1068 (Lewis). The maintenance records for the Shoreham EMDs indicate that all four of the Shoreham EMDs have replacement UTEX engines. SC LP Exs. 45-48.

220. The maintenance records for the Shoreham EMDs for the period 1974 through 1983 show that exclusive of replacement parts and scheduled maintenance periods, 17 cylinder heads, 21 power assemblies (a power assembly consists of a complete cylinder, piston and cylinder head), 3 turbochargers, and 13 starter motors have had to be replaced. From 1974 through 1983, the Shoreham EMDs have operated an average of 2,255 hours per machine. The failure of this number of major components over an average of 2,255 hours per machine is greater than expected for reliable diesels. Tr. 2609 (Eley, Smith).

221. The PSD service agreement states that an engine should be replaced after 72,000 hours of operation; however, all four of the Shoreham EMDs received replacement engines at operating times from 6,030 hours through 8,070 hours. Tr. 1211 (Iannuzzi, Lewis); SC LP Exs. 45-48.

222. The EMD operating manual states that repowering should take place after 12,000 hours of operation. PSD states in its maintenance agreement with LILCO that repowering should take place after 16,000 hours. Tr. 2609-10 (Eley, Smith); Tr. 1210 (Iannuzzi, Lewis).

223. The maintenance records for the Shoreham EMDs show that EMDs 401 and 403 ran only 6,900 hours before requiring repowering. Tr. 2610 (Eley, Smith).

224. At 12,932 hours (i.e., only 6,900 hours after having been fitted with a replacement UTEX engine), the engine in EMD 401 was repowered. Eighty-seven hours later, power units 4, 6, 10, 11, 13 and 18 had to be changed again on EMD 401 because of damage to the cylinder pistons that had occurred shortly after the repowering. (A power unit consists of a cylinder head assembly, cylinder liner, system assembly, carrier assembly, connecting rod assembly and all related gaskets and seals.) After a further 15 minutes of running, power unit No. 11 was

again changed because of cylinder/piston damage. For this number of componen..s to be changed so soon after overhaul, when they would be expected to last approximately 12,000 hours, indicates that either the maintenance or components were of poor quality. Tr. 2611 (Eley, Smith).

225. EMDs 402 and 404 have run only 6,300 and 5,000 hours respectively since they were fitted with replacement UTEX engines. Nonetheless, after their installation inspection at Shoreham, PSD had concerns about the mechanical condition of EMDs 402 and 404 and stated in its installation inspection report that the "engine components are used and approaching overhaul." Tr. 2610 (Eley, Smith); SC LP Ex. 49.

226. The PSD service agreement states that turbochargers have an expected life before required changeout of 16,000 hours. Tr. 1210 (Iannuzzi, Lewis). The normal expected life of a turbocharger is 32,000 hours. Tr. 2611 (Eley, Smith). The turbocharger on EMD 404 failed at 10,992 hours. Tr. 2611 (Eley, Smith).

227. Seven hundred four hours after a turbocharger on EMD 404 failed, the new replacement turbocharger failed in such a fashion that pieces of the broken turbocharger pierced the aftercoolers, requiring them to be changed also. Tr. 2611

(Eley, Smith). These failures, coupled with the fact the EMD turbochargers have had a history of problems, indicate that this component of the Shoreham EMDs has low reliability. Tr. 2612 (Eley, Smith).

228. In light of the fact that the EMDs have required the replacement of parts due to failures as well as repowering much more frequently than is recommended or than would be expected, it is likely that there is some serious deficiency either in some of the machines or in the manner in which they have been maintained. This means there is an increased risk of mechanical failure, which is made worse by the fact that LILCO's test procedure is not adequate to discover developing mechanical problems. Tr. 2612 (Eley, Smith).

229. Messrs. Lewis and Iannuzzi testified that whether the manufacturer's recommended replacement schedules have been followed is another factor to be used in assessing a diesel generator's reliability. Tr. 1170 (Iannuzzi, Lewis).

230. Mr. Lewis testified that his understanding of General Motors' maintenance recommendations is that regardless of the type of turbocharger, a turbocharger on a machine which is run in excess of 50 percent load should be changed-out every 8000 operating hours. Tr. 1121-22 (Lewis). Messrs. Iannuzzi and

Lewis also testified that the PSD maintenance service schedule meets or exceeds the maintenance schedule published by EMD. Tr. 1173 (Iannuzzi and Lewis).

231. The PSD maintenance schedule, however, calls for replacing turbochargers after 16,000 hours of operating, even though Mr. Lewis testified that the Shoreham EMDs were run at 110 percent of rated load while at NEPCO. Tr. 1178 (Lewis); 1210.

232. Mr. Lewis testified that PSD strictly uses UTEX parts (Tr. 1126 (Lewis)), and that NEPCO always replaced parts with new parts when available, and used UTEX parts only when new parts were not available. Tr. 1180 (Lewis). However, the maintenance records for the Shoreham EMDs indicate that on some occasions neither new nor UTEX components were used as replacements, but instead used components were installed. SC LP Ex. 47.

233. Although Mr. Lewis testified that he had "absolutely no problems with UTEX parts," he admitted that he had had some "small" problems with UTEX parts, and that there were quality control problems with EMD UTEX parts. Tr. 1126-27 (Lewis).

234. Messrs. Iannuzzi and Lewis testified that in 1981, EMD recommended that the viscous dampers on diesels of the model at Shoreham be replaced. Tr. 1173-74 (Iannuzzi, Lewis).

235. Mr. Lewis testified that failure of a viscous damper could lead to excessive wear on gear teeth, which in turn would lead to improper pumping of lubricating oil, inoperability of water pumps, and improper operation of the governor drive, which would probably stop fuel from going into the engine. Tr. 1089-90 (Lewis).

236. Although Mr. Lewis testified that he had not seen any damper failures, he testified that PSD had seen wear on gear trains that had run approximately 300 hours after a viscous damper had become out-of-date. Tr. 1090 (Lewis). Lewis further testified that if a damper is out-of-date, it should be replaced. Tr. 1092 (Lewis).

237. Messrs. Lewis and Iannuzzi testified that the viscous dampers on three out of the four EMDs at Shoreham have not been replaced in accordance with the 1981 EMD recommendation or the EMD maintenance schedule. Tr. 1092 (Lewis); 1174 (Iannuzzi, Lewis). In addition, the PSD service schedule for the Shoreham EMDs does not call for regular inspections of the viscous dampers. Tr. 1201-11 (Iannuzzi, Lewis).

238. Mr. Lewis testified that EMD recommends changing both its standard turbocharger and its high capacity turbocharger every 8,000 hours. Tr. 1121-22 (Lewis). In contrast, the PSD maintenance schedule recommends changing turbochargers only every 16,000 hours. Tr. 1210 (Iannuzzi, Lewis). Mr. Lewis also testified the lower the load at which the engine was run the more frequently the turbocharger should be replaced. Tr. 1153 (Lewis).

(xi) Starting Reliability

239. Messrs. Iannuzzi and Lewis testified that EMD diesel engines of the model used at Shoreham "are extremely reliable in starting." Tr. 1178 (Iannuzzi, Lewis). Their testimony is based upon "fast-start" tests performed by EMD and Bruce GM Diesel (the predecessor of PSD and for convenience hereinafter referred to as "PSD"), a 1967 "report" by EMD, and "PSD experience." Tr. 1176-78 (Iannuzzi, Lewis).

240. The fast-start tests performed by EMD were performed in 1968 through 1970 on Model 999 EMDs. EMDs which were subjected to the fast-start tests had two redundant air start systems and two redundant fuel pumps, one electric and one engine-driven. Tr. 1096, 1098, 1176-77 (Iannuzzi). The fast-start tests performed by PSD from 1971 through 1973 also had

redundant air start systems and redundant fuel pumps. Tr. 1176-77 (Iannuzzi).

241. The Shoreham EMDs are not equipped with redundant air start systems and they do not have an electric backup fuel pump. Tr. 1101-02 (Iannuzzi).

242. Mr. Iannuzzi spoke with Art Kornichuk, the EMD Regional Sales Manager about the EMD fast-start tests. Mr. Kornichuk stated to Mr. Iannuzzi that although the Shoreham EMDs have the same engine, they do not have the dual air start system of the Model 999. Therefore, Mr. Kornichuk stated that the fast-start tests are not directly applicable to the Shoreham units, and that starting reliability of the Shoreham EMDs can only be based on previous unit history. Tr. 1099, 1104 (Iannuzzi). Mr. Kornichuk stated in his conversation with Mr. Iannuzzi that the General Motors fast-start tests do not prove that the Shoreham EMDs have the same starting reliability as a Model 999 EMD would have. Tr. 1104 (Iannuzzi).

243. In addition, Mr. Iannuzzi testified that he had reviewed the report entitled "Starting Reliability of EMD Model 999 Diesel Electric Generator Sets," November 1, 1971. That report indicates that the starting features which are present in the Model 999 EMDs but not in the Shoreham EMDs were added

expressly for the purpose of attaining high starting reliability. Tr. 1105-06 (Iannuzzi). See also SC LP Ex. 9.

244. Mr. Iannuzzi testified that a diesel generator equipped for fast start would probably be more reliable than a non-fast start unit such as those at Shoreham as a result of the enhancements made to the fast start unit such as the redundant start system and the backup fuel system. Tr. 1158 (Iannuzzi).

245. Mr. Iannuzzi also testified that "[i]n 1967, EMD reported a success rate of 29,136 starts in 29,362 attempts on electric start units, or 99.23%." Tr. 1177 (Iannuzzi). However, Iannuzzi did not know whether any of the electric start EMDs referred to in the EMD "report" had the same starting system as the Shoreham EMDs. He had no knowledge concerning how the units referenced in the "report" were setup. Tr. 1106 (Iannuzzi). Mr. Iannuzzi also did not know who had collected the data referred to in the EMD "report," the source of the data, or the time period covered by the data. He had no knowledge as to what EMD meant by "successful start" in the "report." Tr. 1107-08 (Iannuzzi).

246. Mr. Iannuzzi testified that his knowledge concerning the 1967 data is derived from a letter dated November 2, 1971

from the EMD Manager of Reseller Sales. That letter states only:

> It is of interest to note in addition to the enclosed report [relating to fast-start tests], Electromotive files on starting reliability of the EMD Model MP-type, equipped with single electric start motor, indicates that information has been obtained as of December 11, 1967, which reveals from a total of 29,362 start attempts 29,136 start attempts have been successful indicating 99.23% successes.

LILCO LP Ex. 2; Tr. 1137 (Iannuzzi).

247. Mr. Iannuzzi testified that the letter on which he relied contained information that PSD would use in talking with a new customer to convince him that these are indeed reliable units. Tr. 1131 (Iannuzzi). The letter was written to PSD at a time when EMD was in the process of selling four diesel generators to PSD. Tr. 1135 (Iannuzzi).

248. Mr. Lewis testified that "PSD experience . . . shows that electric start units are reliable." However, Mr. Lewis had no specific data concerning the total number of starts and total number of failures to start in electric start EMDs subsequent to 1967, he did not know how many electric start EMDs there were in service, he did not know how many start attempts have been made on electric start EMDs, and he did not know how

many failures to start have been experienced throughout the industry on electric start EMDs. Tr. 1093-95 (Lewis).

249. Mr. Schiffmacher testified that for the period 1982-83, the starting reliability of the EMD diesels was 279 starts out of 279 attempts. In four instances out of the 279 times, the units were removed from service. Mr. Schiffmacher testified that if you included those as failures to start, you would have 275 successes out of 279 attempts. Tr. 463 (Schiffmacher).

250. The figures relied upon by LILCO to indicate that the Shoreham EMDs have started 275 times out of 279 attempts, are only taken over the last couple of years during which time the Shoreham EMDs have only run about an average of 150 to 200 hours. Tr. 2472 (Smith).

251. The Staff's testimony concerning the reliability of the EMD diesels is based only upon start attempts of the EMDs. The data set forth in the Staff testimony were received by the Staff from LILCO. Tr. 2348-1882 (Tomlinson). The Staff witnesses did nothing to satisfy themselves that the LILCO data were accurate prior to relying upon them in their testimony. Tr. 1883 (Tomlinson).

252. The maintenance procedures for the Shoreham EMDs never call for a whole starter motor replacement. They only call for inspection at 16,000 hours and, if necessary, replacement of individual components of the starter motor. However, the maintenance records show that approximately 13 starter motors have been replaced on the Shoreham EMDs, all after less than 13,000 hours. Tr. 2609 (Eley, Smith); 2542 (Smith); SC LP Exs. 45-48.

2. The 20 MW Gas Turbine

253. The 20 MW gas turbine is not capable of being started by the control room operator at Shoreham. It can be started by the system operator in Hicksville. The GM diesels on the other hand are started by the control room operator and not by the system operator. Both the diesels and the gas turbines are designed to start automatically. The control room operators control tying in the GM diesels to the plant system, whereas the system operator in Hicksville has control of the rest of the transmission system outside of the RSST and NSST, which includes the 20 MW gas turbine. Tr. 368 (Gunther).

254. There is no evidence that the gas turbine test procedures proposed by LILCO, TP 24.307.04, SP 24.307.07 and TP 24.307.08, constitute an effective surveillance program for the

new service assigned to the gas turbine. Tr. 854 (Gunther); 2613-14 (Minor, Bridenbaugh).

255. The apparent purpose of TP 24.307.08 Revision 1, July 2, 1984, ("Six Month Surveillance on 20 MW Gas Turbine Generator No. 2") is to demonstrate the ability of the gas turbine to start and carry some safety-related load in the event of a loss of off-site power. During this test the gas turbine is required to carry the load of only one or two operating RHR pumps from the 103 emergency bus. These two pumps have a total power rating of 1998 KW, so that if both are run simultaneously, this would load the gas turbine only to approximately 10 percent of its rating. The procedure is silent as to how long the load should be carried. Tr. 2613 (Minor, Bridenbaugh).

