UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

DIRECT TESTIMONY OF MARC W. GOLDSMITH AND GREGORY C. MINOR ON BEHALF OF SUFFOLK COUNTY REGARDING SUFFOLK COUNTY CONTENTION NO. 18 - HUMAN FACTORS - EQUIPMENT

Dated: May 25, 1982

SUMMARY OUTLINE OF SUFFOLK COUNTY
CONTENTION 18 TESTIMONY*

The testimony highlights LILCO's failure to eliminate human factors deficiencies in control room equipment. The deficiencies in the annunciator systems are addressed to demonstrate the steps to improve the safe operation of the Shoreham facility have not been taken.

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*/ ASLB Memorandum and Order, March 15, 1982, p. 30.

Direct Testimony of Marc W. Goldsmith and Gregory C. Minor
Regarding Suffolk County Contention 18 -
Human Factors - Equipment

Q. Please state your names, addresses, occupations, and qualifications.

A. My name is Marc W. Goldsmith, and my business address is 400-1 Totten Pond Road, Waltham, Massachusetts. I am the President of Energy Research Group, Inc. My name is Gregory C. Minor, and my business address is 1723 Hamilton Avenue, San Jose, California. I am a Vice President of MHB Technical Associates, Inc. Our qualifications have been separately provided to the Board.

Q. Would you please state the contention on which you are testifying?

A. Suffolk County contends that LILCO and the NRC Staff have not adequately demonstrated and confirmed that the control room design at Shoreham is adequate to provide the timely control necessary to protect the health and safety of the public, and thus to satisfy 10 CFR 50, Appendix A, GDC 13, 19, 20, 22 and 29. Specifically:

(a) There is no first-out alarm capability provided in the control room annunciator system that identifies the initiating events when multiple annunciator alarms occur. In view of this deficiency, the control room operator is forced to rely on the events computer for the needed information. The events computer is slow, not classified as safety-related, and not directly integrated with response procedures. Accordingly, a reliable and timely response to all plant failures cannot be guaranteed.

Further, the following, taken in conjunction with the above, are other defects such that the information for control room operators is not presented in a manner that facilitates the recognition of developing off-normal conditions and the mitigation of accidents:

(b) There is no audio or visual annunciator indication to signal that an alarmed condition has cleared.

(c) There is no indication why an annunciator is lit -- whether because the system is, in fact, inoperable due to malfunction, or because it has been by-passed and is actually capable of functioning.

(d) The sequence of annunciator trips and events appears on the computer printer which is the only means available to communicate this information to the operator in the event of a major accident or transient. However, the events computer is slow, not classified as safety-related, and not directly integrated with response procedures. The non-redundant, low reliability plant computer has been shown to become overloaded by major accidents and to be incapable of supplying timely information on accident sequences. The computer print-out is not readily visible and is poorly located for use by the operators under accident conditions. Accordingly, a reliable and timely response to all plant failures cannot be guaranteed.

(e) The LILCO responses to the control room human factors audit report leave a considerable number of small equipment changes either delayed until fuel load, deferred for long-term review or not made at all. Individually, these equipment inadequacies do not appear to be significant; however, taken as a whole, they could provide some serious operational difficulties over time. Annunciator light failure frequency is unknown (Shoreham Safety Evaluation Report, Supp. No. 1 [SSER No. 1], Appendix C, Item 2.6) which, combined with lens problems (SSER No. 1, Appendix C, Item 3.14), could lead to operator difficulties in visually detecting alarms. The following additional control room and control board problems, originally identified in the audit, have not yet been resolved:

(i) Ventilation in the control room (SSER No. 1, Appendix C., Item 2.1);

(ii) Background noise levels in the control room ("Human Factors Engineering Control Room Design Review -- LILCO Response to NRC Audit Findings," dated 6/8/81 [hereinafter referred to as "Response to Human Factors Review"], NRC Finding 2.7);

(iii) Lighting level in the control room (SSER No. 1, Appendix C, Item 2.2., and Response to Human Factors Review, NRC Finding 2.3);

