UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear Station, Unit No. 1)	)	(Steam Generator Repair)
	)	

LICENSEE'S TESTIMONY OF DOUGLAS E. LEE,
DON K. CRONEBERGER AND DAVID G. SLEAR
ON ISSUE 2 (CONTENTION 1.a)

To Mr. Lee:

Q1. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair.

A1. My name is Douglas E. Lee. I am employed by Babcock & Wilcox, an operating unit of McDermott, Inc., P.O. Box 1260, Lynchburg, Virginia 24505. I managed the Mechanical Engineering Section of the Engineering Department. This section contained the Mechanical Design Unit that was assigned to design, qualify and implement the kinetic expansion joint installed as part of the TMI-1 steam generator tube repair program.

A statement of my professional qualifications is attached.

To Mr. Croneberger:

Q2. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is Don K. Croneberger. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Director of Engineering and Design, I provided technical management oversight of the failure analysis and repair activities with special emphasis on evaluation of the steam generator's mechanical design and the impact of any indwelling defects on the response of the components. Moreover, my department provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering, Mechanical Engineering and Engineering Mechanics.

A statement of my professional qualifications is attached.

To Mr. Slear:

Q3. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A3. My name is David G. Slear. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. I am the Manager of Engineering Projects for TMI-1. As such, I was the overall task manager for the TMI-1 OTSG Tube Repair Program reporting directly to the Vice President of Technical Functions. My responsibilities included all activities associated with the evaluation and repair of the steam generators.

A statement of my professional qualifications is attached.

To all witnesses:

Q4. What is the purpose of your testimony?

A4. The purpose of this testimony is to address Issue 2 of Contention 1.a as enumerated at page 23 of the Board's Memorandum and Order (Rulings on Motions for Summary Disposition, dated June 1, 1984), in which the Licensing Board stated:

> 2. The effect of inadvertent initiation of emergency feedwater flow at high power or following rapid cooldown after a LOCA should be addressed, with attention to calculation of maximum transient stresses in steam generator tubes.

Q5. Would inadvertent initiation of emergency feedwater flow while the plant is operating at full power cause rupture of a steam generator tube?

A5. No. Inadvertent actuation of the emergency feedwater (EFW) system at full power, i.e., a failure that results in starting of the EFW pumps while the plant is operating normally at full power, will not result in the injection of emergency feedwater into the steam generators. The design of the TMI-1 EFW system is such that once the EFW pumps are started, the actual flow to the steam generators is controlled by automatic valves which respond to a flow demand signal generated by the steam generator level control system. The water level in the steam generator at conditions of power operation is higher than the steam generator EFW level setpoint at which the EFW flow control valves are initiated to open. The EFW pumps are started by signals other than and independent of the steam generator water level. Therefore, inadvertent actuation of the

EFW pumps will not result in EFW injection into the steam generators and will not result in any change to the steam generator tube stresses.

Nevertheless, for purposes of discussion, even if we were to assume both inadvertent actuation of the EFW pumps and inadvertent opening of the EFW valves, resulting in injection of emergency feedwater into the steam generators at full power--a highly unlikely event--the resulting thermally induced axial tube load would not be sufficient to cause rupture of the steam generator tubes.

Emergency feedwater is injected horizontally into the steam generator tube bundle steam space via six auxiliary feedwater nozzles located at approximately equal spacing around the circumference of the steam generator shell. The nozzles have a 2-1/2" diameter throat with a 4" diameter flow expansion. The injection points are located near the top of the tube bundle with the nozzle centerlines 2'11" below the bottom surface of the upper tube sheet. As the EFW is injected into the steam space in the tube bundle, upward turbulent steam flow quickly heats and partially vaporizes the water before it reaches the top of the steam generator. At the top of the steam generator, there is a horizontal steam flow from the center to the periphery of the steam generator. This horizontal steam flow prevents any residual EFW liquid, which is now at saturation temperature, from reaching the upper tubesheet and thus it would not contact any repair joints of the steam generator tubes, all of which are within the upper tubesheet.

