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MEMORANDUM FOR: R. W. Reid, Chief, Operating Projects Branch 4

FROM: D. Tondi, Acting Chief, Human Factors Engineering Branch, DHFS

SUBJECT: TMI-1 CONTENTION RESPONSE

Enclosed are responses to contentions by Sholly, ENCO, and Angry regarding the restart of TMI-1. These responses were prepared by Joseph Joyce and Glenn Kelly. Should you have any questions or comments, please contact Joe Joyce at 492-8217.

D. Tondi, Acting Chief
Human Factors Engineering Branch
Division of Human Factors Safety

Enclosures:
As stated

cc: S. Hanauer
D. Ross
R. Satterfield
R. Ireland
T. Speis
H. Silver
J. Joyce
G. Kelly

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 23 1980

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FROM: D. Tondi, Acting Chief, Human Factors Engineering Branch, DHFS

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H. Silver
J. Joyce
G. Kelly

Q. Please state your name and your position with the NRC.

A. My name is Joseph P. Joyce. I am an employee of the U.S. Nuclear Regulatory Commission assigned to the Office of Nuclear Reactor Regulation, Division of Human Factors Safety, Human Factors Engineering Branch. From September 1974 until April 1980, I was assigned to the Instrumentation and Control Systems Branch.

Q. Have you prepared a statement of professional qualifications?

A. Yes. A copy of this statement is attached to this testimony.

Q. Please state the nature of the responsibilities that you have had with respect to TMI Unit 1 Nuclear Generating Station.

A. I am a member of the team that is responsible for reviewing the TMI-1 Control Room from a human factors standpoint prior to restart of TMI-1.

Q. What issues are you addressing in this testimony?

The five issues I am addressing were submitted as follows:

A. <u>Sholly Issue #13</u>

"It is contended that the Unit 1 computer system does not meet the requirements for instrumentation and control specified in GDC 13,

and is inadequate to insure proper operation of the Unit 1 reactor under all conditions of normal operation, including anticipated operational occurrences and postulated accident conditions. It is further contended that the lack of realtime printout capability during accident conditions and the lack of sufficient redundancy in the computer system place the public health and safety at significant risk during accident conditions, especially if computer function is lost and no backup unit is available. It is contended that until the Unit 1 computer system is upgraded to meet the standards of GDC 13 and until suitable redundancy is provided within the computer system to assurereal-time printout capability at all times, permission for restart must be denied on the basis of risk to public health and safety due to inadequate availability of operational information to Unit 1 operators."

Sholly Issue #15

"It is contended that the design of the Unit 1 control room, instrumentation, and controls is such that operators cannot maintain system variables and systems within prescribed operating ranges during feedwater transients and LOCA's. It is further contended that this violates the provisions of GDC 13 regarding instrumentation and controls. It is contended that in view of the numerous operating difficulties encountered with Unit 2, and the similarities in design and construction between Units 1 and 2, a thorough human factors engineering review of Unit 1's Control Room is called for in

order to provide assurance that the operator-instrumentation interface is such that the operators can exercise adequate control over the reactor and prevent off-site consequences from anticipated operational occurrences and postulated accidents. It is further contended that in order to assure maximum protection for the public health and safety, the human factors engineering review and any necessary changes recommended as a result ofthis review must be completed prior to restart."

ECNP Issue #1a

"The plant computer for TMI-1 is old, obsolete, and inadequate to respond appropriately in emergency situations. During the accident at the adjacent TMI-2, the alarm printer on the similar computer at Unit 2 had a delay time of over 2½ hours at one point, and ran more than an hour behind events for over 7 hours. This delay cannot be viewed as having adequately served the needs of the operators of TMI-2, and there is no reason to believe that a similar accident situation, with as severe or worse consequences, cannot occur at TMI-1 and be severely aggravated by slow and ambiguous computer alarm printer readings."

