# AFFIDAVIT OF DALE G. BRIDENBAUGH

1. My name is Dale G. Bridenbaugh. I am President of MHB Technical Associates, a principal consultant with that firm, a mechanical engineer and a registered professional nuclear engineer in the State of California. My qualifications have previously been submitted in this proceeding.1/

2. I have evaluated the proposed reduced qualified load (3300kW) and emergency service loads described by amendment No. 52 to LILCO's license application, Revision 34 to the Shoreham FSAR. In the course of my review I have examined documents submitted by LILCO to the NRC in support of this amendment, reviewed the amendment itself, and attended the depositions of LILCO and NRC Staff personnel in this matter. I also have conducted a review of EDG load ratings and LOOP/LOCA loads estimated by other utilities in the licensing of approximately 20 other boiling water reactors licensed for operation over the last 15 year period. The relevant data I have evaluated are summarized in attached Table 1. My review was based upon information obtained from the U.S. NRC's Public Document Room in Washington, D.C.

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1/ See Attachment 5 to Joint Direct Testimony of Robert N. Anderson, et al., Regarding Suffolk County's Emergency Diesel Generator Contentions, filed July 31, 1984.

3. As a result of my review and analyses, I have concluded that LILCO's proposed EDG qualification program and LOOP/LOCA emergency load specification does not provide an adequate margin between the EDG capability and the possible maximum emergency service loads to assure that the operation of the Shoreham plant will be in compliance with 10 C.F.R. Part 50, Appendix A, GDC 17. Specific reasons for my conclusion are contained in the following paragraphs.

4. LILCO's original LOOP/LOCA load requirements, as specified in FSAR Table 8.3.1-1, projected that the maximum coincident demand for the highest loaded EDG was 3881.4kW. (FSAR Table 8.3.1-1, page 3, Revision 31). This load was estimated to be approximately constant for the first ten minutes of the accident. After ten minutes, manual action was assumed that resulted in reducing the post-ten minute maximum load to 3409.2kW.

5. I have reviewed the correspondence between LILCO and the NRC Staff discussing possible changes to reduce the EDG loads. The level of the reduced "qualified" load was calculated by LILCO, and LILCO advised the NRC that a 3300kW test run would be performed on EDG 103 that would extend the operating time on that unit to approximately 740 hours. This length of

time was selected to coincide with a crankshaft fatigue cycle level of approximately ten to the seventh stress cycles. The LILCO test run commitment was confirmed in LILCO's SNRC-1094 letter dated 10/18/84, and Exhibit A thereto. Since LILCO claimed credit for 219 hours previously run on EDG 103 at or above 3300kW, it called for an additional run of 521 hours at a load of 3300kW ±100kW.

6. In this same letter (SNRC-1094), LILCO also advised that an FSAR revision would be submitted in the near future which would provide the basis for the qualification of the EDGs at the reduced load requirement of 3300kW. This revision to Section 8.3.1 of the FSAR was formally submitted by LILCO on November 29, 1984 as Amendment 52, consisting of FSAR Revision 34. (Submitted via SNRC-1115, J.D. Leonard to Harold R. Denton, Nov. 29, 1984).

7. Revision 34 contains a number of changes to the original emergency load definition that are of particular relevance. They are:

(a) Two new load terms were added that did not appear on the original Table 8.3.1-1. The first, "Maximum emergency service load" is defined as the maximum load which would exist during a

LOOP/LOCA. It consists of both nameplate and measured loads. The second term, "qualified load," is defined as an upper bound of the maximum emergency service load of all three EDGs. (FSAR, Revision 34, page 8.3.6).

(b) Revisions were made to Table 8.3.1-1 of the FSAR. The changes included the removal of two major loads on EDG-103 from the automatic start category, adjustments to several loads made on the basis of measured rather than nameplate data, and the addition of footnotes indicating that other loads are to be tripped intentionally and in some cases prevented from starting until ten minutes after the LOCA signal.

(c) An additional table, 8.3.1-1A, entitled "Maximum Emergency Service Loads" ("MESL") was added. This table develops MESL totals for each EDG by removing from the Table 8.3.1-1 totals all loads that are cyclic or intermittent or that are tripped or manually initiated after a LOCA signal. By these deletions, LILCO was able to develop loads that are less than 2% below the maximum 3300kW load at which the confirmatory test was purported to have been run on EDG 103.