256. The six month testing of the gas turbine at only five to ten percent of its rated capacity for a non-defined period of time does not sufficiently tax the unit to verify its reliability. The test is too easy. Tr. 2614 (Minor, Bridenbaugh).

257. The position that the proposed surveillance testing is not sufficient to verify the ability of the gas turbine to supply the necessary loads is supported by the NRC Staff's

review of this issue reported in the Safety Evaluation Report. The Staff expressed concern regarding the possible imposition of non-safety loads on the gas turbine that could result in a total load of 17 MW on the unit. The Staff has stated that more frequent full load testing and monthly testing to verify that the normal 69 KV and 4.16 KV load will automatically disconnect are necessary modifications to the Shoreham Technical Specifications. Staff LP Ex. 2 at 8-2; Tr. 2614-15 (Minor, Bridenbaugh).

258. There is no evidence that the NRC Staff has reviewed or approved the surveillance test procedures SP 24.307.07 and TP 24.307.08.

259. Although LILCO's witness Mr. Gunther testified that Procedures SP 24.307.07 and 24.307.08 have been "finalized" (Tr. 853-54 (Gunther)), there is no evidence that the deficiencies described by the County's witnesses or the NRC Staff have been adequately addressed or eliminated.

260. The only indications available in the Shoreham control room from which operation of the gas turbine can be inferred is the indication of voltage on the 69 KV line and the lights which indicate whether the 20 MW gas turbine breaker or the RSST supply breaker is open or closed. Tr. 856 (Gunther); 1812-16 (Clifford); 2615 (Minor, Bridenbaugh).

261. Thus, as with the EMDs, the operators in the control room cannot monitor the operation of the gas turbine in the manner made possible by the comprehensive alarm monitoring system associated with the originally proposed onsite AC power system. Tr. 2615 (Minor, Bridenbaugh).

262. With the gas turbine, the operators do not have the same ability to intervene and rectify developing problems with unit operations that they have with respect to the originally proposed onsite AC power system. Tr. 2615 (Minor, Bridenbaugh).

263. Under most conditions the gas turbine can only be operated at the local control panel at the gas turbine or by the LILCO system operator in Hicksville, if the control is set up for remote control. There is no way to start the 20 MW gas turbine manually from the Shoreham control room, short of artifically creating a loss of power event by isolating the 69 KV line. Tr. 2615-16 (Minor, Bridenbaugh).

264. The control room operator cannot directly start or initiate a restart attempt of the gas turbine as a precautionary or supplemental measure. The only way that the gas turbine can serve the needs of Shoreham in a timely manner is if its controls are left in the proper auto start position, and it

performs correctly during a loss of offsite power event. If the gas turbine failed to start properly, the only way to determine the status of the machine and attempt a restart would be to dispatch an operator to the gas turbine. Tr. 2616 (Minor, Bridenbaugh).

265. The NRC Staff has stated that if the gas turbine is not on line within 10 minutes then the process for placing the EMDs on line should begin. Tr. 2556-57 (Minor); 2351-52 (Knox).

266. According to the LILCO procedures, if the gas turbine fails to start or come on line as expected, initiation of the EMDs is begun, and one of the first steps of that process is to isolate the rest of the electric system, including the gas turbine. Tr. 2558 (Minor); 1850 (Clifford); 2351 (Knox); Staff LP Ex. 2 at 8-4.

267. LILCO's procedures do not provide for the dispatch of an operator to the gas turbine if it does not come on line as expected. If someone were dispatched to the gas turbine to repair it, that process would probably take longer than the 10 minutes within which the gas turbine is supposed to be on line. Tr. 2557-58 (Minor).

268. The gas turbine is not enclosed by anything other than a weatherproof enclosure, and therefore its operation is vulnerable to missiles such as those that could be generated by falling aircraft. Tr. 2616-17 (Minor, Bridenbaugh).

269. The gas turbine is not designed to satisfy the single failure criterion. Because the gas turbine is a single unit, the failure of any one of many critical components could prevent or interrupt its operation. Of particular importance is the reliance of the gas turbine on a single starting system and a single fuel supply line routed to it from the fuel tank approximately 40 yards away. This fuel line can be severed by missile impact, such as falling transmission towers or lines or out-of-control motor vehicles. Tr. 2617 (Minor, Bridenbaugh).

270. The Staff's testimony concerning the reliability of the 20 MW gas turbine relates only to starting reliability. Tr. 2346, 1870-71 (Tomlinson). However, the basis for the Staff's testimony concerning starting reliability was data provided by LILCO to the Staff, and the Staff did nothing to verify the accuracy of the data. The Staff did not do any independent analyses or attempt to discover any additional information concerning reliability of the gas turbine. Tr. 1871 (Tomlinson).

271. The Staff witnesses testified that the gas turbine has been refurbished, and that most of the major mechanical parts on the unit have been replaced since the unit was installed at Shoreham. Tr. 2346, 1872 (Tomlinson). The Staff testified without any explanation or stated basis that replacing parts automatically results in enhancement of the reliability of the unit. Tr. 1873 (Tomlinson).

272. The past performance of the gas turbine does not provide assurance that it will perform reliably in the future, because although this unit had several thousand hours of operations in the past, it was moved to Shoreham only in the spring of 1984. Coincident with this move, the control and starting equipment necessary to provide black start capability was added to the unit. Thus, it is essentially a new installation with the inherent start up "bugs" still to be worked out. Tr. 2617 (Minor, Bridenbaugh).

273. The 20 MW gas turbine is not as reliable as the originally proposed onsite AC power system because it does not meet the single failure criterion, it is not qualified to withstand any of the necessary design basis phenomena, and it is not under the control of the Shoreham control room operators. In addition, LILCO's proposed test procedures do not adequately

assure the reliable operation of the gas turbine, and its alarm monitoring is inadequate. Tr. 2618 (Minor, Bridenbaugh).

274. None of these vulnerabilities and inadequacies present in the 20 MW gas turbine configuration are present in the originally proposed onsite AC power system. As a result the gas turbine is not as reliable as a fully qualified source of onsite power and, therefore, low power operation and reliance on the proposed alternate AC power system would not be as safe as low power operation in reliance on a fully qualified source of onsite AC power. Tr. 2580 (Minor, Bridenbaugh).

3. Complexity of the Proposed Alternate AC Power System

275. The electrical connections associated with the alternate AC power system proposed by LILCO are more complex than those associated with the originally proposed onsite AC power source. Tr. 2618-19 (Minor).

276. The EMDs are not connected directly to the emergency load centers (buses 101, 102 and 103). To reach those centers, AC power from any EMD must pass through three circuit breakers and two buses. Tr. 2619 (Minor). Output from the 20 MW gas turbine must take an even longer and less certain route in order to reach the safety loads connected to the emergency 4 KV

buses. Power from the gas turbine must pass through three circuit breakers, three switches and two transformers. Tr. 2619 (Minor).

277. By contrast, AC power produced by one of the originally proposed fully qualified onsite diesel generators must pass through only one intervening device, a single circuit breaker, in order to reach safety loads connected to an emergency 4 KV bus. Tr. 2619 (Minor).

278. The increased complexity of the proposed alternate AC power system reduces its reliability relative to the originally proposed onsite AC power system. In general, the less complex a system is, the more likely it is to be able to perform its assigned task. A less complex system involves lower potential for failure of intervening hardware and less need for coordination of automatic and manual actions; as a result, a less complex system is more reliable. Tr. 2619-20 (Minor).

279. The greater number of devices and the increased complexity of necessary procedures involved in the LILCO proposed alternate AC power system makes that system subject to greater potential for human error in its design, implementation and operation, than is the originally proposed AC power system. Tr. 2620 (Minor).

4. Other Aspects of Alternate AC Power Configuration which Render it Less Safe than a Qualified AC Power Configuration

280. LILCO's witnesses Iannuzzi and Lewis admitted that the EMD diesels at Shoreham do not comply with all technical requirements for qualified nuclear grade diesels. Tr. 1170 (Iannuzzi, Lewis). They also testified that the Shoreham EMDs and diesel generators which have been qualified for use in nuclear power plants have different auxiliary equipment, including such items as piping, valves, pumps, heat exchangers, tanks, supports and electrical equipment. Tr. 1152, 1181 (Iannuzzi, Lewis).

281. Messrs. Iannuzzi and Lewis know of no four-unit diesel generator packages, such as that installed at Shoreham, that are being used or have been used to supply emergency onsite AC power to a nuclear power plant. Tr. 1112-13 (Iannuzzi, Lewis). They were aware of two-unit packages of nuclear qualified EMDs in use at nuclear power plants, but unlike the EMDs at Shoreham, those qualified EMDs in other nuclear plants are equipped with fast-start capability. Tr. 1113 (Lewis). In addition, Mr. Lewis testified that, unlike those at Shoreham, each of the nuclear qualified EMD diesel generators has its own control cubicle. Tr. 1153-54 (Lewis).

282. In reaching their opinions about the single failure vulnerability of the EMDs and the 20 MW gas turbine, Messrs. Eley, Smith, Minor and Bridenbaugh considered the EMDs and the 20 MW gas turbine as a combined system for providing electrical power to Shoreham. Tr. 2461-62 (Minor).

283. The gas turbine and the EMDs cannot be used together; they cannot both supply power at the same time. Tr. 2449, 2457 (Eley). LILCO's procedures call for attempting to bring loads in from the gas turbine first. The procedures provide that before the EMDs are used the gas turbine must be isolated. Tr. 2456 (Eley); 2464 (Minor). There is no method for paralleling the EMDs and the 20 MW gas turbine. Tr. 2449-50 (Eley).

284. Although a single failure in the EMD starting system would not affect the ability of the 20 MW gas turbine to start, LILCO will not rely on the EMD set unless the 20 MW gas turbine has failed to provide power. Tr. 2464 (Minor).

285. Each of the three TDI generators in the originally proposed system could supply power to the systems independently. Tr. 2457 (Eley). Although the TDI generators do not parallel each other, each of them has a separate bus system. Tr. 2460 (Eley).

286. Although Staff witness Knox testified that the gas turbine and the EMD diesels have independent routing of power which meets the single failure criterion, he admitted that the gas turbine and the EMD diesels are subject to single failures and single events that could cause the loss of both sources of power. Tr. 2350, 1886 (Knox).

287. Staff witness Knox testified that the EMD diesels and the 20 MW gas turbine are both independent of the normal offsite power system at Shoreham, by which he meant the 69 KV line and the 138 KV line. Tr. 2344, 1868 (Knox). However, he admitted that power supplied by the 20 MW gas turbine is supplied on the 69 KV line, so that power from the gas turbine shares a common line with a portion of the normal offsite power system. Tr. 1868 (Knox). <u>See also</u> Tr. 359 (Schiffmacher).

288. In testifying that the gas turbine and the EMD diesels are as "independent" from the offsite power system as the TDIs would be, the Staff witness Mr. Knox did not take into account the fact that the gas turbine shares common equipment with the offsite power system. He merely intended to indicate that both the TDI diesel generators and the gas turbine, prior to a loss of offsite power, sit in a standby condition, with open breakers, and therefore are in that sense only "independent" of the offsite system. Tr. 1870 (Knox).

289. The comparison of operation with the alternate AC power configuration to that with a qualified configuration is premised upon the loss of all offsite AC power. The offsite gas turbines, such as at Holtsville, are part of such offsite power and therefore, are not relevant to the comparison of non-offsite sources of power. In addition, the offsite power system, that is, the 69 KV and 138 KV lines, are subject to a multitude of events that could cause the loss of offsite power that is the underlying presumption of the comparison mandated by the Commission. Power from the far offsite gas turbines is transmitted to Shoreham over the transmission lines which are part of the offsite system. Thus, given a postulated loss of offsite power, the existence of remote gas turbines would have no impact on the availability of AC power at Shoreham because there would be no means of transmitting power from the remote sources to Shoreham. Tr. 2536-38 (Minor).

290. There is an automatic transfer between the two normal offsite power circuits at Shoreham. With that automatic transfer in place, a common failure of the offsite power circuits, the 20 MW gas turbine, and the EMD diesels is possible. Tr. 2354-55 (Knox).

291. As presently configured, there is a potential for common failure of the normal offsite circuits and the EMD diesel circuits and common failure of the gas turbine and the EMD diesels, resulting from a fire. There is no fire barrier nor is there 50 feet of separation between the cables associated with the EMD diesels and the RSST and the NSST. Tr. 2354-55 (Knox).

292. LILCO has not provided the Staff with any information regarding the quality and design standards to which the alternate AC power configuration equipment and associated circuits were designed. Staff LP Ex. 2 at 8-6. Such a quality assurance program is needed to assure that maintenance, testing and operation of the gas turbine, EMD diesels and their associated circuits is performed in accordance with their design specifications, with documentation, to assure their continued reliability. Tr. 2355 (Knox).

293. Mr. Schiffmacher does not know whether the RSST was designed to Appendix B quality assurance standards or whether it was constructed to such standards. Tr. 341 (Schiffmacher). None of the items in the 69 KV system, including transformers, switches, breakers, circuits, and buses, are designed or manufactured or are installed in accordance with Appendix B to

Part 50. Tr. 342 (Schiffmacher). The same applies for the 138 KV line and the NSST. Tr. 342-43 (Schiffmacher). Mr. Schiffmacher does not believe that the EMD diesels were subject to a quality assurance program in accordance with Appendix B when they were installed at New England Power. Tr. 407 (Schiffmacher).