The auxiliary feedwater nozzles penetrate the steam generator shell and pass through the steam annulus between the steam generator shell and the tube bundle shroud. As incoming emergency feedwater passes through the nozzles and enters the tube bundle steam space, the high heat transfer rate from the steam to the incoming water quickly heats the water. By the time that the EFW reaches the tubes, it is approaching the same temperature as the secondary side steam. Thus, the affected tubes experience only a small temperature change in the small portion of the tube being sprayed, which results in an insignificant axial load change in the tube. Temperature measurements taken at an operating steam generator during EFW injection confirm that the temperature change of the affected tubes and thus the change in tube axial load is minimal.

The absence of any significant load change can be addressed quantitatively by making some extremely unrealistic and conservative assumptions. If we were to ignore the turbulent and superheated steam environment and assume that unheated emergency feedwater (40°F minimum) were able to be sprayed directly on the tubes, the water would impinge directly on only about eight tubes opposite each individual nozzle. If we were further to assume that water spray from the 4"-diameter nozzles causes impingement on a 12-inch length of each tube, the cooling effect has been conservatively calculated to produce an approximate change in axial tube load of only 70 pounds tension. This tensile load, in conjunction with the loads on the

affected tubes at full power operation, which are at less than 100 pounds tension, is insignificant compared to the joint design and qualification load of 3140 pounds tension, or cooldown load of 1100 pounds tension. Thus, EFW injection into the steam generators does not induce large changes in tube axial loads and does not cause rupture of a steam generator tube.

Q6. Has the probability of the tube rupture during the rapid cooldown following a loss of coolant accident (LOCA) been increased by the repair procedure?

A6. No. The maximum transient loads on the steam generator tubes following a LOCA have been conservatively calculated to be 2641 pounds. These calculations included the effects of EFW injection into the tube bundle. This load is considerably less than the design basis load of 3140 pounds to which the repair joint was designed and qualified. The maximum transient load and the design basis load are the same for both the repaired tubes and the tubes in the original design condition. Therefore, the likelihood of tube rupture during a rapid cooldown following a LOCA has not been increased by the repair procedure.

PROFESSIONAL QUALIFICATIONS

DOUGLAS E. LEE

EXPERIENCE

Babcock & Wilcox Company

(Current Assignment) Manager, Engineering Department - Responsible for engineering activities involving system design, performance analysis, component design and structural/stress analysis in support of B&W supplied engineering services and engineered service products. Responsibilities also include engineering efforts to complete nuclear steam supply system backlog contracts in the above areas. Responsible to define and implement research programs to maintain and advance base technology, develop new products and services and to automate engineering functions. Work is managed to be in accordance with customer, regulatory and quality assurance requirements. Managed the efforts of 250 professionals organized into three sections and ten units.

(1982 - 1983) Manager, Mechanical Engineering Section - Reponsible for reactor component and reactor accessory equipment mechanical design, specification, acquisition hardware and related engineering services. Also responsible for component performance such as steam generator tube integrity and for reactor plant materials and chemistry. Defined and implemented research programs to maintain and strengthen materials and chemistry technology. Work is managed to be in accordance with contractural, internal and quality assurance requirements. Managing the efforts of about 90 professionals in four working units.

(1980 - 1982) Manager, Plant Engineering Section - Responsible to provide competitive, quality-engineered nuclear power plant and system level engineering design and analysis including reliability and risk evaluations. Responsibilities included system design requirements and functional design, performance and safety analyses, preparation of appropriate SAR materials, defining and implementing computer code development programs, resolving operational problems and developing operator guidelines to safely manage the plant during anticipated transients. Work was managed to be in accordance with contractual and quality assurance requirements. Managed the efforts of approximately 110 professionals in six working units.

(1980) Manager, Equipment Engineering Section - Responsible to develop, specify, standardize, license and provide competitive, reliable, quality-engineered equipment and equipment related services for plant protection, control, monitoring and display, for reactor coolant system and auxiliary system operation, and for fuel storage activities which comply with contractual obligations, satisfy customer needs, meet plant and system performance requirements and meet applicable quality assurance requirements. Managed the efforts of approximately 50 professionals in three working technical units.

(1978 - 1980) Manager, Fluid Systems Unit - Unit responsible for NSSS auxiliary system design, hardware specification and procurement. Specific systems are makeup, chemical addition, decay heat, emergency safeguard cooling and waste processing. Hardware responsibilities include valves, heat exchangers, tanks, demineralizers and filters. Work was managed in accordance with technical, contractual and quality assurance requirements. Directly managed the efforts of 15-20 professionals.