8. I have reviewed the proposed MESL and qualified load data and analyses. I conclude that LILCO has seriously degraded the margin that is normally present to account for uncertainties and limitations that do exist in the LOOP/LOCA load definitions and scenarios. The limitations and uncertainties consist of (but are not necessarily limited to) the following:

(a) Modeling and related factors. It is impossible to actually test the emergency systems in the conditions they may be called upon to operate in the accident situation. Tests are performed by pumping analyzed design flows from tanks to tanks or suppression pool to suppression pool, but the precise system flow conditions cannot be absolutely known. Thus, loads in the accident case may be somewhat higher than the modeled condition due to changes in system flow resistance, the exact valve setup of the complex systems (RHR, RBSW, and RBCLCW), changes in pump efficiencies, addition of loads, and variations in emergency power voltage and frequency. Such off-standard operating conditions must be guarded against for future operation. Accordingly, if pump efficiency deteriorates or instrument error worsens, adjustments will be needed to compensate for the degraded flow conditions. Such adjustments will generally work to increase the increased required electrical load in order to assure that technical specification minimal flows are being delivered. These variations will not be large, but LILCO has provided no margin to account for such uncertainties.

(b) Overload capability. Setting the qualified load almost precisely at the continuous emergency required load provides no margin to accommodate cyclic and intermittent loads, and for the starting transients imposed by the subsequent addition of other pumps and loads. I have calculated that, based on LILCO's own figures, the intermittent or cyclic loads increase the maximum emergency service loads to 3426.1kW for EDG 101, 3380.7kW for EDG 102, and 3414.1kW for

EDG 103. Regulatory Guide 1.9 indicates that less conservative load definition is permissible at the operating license review stage since the design is fixed and the loads are more clearly defined. However, the Regulatory Guide assumes that margin will still be available "within the short-time rating of the diesel-generator unit". (Regulatory Guide 1.9, Revision 2, December 1979, page 1.9-2). The proposed LILCO loading conditions are particularly deficient with regard to overload capability. There is no confirmed overload capability for these EDGs and the qualified load (3300kW) is only 1.4% greater than the maximum continuous emergency service load (3253.5kW). It is a near certainty that the cyclic and intermittent loads arbitrarily removed from the schedule by LILCO will drive the actual EDG load some 5% higher in the first minutes of EDG operation. This is because the event will require the stroking of numerous motor-operated valves early in the cycle, and the starting of the diesels will draw down the starting air tank pressure, automatically actuating the EDG air compressors for fifteen minutes or more. I have reviewed the intermittent and cyclic loads as well as those loads that can be manually connected subsequent to the LOCA signal. The potential effects of these intermittent and manually added loads is summarized on attached Table 2.

9. I have not yet quantified the total magnitude of the additional load that could be imposed by the uncertainties and intermittent and manual loads described in paragraph 8 above. I do know that they can be a net positive addition to the MESL, and I will be working further to quantify them during the next month.

10. I have obtained data from the NRC's Public Document Room in Washington, D.C. to compare the range of emergency load capability safety margins present at previously licensed plants. The results of my review and analyses are summarized in Table 1 attached. This review covered the majority of boiling water reactors licensed for operation since 1969. It includes nineteen different units ranging in size from 597 to 1152 MW. I find that none of these units has been licensed with less than 10.5% margin between the maximum predicted

emergency service load and the qualified continuous or overload rating of the respective EDGs. The range of margins varies from 10.5% to 34.6% and averages approximately 28%. This appears to be the desirable and commonly applied degree of margin to accommodate the uncertainties and cyclic loads described in the preceeding paragraphs.

11. The availability of additional margin in the load capability described in paragraph 10 above is desirable for yet another purpose -- to allow for the effect that the worst case single operator error could have on the EDG load during a LOOP/LOCA or LOOP event. In response to the Staff questioning, LILCO confirmed that EDG 103 could be loaded to as high as 3583.5kW in the post-LOOP/LOCA condition by the single operator error of manually starting the fourth reactor building service water pump. For the LOOP event, the worst case operator error load addition would be the starting of a core spray pump on EDG 101 which would result in a total diesel generator load of 3784kW.2/ LILCO has responded to NRC Staff questions on this subject that the possibility of such an event will be precluded by additional operator training and procedures. I certainly

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2/ See Staff Supplemental Safety Evaluation Report dated 12/3/84, page 5.

recommend that such steps be taken, but human error cannot be totally eliminated. I am aware that under normal interpretation of the single failure criteria, such operator errors are not required to be considered in the review. However, there is no assurance that the LOOP/LOCA or LOOP events will be terminated in any precise short period of time (in fact, such events could continue for hours or days). In actual accident cases (such as at Three Mile Island-2), errors have been made subsequent to the initiation of the event. It is unreasonable to ignore the possibility of such events and to fail to provide some conservatism in the load margins, particularly since LILCO proposes to operate this plant with EDGs having a long history of serious design and quality problems.