294. LILCO has provided to the Staff no evaluation of a design basis event fire in the non-emergency switchgear room, through which both alternate AC power circuits (20 megawatt gas turbine and EMD diesels) pass. The circuits associated with the gas turbine and the EMDs are not protected in accordance with the requirements of 10 CFR Part 50 Appendix R. Staff LP Ex. 2 at 8-8.

295. Before the proposed low power operation would be acceptable to the Staff, four license conditions must be implemented by LILCO:

(1) The automatic transfer between the two normal offsite power circuits at Shoreham must be removed or disabled;

(2) A fire barrier or 50 feet of separation must be provided between the cables associated with the EMD diesels and the RSST and NSST;

(3) A quality assurance program for the gas turbine, EMD diesels, and the associated circuits commensurate with their importance to safety must be initiated and implemented; and

(4) The circuits associated with the gas turbine and the EMD diesels located in the non-emergency switchgear room must be protected in accordance with the requirements of Appendix R or a procedure must be available so that power can be re-established around the switchgear room within 30 days from one of the alternate AC power sources.

Tr. 2354-55; 1887 (Knox).

296. As presently configured, the low power operation proposed by LILCO is not acceptable to the Staff. Tr. 1887 (Knox).

297. The Staff's Safety Evaluation Report sets forth 15 separate technical specification requirements that the Staff believes must be imposed upon LILCO before the proposed low power operation would be acceptable to the Staff. Staff LP Ex. 2 at 8-2 to 8-8. There is another specific technical specification requirement that will be imposed by the Staff set forth in the Staff's testimony. Tr. 2347 (Tomlinson). The Staff

testified that there could be many additional technical specification requirements that the Staff might have to impose upon LILCO as a result of LILCO's proposal to use the gas turbine and the EMD diesels, even though they have not been identified in the Safety Evaluation Report or the Staff testimony. Tr. 1879 (Knox). The NRC Staff has not yet issued technical specifications for Shoreham, nor have they yet been sent to LILCO. Tr. 1881 (Knox).

298. There is no evidence that the modifications which the Staff has stated are required to make the proposed alternate configuration acceptable to the Staff have been implemented by LILCO.

299. All existing means of supplying power to emergency buses by means of the EMDs result in powering a bus located in the non-emergency switchgear room. Tr. 862, 812 (Gunther).

300. LILCO's witness Mr. Schiffmacher stated that LILCO has come up with a conceptual idea for an alternate routing of power from the EMD diesels into the emergency switchgear room; however, no such capability exists at the plant today. Tr. 863, 813 (Schiffmacher); 2539 (Bridenbaugh). The "conceptual drawing" submitted with LILCO's testimony (Tr. 867) does not show how cables would be connected to the EMD switchgear

cubicle, how cables are to be tied into the emergency switchgear room, which elements of the conceptual idea would be installed before, as opposed to after a seismic event, or which portions would be completed before, rather than after, Phase III of LILCO's proposed low power testing. Tr. 819-20 (Schiffmacher). No cable raceways now exist for this conceptual alternate routing. Although there are several different ways that cable raceways could be supported, LILCO has not yet picked out which method it intends to use. Tr. 814 (Schiffmacher).

301. LILCO's conceptual proposal to install an alternate electrical output feed from the EMD control cubicle to the emergency switchgear room has not resolved the question of how the alternate feed can be tied into the emergency switchgear room and brought to the outside of the plant on the outer wall of the emergency diesel facility without reducing the reliability of operations inside the emergency switchgear room. Such a connection, if made, would be very unusual. Tr. 2539 (Minor).

302. LILCO has specifically considered two options with respect to the proposed conceptual alternate routing of EMD power to the emergency switchgear room. Tr. 832

(Schiffmacher). However, LILCO has not yet decided which of those two options to utilize. In addition, if there was another option that was attractive from a technical point of view or had some other merits, LILCO would also consider that option. Tr. 838-39 (Schiffmacher).

303. Even after a decision were made as to how the conceptual alternate tie-in would be made, the engineering for the tie-in would have to be completed, and hardware changes would have to be implemented. Following that, there would also have to be changes made in procedures, and procedures would then have to be reviewed and approved by the Review of Operations Committee. Then additional training would have to be performed for operators with respect to revised procedures. Tr. 839-40 (Gunther). The LILCO witnesses were unable to state what procedures or training would need to be revised or what revisions would be necessary in order to implement the conceptual proposal described in the testimony. Tr. 840 (Gunther).

304. The Staff has not reviewed any engineering drawings or documentation submitted by LILCO concerning any proposed alternate routing for the EMD diesels. NRC Staff did not know whether any such alternate routing has actually been constructed or installed. Tr. 1896 (Knox).

305. LILCO witnesses Rao, Eckert, Dawe, and Kascsak testified regarding their review of all events considered in Chapter 15 of the Shoreham FSAR to compare the effects on public health and safety of operation of the Shoreham plant during fuel load, cold criticality testing, and low power operations, with the effects at full power operation. Tr. 274-75 (Rao, et al.). This testimony regarding a comparison of low power operation and the risks thereof with full power operation and the risks thereof does not address the standard ennunciated by the Commission in CLI-84-8, namely a comparison of low power operation with the alternate AC power system versus low power operation with a fully qualified AC power system.

306. Using very conservative regulatory assumptions, LILCO's witnesses concluded that for a LOCA event, there will be approximately 370 minutes in Phase III and 86 minutes in Phase IV before any operator action is required in order to maintain adequate core cooling and containment integrity. Using "more realistic assumptions," the calculated operator action times are greater than 24 hours for Phase III and 3 hours for Phase IV. Tr. 297-98 (Rao, et al.). The conservative analysis referred to above used all the models that are required by 10 C.F.R. § 50.46 and Part 50, Appendix K. Under the "realistic analysis," some but not all of the major

conservatisms that exist in Appendix K analyses were removed. Tr. 303-04 (Rao, et al.). Using more conservative calculations (a peaking factor of 5 rather than 3.38) would lead to a requirement of power within 55 minutes in order to keep within the 10 C.F.R. § 50.46 limits. Tr. 307-08 (Rao).

307. Staff witness Hodges testified that if Shoreham were operating at 5 percent power with qualified TDI diesels and there was a loss of offsite power and a LOCA, the peak cladding temperature has been calculated to be 550°F. He also testified that if there was a LOCA and a loss of offsite power without qualified diesels, assuming that the EMD diesels started in 30 minutes, the peak cladding temperature is calculated to be 1086° F. Tr. 1788, 1749-50 (Hodges). Mr. Hodges testified that in terms of the cladding temperatures, there is less margin of safety with the alternate configuration than there would be with qualified TDI diesels. Tr. 1751 (Hodges).

308. Mr. Hodges' conclusion that operation at 5 percent power is as safe with the alternate configuration as with qualified diesels is dependent upon the assumption that AC power is restored within 55 minutes using the alternate configuration. Tr. 1788, 1751-52 (Hodges).

309. The Staff's discussion of the consequences of Chapter 15 accidents during low power operation is a comparison of the consequences during 100 percent power operation to the consequences during 5 percent operation. Tr. 1789-1792, 1754-1758 (Hodges). That testimony does not address the safety of 5 percent power operation with a qualified source of onsite power as compared to 5 percent operation with the alternate configuration proposed by LILCO.

310. In the Staff's Safety Evaluation Report, it was noted that two 3/4 inch diameter valves require prompt closure capability to assure containment integrity. Those valves are normally powered by AC power, although they can be closed manually. The Staff found that containment integrity was threatened in the event of a breach in the Reactor Building Closed Cooling Water System inside the containment coincident with a LOCA, assuming no offsite power was available, and assuming the alternate power configuration proposed by LILCO. Therefore, in order to assure containment integrity in a timely manner, it was necessary for LILCO to commit to station an assigned equipment operator to the reactor building whenever the reactor vessel is pressurized during Phases III and IV. It would not be necessary to utilize an equipment operator to perform this function if there were a qualified source of AC power

available. Staff LP Ex. 2 at 15-6; Tr. 1765 (Hodges). This assigned equipment operator will be required by the Staff as a license condition or a technical specification amendment. Tr. 1765-66 (Hodges).

311. The Standby Gas Treatment System (SGTS) is dependent upon the availability of AC power. Tr. 1767 (Quay). In the Staff's Safety Evaluation Report and in Staff witness Quay's testimony, the impact of loss of the SGTS is discussed. If there were a fuel handling accident resulting in a release of fission products, and there were no SGTS available due to a loss of offsite power, the mitigative effects of that system, which is designed to reduce the quantity of radioactive iodine released to the environment, would not be available. Tr. 1769, 1797 (Quay).

312. Although Staff witness Quay asserted that in his opinion it is "highly unlikely" that LILCO would be moving fuel during low power testing, he stated that he had a very limited knowledge in the area of low power test programs. Tr. 1746, 1772 (Quay). He has never reviewed any results of low power test programs conducted at nuclear power plants. Tr. 1775 (Quay). He also admitted that it would be necessary to move fuel during low power testing if changes to the core were

required or if it were necessary to check core support structures. Tr. 1868 (Quay).

313. The Staff testified that if the alternate power sources at Shoreham failed to survive a seismic event, repairs could be made or additional sources of AC power could be made available to the site well within the time needed. Tr. 2343 (Knox, Tomlinson). There is no evidence, however, that the "additional sources of AC power" referenced by the Staff -- that is, a generator from the Army Corps of Engineers -- would in fact be available, that the use of such equipment would be feasible, that the equipment would be compatible with the Shoreham plant or its proposed operation, or that LILCO has any intention of relying on such a source of AC power. Tr. 1867 (Tomlinson).

II. <u>Exigent Circumstances</u>

A. <u>LILCO's Asserted Training Benefits</u>

314. LILCO's witness Mr. Gunther testified that LILCO's proposed low power test program would provide operators additional training "beyond the normal training benefits gained during low power testing." Tr. 846 (Gunther).

315. Fuel loading and pre-criticality testing which will take place during Phase I involves the performance of water chemistry surveillance testing, control rod drive stroke time and friction tests, installation, calibration and utilization of special start-up neutron instrumentation, source range monitor testing and alignment tests, core verification instrument operability checks, local power range monitor (LPRM) sensitivity testing, zero power radiation surveys, recirculation system instrument calibration checks, control rod drive scram time testing, and cold MSIV timing functional tests. Tr. 846-48 (Gunther). Each of those tests are required, and set forth in the Shoreham FSAR or the Shoreham Technical Specifications. Tr. 757-63, 846-48 (Gunther). The tests are part of the standard power ascension program, and they would be performed whenever low power testing were conducted, whether that took place because LILCO obtained an exemption or because LILCO had complied with GDC 17. Tr. 761-62; 764 (Gunther).

316. Mr. Gunther testified that the experience and training gained from Phase I testing activities will be a Shoreham specific augmentation to pre-operational training previously received by reactor operators; he admitted, however, that such augmentation would be received by those operators whenever low power testing took place. Tr. 849, 764-65 (Gunther).

317. There is no evidence that Phase I of LILCO's proposed low power testing program would result in any additional or augmented training beyond that which would be received by operators if low power testing were to take place without an exemption.

318. Phase II of LILCO's low power testing program involves cold criticality testing. Tr. 849 (Gunther). Phase II is part of the power ascension program which has been scheduled by LILCO, and which involves tests and a series of operations within the plant that must be performed. Tr. 766 (Gunther).

319. Mr. Gunther testified that LILCO plans to provide additional training for operators during Phase II by having certain activities repeated. Tr. 849-50 (Gunther). The additional training during Phase II will take place during a 72 hour period. It is intended to provide an opportunity for each operating shift to perform criticality maneuvers. Tr. 850, 770-71, 776 (Gunther).

320. Beginning whenever an operating license is granted to LILCO, whether as a result of an exemption or not, the Shoreham operators must annually perform a minimum of 10 reactivity control manipulations. Mr. Gunther testified that operators would be able to perform some of these required manipulations during

the low power test program. Tr. 849, 765 (Gunther). All Shoreham reactor operators would perform a minimum of 10 reactivity control manipulations during the first year of Shoreham's operation regardless of whether low power testing begins as a result of the grant of an exemption or as a result of LILCO's having complied with all regulations. Tr. 765 (Gunther).

321. LILCO estimates that there will be 5,000 total man-hours of training accomplished during Phases I and II. Tr. 850 (Gunther). The 5,000 total man-hours of training includes the additional 72 hours proposed for the performance of additional criticalities during Phase II. Tr. 773-74 (Gunther). The hundreds of man-hours involved in the additional 72 hours are included in the total of 5,000 man-hours of training to be involved in Phases I and II. Tr. 837 (Gunther).

322. The total of 5,000 man-hours of training is spread among 31 licensed operators and supervisory personnel, five engineers and six shift technical advisors from the Reactor Engineering Department, and maintenance personnel and instrumentation and control personnel. Tr. 774 (Gunther).

323. Mr. Gunther testified that operating personnel and instrument and control technicians receive valuable training

and experience during Phases III and IV of LILCO's low power test program. Tr. 851 (Gunther).

324. The tests to be performed during Phases III and IV are required according to the FSAR, and would be performed whenever low power testing were conducted. Tr. 774-75 (Gunther). Phase IV would involve either two or three reactor heatups, but would not involve performance of the main turbine roll. Tr. 775-76 (Gunther).

325. LILCO has not scheduled any additional time or training into Phase III of its low power testing program. It has, however, scheduled three days at the conclusion of Phase IV testing for reactor operators to perform three to five additional reactor heatups. Tr. 851-52, 777-78 (Gunther).