(1978) Associate Project Manager - Responsible for portions of the NSSS being supplied to the Power Authority of the State of New York for the Greene County Nuclear Power Plant. Plant design and licensing reached the stage of meeting the requirements for a construction permit.

(1977 - 1978) Site Coordinator - Temporarily assigned to TMI-2 to organize and coordinate site efforts to install accelerometers and strain gages in the primary side of a steam generator for the purpose of measuring tube vibration. Work included supervision of craft personnel, planning and coordination with customer, site personnel and B&W design engineering to complete the installation prior to reactor start-up.

(1975 - 1977) Associate Project Manager, NSSS supplied to Power Authority of the State of New York. Responsibilities included ensuring that the accessory equipment portion of the B&W scope of supply is technically acceptable, delivered on time and delivered within the contract budget. Contract in the detailed design phase requiring frequent, detailed interface with the Architect Engineer as well as project direction of engineers in matrix organization assigned to the contract.

(1974 - 1975) Generic Project Manager - Responsibilities included identifying items with potential risk impact (cost increases) to backlog NSSS contracts and driving these problems to a least impact solution, managing selected programs designed

to minimize cost impacts to backlog contracts, and performing assigned Project Management Department projects. Key feature of assignment was to work across NSSS contracts to identify and minimize contract risk.

(1973 - 1974) Auxiliary Systems Engineer - Responsible for the system design and equipment procurement for reactor support fluid systems such as makeup and decay heat. Work included preparing system descriptions, PSAR material, equipment specifications and obtaining quotations for the Toledo Units 2 and 3 (NSS-25 & 26) project as well as providing support for the Toledo Unit 1 (NSS-14) project. Achieved the functional level of Task Engineer in this assignment.

Division of Naval Reactors, USAEC

(1968 - 1973) Engineer in the Refueling Branch - Responsible for supervising prime contractor organizations in the refueling and maintenance of U.S. Navy and AEC nuclear reactors. This work includes technical responsibility for the development of refueling systems, for planning and following refueling work and for design and procurement of specialized refueling equipment. Work with equipment ranged from approving initial equipment design concepts and specifications through use of the equipment by field organizations such as shipyards. Have extensive experience in planning, design, procurement and use of special purpose weld cutting and welding machines.

EDUCATION

University of Virginia, Charlottesville, Virginia

B.S. degree in Engineering, graduated with distinction in June, 1968. Majored in aerospace engineering. Dean's List, elected to Tau Beta Pi Honorary engineering fraternity. Naval Reserve Officer's Training Corps scholarship program. Midshipman Battalion Commander. Awarded the Commanding Officer's Sword as the outstanding midshipman.

Lynchburg College, Lynchburg, Virginia

Master of Business Administration in May, 1980. Subject area was Management Control.

MILITARY SERVICE

Commissioned Ensign, USN in June, 1968 upon graduation from college. Assigned duty with the Division of Naval Reactors, USAEC, Washington, D.C. Earned a certificate from the Bettis

Reactor Engineering School, Pittsburgh, Pennsylvania in June, 1969. Promoted to grade of Lieutenant in June, 1971.

PROFESSIONAL QUALIFICATIONS

Don K. Croneberger
Director - Engineering & Design
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Mechanical, Electrical, Civil/Structural, Chemical, Radwaste and Materials Engineering support for all nuclear generating stations for the GPU Systems.

1978 to 1980 was Manager - Design and later Manager - Engineering & Design with GPU Service Corporation. Directed design engineering activities for all nuclear and fossil power generating facilities and modifications assigned to GPUSC.

Other Experience:

Prior work experience included a number of positions at Gilbert/Commonwealth during the period 1963 to 1978. The last position was Manager Structural Engineering. It included technical responsibility for structural engineering mechanics for all nuclear and fossil generating facilities. Some of the other positions included Project Manager for balance of plant studies for a liquid metal fast breeder reactor demonstration plant. Other positions as Project Structural Engineer included responsibility for technical supervision of structural engineering and engineering mechanics for a number of domestic nuclear power plants. Earlier experience with the U.S. Navy included engineering and construction of radio telescope and ancillary experience.

