LIC 10/21/80

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289
	)	(Restart)
(Three Mile Island Nuclear Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF

GARY R. CAPODANNO, LOUIS C. LANESE AND JOSEPH A. TORCIVIA

IN RESPONSE TO BOARD QUESTIONS

6.a, 6.b, 6.c, 6.g, 6.h, 6.i, 6.j and 6.k

OUTLINE

The purposes and objectives of this testimony are to respond to Board Questions 6.a through 6.c, and 6.g through 6.k, on Emergency Feedwater Reliability. The testimony evaluates the effect of loss of AC power, loss of instrument air and loss of non-nuclear instrumentation on EFW operation, as well as the effects of operator errors and failures in non-safety-grade systems. Information is presented on the failures experienced in EFW systems at other plants. It is shown that the EFW system can protect the plant even with the assumed failure of the turbine-driven pump and one motor-driven pump. EFW system reliance upon AC power is addressed, as well as the low probability of a loss of off-site power at Three Mile Island. The testimony assesses the reliability of the EFW system following the short-term modifications and the expected improvement upon conversion to safety grade.

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INTRODUCTION

This testimony, by Mr. Gary R. Capodanno, GPU Manager of Mechanical Systems Engineering, Mr. Louis C. Lanese, GPU Senior Control and Safety Analysis Engineer, and Mr. Joseph A. Torcivia, GPU Senior Project Engineer, is addressed to Board Questions 6.a, 6.b, 6.c, 6.g, 6.h, 6.i, 6.j and 6.k. Each question addressed is quoted below, followed immediately by Licensee's response to the question.

BOARD QUESTION NO. 6.a

> Is a loss of emergency feedwater following a main feedwater transient an accident which must be protected against with safety-grade equipment? Would such an accident be caused or aggravated by a loss of non-nuclear instrumentation, such as occurred at Oconee?

RESPONSE TO BOARD QUESTION NO. 6.a

BY WITNESSES CAPODANNO AND LANESE:

Licensee understands the Board's question to ask if a total loss of main and emergency feedwater (provided by non-safety-grade equipment) requires mitigation by safety-grade equipment. The emergency feedwater system will not be fully safety-grade before the restart of TMI-1. The postulated event, then, if unmitigated, would result in a violation of plant safety limits (i.e., the limits of 10 CFR 50.46); therefore, we believe that the event must be protected against

by the use of safety-grade equipment. The safety-grade equipment and systems that are available to mitigate this transient are the High and Low Pressure Injection systems in the feed and bleed mode, as described in Licensee's testimony in response to UCS Contention No. 2 (Natural and Forced Circulation). As demonstrated by Licensee's testimony in response to UCS Contention No. 8 (Additional LOCA Analysis), emergency feedwater or HPI would be required to be initiated by the operator within twenty (20) minutes after a loss of main feedwater. Auto initiation would occur well in advance of 20 minutes either by the loss of feedwater or loss of Reactor Coolant Pump signals.

In regard to the question of whether a loss of emergency feedwater can be caused by, or whether the accident would be aggravated by, a loss of non-nuclear instrumentation (NNI) as occurred at Oconee, following a loss of main feedwater transient, Licensee is reviewing the response of the various emergency feedwater and other systems' equipment responses to an NNI loss. However, based on a preliminary review of an Integrated Control System (ICS)/NNI power supply failure, Licensee will provide, prior to restart, steam generator level indication independent of the ICS, control room indication of failed power supplies and a manual switch, operable from the control room, to transfer the ICS supply bus from the inverter bus to the regulated AC supply. The accompanying exhibit, "TMI-1 Emergency Feedwater System," provides additional

information on these modifications. In addition, TMI-1 will have the capability, prior to restart, to operate the EFW system independent of the ICS, as described in Licensee's response below to Board Question No. 6.h.

BOARD QUESTION NO. 6.b

In what respect is the emergency feedwater system vulnerable to non-safety-grade system failures and to operator errors?

RESPONSE TO BOARD QUESTION NO. 6.b

BY WITNESS CAPODANNO:

The function of the emergency feedwater system in response to the conditions of loss of main feedwater or a small break loss of coolant accident is to provide adequate flow to remove heat from the reactor coolant system through one or two steam generators. The extent to which other safety-grade and non-safety-grade systems' failures can affect this function has been evaluated.