326. LILCO only intends to perform such additional reactor heatups at the end of Phase IV if additional time is available after the completion of the low power test program. Tr. 777 (Gunther). If LILCO had its full power license by the time it had finished two or three reactor heatups as contemplated in Phase IV, however, LILCO does not intend to perform any additional reactor heatups at the end of Phase IV to provide additional training. Tr. 777 (Gunther).

327. The training involved in the performance of three to five extra reactor heatups would occur whenever testing above five percent power occurs, since higher power testing calls for a multiple number of reactor startups, shutdowns, and heatups. Tr. 777 (Gunther).

328. The 6,000 manhours of training which will occur during Phases III and IV are spread among 31 licensed operators and supervisory personnel, five engineers and six shift technical advisors, maintenance personnel, instrumentation and control personnel, and health physics technicians. Tr. 774, 777-78 (Gunther).

B. LILCO's Asserted Good Faith Efforts to Comply with GDC 17

329. LILCO's witness Brian McCaffrey testified that "LILCO's extensive efforts" to meet the requirements of GDC 17 are among the exigent circumstances that justify granting LILCO's exception request. Tr. 1702-03 (McCaffrey). The efforts he discussed relate to the original design of the Shoreham plant, efforts relating to the reliable performance of the diesel generators manufactured by Transamerica Delaval Incorporated ("TDI"), and the acquisition of diesel generators manufactured by Colt Industries. Tr. 1703-04 (McCaffrey).

330. Mr. McCaffrey has had no direct experience in the design of diesel engines and he was not involved in preparing the purchase specifications for the TDI diesels. He has had no experience with the manufacture of a large diesel engine and he has never personally operated one of the diesels at Shoreham, although he has supervised individuals who witnessed diesel testing. Tr. 1423-26 (McCaffrey).

331. Mr. McCaffrey testified that Shoreham's design included three emergency diesel generators intended to meet all applicable regulatory requirements for onsite power sources. The specifications for the machines were developed by Stone & Webster and LILCO with all applicable regulatory requirements in mind. Tr. 1705 (McCaffrey).

332. The performance rating of each of the emergency diesel generators which LILCO procured to constitute the on-site electric power system for Shoreham was continuous 8,760 hours, at 3,500 KW. The rating for overload for the emergency diesel generators was two hours per 24-hour period at 3,900 KW. The ratings are set forth in the FSAR § 8.3.1.1.5. Tr. 1446-47 (McCaffrey).

333. The basis for Mr. McCaffrey's testimony that the purchase specification, as reflected in Section 8.3 of the FSAR,

was intended by LILCO to provide for compliance with GDC 17 is based upon McCaffr y's reading of the preliminary safety analysis report and the specification as reflected in the FSAR. Mr. McCaffrey testified that the specification containing the performance ratings reflected in the FSAR was intended by LILCO to provide diesel generators that complied with the requirements of GDC 17. Tr. 1455-58 (McCaffrey).

334. LILCO intended that the TDI diesels it procured, using a specification that related to performance requirements, would assure that the core would be cooled and containment integrity and other vital functions would be maintained in the event of postulated accidents. Tr. 1440-41, 1443 (McCaffrey).

335. Mr. McCaffrey testified that when LILCO purchased the three diesel generators from TDI, LILCO required that the machines be manufactured in accordance with the LILCO specification. Tr. 1705 (McCaffrey). The purchase order from LILCO was the first order ever received by TDI to provide an emergency diesel generator for a commercial nuclear power station. SC LP Ex. 17, p. 2.

336. Mr. McCaffrey testified that when the engines were being procured from TDI, to ensure that the engines would meet the performance rating in the FSAR, LILCO utilized its quality

assurance organization and programs, and those of its architect/engineer to oversee the manufacturer's quality programs. He stated that in general those quality programs require documentation, inspections, and examinations to provide assurance that the equipment is being delivered in compliance with the programs; however, Mr. McCaffrey stated that he did not know all the elements of what LILCO did to assure that the TDI diesels were being manufactured in a way that would make them capable of the performance set forth in the specification. Tr. 1459-60 (McCaffrey).

337. Mr. McCaffrey testified that there were physical inspections of the TDI quality assurance program by agents of LILCO during the manufacturing process. Tr. 1465-66 (McCaffrey). He did not know how many inspections LILCO or its agents carried out to make sure that the rating of the engines was proper. Tr. 1460-61 (McCaffrey).

338. Although Mr. McCaffrey testified that LILCO sent people to TDI to observe the testing of the diesels, he did not know how many hours Delaval tested the engines to determine whether they could perform for 8,700 hours as required by the specification. He also did not know whether LILCO made any effort or attempt to determine how many hours Delaval tested the engines. Tr. 1469 (McCaffrey).

339. In August 1983, the crankshaft on TDI diesel generator 102 failed. Following the failure, LILCO hired Failure Analysis Associates to determine the cause of the crankshaft failure. Failure Analysis Associates determined that the cause of the failure involved torsional fatigue, and also determined that the crankshaft design was definitely inadequate. Tr. 1470-71 (McCaffrey). LILCO reported to its NRC that the results of its crankshaft failure investigation revealed that the crankshaft had been improperly designed, and had failed because the loading function used in the original design calculations was too small. SC LP Ex. 18, p. 5.

340. Mr. McCaffrey did not know how LILCO used its best efforts to determine whether the crankshafts in the engines were adequately designed. He also did not know whether LILCO's attempts to ensure that the engines would meet the requirements of GDC 17 included a review of the design of the crankshafts. Tr. 1470-72 (McCaffrey).

341. After the diesels were delivered to LILCO, LILCO did not determine whether the crankshaft design was adequate. After delivery, the machines were placed in storage. Tr. 1472 (McCaffrey).

342. Mr. McCaffrey testified that LILCO used a building block approach to pre-operational testing of the TDIs, and that such testing included enhancements imposed by LILCO to provide additional measures of the engines' reliability above and beyond the regulatory norms. Tr. 1706-07 (McCaffrey).

343. On May 26, 1982, LILCO performed a pre-operational test of TDI diesel generator 102. The test was performed to verify the diesel generator's capability of running at its two hour rating. Although the acceptance criterion in LILCO's test procedure specified this rating to be 3900 KW, the LILCO procedure step used to verify that this criterion was met specified that the generator be run at a load between 3850 KW and 3900 KW for two hours, and that data be recorded at 15 minute intervals. SC LP Ex. 16, p. 4. The engine upon which this test was run was the same engine which suffered a crankshaft breaking in two pieces in August 1983. Tr. 1480 (McCaffrey).

344. When LILCO performed the test on May 26, 1982, load values did not meet either the acceptance criterion or the procedure step, in that data recorded at 15-minute intervals for the two-hour period indicated a range of load values from 3500 KW to 3850 KW. Nonetheless, the LILCO Test Engineer and Operational Quality Assurance inspectors signed and accepted the results. SC LP Ex. 16, p. 4.

345. As a result of LILCO's conduct relating to the May 26, 1982 test, the NRC issued a Notice of Violation of severity level III, and levied a fine of $40,000 upon LILCO. SC LP Ex. 16. The Staff stated that "the approval of the results of a test performed to confirm a safety system's capability of meeting design safety requirements when, in fact, test results presented to the Joint Test Group (JTG) have not satisfied all requirements, is of significant concern to the Staff." SC LP Ex. 16, p. 1.

346. The NRC Staff also stated:

> While we have considered [LILCO's proposed] remedial actions, the diesel generator testing violation demonstrates a lack of aggressiveness on the part of LILCO to pursue, identify and resolve associated problems that can affect the reliability of the diesel generators, including attention to detail during performance data review, and approval of the test results of [LILCO's] preoperational test program. These actions are necessary to demonstrate that the components will perform satisfactorily in service.

SC LP Ex. 16, p. 2.

347. Mr. McCaffrey did not know whether the proper performance of the test at 3900 KW would have made discovery of the crankshaft deficiency more likely in May 1982 rather than in

August 1983 when the crankshaft actually broke. Tr. 1480-82 (McCaffrey).

348. In March 1983, following a review of LILCO's documents and reports, and after having observed and witnessed LILCO's testing of the TDI diesels, the NRC Staff told LILCO, and issued a report which stated, that "the reliability for continuous operation and for standby electric power is questionable at this point [with respect to the TDI diesels]." SC LP Ex. 17, at 6. McCaffrey read that report when it was issued in March 1983. Tr. 1492 (McCaffrey).

349. The March 1983 NRC report listed some of the problems which arose with the Shoreham TDIs during pre-operational testing, but six months before the crankshaft broke. The Staff listed 47 incidents and/or failures that had occurred in the year preceding March 1983, just according to LILCO's own Deficiency Reports. SC LP Ex. 17, p. 7. It was Mr. McCaffrey's judgment that the number of problems which occurred in the TDIs during that time period was on the high side of what would be expected during a normal shakedown process. Tr. 1492 (McCaffrey).

350. In March 1983, the Staff raised several concerns with LILCO relating to the TDIs, including the following:

-- an apparent overall excessive vibration problem exists with all three of the TDI diesels;

-- there are many apparent causal factors underlying the numerous incidents that have occurred to the TDIs;

-- further trend analysis of these incidents and occurrences is required to resolve the continuing high incident rate of problems and failures to the TDIs.

According to the Staff in March 1983, its findings at that time constituted "an immediate concern to the NRC." SC LP Ex. 17 at 6, 8.

351. In March 1983, in response to the NRC's concern about reliability of the TDIs, LILCO implemented a diesel operability review program, which was aimed at addressing the entire history of problems that arose in prior testing of the TDIs. Tr. 1492-93 (McCaffrey). However, despite the operability review program which was implemented in March, the diesels were never disassembled until after the crankshaft on engine 102 broke in August 1983. Tr. 1495 (McCaffrey).

352. When the engines were disassembled in August 1983, LILCO found that the crankshafts in the other two TDI engines, numbered 101 and 103, also had cracks in them. In addition, other defects were found in engine 102, including cracking in

the camshaft galley, cracks in the piston skirts, and cracks in the connecting rod bearings. Tr. 1493-95 (McCaffrey).

353. LILCO reported to the NRC that its preliminary finding concerning four failed connecting rod bearings which were discovered when the TDIs were disassembled, was that the failures occurred because the bearing material did not meet specifications, and the bearing loads had not been properly accounted for. SC LP Ex. 18, p. 5.

354. Mr. McCaffrey said he did not know whether, if in response to the NRC's March 1983 concerns about the reliability of the engines LILCO had disassembled and inspected those engines, it might have found those defects and cracks earlier. Tr. 1496 (McCaffrey).

355. The enhancements that LILCO imposed prior to the crankshaft failure to provide additional measures of the diesel's reliability above and beyond regulatory norms were the performance of a 72-hour endurance test and a detailed vibration and balance testing. Tr. 1504 (McCaffrey). The vibration and balance test was not initiated until after the issuance of the NRC's March 1983 report concerning reliability problems with the TDIs. Tr. 1505 (McCaffrey). Mr. McCaffrey did not know the load profile used for the 72-hour tests; however, Mr.

McCaffrey did not believe that the 72-hour test showed any problems. Tr. 15C[illegible]-06 (McCaffrey).

356. Prior to the August 1983 failure of the crankshaft, LILCO did not make any effort to determine whether a crankshaft of the design that broke had been installed in any other TDI engines of the same model as the Shoreham engine. Tr. 1483-84 (McCaffrey). Mr. McCaffrey did not know (a) whether LILCO's agents ever had any discussions or correspondence with TDI regarding the design of the crankshaft in the Shoreham engines, (b) whether Delaval ever told LILCO or anyone else that the crankshafts in the Shoreham engines had been found to be unqualified for those engines by the American Bureau of Shipping, or (c) whether prior to the time the crankshaft broke TDI ever told LILCO or any of its agents that a new, larger size crankshaft was available for use in engines of the model used at Shoreham. Tr. 1484-87 (McCaffrey).

357. Mr. McCaffrey did not know whether LILCO communicated with other owners or operators of TDI diesels, prior to the crankshaft failure and during the time that the NRC was setting forth its concerns, to determine whether other owners or operators were having problems with those engines. LILCO did not join a group of other TDI diesel owners to exchange information

on difficulties with the machines until January 1984. Tr. 1500-02 (McCaffrey).

358. LILCO has a number of mechanisms in place to obtain information about failures of components such as diesels at other nuclear power plants or from vendors. Mr. McCaffrey personally was involved in the company's overall efforts to receive documents from the Institute of Nuclear Power Operations (INPO) and Mr. McCaffrey's organization disseminates significant event reports and significant operating experience reports received from INPO throughout the company. LILCO also participates in a program called NPRDS which allows a company to search out operating experience relating to particular equipment. In addition, Mr. McCaffrey, as LILCO's primary NRC contact, receives all bulletins, circulars and information notices from the NRC. These mechanisms also result in LILCO receiving reports from utilities under 10 CFR 50.55(e) or Part 21. Tr. 1510-12 (McCaffrey).

359. The INPO and NPRDS programs were in effect at LILCO prior to the time that the crankshaft broke. Tr. 1522 (McCaffrey). Mr. McCaffrey did not know whether information relating to the TDI diesels actually came through the NPRDS or INPO systems. Tr. 1524 (McCaffrey).

360. Mr. McCaffrey is the chairman of LILCO's Independent Safety Engineering Group (ISEG). Tr. 1528 (McCaffrey). ISEG evaluates industry experiences and issues recommendations to the plant for engineering organizations where improvements in safety or reliability are appropriate. Mr. McCaffrey did not know whether ISEG put information concerning the TDI diesels into a package or issued any recommendations on that subject before the crankshaft broke at the LILCO plant. Tr. 1528-30 (McCaffrey).