ECNP Issue #1i

"The interface between the operator and the reactor, the control room panel, is not adequate to provide the appropriate and necessary

information to the operators in the event of an accident. Control room and control panel design of TMI-1 must be altered to assure that all appropriate and necessary information is available to, received by, and comprehensible to operators and that control room facilities maximize ability of operators to respond to accident conditions quickly and accurately."

Angry Issue #5c

"The NRC Order fails to require as conditions for restart the following modifications in the design of the TMI-1 reactor without which there can be no reasonable assurance that TMI-1 can be operated without endangering the public health and safety."

(c) Performance of an analysis of and implementation of modifications in the design and layout of the TMI-1 control room as recommended in NUREG-0560.

Q. (Sholly 13-1)

Identify all requirements within NRC regulations relating to the Unit 1 computer.

A. The past and present NRC Regulations do not contain requirements for computer per se, nor has the NRC required that licensees of nuclear power plants have a computer system.

Q. (Sholly 13-2)

Has the NRC required computer systems at nuclear reactors to meet GDC 13 requirements? If not, why not?

A. The NRC regulations do not require computer systems at any nuclear power generating stations to meet GDC-13 requirements, nor any other regulatory requirements. The Staff requires compliance with the general design criteria, but does not specify design and implementation methodology.

Q. (Sholly 13-3)

Will the Licensee be required to meet GDC-13 criteria for Unit 1's computer prior to restart? If not, why not?

A. No. The licensee will not be explicitly required to have a plant computer to meet GDC-13 requirements. As stated in response to item 13-2, GDC 13 must be satisfied; however, the licensee has not opted at this time to use the plant computer to satisfy this criterion.

Q. (Sholly 13-4)

Thelack of real time printout capability during accident conditions and the lack of sufficient redundancy in the computer system places the public at significant risk during accident conditions. What are you doing to reduce the public risk?

A. The NRC agrees that improvements are required with regard to acquisitions of important information, on a real-time basis, during accident situations. Further, we also believe that this information should be available to the control room operating personnel and that redundancy of information be provided.

The NRC has required licensees of operating plants to provide redundant instrumentation to follow the course of an accident, with at least one channel being recorded. This requirement is presently met by the TMI-1 licensee; therefore, we will not place other explicit requirements on the plant computer at this time. However, the NRC is presently revising the accident monitoring requirements for all nuclear power plants, and these new regulatory requirements will be imposed on TMI-1, along with the implementation schedule stated in Regulatory Guide 1.97, Rev. 2.

Q. (Sholly 13-5)

Will the Licensee be required to provide for redundancy in Unit 1's computer and printout capabilities prior to restart? If not, why not?

A. No. The licensee is not currently required to provide any major upgrading of the plant computer system as a prerequisite to restart. The licensee is undertaking a major upgrading of the Unit 1 plant computer capabilities under its own initiative. The NRC relies on the Class IE hardwired redundant instrumentation for the acquisition of important information during accident situations.

Q. (Sholly 15-1)

Is NRC going to conduct a human factors engineering review of Unit 1 control room prior to restart?

A. The Human Factors Engineering Branch (review team) and consultants are planning a site visit to the TMI-1 control room July 21 to July 25. At this time, the control room will be audited on the basis of human engineering guidelines developed in part by Essex Corporation and currently being revised by the NRC and its consultants. The review will focus on the following:

- man-machine interface
- control and display design
- work station layout
- control room environment
- emergency procedures

Q. (Sholly 15-2)

What happens to the design discrepancies that are revealed during the control room review?

A. Each of the discrepancies will be analyzed and assigned a Subject Risk Assessment Weight based on the likelihood that the discrepancy will precipitate or contribute to operator error during critical activities. This assessment is based on the opinions and experience of the NRC review team and our human engineering consultant. The licensee is then required to fix the descrepancies within an established schedule.

Q. (ECNP 1a-1)

What are the requirements within NRC regulations that are applicable to plant computers?