Included within this evaluation have been the electrical power supplies, non-nuclear instrumentation, instrument air supply and heating and ventilating systems for the areas within the plant where emergency feedwater components are located.

Single active failures within the heating and ventilating system and its support systems will not adversely affect operation of the emergency feedwater system due to redundancy within those systems. Under conditions of loss of all AC power the environmental temperature limits for the turbine driven emergency feedwater components will not be exceeded for a period of over eight hours. Under these same conditions the motor driven pumps could not be operated. They will not be damaged, however, during the time that they are idle.

As indicated in the accompanying exhibit, "TMI-1 Emergency Feedwater System," the emergency feedwater system can operate and meet its design function with loss of instrument air, loss of AC power and loss of non-nuclear instrumentation. As indicated in licensee's response to Question 10i in Supplement 1, Part 1 of the Restart Report, the emergency feedwater pumps' lubrication and bearing cooling are not subject to failure of non-safety-grade systems.

Operational errors that might affect the functioning of the emergency feedwater system have been evaluated and procedural changes have been instituted to assure proper surveillance and operation of the system to preclude loss of function. (See Licensee's testimony in response to UCS Contention No. 10 and Sholly Contention No. 3 on Safety System Bypass and Override. Also see Licensee's testimony in response to UCS Contention No. 9 and ECNP Contention No. 1(c) on Safety System Status Panel.)

BOARD QUESTION NO. 6.c

What has been the experience in other power plants with failures of safety-grade emergency feedwater systems, if they have such systems in other power plants?

RESPONSE TO BOARD QUESTION NO. 6.c

BY WITNESS CAPODANNO:

Although an exhaustive review of the experience in other power plants with failures of emergency feedwater systems has not been done, Licensee has reviewed the NRC "LER Output on FW Events at B&W Plants" from 1969 to March 28, 1979.

It should be noted that this type of review only yields the reported failures and does not contain data on successful EFW actuations on demand or during surveillance testing.

Of the reported failures in the EFW systems at these other plants, the demand or surveillance testing actuations resulted in only five instances where no EFW flow could be, or could have been, instantaneously delivered to the steam generators. Manual action by the operator could have been, and had been used, to initiate the EFW flow to the steam generators in some of these events. The five instances mentioned above are:

Plant	Event Date	LER	
Davis Besse-1	7-27-77	77-01T	Speed relay trip for one pump and MCC trip on the other pump rendered both pumps inoperable.
	10-20-77	77-017/01T	Personnel error in line up of bearing cooling water would have caused pumps to fail.
	12-16-77	77-113/03L	Operator misalignment of steam and EFW valves rendered both EFW pumps inoperable.
Rancho Seco-1	2-18-77	77-01L	Operator error to reset tested and tripped pump with other pump out of service resulting in no EFW pumps available.
TMI-2	3-28-79	79-012-01T	Operator misalignment of EFW pump discharge valves resulted in no EFW flow to steam generators.

Licensee has committed to perform functional testing of the EFW system at TMI-1 prior to restart to demonstrate the adequate operability of the system to meet its design function. Licensee has also committed to perform increased surveillance testing and operator training which will increase the reliability of the EFW system.

BOARD QUESTION NO. 6.g

If there is a loss of steam in the secondary system which results in failure of the turbine-driven feedwater pumps, will both motor-driven pumps be required to supply the requisite amount

of feedwater? Does this meet the usual single-failure criteria since it appears that a redundant system requires multiple components to operate?

RESPONSE TO BOARD QUESTION NO. 6.g

BY WITNESS LANESE:

Licensee understands the Board's concern to be that if motor-power is lost to the turbine-driven EFW pump as a consequence of an event, both motor-driven pumps might be required to maintain plant safety limits. The following response summarizes the capability of the EFW system to mitigate loss of main feedwater transients and small break loss of coolant accidents.

The design capacity of one motor-driven emergency feedwater pump is 460 gpm at 1020 psig. The actual flow capacity of the system at this pressure is 477 gpm if flow is to one generator, and 511 gpm if flow is to both steam generators.