361. On February 13, 1984, the NRC Staff issued Board Notification 84-020 which contained a written summary by the Staff of TDI operating experience for both nuclear and non-nuclear applications. SC LP Ex. 18. That Board Notification includes information concerning problems with TDI diesels at the San Onofre nuclear plant in April 1977 which occurred prior to August 1983 when the crankshaft at Shoreham broke. The TDIs at San Onofre were declared operational in April 1977. SC LP Ex. 18. McCaffrey did not know whether prior to the failure of the Shoreham crankshaft LILCO was aware of the problems experienced with the TDI diesels at San Onofre. Tr. 1525-26 (McCaffrey). He also did not know whether the problems encountered at San Onofre were taken into account by LILCO in its efforts to determine whether the TDI diesels could be

assured to meet the requirements of GDC 17. Tr. 1526 (McCaffrey).

362. Mr. McCaffrey also did not know whether LILCO made any effort to, or actually did, find out about the problems with TDI engines at the Grand Gulf nuclear plant, which also occurred before the crankshaft broke. Tr. 1527 (McCaffrey); SC LP Ex. 18.

363. Pre-operational testing of TDIs at Grand Gulf began in 1981. In Board Notification 84-020, the NRC Staff stated that the Grand Gulf TDIs experienced significant problems in completing the pre-operational test program, had several major failures and many minor failures. At least 12, and possibly more, of the problems at Grand Gulf occurred before the crankshaft failure at Shoreham. SC LP Ex. 18, p. 3-4.

364. Mr. McCaffrey did not know whether LILCO did anything to ascertain information concerning problems involving TDI diesel generators in non-nuclear marine applications, as set forth on pages 6-20 of Board Notification 84-020. SC LP Ex. 18; Tr. 1530 (McCaffrey).

365. Information available from the State of Alaska, U.S. Steel, and Titan Navigation, Inc. indicates that TDI diesels in

marine service for those organizations have experienced severe reliability problems, relating to faulty cylinder heads, pistons, cylinder liners, turbochargers, cylinder blocks, connecting rods, connecting rod bearings, main journal bearings, and camshafts. SC LP Ex. 18, p. 7-20.

366. Although Mr. McCaffrey testified that the TDI diesels are now available to perform their intended functions (Tr. 1705 (McCaffrey)), the blocks on diesels 101 and 102 currently have cracks in them. Tr. 1497 (McCaffrey).

367. Although LILCO believes that the Colt diesels could be ready to operate as emergency on-site electric power systems by May 1985, it does not presently intend to connect the Colt diesels and use that equipment until the first refueling outage; instead, LILCO will use the TDI diesels for full power operation until the first refueling outage. Tr. 1499-1500 (McCaffrey).

C. LILCO's Asserted Undue Burden from NRC Licensing Proceedings

368. Mr. McCaffrey testified that the "unusual burdens placed upon LILCO over the years" during the NRC licensing process are among the exigent circumstances that justify granting LILCO's exemption request because in weighing equities and

considering the long licensing process "fairness dictates" that LILCO should be granted an exemption. Tr. 1702, 1730-31 (McCaffrey).

369. Mr. McCaffrey testified that during the period 1976 to 1979, LILCO without technical justification was consistently held by the NRC Staff to a different standard than other plants. He stated that in his opinion, the intervention in the Shoreham licensing proceeding affected the Staff review, for example, because "often the Staff review would include issues raised in Intervenor contentions because the Staff knew it would have to prepare testimony on these issues." Tr. 1716 (McCaffrey).

370. In Mr. McCaffrey's opinion, the Staff, in the course of its Shoreham review, would ask far more questions of LILCO than it would of other utilities. In addition, according to Mr. McCaffrey, when LILCO would provide technical arguments for compliance with a regulatory requirement, the Staff was less inclined to accept alternative approaches from LILCO than it would be from other utilities. Tr. 1545 (McCaffrey). In Mr. McCaffrey's view, the Staff held LILCO to a higher burden of proof and had no technical justification for doing so. Tr. 1547-48 (McCaffrey).

371. Mr. McCaffrey also stated that the Staff was more inclined to have LILCO follow the standard review practices, and that he does not believe that the Staff held LILCO to a standard that violated the regulatory requirements. Tr. 1545-46 (McCaffrey).

372. Mr. McCaffrey's opinion that the Staff imposed a higher burden of proof upon LILCO was based upon the fact that the NRC Staff rejected some of the alternative approaches proposed by LILCO and did not accept some of the answers provided by LILCO to Staff questions without asking additional questions. In LILCO's view, during the period 1976 to 1979, the NRC Staff did a different type of review for the Shoreham plant than the review that it did for a non-contested plant. Tr. 1547 (McCaffrey).

373. Mr. McCaffrey could only think of one example, during the period 1976 to 1979, of an issue upon which, in his view, LILCO was held by the Staff to a higher standard without technical justification. Tr. 1551, 1559 (McCaffrey). The example involved a steam bypass issue relating to a testing requirement to demonstrate the ability of seals around the primary containment drywell area to withstand a LOCA. LILCO made technical arguments to the Staff to support its request for a reduction

in the testing requirement. The Staff did not agree with LILCO's proposed approach. Mr. McCaffrey testified that he believes that the Staff's position was affected by the intervention process. Tr. 1548, 1551 (McCaffrey).

374. LILCO objected to the Staff's actions on the steam bypass issue by making presentations to various technical branches at the NRC. Tr. 1551-54 (McCaffrey). However, the NRC Staff did not change its mind in response to LILCO's objections, nor did the Staff agree that its requirement of LILCO on the steam bypass issue was without technical justification. Tr. 1554 (McCaffrey).

375. The NRC Staff never told LILCO that it was requiring something of LILCO on the steam bypass issue that it was not requiring of other plants. Tr. 1556 (McCaffrey). Mr. McCaffrey could not recall whether the Staff indicated to LILCO any reason that it was taking the position it did on the steam bypass issue with respect to the Shoreham plant. Tr. 1556 (McCaffrey). Mr. McCaffrey was not aware of any other plant that made the same proposal to the NRC Staff on the steam bypass issue that LILCO did; thus, he did not know that any other plants were held by the Staff to a different standard than LILCO on the steam bypass issue. Tr. 1558-59 (McCaffrey).

376. Mr. McCaffrey also could not recall whether the steam bypass issue was a contested issue in the 1976 to 1979 timeframe. Tr. 1554 (McCaffrey). The steam bypass issue, however, is related to substantial problems with the Mark II containment (such as that at the Shoreham plant) which had been identified a number of years prior to 1979. The problems relating to the Mark II containment had not been resolved as of 1979. Tr. 1554-55 (McCaffrey).

377. Mr. McCaffrey's testimony included no other facts or data to support his assertions concerning the actions of the Staff from 1976 to 1979.

378. Mr. McCaffrey stated that in his opinion, the Staff's Safety Evaluation Report, which was issued in April 1981, could have been issued in early 1979 or late 1978 (prior to the Three Mile Island accident), had it not been for the effect of the intervention process. Tr. 1560, 1716-17 (McCaffrey). Although Mr. McCaffrey believes that in late 1978 and early 1979 the Staff had sufficient information to issue a Safety Evaluation Report, the NRC Staff did not indicate to LILCO in late 1978 that it was satisfied with the submittals made to that date by LILCO on the issues that the Staff was then reviewing. Tr. 1561 (McCaffrey).

379. When the April 1981 SER was issued, there were 60 outstanding open items in addition to the items related to the TMI accident. Tr. 1563 (McCaffrey). Mr. McCaffrey testified that in his opinion the status of open items was the same in 1978 as it was in April 1981 when the SER was issued. Tr. 1563-64 (McCaffrey).

380. Mr. McCaffrey's testimony included no facts or data to support his assertions concerning the issuance of the SER.

381. Mr. McCaffrey participated in meetings with the NRC Staff related to the Systematic Assessment of Licensee Performance (SALP) program, and he is familiar with SALP reports. Tr. 1586-87 (McCaffrey). SC LP Ex. 19 sets forth in a summary fashion the performance evaluation by the Office of Nuclear Reactor Regulation (NRR) of LILCO's performance, during the period July 1, 1980 to June 30, 1981. The document was prepared by Jerry Wilson, who was the NRC project manager during that period. Tr. 1587-88 (McCaffrey).

382. The NRC project manager for the Shoreham plant characterized LILCO's responses and submittals to the NRC Staff during the period July 1, 1980 through June 30, 1981 as "below average." SC LP Ex. 19.

383. In the NRR performance evaluation for the July 1980 through June 1981 period, the NRC project manager stated that "the Shoreham FSAR and amendments provide insufficient information to provide a clear understanding of plant design," and that LILCO's "answers to generic letters and requests for additional information are usually not responsive to staff concerns." SC LP Ex. 19.

384. In the NRR Performance Evaluation, the NRC project manager stated that during the latter portion of the period July 1, 1980 to June 30, 1981, LILCO "put in a great deal of effort in responding to open items in the Shoreham SER and the responses usually met our time schedules. However, the applicant's responses were frequently inadequate. Therefore, each open item required several meetings, phone conversations and letters to achieve resolution." SC LP Ex. 19.

385. In the NRR Performance Evaluation for July 1, 1980 to June 30, 1981, the NRC project manager stated that LILCO "had many long-standing open items throughout [the] appraisal period. Because the applicant had not neared completion of construction, they opposed many Staff positions in the hope that the Staff would back off." SC LP Ex. 19.

386. The NRC project manager stated in the NRR Performance Evaluation that as of June 30, 1981:

> The applicant has not kept the FSAR up to date and representative of the actual plant. There is poor control of construction activities resulting in ever-increasing discrepancies between the plant, the design and the FSAR. The applicant continues to generate E&DCRs on the construction of the Shoreham facility which now totals 35,000. This is causing a potential for an ever-widening gap between the actual plant and the analyzed improved design. I doubt that either Stone and Webster or LILCO fully understand the capability of this facility with such a large discrepancy between the plant and the A/E approved design.

SC LP Ex. 19, p. 2.

387. Although the NRC project manager stated that during the period July 1, 1980 to June 30, 1981, LILCO was "an active and technically knowlegeable applicant," he also stated that "they lack BWR operating experience and they are frequently recalcitrant." SC LP Ex. 19, p. 2.

388. Mr. McCaffrey testified that some Staff actions during the period 1978 (when he believed the SER should have been issued) to April 1981 (when it was issued) were not technically justified. The only examples he could give were the steam bypass issue discussed above, and an issue having to do with

whether the Reactor Core Isolation Cooling System (RCIC) should include an automatic, rather than a manual switchover of the RCIC pump from the condensate storage tank to the suppression pool. Tr. 1567-68 (McCaffrey).

389. LILCO objected to the Staff's handling of the RCIC issue, but the Staff did not agree with LILCO that its requirements of LILCO were without technical justification. Tr. 1569 (McCaffrey). There is no evidence that the RCIC issue was the subject of an Intervenor contention during the time period 1976 to 1981.

390. Mr. McCaffrey discussed the fact that LILCO and its consultants were required to respond to numerous document requests and interrogatories, prepare responses to hundreds of contentions, and devote substantial time to developing affidavits and other supporting materials for motions for summary disposition. Tr. 1718 (McCaffrey). However, Mr. McCaffrey admitted that the contentions were filed pursuant to NRC regulations, that the licensing proceeding was being presided over by an Atomic Safety and Licensing Board, and that the contentions concerning which discovery was conducted and summary disposition motions were prepared had been admitted for litigation by the then presiding Atomic Safety and Licensing Board. Tr. 1570-72 (McCaffrey).

391. Mr. McCaffrey also testified that during 1979 to 1981, new contentions were filed on matters related to Three Mile Island. Tr. 1718 (McCaffrey). The TMI Action Plan, NUREG 0737, identified a large number of issues and matters to be evaluated by the NRC Staff as a result of lessons learned from the Three Mile Island accident. Tr. 1575 (McCaffrey). Mr. McCaffrey did not suggest that the contentions filed on matters related to TMI were improperly admitted by the Licensing Board. Tr. 1575 (McCaffrey).

392. Mr. McCaffrey characterized as "massive" the discovery that took place in the first half of 1982. Tr. 1719 (McCaffrey). He admitted, however, that that discovery was conducted pursuant to an order by the then sitting Licensing Board. Tr. 1576 (McCaffrey). Mr. McCaffrey did not suggest that the discovery was not conducted in accordance with the NRC regulations. Tr. 1576 (McCaffrey). In addition, LILCO objected frequently to the discovery and LILCO's objections were sometimes sustained and sometimes not sustained by the Licensing Board. Mr. McCaffrey admitted that LILCO used the regulatory process and the rules that govern the conduct of that process to protect LILCO's rights during the discovery and hearing process. Tr. 1576-77 (McCaffrey).

393. Although Mr. McCaffrey asserted that the Licensing Board which ruled on objections made by LILCO during discovery provided Intervenors "tremendous leeway," he also stated that the provision of leeway does not violate the NRC's regulations, nor is it in any way improper. Mr. McCaffrey asserted that the Licensing Board was affected by the intervention process and that the Board wanted to make every effort to assure that the Intervenors were provided every possible avenue to create their case. Mr. McCaffrey's testimony included no facts or data to support his opinion concerning the reason the Licensing Board acted and ruled as it did. Tr. 1577-78 (McCaffrey).

394. Mr. McCaffrey referenced a particular request for quality assurance documents as an example of the County having "used LILCO's filing of testimony as a pretext for additional document requests." Tr. 1720, 1580 (McCaffrey). However, Mr. McCaffrey admitted that with respect to that request, LILCO agreed to produce certain of the documents and the Licensing Board directed LILCO to produce certain other of the documents requested. Tr. 1582 (McCaffrey).

395. Mr. McCaffrey agreed that a request for documents following the filing of testimony is permitted by NRC regulations, and that the Licensing Board's rulings granting the

County's requests for documents following the filing of testimony by LILCO does not violate the NRC's regulations. Tr. 1580-81 (McCaffrey).