Industry affiliations have included the EPRI Steam Generator Owners Group, ASME Section 3 Division 2 (former Chairman) and other industry nuclear standards activities including Nuclear Structures and Plant Design Against Missiles.

Education and training includes a B.S. degree in Civil Engineering from Pennsylvania State University, 1959. Other technical training includes courses at U.C.L.A., M.I.T. and the University of Michigan.

I have been involved in the Steam Generator tube failure issue from the beginning. I provided technical management oversight of failure analysis and repair activities. Special emphasis was placed on understanding the mechanical design of the Steam Generators and applying that understanding to the repair program and the understanding of the impact of the repair on the response of the components.

My department provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering and Chemistry, Mechanical Engineering and Engineering Mechanics.

PROFESSIONAL QUALIFICATIONS

DAVID G. SLEAR

WORK EXPERIENCE

Company:	GPU Nuclear Corporation
Title:	TMI-1 Manager Engineering Projects
Responsibilities:	Management of TMI-1 modification, which entails: Management of the $25 million annual budget allocated for plant modification; prioritization of the various phases of plant modification; oversight of the technical adequacy of plant modification and of the components involved in plant modification; consultation regarding problem resolution with respect to matters concerning plant modification; and direct supervision of 16 GPU employees. This position demands constant attention to long term and daily plant modification concerns and an extremely firm grasp of both the technical aspects of TMI-Unit 1 and of the various modes and components of modification available for implementation at TMI-Unit 1.
Dates:	1983 - Present
Company:	GPU Nuclear Corporation
Title:	OTSG Repair Project Manager
Responsibilities:	Management (in conjunction with individual task managers) of all aspects of the OTSG Recovery program at TMI-1 including failure analysis, eddy current testing, corrosion testing, RCS examination, RCS sulfer cleanups, and plant performance analysis. This position involved direct management of the OTSG repair process and personal involvement in the decision making process with respect to the repair program. This position also entailed the definition and implementation of the overall project, and required a broad overview and analysis of the OTSG Recovery program. In his capacity as OTSG Repair Project Manager, Mr. Slear was also called

upon to deliver numerous presentations concerning project details before the NRC, ACRS, TPR, and the GPU Nuclear Corp. management.

Dates: December 1981 - November 1983

Company: GPU Service Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Similar to those listed for Mr. Slear's present position including management of a $20 million budget and of project engineering for modifications.

Dates: 1979 - 1981

Company: GPU Service Corporation

Title: Preliminary Engineering Manager

Responsibilities: This position entailed: the analysis and preliminary design of 400 Megawatt combustion turbines and of a 600 Megawatt coal fired power plant; extensive analysis of the reliability and availability of the components to be installed in the prospective power plant; and the establishment of a baseline criteria document for the designated plants including the technical documentation and presentation of the plant design for management review.

Dates: 1978 - 1979

Company: GPU Service Corporation

Title: Component Engineer

Responsibilities: This position entailed: the review of design specifications and technical details of products going into TMI-2, including the steam generators, pressurizer, main

condensors, cooling towers, reactor vessel, and internals; technical consultation and analysis of problems; and review of the contractor's design work on new components going into a plant.

UNITED STATES NAVY NUCLEAR SUBMARINE FORCE OFFICER

Title: Engineer Officer

Responsibilities: This position entailed: essentially primary responsibility and control of the onboard nuclear power plant; control of all engineering sections, command of 4 divisions; and supervision of approximately 55 crewmen.

Dates: 1972 - 1974

Title: Machinery Division Officer

Responsibilities: As Machinery Division Officer, Mr. Slear was responsible for: all mechanical components of the primary and secondary systems of the power plant including the steam generator, reactor, and drive controls; chemistry control of the primary and secondary systems; and the supervision of 15 crewmen. Mr. Slear also served as an Auxiliary Division Officer in charge of non-nuclear life support systems, and as a Communications Division Officer.

Dates: 1968 - 1972

Mr. Slear also attended the Nuclear Power Submarine School from 1966 - 1968, during which time he obtained one year of nuclear power plant training (6 months classroom, 6 months actual plant training) in addition to the submarine qualification program.

EDUCATION

College: University of Oklahoma

Degree: B.S. Mechanical Engineering

Dates: 1961 - 1966

College: Stevens Institute of Technology

Degree: M.S. Mechanical Engineering

Dates: 1974 - 1978