(iv) Security console in the control room (Response to Human Factors Review, NRC Finding 1.2);

(v) J-handled switches on the front row of control panels (SSER No. 1, Appendix C, Item 4.1);

(vi) Mirror image on IRM selectors (Response to Human Factors Review, NRC Finding 4.3);

(vii) Location of ADS service air controls (Response to Human Factors Review, NRC Finding 6.12);

(viii) The range of the Reactor Water Level display (SSER No. 1, Appendix C, Item 6.17);

(ix) Strip chart recorders (SSER No. 1, Appendix C, Items 10.1, 10.2, 10.3 and 10.4, and Response to Human Factors Review, NRC Findings 10.1 through 10.9); and

(x) Reactor mode switch and key location (SSER No. 1, Appendix C., Item 4.13).

Q. What is the purpose of this testimony? Please provide pertinent background data which relate to your concerns.

A. This testimony addresses deficiencies in the Shoreham control room design features and equipment when evaluated from a human factors perspective. The TMI-2 accident assessment showed a major deficiency in human factors design of reactor control rooms. The NRC response was to conduct audits of existing control room designs including NTOL's such as Shoreham. The Shoreham audit disclosed many deficiencies, some of which were resolved; others were not.

We have addressed specific deficiences with the human factors design of the annunciator system. The other deficiencies are not addressed here because of time constraints in preparation of testimony. The absence of comment on these issues does not imply any reduction in our view of their importance and the need for correction of the deficiencies.

Q. What are the regulatory requirements pertinent to your testimony which concern instrumentation and control room design?

A. The general requirements for design of instrumentation systems and control rooms are included in GDC 13 and 19. Other GDC describe the features to be considered specifically for reactor protection system design and functioning.

Specific criteria for the human factors design of nuclear power plant control rooms were initially documented in NUREG/CR-1580[1/] and later in NUREG-0700[2/]. The NRC developed these criteria to guide the conduct and assessment of control room audits required by NUREG-0737 (Item I.D.1)[3/]. The Shoreham control room design was audited in March, 1981. The NRC assessments of and LILCO responses to high priority issues (priority 1 and 2 items) were published in the Shoreham SER Supplement 1 as Appendix C.

Q. In your technical opinion, how do the Shoreham control room design features violate regulatory requrements with regard to their human factors implications?

A. The NRC's control room audit of Shoreham identified over 200 human engineering discrepancies[4/]. The NRC assessed their

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1/ Human Engineering Guide to Control Room Evaluation. NUREG/CR-1580. US NRC, July 1980 and Supplement NUREG-0659, US NRC, March, 1981.

2/ Guidelines for Control Room Design Review, NUREG-0700, US NRC, September, 1981.

3/ Clarification of TMI Action Plan Requirements, NUREG-0737, October, 1980.

4/ NUREG-0700 defines human engineering discrepancies as "a deviation from some benchmark such as a standard or convention of human engineering practice, an operator preference or need or an instrument/equipment characteristic implicitly or explicitly required for an operator task". (NUREG-0700 at p. 4).

safety significance and ranked them in terms of priority. The items which are highest priority (priorities 1 and 2) are included in SSER 1 Appendix C and LILCO has committed to correct them prior to fuel load[5/]. The items identified in the wording of this contention are some of the discrepancies which LILCO has neither corrected nor adequately justified the present design. Thus, for these items, the Shoreham control room does not meet the human engineering guidelines in areas deemed important to safety by their priority ranking, and, therefore, LILCO has not demonstrated compliance with GDC 13 and 19.

Q. Please describe in greater detail the human factors concerns regarding the Shoreham control room annunciator/alarm system.

A. One way the operators can decide quickly what type of an accident or transient is occurring is to look at the plant annunciators. However, when an accident or transient occurs, numerous annunciators may be lit within a very short time following the initiation event. In addition, there are some annunciators which may be on during normal operation and, thus, add extra data which must be deciphered and analyzed to discover the first annunciators in the sequence.