396. Mr. McCaffrey testified that the operating license hearing process has "placed a considerable drain on LILCO and its consultants' resources at a time the Company was attempting to complete the plant and the NRC Staff review process." Tr. 1722 (McCaffrey). He stated, further, that "personnel with first hand knowledge of the systems or components at issue and associated documents were involved in developing a response to contentions," and that "many times these were the same people [who were] responsible for designing and completing the systems, testing them and making them ready for operations." Id. He stated that "at a time when LILCO was attempting to finish the plant, critical personnel were being diverted to the litigation arenas." Tr. 1726 (McCaffrey).

397. Mr. McCaffrey admitted that LILCO never requested a stay of the operating license proceeding so that its critical personnel could finish the plant. Tr. 1631 (McCaffrey).

398. Mr. McCaffrey asserted that challenges to construction permit extension requests, and to shipment of new fuel to the site by Suffolk County were "frivolous" and were efforts to

delay licensing of Shoreham because, in his opinion, permit extensions and receipt of new fuel onsite "are routine matters that any knowledgeable person recognizes as having no safety impacts on the public." Tr. 1723 (McCaffrey). However, Mr. McCaffrey was unable to identify when such challenges were made by the County, the basis for any such challenges, or whether the challenges in fact were based upon the safety impact of LILCO's proposed activities. Tr. 1616, 1619 (McCaffrey). Mr. McCaffrey did not review any documents in preparing his testimony or in reaching his opinion that the referenced challenges filed by Suffolk County were frivolous. Tr. 1617, 1619 (McCaffrey). He also does not assert that the challenges delayed the licensing of the plant. Tr. 1618 (McCaffrey).

399. The shipment of new fuel was stayed by the Licensing Board "in view of the apparent relevance of the material license to at least those contentions in this licensing proceeding relating to LILCO's Security Plan." In addition, the stay issued by the Licensing Board was not lifted until LILCO had agreed to implement additional security measures which met the County's concerns, and the Staff had reviewed and found the proposed resolution of the security concerns acceptable. SC LP Ex. 22.

400. Mr. McCaffrey testified that the Marburger Commission appointed by Governor Cuomo resulted in a drain upon LILCO's resources because the County discussed before that Commission many of the same health and safety issues that had been litigated before the Licensing Board. Tr. 1724, 1595 (McCaffrey). The Marburger Commission hearings took place in 1983, at a time when there was no suggestion by LILCO that it had need of an exemption from Commission regulations. Tr. 1597 (McCaffrey). The Marburger Commission hearings had nothing to do with onsite or offsite power at the Shoreham Nuclear Power Plant. Tr. 1595 (McCaffrey).

401. Indeed, neither the creation of the Marburger Commission nor the subjects it chose to address, were the responsibility of Suffolk County. On April 19, 1983, the Governor of New York proposed the creation of a "Fact Finding Panel" on the Shoreham nuclear power facility to develop clearly derived, reliable and objective information on the economic costs and safety of the Shoreham plant. SC LP Ex. 20. The Panel was charged by the Governor to examine:

1. The projected impact on Long Island Lighting Company's (LILCO) ratepayers assuming that Shoreham would or would not operate, and

assuming various ratemaking scenarios including those in which shareholders may be responsible for a part of the construction costs;

2. The projected revenue impacts on local governments and the projected impacts on the Island's economy under these scenarios;

3. The amount and potential sources of revenue required to service the debt on Shoreham and to enable LILCO to meet its normal operating costs;

4. The nature and manner of assessment of risks associated with the operation of a nuclear power plant and especially the Shoreham facility;

5. The requirements of the Federal government with regard to the development and implementation of off-site emergency preparedness plans, and to what degree Suffolk County has met or exceeded these standards and the rationale therefore.

SC LP Ex. 20 at 1.

402. LILCO presented testimony and information to the Marburger Commission concerning the particular subjects which

the Governor requested the Marburger panel to examine. Tr. 1602-03 (McCaffrey). Thirteen witnesses employed by LILCO appeared at the hearing, whereas only five employed by Suffolk County appeared. SC LP Ex. 20 at 7-2, 7-3.

403. Although Mr. McCaffrey asserted that the County's claims before the Marburger Commission were "baseless," he admitted that it was not the consensus opinion of the Marburger Commission that the positions taken by Suffolk County in those hearings were baseless. Tr. 1614 (McCaffrey).

404. The Marburger Panel worked hard to discover points of agreement, and the section of its report titled "General Conclusions" sets forth paragraphs that were carefully worded to reflect that agreement. SC LP Ex. 20 at 35. The general conclusions, which reflected "coagulations of consensus in the thick stew of interpretive viewpoints set forth in the Panel's meetings and hearings," included those set forth in the proposed findings that follow.

> I. Suffolk County adopted its position relating to offsite emergency planning for Shoreham after commissioning studies of reasonable quality. The County consultants are reputable in their fields, and their reports indicate deep and relevant technical knowledge of the issues with which they dealt. SC LP Ex. 20 at 35.

2. The Shoreham plant will probably prove to have been a mistake in the sense that everyone might have been better off if the plant had never been built. The location probably would be regarded as unsuitable as a site for a nuclear power station and would not be acceptable as a licenseable site under current siting practices. Estimates of demand for electricity, the price of oil and the cost of construction all turned out to be grossly inaccurate, leading to a pattern of rates and expenses that no one, including LILCO, wanted. Opinions as to how much blame LILCO must accept for creating such a situation vary, but many now feel that LILCO must be held responsible for allowing the Shoreham disaster to happen. SC LP Ex. 20 at 35.

3. LILCO did not prepare itself adequately for its move into the technology of nuclear power and still lacks credibility as an operator of a nuclear power plant. SC LP Ex. 20 at 36.

4. The Marburger Panel viewed nuclear power as a high technology industry that demands a "zero defects" management attitude similar to that in the aerospace industry. What the Panel learned about LILCO training

programs, quality assurance structure, and management experience with relevant nuclear reactor operation led many to question whether such an attitude is present. SC LP Ex. 20 at 3.

5. The Panel stated that the NRC practice of deferring consideration of off-site emergency response planning feasibility until after completion of construction does not make sense. Such considerations were in fact introduced in Shoreham construction licensing hearings but were dismissed by the hearing officer as irrelevant at that time. It is clear that the existence of a completed nuclear power plant is a powerful incentive to find reasons to grant an operating license. It is too late for a change of construction licensing practice to affect the Shoreham case, but the philosophy of answering significant site-related questions before construction is too advanced may be applied to the current low power licensing situation. The governor's request of the NRC that a low power operating license not be issued before the off-site planning impasse is resolved is consistent with this philosophy. SC LP Ex. 20 at 36.

6. The Panel expressed reservations about LILCO's ability to implement an offsite emergency response plan that achieves an adequate state of emergency preparedness. SC LP Ex. 20 at 37.

7. The Panel found that the projections for Long Island's future electrical energy needs on which the Shoreham construction schedule was originally based were obviously overestimates. The Panel was persuaded that ample LILCO generating capacity exists to satisfy probable demand for at least the next decade, and probably longer. Such estimates are of course subject to the same uncertainties that cause the original projections to be so wrong. But, the Panel concluded that it is difficult to see how the demand for electricity could be so great as to require a Shoreham-sized plant within a decade or more.

SC LP Ex. 20 at 36.

405. Mr. McCaffrey stated that the length and cost of the Shoreham licensing proceeding demonstrate "the unusual burdens" placed upon LILCO over the years by Intervenors' use of the NRC Licensing process. Tr. 1730, 1635 (McCaffrey). However, his testimony does not address the cost or burdens imposed on any other party that have resulted from the LILCO licensing

process. Tr. 1635 (McCaffrey). In addition, his testimony does not compare any burdens placed on any other applicants to burdens placed upon LILCO, resulting from the NRC licensing processes. Tr. 1636-37 (McCaffrey).

406. Mr. McCaffrey also testified that the extended hearings have and will continue to delay the Shoreham plant's fuel load date. Tr. 1730 (McCaffrey). However, he also stated that the Shoreham plant was not capable of loading fuel until April or May 1984. Tr. 1632 (McCaffrey).

407. Fuel load is dependent upon the issuance of a license by the NRC permitting loading of fuel, and the issuance of such a license must await the issuance of an exemption because of the failure of LILCO's TDI diesels and the nonavailability of an onsite power source that complies with GDC 17. Tr. 1632 (McCaffrey).

408. The reason that fuel load did not occur in April or May of 1984 and in fact has still not occurred to date is not because of extended hearings, but rather because the Commission has not issued a license permitting such fuel load. Tr. 1632 (McCaffrey).

409. Mr. McCaffrey testified that the protracted licensing process has created the perception that the Shoreham licensing proceeding may never end, and that this asserted perception is also among the exigent circumstances which justify granting LILCO's request for an exception. Tr. 1729 (McCaffrey).

410. The perception discussed by Mr. McCaffrey was that of LILCO, the nuclear industry, and the general public as perceived by Mr. McCaffrey. His conclusion as to the public perception is not based upon any studies or surveys or polls on that subject, nor is Mr. McCaffrey a social scientist or statistical analyst who is qualified to opine upon public perceptions. Tr. 1633-34 (McCaffrey).

411. Mr. McCaffrey asserted that a public perception that the proceeding may never end could contribute to that actually happening. Tr. 1635 (McCaffrey). Mr. McCaffrey was unable to state what such a perception has to do with LILCO's noncompliance with GDC 17. Tr. 1634-35 (McCaffrey).

III. <u>Public Interest</u>

A. <u>LILCO's Asserted Foreign Oil Benefit</u>

412. Cornelius A. Szabo testified on behalf of LILCO concerning the alleged benefit of reduced dependence on foreign

oil which might result from the earlier commencement of commercial full power operation of the Shoreham plant. Tr. 1216 (Szabo).

413. Mr. Szabo is Manager of Resource Valuation for LILCO, whose responsibility includes forecasting of oil and coal prices and availability. Tr. 1217 (Szabo). Mr. Szabo's prior experience included consulting for six public service commissions in the area of fuel prices, fuel supply and oil availability. Tr. 1218 (Szabo). By his own admission, Mr. Szabo is not a military expert and is not qualified to opine as to the likelihood of a cut-off of foreign oil supplies as a result of the Iran-Iraq war. Tr. 1219 (Szabo).

414. LILCO claims that the earlier performance of low power testing which could result from the grant of the exemption, in turn, might lead to an earlier date for commercial full power operation. Tr. 1330 (Szabo). Mr. Szabo testified that because LILCO is heavily dependent on imported oil, to the extent that commercial operation of the Shoreham facility displaces foreign oil, there would be a benefit from such operation. Tr. 1235 (Szabo).

415. Mr. Szabo conceded, however, that only if low power operation leads to earlier commercial full power operation

would there be a benefit arising out of reduced dependency on foreign oil. Tr. 1236 (Szabo). Accordingly, if earlier low power testing has no effect on when commercial operation, if ever, occurs, LILCO's testimony concerning dependence on foreign oil is not relevant to whether the requested exemption should be granted. Tr. 1236 (Szabo).

416. A necessary predicate to LILCO's hypothesis of a benefit to the public from the grant of the exemption is the assumption that both the TDI diesel generator proceeding and the emergency planning proceeding will be concluded at approximately the same time and that they will both be concluded favorably to LILCO. Tr. 1249-50 (Szabo).

417. Whether there will continue to be a glut of oil, or whether there might be a disruption in the supply of foreign oil such as would affect LILCO in any way, consists of no more than "speculation on speculation." Tr. 1247 (Judge Miller).

418. Mr. Szabo was unable to state whether a disruption in the availability of foreign oil would be likely to occur now, within the next three months, or within the next ten years. Tr. 1273 (Szabo). Specifically, Mr. Szabo testified that there was an equal probability that a serious disruption would occur within the next ninety days as within the next ten years. Tr. 1275 (Szabo).

419. Mr. Szabo's principal basis for concern about a possible future disruption in oil supplies is the ongoing war between Iraq and Iran in the vicinity of the Persian Gulf. Tr. 1337 (Szabo). Nevertheless, despite the fact that the war has been ongoing for approximately four years, Mr. Szabo conceded that there is presently a glut of oil on the market. Tr. 1271 (Szabo).

420. Moreover, Mr. Szabo acknowledged that non-OPEC oil-producing countries have been increasing their productive capacity in recent years. Thus, for 1983, the non-OPEC oil-producing countries have increased their capacity by "about a million barrels a day." Tr. 1277 (Szabo).

421. There has been established in the United States a strategic petroleum reserve. The level of the reserve is about 400 million barrels at this time. Such a level would be enough to replace approximately (a) ninety days of average United States imports from all sources; or (b) nine hundred days of U.S. imports from the Persian Gulf; or (c) seven months of net imports from all OPEC nations. Tr. 1277-78 (Szabo).

422. Mr. Szabo also testified that the price of oil has been declining over the last several years. Thus, during the fourth quarter of 1980, the spot price of oil was $38.40 a

barrel and in the third quarter of 1983 the spot price was $28.90 a barrel. The contract price has declined from about $34 a barrel in 1981 to $29 a barrel in 1983. Tr. 1279 (Szabo).

423. In order for a major disruption to have any impact on LILCO, insofar as the grant of the exemption is concerned, the disruption would have to occur during a period beginning about two months before the commencement of commercial operation of Shoreham and persist for three months thereafter. Tr. 1302-1303 (Szabo).

424. Mr. Szabo's conclusions concerning the effect of LILCO's dependency on foreign oil are based on a "myriad of unpredictable factors" and are of a "tenuous nature." Tr. 1287 (Judge Miller); SC LP Exs. 12-13(A-I). Given the uncertainties as to the supply and price of oil, there is as much probability that the price of oil would continue to decline as that it would increase. Tr. 1247 (Judge Miller).