The transient which results in the most severe plant heatup is the loss of main feedwater transient. Assuming multiple failures in the emergency feedwater system of the turbine-driven pump and one motor-driven pump, then plant safety limits could still be met; i.e., system pressure would be less than 110% of its design value and fuel cladding integrity would be maintained. Analyses prepared by B&W (see Restart Report, Supplement 1, Part 2, Question 3) demonstrate

the acceptability of results for EFW flows of 500 gpm or more. Licensee's analyses (see Restart Report, Section 8A) indicate that flows at least as low as 460 gpm also maintain plant safety limits.

Analyses which support the flow requirements of the emergency feedwater system during small break LOCA's are described in Section 6 of Licensee's exhibit, "Auxiliary Feedwater Flow Required for LOCA," Supplement 3 to the May 7, 1979 Small Break Analyses (May 24, 1979). These results showed that for a plant with a power level of 2722 mw(t), two different flow requirements exist:

Case (1) For breaks in which EFW is available, at least 300 gpm is required within 40 seconds after EFW initiation signal.

Case (2) For breaks in which emergency feedwater is not immediately available, a flow of 550 gpm must be supplied within 20 minutes. Subsequent B&W analysis has demonstrated that for a plant of the TMI-1 power level (2535 mw(t)), 500 gpm of emergency feedwater yields satisfactory results. (See Table 3 of Licensee's Testimony in Response to UCS Contention No. 8 on Additional LOCA Analysis.)

Given the multiple failure situation of a loss of both the turbine-driven pump and a motor-driven pump, then the total EFW flow available to the steam generators at 20 minutes for Case

(2) would be 511 gpm (total) to both OTSG's. It should be further noted that the EFW system would receive an initiation signal from either of two sources. The first would occur when all four reactor coolant pumps are tripped. The second would occur upon loss of both main feedwater pumps.

In summary, the emergency feedwater system can protect the plant within the established safety limits even with the assumed failure of the turbine-driven pump and one motor-driven emergency feedwater pump, even though this situation is beyond the single failure criterion.

BOARD QUESTION NO. 6.h

Can the turbine driven pumps and valves be operated on Direct Current, or are they dependent upon the Alternating Current safety buses?

RESPONSE TO BOARD QUESTION NO. 6.h

BY WITNESS CAPODANNO:

The TMI-1 turbine driven emergency feedwater train can operate to supply feedwater on Direct Current power sources and is not dependent upon the Alternating Current safety buses.

The existing EFW system can provide automatic or manual control of the EFW flow utilizing DC power from the "Red" battery through the ICS/NNI. The turbine steam supply valves are also opened by power directly from either the "Red" or "Green" batteries.

Licensee has added manual EFW flow control and OTSG level indication in the control room which is independent of the ICS/NNI and which receives power from either the "Red" or "Green" batteries. Each OTSG will have independent and redundant level indication and independent EFW flow regulation.

Licensee's modifications to the EFW system instrument air supply, as described in TMI-1 Restart Report Supplement 1, Part 2, Response to Question No. 14, will provide a back-up two-hour air supply, independent of AC power, to the EFW regulatory valves, as well as to the EFW turbine steam supply regulator valve.

Thus, the TMI-1 turbine driven EFW pump and control system can perform its function independent of any AC power for a two-hour station blackout period.

BOARD QUESTION NO. 6.i

> Will the reliability of the emergency feedwater system be greatly improved upon conversion to safety-grade, and is it the licensee's and staff's position that the improvement is enough such that the feed-and-bleed back-up is not required?

RESPONSE TO BOARD QUESTION NO. 6.i

BY WITNESSES CAPODANNO AND LANESE:

The ability of the emergency feedwater system to respond to anticipated transients, and many other accidents, will not be substantially improved upon conversion to safety grade, since the principal deficiencies in the existing EFW system are in the environmental qualification of equipment for non-LOCA events. The upgrading program for equipment for the most severe environmental conditions is addressed in Licensee's Testimony in Response to UCS Contentions 12, 14 and 3 (Safety Classification). As discussed in the other portions of the response to Board Question 6, the EFW system at restart will have redundancy, diversity and sufficient capacity to act as a supply of water for RCS cooling under the normal single failure assumptions applied to safety-grade systems. The system can be controlled independently of non-safety grade system failures. The auxiliary supporting systems are also capable of performing their intended functions, as noted in the response to Board Question 6.b.