Further, many annunciators indicate more than one failure on a system. For example, a system degraded annunciator may indicate loss of power to valves and controllers, loss of cooling water or loss of electrical power. Therefore, the indication of a degraded system could be redundant with a variety of other annunciators.

Shoreham does not have the ability to display "first-out" annunciators. However, the Rochester Instrument Systems, Inc. annunciator system used at Shoreham can be purchased with first-out alarm sequences. Instead, the operator must rely on the non-safety-grade process computer to provide the sequence of annunciator actuation after an accident has occurred. This is confusing because the alarm response procedures do not provide for consistency of action following an annunciator alarm. For example, the operator action following an

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5/ SSER 1 Appendix C, p. C-1.

annunciator actuation appears to have no priority of response or priority of action following the alarm acknowledgement. An example might be as follows: a loss-of-DC power requires a much more complex response than Diesel 3 System inoperative, though Diesel 3 inoperative could be the cause or effect of DC Power loss; both events could be annunciated simultaneously. In this example, the first-out alarm capabilty would indicate cause and effect and would guide the operator to the appropriate response. Using the events computer may provide too much detail and divert operator attention. It is not an adequate substitute for first-out annunciator capability.

Just as an operator needs to know when an annunciator trips, he also benefits by being informed when an annunciator has cleared. This is referred to as a ring-back function and will call the operator's attention to a reset condition even if the operator has gone on to other tasks or is distracted. LILCO has not implemented a ring-back at Shoreham to indicate a cleared annunciator.

A third area of human factor deficiency is in the Shoreham annunciators which indicate bypass/inoperative status. While some annunciators are provided to indicate a system as bypassed or inoperative, they do not tell the operator which of the two conditions prevails. This may be important if the operator is attempting to ascertain the availability of the unit in question. For instance, an instrument channel which is bypassed but otherwise perfectly functional could be returned to service quickly. However, if it is inoperative (i.e., failed in some way), it may take a longer time to repair the instrument before it can be put back into service.

Q. What is LILCO's position on the human factors implication of the annunciator/alarm system as it currently exists?

A. LILCO has resisted making changes to its existing annunciator system. As repeated in the SSER 6/, LILCO believes:

1. The existing design is a LILCO standard. Therefore, first-out capability is not required.

6/ SER Supplement 1, Appendix C. Items 3.2, 3.3.

2. The operators may be confused by the addition of ring-back.

3. Operators check to see if function has cleared at the end of their related actions.

Q. What problems remain with LILCO's position and action taken relative to these concerns?

A. LILCO has made an evaluation in favor of not correcting the annunciator first-out and ring-back deficiencies. That evaluation is contrary to the guidelines provided by the NRC's Division of Human Factors Safety[7/]. The limitation of not providing a first-out annunciator is that LILCO does not provide the immediate guide to the operator to assist in implementation of the diagnostic procedures. LILCO relies instead on a print-out from the plant process computer, which is not safety-related and has an unspecified availability[8/]. By not providing a first-out indication on the main control boards, LILCO requires an operator to read the computer print-out. This takes the operator away from his work station at the panels at a potentially critical time during an accident or transient. By not adding a ring-back function, the operator has the potential of missing the positive confirmation that an alarmed condition has cleared (returned to a non-alarmed state).

Q. Are there improvements LILCO should make in the annunciator system?

A. The first-out alarm function and a ring-back function are part of the annunciator guidelines of the NRC's Division of Human Factors Safety. LILCO does not have either of these features,

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7/ NUREG-0700, "Guidelines for Control Room Design Review," September 1981, Section 6.3.

8/ Response to SOC's fourth set of interrogatories, Interrogatory 7a(4)-1, states that the reliability and availability of the process computer are unspecified.

Factors Safety. LILCO does not have either of these features, and the justification provided for the deviations is not substantiated with human factors data or comparative evaluation. Thus, LILCO should be required to improve the system by adding the features or providing supportive human factors analyses that show that LILCO's design will provide an equivalent level of operator efficiency and freedom from operator error during accident or transient conditions.

Q. Does this conclude your testimony?

A. Yes.