425. If the current oil glut were to continue and the price of oil continued to decline, there would be no benefit from earlier full power commercial operation of Shoreham. Tr. 1246 (Szabo).

426. Although Mr. Szabo's testimony dealt with the potential of a major disruption in the supply of oil from the Middle East, it turns out that only a small fraction, one percent or maybe less, of LILCO's oil is derived from that area. The rest of LILCO's oil is derived from Venezuela, Mexico and Brazil. Tr. 1268-69 (Szabo).

427. Mr. Szabo testified that there were available alternatives to the commercial operation of Shoreham that could protect LILCO from the effects of a substantial disruption in the availability of foreign oil. Thus, LILCO could increase the amount of reserves that it is required by the New York Public Service Commission to have on hand. Tr. 1319 (Szabo). Additionally, LILCO could purchase futures contracts on oil to assure itself of a supply in the event of a near term disruption in the oil market. Tr. 1320-21 (Szabo).

428. In the aggregate, Shoreham would displace less than half of LILCO's present purchases of oil. Tr. 1322 (Szabo). And, in the absence of a major disruption of oil supplies, LILCO will have no difficulty in obtaining foreign oil. Tr. 1300 (Szabo).

B. Economic Impact of the Grant of the Exemption

429. The following witnesses testified as to whether there would be any economic benefit to the public as a result of the granting of the exemption: Jamshed Madan and Michael D. Dirmeier on behalf of Suffolk County; Richard Kessel on behalf of the State of New York; and Anthony Nozzolillo on behalf of LILCO.

430. Mr. Madan is a principal in the firm Georgetown Consulting Group, Inc., which provides financial and management consulting services with special emphasis on utility regulation. Mr. Madan received his Bachelor of Science degree in electrical engineering from the Massachusetts Institute of Technology, and a Master of Science degree in management from the Alfred P. Sloan School of Management of the Massachusetts Institute of Technology. From the period 1968 through April of 1979, Mr. Madan was primarily employed by Touche, Ross & Co., an international auditing and management consulting firm. He became a principal in that firm in 1977. While at Touche, Ross, Mr. Madan provided expert testimony or consulting relating to a number of hearings involving fuel prices, the setting of fuel clauses and the policy for fuel clauses in several states. Mr. Madan has also testified in a number of

proceedings which have involved the regulatory treatment of nuclear plants. He has testified in about 15 different jurisdictions in the area of utility regulation. For approximately six months, from October 1975 through March 1976, Mr. Madan was employed as the General Manager of Corporate Development for Public Service Electric & Gas Company of New Jersey, one of the largest utilities in the country. Testimony, 1-3 and Attachment 1; Tr. 1917-20 (Madan).2/

431. Mr. Dirmeier is also a principal in Georgetown Consulting Group, Inc. He received a Bachelor of Science degree in physics from Texas A&M University, and a Master of Business Administration degree in finance from the University of Chicago. Mr. Dirmeier has been employed by Bendix Corporation and Touche, Ross & Co. While with Touche, Ross, Mr. Dirmeier participated in operations analyses of nonregulated corporations as well as in utility rate setting matters. Since 1979, when Mr. Dirmeier joined Georgetown Consulting Group, Mr. Dirmeier has had experience in regulation involving nuclear

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2/ The prefiled testimony of Messrs. Dirmeier and Madan was not bound into the transcript of the hearing. Accordingly, citations to their prefiled written testimony will be as follows: "Testimony, _____ (Dirmeier, Madan)." Citations to their oral testimony will be to the pertinent transcript page.

plants, nuclear economics, the potential abandonment of nuclear plants, accidents at nuclear plants, fuel clauses, decommissioning of nuclear plants, and the operation of a nuclear plant. Testimony, 3-4 and Attachment 1; Tr. 1920-21 (Dirmeier).

432. LILCO's witness Mr. Nozzolillo is the Manager of the Financial Analysis and Planning Department of LILCO. Mr. Nozzolillo has a Bachelor of Science degree in electrical engineering from the Polytechnic Institute of Brooklyn, and a Master of Business Administration degree from C.W. Post Center of Long Island University. Mr. Nozzolillo has been employed by LILCO since 1972. He has been in the company's Planning Department and has been Manager of the System Planning Division. Mr. Nozzolillo's responsibilities include the development and maintenance of LILCO's financial modeling systems. He is also involved in the development and analysis of financial options and in the analysis of various system development plans for economic impact on both the company and its customers. Tr. 1402-04 (Nozzolillo).

433. The State of New York's witness Richard M. Kessel is the Executive Director of the New York State Consumer Protection Board, which is the State of New York's consumer affairs

agency. He was appointed to that position by Governor Mario Cuomo. Mr. Kessel has been a consumer advocate working in the public interest for approximately ten years. He has taught consumer economics at Brooklyn College, and has developed at Brooklyn College a curriculum on consumers and energy which he taught for several years. Mr. Kessel has represented the Borough of Manhattan and the City of New York before the New York Public Service Commission on matters relating to rate increases for Consolidated Edison and New York Telephone Company. He has also participated on behalf of the public in several hearings relating to LILCO rate increases, and has filed a number of generic petitions, which have been adopted and accepted by the New York State Public Service Commission, including one which establishes the right of the public to submit economic evidence to be considered by the Public Service Commission in evaluating the public interest. Tr. 2879-80 (Kessel).

434. Although in its application for an exemption, LILCO initially claimed that granting the exemption would be "in the public interest because it will result in economic benefits of $90-$135 million" (Application, 20-21), Mr. Nozzolillo testified that the alleged economic benefit to LILCO's customers will be either $8 million or $45 million, depending on the timing of LILCO's receipt of certain tax benefits. Tr.

1357-1362, 1407, 1410 (Nozzolillo); Testimony, 6 (Dirmeier, Madan).

435. Both the $8 million figure and the $45 million figure reflect possible benefits which would accrue if the granting of the pending exemption application would enable Shoreham to go into commercial operation approximately three months earlier than would otherwise be the case. Tr. 1354, 1405 (Nozzolillo); Testimony, 6 (Dirmeier, Madan).

436. The financial models on which LILCO bases its claimed $8 million to $45 million benefit to its customers compare the potential impact on ratepayers of commencing commercial operation on July 1, 1985 (as presently projected by LILCO) with commencing commercial operation on October 1, 1985. Tr. 1354, 1406 (Nozzolillo); Testimony, 6 (Dirmeier, Madan). Mr. Nozzolillo conceded that these models "are not the real world, today." Tr. 1377 (Nozzolillo).

437. The financial models consist of computer-based corporate financial models of sales, revenues, expenses, balance sheets and cash flows covering the years 1984-2000 prepared by LILCO. SC LP Ex. 63; Testimony, 7 (Dirmeier, Madan).3/

3/ Two working days before Suffolk County's testimony was due to have been filed, LILCO furnished the County with re-

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438. The models were developed for three alternative hypothetical dates on which Shoreham would be considered to be "in service" as follows:

Commercial Operation	In-Service for Tax Purposes
July 1, 1985	December, 1984
July 1, 1985	January, 1985
October 1, 1985	March, 1985

For each alternative, LILCO computed the revenue requirements (that is, the amount LILCO must receive from ratepayers), expenses and other financial indicators in each of the years 1984-2000. In order to compare the financial results, LILCO then computed the net present value of the revenue requirements under each alternative. SC LP Ex. 63; Tr. 1355, 1405-6 (Nozzolillo); Testimony, 7 (Dirmeier, Madan).

439. LILCO's present value analysis, or "present worth of future dollars," discounts a future stream of revenue requirements to a present date, given certain assumptions as to

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vised computer runs. Tr. 2032 (Dirmeier). Due to the testimony filing deadlines, Suffolk County's experts were unable to incorporate the new runs into their prefiled testimony. Id. However, both LILCO's and Suffolk County's witnesses agreed that the two sets of computer runs ended up with "results . . . in the same order of magnitude," and did not change the witnesses' overall conclusions. Tr. 1372 (Nozzolillo); 2032 (Dirmeier).

interest rates. Tr. 1357 (Nozzolillo). A higher net present value equates to higher revenues and is, therefore (all other things being equal), less desirable, from a ratepayer's or customer's point of view, than a lower net present value. Testimony, 7 (Dirmeier, Madan).

440. LILCO's minimum claimed benefit of $8 million from the grant of the exemption is based on the assumption that Shoreham will be in service (i.e., "synchronized") for tax purposes in 1985, and represents LILCO's projected effect of beginning commercial operation three months earlier than would be the case without the grant of the exemption. Tr. 1360, 1410 (Nozzolillo); Testimony, 8 (Dirmeier, Madan).

441. LILCO's maximum claimed benefit of $45 million starts with the $8 million effect of a three-month change in the timing of full power operation plus an additional $37 million benefit which could be obtained only if Shoreham can be declared in service for tax purposes in 1984 rather than in 1985. Tr. 1361, 1410 (Nozzolillo); Testimony, 9 (Dirmeier, Madan).

442. Thirty-seven million of the $45 million potential benefit postulated by LILCO is based on the assumption that Shoreham is in service for tax purposes on or before December

31, 1984. If Shoreham is not in service by that date, however, the $37 million differential disappears, and the only potential benefit is $8 million. Tr. 1361, 1410 (Nozzolillo); Testimony, 9 (Dirmeier, Madan).

443. The $8 million figure represents the present value of the differential in rates necessary to cover revenue requirements for all items other than tax depreciation (including, for example, the estimated fuel savings), based on commencing commercial operation of Shoreham on July 1, 1985 instead of October 1, 1985. Testimony, 9 (Dirmeier, Madan).

444. In the first twelve months after Shoreham begins commercial operation, LILCO's revenue requirements will be increased by over $800 million. Tr. 1931 (Madan); Testimony, 10 (Dirmeier, Madan). This increase, which, in turn, must be recovered from ratepayers, arises from the need to recover carrying charges associated with Shoreham and the related depreciation, operations and maintenance expenses. Testimony, 11 (Dirmeier, Madan).

445. If Shoreham goes into commercial operation on July 1, 1985, customers will pay approximately $166 million more in revenue requirements in 1985 than if commercial operation begins October 1, 1985. Tr. 1364-65 (Nozzolillo); Tr. 1931 (Madan); Testimony, 11 (Dirmeier, Madan).

446. There is a greater revenue requirement associated with a July 1985 commercial operation date, as opposed to an October 1, 1985 commercial operation date, because there will exist three more months in 1985 at which the higher (approximately $800 million) revenue requirement amount will be charged to ratepayers. Testimony, 11 (Dirmeier, Madan).

447. On a cumulative basis, according to LILCO's own computations, even assuming a July 1985 commercial operation date (with a January 1985 synchronization) as opposed to an October 1985 commercial operation date, LILCO's customers would not begin to receive any economic benefit from the earlier commercial operation until the year 1997, at the earliest. Tr. 1372 (Nozzolillo); Tr. 1931 (Madan); SC LP Ex. 14.

448. Moreover, the $8 million net present value of the benefit identified by LILCO would likely result from any three-month difference in the timing of the commencement of full power operation, not just from the three month differential assumed by LILCO to be attributable to the grant of an exemption. Testimony, 12 (Dirmeier, Madan).

449. LILCO's claimed benefits are greatly overstated; indeed, based on LILCO's own analysis, an economic detriment of $49 million would result from the grant of the exemption. Tr. 1933 (Madan); Testimony, 12 (Dirmeier, Madan).

450. Shoreham could not be in service for tax purposes during LILCO's proposed low power testing program, which is all that would be authorized by the requested exemption. Tr. 1930 (Madan); Testimony 13-15 (Dirmeier, Madan).

451. In order to be in service for federal income tax purposes, Shoreham has to generate sufficient electric power to the LILCO grid such that the electric output from the plan exceeds the amount taken from the grid to run the plant (i.e., the net output has to be a positive figure to the grid). Tr. 1358-1359 (Nozzolillo); Testimony, 14 (Dirmeier, Madan).

452. Since the Shoreham generator will not even be connected to the LILCO grid during the low power testing proposed by LILCO, there is no possibility that Shoreham will be in service for federal income tax purposes prior to the issuance of a full power license. Tr. 1359, 1373 (Nozzolillo); Testimony, 15 (Dirmeier, Madan).

453. In order to place the Shoreham plant in service for tax purposes, LILCO must obtain a full power operating license which would require final NRC decisions on the outstanding emergency planning and TDI diesel issues. Testimony, 13 (Dirmeier, Madan).

454. By LILCO's own admission (see Application for Exemption at 21), and as is clear from the current schedules for litigation of those issues, such decisions are unlikely prior to the end of 1984. Testimony, 15 (Dirmeier, Madan).

455. Thus, it does not appear to be possible for Shoreham to be in service for tax purposes in 1984, which means that $37 million of the $45 million maximum claimed benefit cannot be obtained. LILCO's claimed economic benefit, therefore, is in reality at most, only $8 million. Testimony, 13 (Dirmeier, Madan).

456. LILCO's postulated $8 million benefit is overstated and is actually a detriment of up to $49 million. Testimony, 13 (Dirmeier, Madan).

457. Achieving commercial operation three months earlier would result in an economic detriment of up to $49 million because of: (a) a mismatch in LILCO's analysis which erroneously favors earlier full power operation by an amount having a net present value of approximately $26 million; and (b) a failure to recognize an energy-savings offset having a net present value effect of $31 million arising out of LILCO's arbitrarily terminating its financial analysis at the year 2000. Tr. 1932, 1933 (Madan); Testimony, 15-21 (Dirmeier, Madan).