12. In addition to the inadequate load margin discussed in the paragraphs above, the actual qualification of the EDGs at 3300kW is suspect. EDG 103 recently completed a 740-hour test run at load levels of approximately 3300kW, but only after a major rebuild of the engine after 219 hours of operation at that load or greater. The installation on EDG 103 of a completely new and redesigned engine block made of a different grade of cast iron makes suspect the relevance of the completion of the "740-hour run" on this renovated unit to the two other engines with cracked blocks which have not been replaced.

13. There are other factors which further bring into question the 740-hour run. LILCO indicated that the load for the qualification run would be maintained at a level of 3300kW ±100kW.[3/] In a deposition on December 12, LILCO witnesses confirmed that normal station instrumentation was utilized in establishing the load level for the run and that no calibration of the instrumentation was required before, during, or after the run was completed.[4/] Thus, there is no assurance that the accuracy of the instrumentation even meets the nominal 2% full scale accuracy that was specified from the 5600kW EDG load instrument. Even if the instrumentation is within the specified accuracy, it would still be possible for a portion or some of the test run to have been carried out at a load level of less than 3200kW. I have examined the single handwritten log sheet provided to the County by LILCO, which indicates the EDG load every one-half hour for three hours on 10/31/84. The load level recorded is exactly 3300kW for each entry. I know that the load would vary some amount from hour to hour, and am concerned that the load level was not precisely recorded. It

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3/ SNRC-1094, October 18, 1984, Confirmatory Testing of TDI Diesel Generators.

4/ Deposition of J. Notaro, E. Youngling, G. Dawe, and W. Schiffmacher, Dec. 12, 1984, at 41-42.

is therefore possible that the operators could have interpreted the instructions that the load was to be set at approximately 3300kW and recorded only a nominal level. If the instrumentation was off by plus 2%, and the actual load was running at the low end of a nominal range, the actual load could thus have been well below 3188kW; if a nominal range of ±100kW is assumed, the actual load could have been 3088kW.

14. Taking all of the above uncertainties into account, it is possible that the load qualification test performed on EDG 103 was conducted at levels of only 3200kW or even lower. This is obviously less than the continuous emergency load, and the actual peak emergency load will be higher than the continuous load. There are two different times during the course of the accident when this could be particularly acute. First, during the early minutes, adding the intermittent loads to the MESL (continuous) load of 3253.5kW will lead to an actual LOOP/LOCA EDG load of as high as 3426.4kW. Later in the accident (after ten minutes), load adjustments including the possible addition of an RBSW pump and an RBCLCW pump, require "juggling" of the loads. As shown on Table 2, there is a potential for the load on one EDG to reach as high as 4126.8kW under this condition. The EDG Emergency Operating Procedure cautions the operator in the post-accident condition to limit the EDG load to 3300kW ±100kW.[5] No guidance is given as to

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5/ SP 29.015.01, Revision 6, Loss of Offsite Power Emergency Procedure.

exactly how this caution is to be enforced. The most likely method would be to rely upon the control room indicating kW meter provided for each EDG. These instruments have an accuracy that is specified as ±2% accuracy full scale. Thus, it is possible that the 3300kW ±100kW load stated in the procedure could in actuality reach as high as 3512kW on the EDG. I reach this value by assuming the maximum load permitted by the procedure (3400kW) and adding to it the 2% full scale instrument error permitted (112kW). Thus, it is possible that the maximum emergency service load peak could exceed the 3088kW potential lowest level at which EDG 103 was tested by 10.9 percent for the intermittent peak, and by 13.7 percent for the worst case manually loaded condition in the post-accident condition.

15. I declare under penalty of perjury that the foregoing is true and correct in all respects and that if called as a witness I could and would competently testify thereto.

Dale G Bridenbaugh

DALE G. BRIDENBAUGH

Subscribed and sworn to before me
this 2 day of JANUARY, 1985.

James F. Lehman

Notary Public In and For Said County
of Santa Clara and State of California

OFFICIAL SEAL
JAMES F. LEHMAN
NOTARY PUBLIC - CALIFORNIA
SANTA CLARA COUNTY
My Comm. Exp...