As Mr. Jones testified at page 4 of Licensee's Testimony in Response to UCS Contention No. 8 (Additional LOCA Analysis), the feed and bleed mode is capable of cooling the core and will still be available for LOCA mitigation in the event of a loss of all feedwater following the EFW upgrade.

BOARD QUESTION NO. 6.j

Will the short-term actions proposed improve the reliability of the emergency feedwater system to the point where restart can be permitted?

RESPONSE TO BOARD QUESTION NO. 6.j

BY WITNESSES CAPODANNO AND LANESE:

The TMI-1 emergency feedwater system, described in the accompanying exhibit, "TMI-1 Emergency Feedwater System," was a very reliable system prior to the implementation of the short-term, or restart modifications. The reliability of that system has been demonstrated by ten manual EFW initiations which exhibited no component failures and by surveillance testing of individual components which did not reveal conditions in excess of allowable technical specification limits.

The short-term modifications have further enhanced the reliability of the TMI-1 emergency feedwater system which, in our view, is sufficiently reliable to permit restart of the plant.

BOARD QUESTION NO. 6.k

Question 6 should be addressed with reference to Florida Power & Light Co. (St. Lucie, Unit 2), ALAB-603, (July 30, 1980), i.e., whether loss of emergency feedwater is a design basis event notwithstanding whether design criteria are met.

RESPONSE TO BOARD QUESTION NO. 6.k

BY WITNESSES CAPODANNO, LANESE AND TORCIVIA:

In the responses provided by Licensee to Board Questions 6.a through 6.j on Emergency Feedwater Reliability, multiple failures (the subject of the St. Lucie decision) were addressed.

With regard to the specific event postulated in St. Lucie -- loss of all AC power -- the testimony above in response to Question 6.h shows that the emergency feedwater system will perform during a two-hour station "blackout." In addition, it should be noted that the high probability of the loss of off-site power at St. Lucie, 0.1 to 1.0 per year, does not exist at Three Mile Island.

The power for the TMI-1 plant is obtained from the TMI substation located approximately 500 cable feet from the plant proper. This substation in turn is fed from a switching station designated as Middletown Junction. Middletown Junction is about 1.5 cable miles from the TMI substation.

Power is supplied to Middletown Junction from nine different independent transmission lines tied to the PJM grid, which in turn is fed by numerous plants in New Jersey, Pennsylvania and Maryland. The operating history of the PJM grid has shown it to be highly reliable.

The TMI substation is fed from two independent lines from Middletown Junction and from an additional three lines from other independent switching stations.(1)

As a result of these multiple power feeds, TMI has not experienced any loss of off-site power and it is not expected that such an event will occur during the life of the plant.

Even in the highly improbable event that a loss of off-site power would occur, and that both diesel generators failed, AC power for Three Mile Island can be obtained from off-site combustion turbines within two hours.

REFERENCE

(1) Enclosure 1 to letter, March 28, 1980 (TLL-150) to J. T. Collins (NRC) from R. F. Wilson (Met Ed) and attachments.

GARY R. CAPODANNO

Business Address:

GPU Service Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Education:

B.S., Mechanical Engineering, Farleigh Dickinson University, 1967.
M.S., Mechanical Engineering, Newark College of Engineering, 1974.

Experience:

Manager of Mechanical Systems Engineering, GPU Service Corporation, 1978 to present. Responsible for technical and administrative direction of the activities of company mechanical and nuclear engineers in the design of new power plants and major modifications to existing power plants for the three operating companies that comprise the GPU System. Also responsible for directing these engineers in the review of work being done for GPU and the operating companies by architect-engineering firms.

Lead Systems Engineer, Ebasco Services Incorporated, April, 1978 to July, 1978. Worked on the Synthesis Gas Demonstration Plant Program for W. R. Grace Co. and the United States Department of Energy. Responsible for plant arrangements and system design work. Directed mechanical engineers in the design of steam, cooling water and materials handling systems for a plant that was to use coal as a feedstock for the preparation of anhydrous ammonia and the production of elemental sulfur or sulfuric acid as a by-product.

Mechanical Group Supervisor, Burns and Roe, Inc., 1974 to 1978. Engineering supervisor responsible for the

technical and administrative direction of project engineers in the development of: plant general arrangements, system flow diagrams, engineering calculations, equipment specifications, bid evaluations, construction liason, and licensing activities for nuclear power plants.