A. There are no requirements within NRC for plant computers to provide vital information to the operators during an emergency situation. The NRC has

required licensees of operating plants to provide redundant instrumentation to follow the course of an accident, with at least one channel being recorded. This requirement is presently met by the TMI-1 licensee; therefore, we will not place explicit requirements on the plant computer at this time. However, the NRC is presently revising the accident monitoring requirements for all nuclear power plants, and these new regulatory requirements will be imposed on TMI-1, along with the implementation schedule stated in Regulatory Guide 1.97, Rev. 2.

Q. (ECNP 11-1)

Is NRC going to conduct a review of TMI-1 control room?

A. The Human Factors Engineering Branch (review team) and consultant are planning a site visit to the TMI-1 control room July 21 through July 25. At this time, the control room will be audited on the basis of human engineering guidelines developed in part by Essex Corporation and currently being revised by the NRC and its consultants. The review will focus on the following:

- man-machine interface
- control and display design
- work station layout
- control room environment
- emergency procedures

Q. (ENCP 1i-2)

What improvements will the licensee be required to make in Unit 1 control room to provide the appropriate and necessary information to the operator?

A. The NRC has required licensees of operating plants to provide a Safety Parameter Display System (SPDS) to assist control room operators in evaluating the safety status of the plant. The SPDS is to provide a continuous indication of plant parameters, representative of important plant functions, from which the plant's safety status may be assessed.

The important plant functions shall include, but not be limited to:

- reactivity control
- reactor core cooling
- radioactivity containment
- reactor coolant system integrity
- containment integrity

Q. (Angry 5C-1)

Is NRC going to conduct a review of TMI-1 control room?

A. The Human Factors Engineering Branch (review team) and consultant are planning a site visit to the TMI-1 control room July 21 through July 25. At this time the control room will be audited on the basis of human

engineering guidelines developed in part by essex Corporation and currently being revised by the NRC and its consultants.

The review will focus on the following:

- man-machine interface
- control and display design
- work station layout
- control room environment
- emergency procedures

Joseph P. Joyce
Professional Qualifications
Human Factors Engineering Branch
Division of Human Factors Safety

Since April 28, 1980, I have been assigned to the Human Factors Engineering Branch as a technical reviewer. My primary responsibilities include reviewing control rooms from a human factors standpoint and developing human factors review guidelines for use by licensees to conduct their year-long design reviews of the control rooms. My present title is Senior Reactor Systems Engineer (Electrical).

Following the TMI-2 accident, from May to December 1979, I was assigned to the Bulletins and Orders Task Force as a technical reviewer in the area of instrumentation and control.

From September 1974 to May 1979, I served as a technical reviewer in the Instrumentation and Control Systems Branch (ICSB). In the ICSB, my primary responsibility was to perform technical reviews of the design, fabrication, and operation of electrical, instrumentation, and control systems for nuclear power plants. This review encompasses evaluation of applicants' safety analysis reports, generic reports, and other related information on the instrumentation and control designs.

I received a Bachelor of Science degree in electronic engineering in 1969 from Capital Institute of Technology. I am a member of the Institute of Electrical and Electronic Engineers (IEEE).

From 1973 to 1974, I was a design engineer with NUS Corporation, where my duties included design responsibility in meteorological systems.

From 1969 to 1973, I was a system design engineer at Hydrospace Challenger Research, Inc. and was responsible for design, analysis, and preparation of electrical and wiring diagrams for the signal Converter and Switching Cabinet $(SC)^2$, which is the interface between the Simulation Computer AN/UYK-7 and the Central Computer Complex. In this position, using Fortran IV, I developed a working model of the hydrophone, cable, and preamplifier of the TRIDENT Sonar System.

Q.1 Please state your name and your position with the NRC.

A. My name is Glenn B. Kelly. I am an employee of the U.S. Nuclear Regulatory Commission, assigned to the Human Factors Engineering Branch, Division of Human Factors Safety, Office of Nuclear Reactor Regulation. From March 1976 to April 1977 I was assigned to the Analysis Branch, Division of Systems Safety. From April 1977 to April 1980, I was assigned to the Reactor Systems Branch, Division of Systems Safety.

Q.2 Have you prepared a statement of professional qualifications?