TABLE-1

Comparative BWR EDG Ratings and LOOP/LOCA Loads

| Plant | Unit Rating MW | In Service | kW EDG Rating | (4)kW Peak Load | % Marg |
|---|---|---|---|---|---|
| Oyster Creek | 650 | 1969 | 2500(1) | 1950 | 28.2 |
| Duane Arnold | 597 | 1975 | 3250(3) | 2510 | 29.5 |
| Cooper | 836 | 1974 | 4000(1) | 3619 | 10.5 |
| Dresden 2-3 | 800/800 | 1970/71 | 2860(2) | 1950 | 46.7 |
| Quad Cities 1-2 | 800/800 | 1972/72 | 2850(2) | 2122 | 34.3 |
| Pilgrim | 655 | 1972 | 2750(2) | 2398 | 14.7 |
| Peach Bottom 2-3 | 1152/1152 | 1974/74 | 3250(1) | 2560 | 26.9 |
| Brunswick 1-2 | 821/821 | 1977/75 | 3850(2) | 2860 | 34.6 |
| Hatch 1 | 850 | 1975 | 11700(5) | 9670 | 21.0 |
| Hatch 2 | 850 | 1979 | 3500(3) | 3100 | 12.9 |
| LaSalle 1-2 | 1078/1078 | 1984/85 | 3250(3) | 2719 | 19.5 |
| WPPS-2 | 1103 | 1984 | 4650(2) | 3860 | 20.5 |
| Susquehanna 1-2 | 1152/1152 | 1983/85 | 4700(2) | 3542 | 32.7 |
| | AVERAGE | = | | | 27.7% |

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Notes:
(1) Continuous Rating
(2) 2000 Hour Rating
(3) 30 Minute Rating
(4) Peak Loads are those automatically loaded on LOCA/LOOP
(5) Assuming 4 of 5-2925kW EDGs start
(6) All data taken from USNRC Public Document Room FSARs

TABLE-2

Shoreham Emergency Service Loads (in kW)
(Data extracted from Proposed Revision 34 to the FSAR

| | EDG 101 | EDG 102 | EDG 103 |
|---|---|---|---|
| LOOP/LOCA Maximum Emergency Service Loads (Per LILCO Proposed Table 8.3.1-1A) | 3253.3 | 3208.7 | 3225.5 |
| Auto-Start Cyclic & Intermittent Loads (Remarks 5, 7, & 8): | | | |
| Air Comp. | 12.0 | 12.0 | 12.0 |
| Fuel Oil Transfer | 0.4 | 0.4 | 0.4 |
| 480V M-G Set | 141.0 | 141.0 | 176.0 |
| MOVs | 19.7 | 18.3 | 0.7 |
| SUBTOTAL | 173.1 | 171.7 | 189.1 |
| Auto-Start Loads as a % of 3300 | 5.2 | 5.2 | 5.7 |
| Maximum Auto-Start Loads Emergency Service Loads | 3426.4 | 3380.4 | 3414.6 |
| Loads Which May Be Added Manually Or After Ten Minutes (excludes those that are illogical such as EDG heaters, refueling plat- | | | |

TABLE-2

Shoreham Emergency Service Loads (in kW)
(Data extracted from Proposed Revision 34 to the FS

| | EDG 101 | EDG 102 | EDG 103 |
|---|---|---|---|
| form, etc.) | | | |
| | -- | -- | 358.0 |
| | -- | -- | 80.0 |
| | -- | -- | 52.0 |
| | 109.0 | 109.0 | -- |
| | -- | 26.4 | -- |
| | 7.0 | 3.5 | -- |
| | 180.0 | -- | -- |
| | 20.0 | 20.0 | -- |
| | -- | -- | 20.0 |
| | 2.4 | 2.4 | -- |
| | 206.1 | 206.1 | -- |
| | 80.0 | 80.0 | -- |
| | 1.6 | 1.6 | -- |
| | -- | 48.0 | 48.0 |
| | -- | -- | 0.4 |
| | -- | -- | 32.0 |
| | 8.0 | 8.0 | 12.0 |
| | 1.2 | 1.2 | -- |
| | 8.0 | 8.0 | -- |
| | 1.2 | 1.2 | -- |
| | 32.0 | 32.0 | -- |
| | -- | 10.0 | -- |
| | 45.0 | -- | -- |
| | 3.0 | 3.0 | -- |
| | 95.9 | 75.3 | -- |
| SUBTOTAL | 700.4 | 635.7 | 602.4 |
| Maximum Potential Emergency Service Load After Ten Minutes | 4126.8 | 4016.1 | 4017.0 |