458. The mismatch in LILCO's analysis consists of the following: LILCO's analysis shows that the cash cost of Shoreham decreases by $59 million if full power operation is moved up by three months. This reduction in cash cost is achieved because expenses and revenue requirements are increased as costs are charged to customers rather than charged to the cost of Shoreham. LILCO's analysis further shows, however, only a $31 million increase in expense when Shoreham is operated three months earlier, although the cash cost of the plant is decreased by $59 million. Testimony, 15 (Dirmeier, Madan).

459. Therefore, there is a $28 million mismatch in LILCO's analysis that erroneously favors the economics of earlier full power operation, because it either understates revenue requirements associated with a July 1, 1985 start-up date or overstates revenue requirements associated with an October 1, 1985 start-up. Testimony, 15 (Dirmeier, Madan). In either event, correction of this error, which has a net present value of $26 million, reduces LILCO's $8 million benefit claim to an $18 million detriment. Testimony, 16 (Dirmeier, Madan).

460. LILCO's financial models show that three months earlier commercial power operation decreases the capitalized cash

cost of Shoreham by $59 million. Correspondingly, the amount expended if operation is three months earlier should be $59 million greater to balance the lower capitalized cash cost. However, LILCO's own financial projections show only a $31.1 million increase in expense, and therefore the capital cost is improperly not balanced by equal increases in expenses. Testimony, 16-17 (Dirmeier, Madan).

461. Messrs. Dirmeier and Madan examined the impact on revenue requirements if expenses in the October 1 model were decreased by the $27.9 million difference between capital change ($59 million) and expense change ($31.1 million). According to their analysis, if expenses are lower, revenue requirements will be lower by a similar amount to achieve the same earned rate of return on investment. Accordingly, the net present value of revenue requirements for the October 1 operation alternative is reduced by $26 million, thereby improving that alternative's economic effect. Testimony, 17-18 (Dirmeier, Madan). In other words, under the Company's analysis, LILCO's customers would be better off if the commencement of Shoreham's commercial operation were delayed by three months.

462. LILCO's second error results from its decision to stop the economic analysis in the year 2000, rather than analyzing the effect of early operation over Shoreham's anticipated full life cycle. This error results in an implicit assumption that early low power operation results in greater lifetime energy production from Shoreham. Correcting this error results in a reduction in the benefit of up to $45 million. Testimony, 16 (Dirmeier, Madan).

463. Allowing Shoreham to operate commercially three months earlier in 1985 creates an increase in revenue requirements in that year of $166 million, because any fuel savings that may be achieved are far outweighed by increases in base rates to provide for depreciation, return, operation and maintenance of the unit. If Shoreham begins commercial operation three months earlier, then it should correspondingly be assumed that the plant would be retired three months earlier. The anticipated life of Shoreham is currently thirty years. Early operation in 1985 results in increased revenue requirements in the year 2015, because early retirement will result in lower fuel savings in that year. Testimony, 18, 20 (Dirmeier, Madan).

464. A proper and consistent economic analysis of Shoreham's early operation would examine the trade-offs between the higher rates in 1984, and the lower rates in 2015, as well as the differences in revenue requirements in the intervening years. Testimony, 18-19 (Dirmeier, Madan).

465. In the long run, LILCO's claim of fuel savings can only be true if earlier operation results in a change in the operating life of Shoreham. Whether Shoreham operates for thirty years from July 1, 1985 or from October 1, 1985 should result in no difference in the overall amount of fuel that Shoreham will save, because the date of shutdown of the plant will change by a corresponding amount of time. Testimony, 20-21 (Dirmeier, Madan).

466. Even if there were no fuel offsets in the year 2015, LILCO's analysis would still show a $4 million detriment due to early operation of Shoreham. Testimony, 19 (Dirmeier, Madan); SC LP Ex. 23.

467. In short, LILCO's analysis fails to support any claim of economic benefit from early operation of Shoreham. In fact, there is an economic detriment of up to $49 million associated with earlier operation of Shoreham. Earlier operation of Shoreham, if it leads to earlier rate recognition, will

simply result in placing that increased burden on customers earlier rather than later. Testimony, 21 (Dirmeier, Madan).

C. Other Results of the Grant of the Exemption that are Contrary to the Public Interest

468. Mr. Kessel, Executive Director of the New York State Consumer Protection Board, testified on whether, in the view of the State of New York, the public interest would be served by granting the exemption. Tr. 2877-2919 (Kessel).

469. The function of the agency headed by Mr. Kessel is to represent the public interest. Tr. 2885 (Kessel).

470. Mr. Kessel testified that the State of New York has already taken a number of measures to reduce the State's dependency on foreign oil, including, the development of a statewide energy conservation plan, the encouragement of coal conversions, and the use of hydro-electric power as an alternative to oil. Tr. 2890-91 (Kessel).

471. LILCO's proposed exemption is not in the public interest because it is not in the public interest to permit contamination of a nuclear facility before the uncertainties surrounding its future operation have been resolved. Tr. 2912 (Kessel). Permitting the contamination of the Shoreham plant

before resolution of the uncertainties surrounding its future commercial operation would not be in the public interest because, if Shoreham were to be operated at low power and subsequently abandoned, costs would increase unnecessarily. Tr. 2912 (Kessel). For example, the value of the nuclear fuel would be substantially reduced, and the salvage value of the irradiated equipment would be reduced. Tr. 2912-13 (Kessel).

472. LILCO's rush to license Shoreham has already resulted in a decline in the quality of service to its customers, and further expenditures will cause further unacceptable deterioration of electric service which is not in the public interest. Tr. 2913-14 (Kessel).

473. Austerity measures that have been and will be implemented by LILCO have already affected its non-nuclear operations. LILCO's proposal to accelerate low power testing will likely require the expenditure of additional funds, which LILCO would have to obtain by further reducing its non-nuclear related costs; that would impair even more the already reduced quality of service being provided to LILCO's customers. Thus, LILCO's proposal to accelerate low power testing will cause further unacceptable deterioration of electric service which is not in the public interest. Tr. 2913-14 (Kessel).

474. It is not in the public interest to allow a financially weakened and nearly bankrupt company to operate a nuclear facility. Tr. 2916 (Kessel).

475. Consumers' fears regarding Shoreham's operation will not be alleviated with the knowledge that LILCO's financial condition may preclude it from expending the funds necessary to operate Shoreham safely. Tr. 2916 (Kessel).

476. LILCO's financial problems have recently caused a strike of the Company's unionized employees. This indicates that LILCO's precarious financial condition has already undermined the reliability of its personnel and operations. Tr. 2916 (Kessel).

477. There is no dispute that LILCO is presently in a financially serious condition. Tr. 1378-1386 (Nozzolillo). At the time of the filing of its annual report with the Securities and Exchange Commission on Form 10-K (i.e., on or about March 30, 1984), the company believed it only had "on hand sufficient cash and short-term investments to continue the company's operations until the fall of 1984." SC LP Ex. 24, at 6.

478. In its quarterly report to the Securities and Exchange Commission on Form 10-Q for the three months ended March

31, 1984, LILCO identified August 31, 1984 as the date beyond which it will not have "sufficient cash and short-term investments to continue the company's operations." SC LP Ex. 26, at 22.

479. The Form 10-Q also reveals that $90 million of LILCO's outstanding bonds will mature on September 1, 1984. SC LP Ex. 24, at 6; Tr. 1381 (Nozzolillo).

480. LILCO has unilaterally ceased construction payments for its share of Nine Mile Point Two, even though such action threatens acceleration of $500 million of LILCO's outstanding debt. SC LP Ex. 24, at 58.

481. LILCO has instituted austerity measures intended to save $100 million in cash. SC LP Ex. 24, at 2.

482. LILCO's financial situation has forced it to omit common stock dividends, which would otherwise have amounted to approximately $180 million, during the remainder of 1984. SC LP Ex. 24 at 6, 42.

483. LILCO's financial situation has deteriorated to the point that its outside auditor, Price Waterhouse, qualified its report on the company's financial statements to the effect that the opinion was "subject to the company's continued financial

viability." SC LP Ex. 24, at 49. In its report to LILCO, Price Waterhouse enumerated specific matters, the outcome of which was indeterminable, as were their effects on the financial position or results of operation of LILCO. Specifically, Price Waterhouse noted:

(a) That the staff of the New York Public Service Commission, on February 10, 1984, alleged "serious mismanagement and inefficiency throughout" the Shoreham project;

(b) That LILCO had been notified that other participants in the Nine Mile Point Two project consider LILCO to have defaulted in its financial obligations to the project; that LILCO's suspension of its payments for Nine Mile Point Two may have constituted a violation of LILCO's agreements with lending banks; that the banks have effectively given LILCO a renewable (at the bank's option) 30-day grace period; and that in the absence of such a grace period, other "long term debts of the company could become due and payable as a result of cross-defaults and result in rights of acceleration of maturities of such debt"; and

(c) That recovery of $118 million in costs of abandoned nuclear projects and $111 million advanced to a supplier of uranium concentrates were (as evidenced elsewhere in the Form 10-K) uncertain. SC LP Ex. 24, at 49.

484. Price Waterhouse concluded, therefore, that LILCO "cannot give any assurance of its ability to meet its capital and operating requirements." SC LP Ex. 24, at 49.

485. LILCO has stated that it would require $700 million in 1984 cash to meet anticipated capital expenditures and refunding requirements. SC LP Ex. 24, at 46. As of December 31, 1983, the company had approximately $275 million in cash and temporary cash investments (Id. at 52); by February 20, 1984, the $275 million figure had been reduced to $214 million (SC LP Ex. 25, at 1); and by March 31, 1984, cash and short-term investments amounted to only $174 million. SC LP Ex. 26, at 4.

486. According to LILCO's Form 10-K, all of LILCO's existing lines of credit have been drawn down. SC LP Ex. 24, at 8.

487. LILCO's Form 10-K states: ". . . given the various adverse factors now impacting the company, little or no assurance can be given regarding the company's ability to raise additional funds in 1984 and in future years in order to meet construction and other capital requirements and other operational needs." SC LP Ex. 24, at 6.

488. The New York Public Service Commission is "currently investigating the prudency of costs incurred by the company in the construction of Shoreham." SC LP Ex. 24, at 22. In that proceeding, the Staff of the PSC has recommended that "no more than $2.296 billion of the Shoreham costs be allowed in rate base" because of LILCO's alleged "serious mismanagement and inefficiency throughout the project. SC LP Ex. 24, at 48. The estimated overall cost of Shoreham is $4.1 billion. Id. at 19. The PSC Staff's recommendation, if adopted by the PSC, would mean that LILCO would have to absorb $1.8 billion of Shoreham-related costs. According to LILCO's Form 10-K, any disallowance has a potential to "jeopardize the company's ability to meet its financial obligations." Id., at 23.

489. On February 9, 1984, LILCO suspended payments for its 18% share of construction costs of Nine Mile Point Two, a nuclear generating unit under construction near Oswego, New York. The co-tenants of Nine Mile Point Two, in addition to LILCO, are Niagara Mohawk Power Corporation, who acts as agent for the co-tenants, New York State Electric and Gas Corporation, Rochester Gas and Electric Corporation, and Central Hudson Gas and Electric Corporation. SC LP Ex. 24, at 27. As a result of this suspension, "Niagara Mohawk has notified the company that it considers the company to be in default of its

obligations to the other co-tenants and has demanded payment." Id. Niagara also has advised LILCO that Niagara Mohawk "may institute litigation against the company . . . [which] would result in encumbering, diminishing or eliminating" LILCO's interest in Nine Mile Point Two. Id. As of December 31, 1983, the cost of LILCO's share of Nine Mile Point Two was $585 million. Id.

490. Counsel for the banks who made loans to LILCO for purposes of Nine Mile Point Two has questioned whether LILCO's suspension of payments for Nine Mile Point Two violates the terms of LILCO's debt obligation. SC LP Ex. 24, at 57. In order to forestall immediate acceleration of LILCO's debt, however, LILCO and the lending banks for Nine Mile Point Two have agreed that for so long as holders of two-thirds of the Nine Mile Point Two debt continue to agree, no default on the debt will be declared for successive 30-day periods beginning April 27, 1984. Id.

491. As of December 31, 1983, LILCO had invested $585 million (including payments for fuel and debt service) in Nine Mile Point Two. Since then, it paid $11.5 million in January 1984. LILCO is obligated to pay an additional $65 million in financing costs for Nine Mile Point Two during 1984. SC LP Ex. 24, at 27.

492. As revealed in LILCO's recent report to the Securities and Exchange Commission on Form 10-Q, the total estimated cost for completing Nine Mile Point Two has risen to about $5.1 billion. SC LP Ex. 26, at 8. LILCO's 18% share of that amount is estimated to be $918 million. As noted, LILCO is already in default in the payment for its share of this project. Tr. 1385 (Nozzolillo).

493. It is not in the public interest to allow a financially weakened and nearly bankrupt company to operate a nuclear facility, since LILCO's financial condition may preclude it from expending the funds necessary to operate Shoreham safely at low power. It does not make sense, nor is it in the public interest, to impose additional safety responsibilities upon a company which is so close to insolvency. Tr. 2916 (Kessel).

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Dated: August 31, 1984

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before The Atomic Safety And Licensing Board

In the Matter of

LONG ISLAND LIGHTING COMPANY

(Shoreham Nuclear Power Station, Unit 1)

Docket No. 50-322-OL-4
(Low Power)

CERTIFICATE OF SERVICE

I hereby certify that copies of Brief of Suffolk County in Opposition to LILCO's Motion for Low Power Operating License and Application for Exemption and Suffolk County and State of New York Proposed Findings of Fact have been served on the following this 31st day of August 1984, by U.S. mail, first class, except as otherwise noted.

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