A. Yes. A copy of this statement is attached to this testimony.

Q.3 Please state the nature of the responsibilities that you have had with respect to the TMI Unit 1 Nuclear Generating Station.

A. I am a member of the Human Factors Engineering Branch team responsible for reviewing control rooms from a human factors standpoint.

Q.4 What is the purpose of your testimony?

A. The purpose of my testimony is to supplement the response of Joseph P. Joyce to Sholly Issue 15, which states:

> It is contended that the design of the Unit 1 Control Room instrumentation, and control is such that operators cannot maintain system

variables and systems within prescribed operating ranges during feedwater transients and LOCA's. It is further contended that this violates the provisions of GDC 13 regarding instrumentation and controls. It is contended that in view of the numerous operating difficulties encountered with Unit 2, and the similarities in design and construction between Units 1 and 2, a thorough human factors engineering review of Unit 1's Control Room is called for in order to provide assurance that the operator-instrumentation interface is such that the operators can exercise adequate control over the reactor and prevent off-site consequences from anticipated operational occurrences and postulated accidents. It is further contended that in order to assure maximum protection for the public health and safety, the human factors engineering review and any necessary changes recommended as a result of this review must be completed prior to restart.

My testimony addresses the question of what information is required by an operator to successfully mitigat a LOCA or a loss-of-feedwater event.

Q.5 What is generally meant by a loss-of-feedwater transient?

A. A loss-of-feedwater (LOFW) transient usually means a partial or total loss of main feedwater flow to one or both steam generators.

Q.6 What conditions could cause or initiate a LOFW transient?

A. A wide variety of conditions could cause a LOFW transient. One of the more common causes at many plants is tripping of one or both main feedwater pump as an equipment protective measure for the pumps. The motive force for the main feedwater pumps comes from steam turbines, which have a number of devices to initiate shutdown of the turbines. Some of the automatic trips for turbine protection are loss of lubricating oil, loss of condenser vacuum, thrust bearing failure, pump suction valve closure, fewer condensate pumps than feedwater pumps operating, and turbine overspeed. The TMI-1 feedwater pumps are not protected against inadequate suction pressure, as is the case at TMI-2.

Instrumentation malfunctions can also cause LOFW transients. For example, failure of the main feedwater flow transmitter may cause the integrated control system (ICS) to close the feedwater control valves, thus initiating a partial LOFW, even though the pumps are still running.

Q.7 How is the plant designed to safely handle a LOFW transient?

A. GPU has committed to a series of modifications to the emergency feedwater (EFW) System for TMI-1 which enhance the response of the primary and secondary systems to a loss of feedwater event. Following a loss of feedwater, primary system pressure increases. The licensee has committed to modify the pressurizer PORV setpoint and the high pressure scram setpoint to ensure that the reactor trips early in a LOFW transient and to minimize the probability of opening the pressurizer safety valves.

Auto initiation of the EFW system has been upgraded so that one of four independent parameters (loss of both feedwater pumps, loss of all reactor coolant pumps, 2/4 low steam generator levels, and steam/feed flow mismatch) will actuate the EFW system. Emergency feedwater system flow indication has been improved so that each steam generator has two independent safety grade flow indications in the control room. An improved station for manual control of the EFW flow control valves has been committed to by the licensee, while the discharge lines to the steam generators now contain parallel isolation and control valves. The ICS no longer controls the EFW system because automatic control is now solely dependent on steam generator level. The EFW system has been modified so that the motor-driven pump will auto sequence onto safety buses in the event of loss of offsite power. Installation of safety grade steam generator level indication has been committed to by the licensee.

While the ICS has not been modified to improve the EFW system, it is designed to initiate a runback (i.e., a reduction in power) of the reactor and turbine to within the capacity of the remaining feedwater flow in the event of only partial loss of feedwater.

These modifications are detailed in NUREG-0680, "TMI-1 Restart," and justification for acceptance of any delays in complaince with previous staff requirements or schedules is discussed there.

Q.8 What information or data are necessary for the operators to diagnose and respond to a LOFW transient?

