Enclosure 2

March 12, 1980

To: Leo Beltracchi

From: Ken Mallory

Subject: Findings of the CR review at Indian Point - Unit 2

During the week of February 19, 1980, the Essex Corporation in cooperation with the NRC/NRR began a human engineering review of the control room at Consolidated Edison's Indian Point - Unit 2 Nuclear Power Plant. Because of problems at the plant, the review was terminated before walk-throughs/talk-throughs could be completed. The review was completed on March 10-11, 1980.

Essex had three objectives for this review:

1. To identify features in CR design and procedures that could induce operator error under normal or emergency conditions.

2. To examine evaluation guidelines and procedures for the guidebook and modify accordingly.

3. To identify design and procedural problems and backfits common among control rooms.

1.0 SUMMARY CONCLUSIONS

a. The Indian Point - Unit 2 control room exhibited a number of design and procedural features that were contradictory to human engineering standards and practices (Described below).

b. The Essex procedures were upgraded as a result of the Indian Point review:

- o Procedures for using checklists are being altered
- o Walk-through/talk-through procedures were verified
- o Surveys are being expanded to include trending and a revised control/display relationship section.

2.0 OBSERVATIONS

Each of the observations described below is given a Subjective Risk Assessment Weight based on the likelihood that a particular aspect of CR design will lead to an operator error in a safety-related activity. The likelihood is based on the opinion(s) of the Essex human engineer(s) reviewing the CR.

All of the observations below are based on a short-term review of the CR; therefore, none is intended to require backfit. These observations only point to potential problem areas.

Category 1 — High Risk of Operator Error in Safety-Related Activity

Category 2 — Moderate Risk of Operator Error in Safety-Related Activity

Category 3 — Risk of Operator Error is Safety-Related Activity

Category X — Additional evaluation required

a. Turbine Start-Up, Bearing Oil Pump are not located with primary turbine operation panels (Category X).

b. Ambient noise at SC panel inhibits speech communication with operator located near Engineered Safeguards (Category 3).

c. Delay in onset of emergency lighting (Category X).

d. On Steam DRVM Aux FW Man Flow (Aux 21-24) 100% is O pump output; O is 100% output. Contrary to convention. Narrow range of steam-generator level is given in percentage; wide range is given in feet of water (Category 1).

e. Annunciators

- o Angle of view makes most annunciators unreadable to operator standing at vertical panel (Category 1).
- o Many Tiles are illegible (Category 1).
- o Green annunciators possible source of confusion (Category X).
- o Flash rate of 1/sec. (simulator) is too low (Category 3).

f. Labeling

- o Need Demarcation lines and summary labels throughout Flight and Vertical Panels (Category 2).
- o Some controls/displays have no labels (Category 2).
- o Operator yellow tape backfits should use tape with high contrast to the board (Category 3).
- o Some labels are covered with ink and difficult to read (Category 3).

g. Ventilation Fan over vertical panel will, if a fire occurs in the cabinet, dump fumes/smoke into crew area (Category X).

h. Inconsistencies in switch position nomenclature (Category 1).

i. Some switches (unguarded) are exposed to inadvertent actuation (pull-to-defeat "J" handles) (Category 2).

j. Star-handle rotaries obscure labels on benchboard and on verticals (Category 1).

k. Control/display confusion on M.O. Disc Switches and associated indicator lights (Category 3).

l. Strip Chart: (Category X)

- o Problems with leakage, spillage
- o "Pull-out" obscures labels and controls (on Flight Panel)
- o Salinity Strip Chart on Unit 1; operators indicate that chart is often needed
- o Ink mark seems to spread on paper (possibly too porous).

m. Glare problem on two vertical meters mounted high on vertical panel (operator backfits an afixed).

n. Horizontal Seal Injection Flow meters:

- o No labels (Category 1)
- o Parallax apparent from side (Category 2)
- o Out-of-place (RCP on SA panel) (Category 3).

o. Several Generator switches have labeling contrary to convention (raise lower; rather than lower raise). Switch with such labeling was in involved in an observed incident where an operator inadvertently raised turbine governor (Category 1).

p. Turbine trip reset flags have low conspiquity (Category 3).

q. Emergency Protective Equipment (Category 1):

- o Operator need more training in donning (long time/mistakes)
- o Voice communications virtually impossible with Scott packs
- o Equipment spread among three cabinets; should be organized into individualized packages
- o Sizing information needs to be available on clothing.

r. Location of Shift Supervisor desk prevents quick response to emergency (Category X).

s. Location of Phase B Containment Isolation switches prevents smooth operation (Category 3).