Mechanical Engineer, Burns and Roe, Inc., 1971 to 1974. Responsible for design engineering of nuclear and conventional mechanical equipment and systems for nuclear power stations. This included preparation of specifications and system flow diagrams, evaluation of equipment proposals, performance of design calculations, construction liaison activities, and activities related to governmental licensing of nuclear power plants.

Design Engineer, Foster Wheeler Corporation, 1969 to 1971. Responsible for design and development engineering of fossil fuel firing equipment and systems for electric generating plant steam generators, preparation of engineering standards, evaluation of vendor equipment, and engineering assistance to company project site personnel.

Mechanical Engineer, Consolidated Edison Company, 1967 to 1969. Responsible for design and applications engineering of mechanical equipment and systems for nuclear and conventional electric generating stations.

Professional Affiliations: Licensed Professional Engineer--New York, New Jersey and Pennsylvania.

Member--American Nuclear Society.

Publications: "New Approach to Optimization of the Multistage Flash Desalination Process" Summer Simulation Conference, San Diego, 1972.

LOUIS C. LANESE

Business Address:

GPU Service Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Education:

B.S., Engineering Science, Newark College of Engineering, 1970.
M.E., Nuclear Engineering, New York University, 1972.
Nuclear Engineering courses, Polytechnic Institute of New York, 1975 to present (completing thesis).

Experience:

Senior Control and Safety Analysis Engineer, GPU Service Corporation, 1979 to present. Responsibilities include the performance of the TMI-1 Restart Safety Analysis; TMI-1 Emergency Feedwater design, design review of TMI-1 restart and long-term modifications. Member of the TMI-1 and TMI-2 safety review committees (GRC).

Control and Safety Analysis Engineer, GPU Service Corporation, 1978 to 1979. Responsibilities included the performance of containment analyses in support of plant operation; developing analyses in support of the TMI-2 feedwater system modification; preparation of the TMI-1 restart safety analysis.

Lead Nuclear Licensing Engineer, GPU Service Corporation, 1977 to 1978. Primary responsibility for TMI-2 licensing activities and for licensing matters involving generic safety issues affecting all GPU system plants.

Safety and Licensing Engineer, GPU Service Corporation, 1974 to 1977. Responsibilities included technical

resolution of TMI-2 licensing open items; conformance of Forked River systems design to licensing criteria; and, safety review of Oyster Creek radwaste facility.

Assistant Safety and Licensing Engineer, Ebasco Services, Inc. Performed licensing and safety review of St. Lucie Units 1 and 2 Safety Analysis Report pertaining to instrumentation and power systems; cooling water and HVAC systems, radwaste systems; and, accident analysis. Performed dose analyses and developed secondary system source terms.

Professional Affiliations:

Babcock & Wilcox Owners Group, Chairman of the Asymmetric LOCA Loads Technical Subcommittee for 177 FA B&W plants.

JOSEPH A. TORCIVIA

Business Address:

GPU Service Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Education:

B.S.E.E., Pratt Institute, 1936.
Post-graduate courses in: protective relaying including extensive experience in coordination and ground fault studies; process control and instrumentation for industrial plants; industrial electronics; cathodic protection; and, switchgear and motor controls in all voltage classifications.

Experience:

Lead Senior Electrical Engineer, GPU Service Corporation, 1972 to present. Responsible for the design, documentation, and review of all power equipment for the nuclear powered electric generating stations of the GPU system. Responsible for the major studies and responses to the NRC related to the electric power equipment.

Engineer, C.F. Braun Architectural Engineering Corp., 1971 to 1972. Responsible for performing process control engineering projects for chemical and electrical industrial organizations.

Plant Manager, Federal Pacific Electric Company, 1970 to 1971. Overall responsibility for manufacturing of power equipment.

Engineer, A.G. McKee Architectural Engineering Company, 1969 to 1970. Responsible for process control applications for the petrochemical industry.

Westinghouse International, 1968 to 1969, consulting sales applications overseas.

Engineering Manager, Westinghouse Electric Corporation, 1936 to 1968. Responsible for engineering of manufactured switchgear motor control and all types of power equipment for Manufacturing Division.

Professional Affiliations:

Member, IEEE - IAS Group.
Registered Professional Engineer, New Jersey and Massachusetts.