A. The operators need information regarding the following:

a. whether the RPS has been called on to shutdown the plant;

b. the magnitude of the loss of feedwater (i.e., whether one or both pumps have been lost or whether control of feedwater flow has been lost);

c. whether the emergency feedwater system, if required, is functioning as designed; and

d. whether the ICS is responding as required.

Q.9 In your opinion, are the instruments described in this testimony adequate to aid in diagnosis and control after an off-normal condition engendered by a LOFW transient?

A. Yes.

Q.10 What is generally meant by a LOCA?

A. A loss-of-coolant accident (LOCA) is an event wherein the primary system pressure boundary is inadvertently breached with a resulting loss of reactor coolant.

Q.11 How is the plant designed to safely handle a LOCA?

A. In the plant, there are many design features whose function is to mitigate a LOCA. These systems have not been substantially modified following the TMI-2 event. However, modifications and additions that have been and will be made include:

1) position indication for safety valves, the PORV and the PORV isolation valve;

2) a subcooling meter to measure primary system margin to saturation;

3) manual reactor coolant pump trip on a combination of safety injection and low primary system pressure (an automatic system has been committed to by the licensee);

4) the licensee has committed to modify pressurizer heaters, PORV level instrumentation, and PORV block valve indication so that in the event of a loss-of-offsite power they will automatically switch onto emergency buses; and

5) procedures are to be developed and instrumentation identified which will allow the operator to recognize inadequate core cooling.

The LOCA procedures will also be modified in response to the insight gained during and after the TMI-2 event and its subsequent study. Systems traditionally considered to mitigate a LOCA which has not been changed

substantially subsequent to the TMI-2 event include the emergency feedwater system, the reactor protection system, the residual heat removal system, containment isolation, the emergency core cooling system and support sytems for each of these systems.

Q.12 What information or data are necessary for the operators to diagnose and respond to a LOCA?

A. Following a LOCA, an operator would verify that automatic actions (i.e., reactor trip, turbine trip, safety injection actuation, etc.) had occurred and would prepare to verify/actuate switchover from injection to recirculation. The operator requires information on ECCS flows, EFW flows, SG levels, pressurizer pressure, RWST level, valve positions, pumps status, hot- and cold-leg temperatures, margin to saturation, containment pressure, and containment radiation, as well as other information depending on the plant status.

Q.13 In your opinion, are the instruments described in this testimony adequate to aid in the diagnosis and control after an off-normal condition engendered by a LOCA?

A. Yes.

Glenn B. Kelly
Professional Qualifications
Human Factors Engineering Branch
Division of Human Factors Safety

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From May to December 1979, I was assigned to the Bulletins and Orders Task Force as a Technical reviewer in the area of reactor systems. From April 1977 to May 1979, I served as a technical reviewer in the Reactor Systems Branch (RSB). In the RSB, my primary responsibility was to perform technical reviews of the design and operation of residual heat removal and emergency core cooling systems for nuclear power plants and to review accident analyses that were submitted. This review encompassed evaluation of applicant's safety analysis reports, generic reports, and other related information on systems operation and design. From March 1976 to April 1977, I served as a technical reviewer in the Analysis Branch (AB). In AB, my primary responsibilities were to perform technical reviews of core thermal hydraulics and to review topical reports.

I received a Bachelor of Science degree in mathematics from Bethany College in West Virginia in 1969, and a Masters of Arts degree in mathematics from the

University of Maryland, College Park, in 1974. I am completing a Mater's of Science degree in energy at George Washington University, Washington, D.C.

From 1973 to 1976, I worked for Singer Simulation where I initially was as a lead engineer and later a section manager. My responsibilities as a lead engineer included development of methematical models and computer programs for various reactor systems which were to simulate the operations of a nuclear plant in real time. As a section manager, I was responsible for technical output, schedules, and proposals.

From 1971 to 1973, I was a registered representative for Pennsylvania Securities Company, where my main focus was on financial planning, investment sales, life insurance programming, and sales and pension programs.