t. No provision for lamp test. Burned-out bulbs on panels were found (Category 1).

u. There are no indicator lights for manual valve status (Category X).

v. Location of "Personnel Hatch" and "Equipment Hatch" switches on SM panel are poorly placed for Containment Isolation Reset operation (Category 3).

w. OPS meters used in cold shutdowns should have marks for upper and lower tolerance units (Category 3).

x. Rod Insertion Annunciator widows cannot be viewed directly from Flight panel (Category 3).

y. Strip Chart for Containment Bldg. Dew Point was same ink for all Recirc. fans (Category X).

z. Staff of two to three operators must be available at all times. Emergency procedures difficult for one operator (Category 1).

aa. Rod (out-in) is contrary to stereotype (in-out).

bb. No computer analog trending capability (Category X).

cc. To use the computer the operator must in some cases perform a partially random ~~search~~ among addresses to locate the appropriate data point to be displayed, trended (etc.) (Category X).

dd. Procedures (Category 1)

- Instructional steps or references to other documents/procedures often imbedded within "Notes." Notes may be overlooked by operator and these steps or references therefore may be overlooked.
- Ambiguous instructions.
- Instructions which must be performed by NPOs not clearly identified as such (listed among CR operator actions in CR operator-designated Procedures).
- Reference mode in Immediate Operator Actions to other procedures (particularly E-1 Emergency Shutdown resulting from a unit trip) Not clear when to return to originally pulled procedure.
- Use "verify" and "ensure" interchangeably. Should avoid use of synonyms in instructions.
- Wordiness of instructional steps results in operators not reading procedures, rather skimming and extracting information (observed in procedures walk-throughs). Could result in overlooked steps.
- Lengthy sentences common (20-30 words) in instructional steps.
- Multiple steps nested within one insructional statement.
- Frequently, the response of displays or indicators (Feedback) to operator actions are not defined in the instruction. Also delays in system response is not specified.

- Procedures did not provide diagnostic aids for operation.

3.0 HUMAN ENGINEERING STRENGTHS

The CR at Indian Point - Unit 2 had several exemplary human engineering features.

- Panels organized to support Emergency Operations
- Some emergency operations are performed with switches arranged by sequence
- Use of Red labels to differentiate between Phase A and B isolation
- Most annunciators are located over panels with systems that they monitor
- Few operator backfits to labels, markings, etc.
- Labeling is reasonbly clear and concise
- Con. Ed. management has effectively implemented an informal system to review, evaluate, and act on operator design/procedural recommendations
- Operators have used switch handle shape to break up long strings of identical switches. This reduces the likelihood of choosing the wrong switch for actuation.
- Trip-related displays in one matrix over the flight console.
- Vertical meters are used only for levels.

Enclosure 3

REQUIRED CORRECTIVE ACTIONS

1. Short-Term Items - The following corrective actions should be implemented by February 1, 1981:

   a. Modify the emergency lighting system to provide illumination immediately after loss of normal lighting.

   b. Replace illegible annunciator tiles.

   c. Add demaration lines or equivalent to show functional or systematic grouping of controls and displays on panels.

   d. Add missing control/display identification labels.

   e. Replace labels wich are obscured or otherwise difficult to read.

   f. Permanently affix to panels all operational aids that have been temporarily added by operators.

   g. Where color coded labels are used, provide labels with high contrast to panels.

   h. Provide switch guards, or equivalent protection to minimize inadvertent switching of exposed "J" handle switches which have safety significance.

   i. Provide visible labels where star handle switches obscure them.

   j. Correct problems associated with the strip chart recorders.

   k. Store emergency operator equipment in one location/cabinet.

   l. Provide for periodic training and exercises for operator's in the donning of emergency equipment.

   m. Affix permanent and visible sizing information on emergency clothing.

   n. Provide cross indexing of data point information to improve the operator capability to use the process computer.

   o. Make the necessary corrections and improvements to the emergency procedures.

   p. Provide a lamp test capability for all ESF system and safety significant indicator and status monitoring lamps.

2. Longer-Term Items - The following corrective actions should be implemented by May 1, 1981:

   a. Provide a system for operator communication between the SO panel and the ESF panels.

   b. Correct the deficiency in the steam driven auxiliary feedwater manual flow controllers.

c. Correct the deficiency associated with the green and green/white annunciator tiles.

d. Increase the flash rates of the annunciators to 3 to 5 cps.

e. Correct the deficiencies in switch position nomenclature to agree with convention.

f. Provide a system to improve communication between operators wearing protective equipment.