June 29, 1984

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 RICHARD F. WILSON,
DAVID G. SLEAR AND F. SCOTT GIACOBBE
ON ISSUE 1.b (CONTENTION 1.a)

To Mr. Wilson:

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

A1. My name is Richard F. Wilson. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As Vice President of Technical Functions, I was responsible for the overall project and technical management of the TMI-1 steam generator tube repair program.

A statement of my professional qualifications is attached.

To Mr. Slear:

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

A2. My name is David G. Slear. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Manager of Engineering Projects for TMI-1, I was the overall task manager for the TMI-1 steam generator 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 Mr. Giacobbe:

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

A3. My name is F. Scott Giacobbe. I am employed by GPU Nuclear Corporation, P.O. Box 1018, Reading, Pennsylvania 19603. As Manager of Materials Engineering/Failure Analysis I have been involved in the planning and management of the failure analysis activities, corrosion testing programs, materials evaluation and tube sampling and removal programs associated with the steam generator tube repair program.

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 1.b 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:

> 1. The rationale underlying certain proposed license conditions should be addressed, with attention to:
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> * * * *
>
> b. Method of determining frequency of ECT tests.

Q5. How was the frequency of eddy current testing following restart of Unit 1 determined?

A5. Industry experience has shown eddy current testing (ECT) is the preferred method for non-destructive examination of steam generator tubes to ascertain damage. The technique has the ability to detect different types of tube damage states, such as different kinds and sizes of cracks, inside and outside surface defects, and tube erosion and wear. It is used to provide knowledge of the generator state well before tubes degrade to the point of through-wall leakage or an unsafe condition develops within the generator. Characterization of the signal gives insight as to the type of damage and substantially assists the investigator in understanding the damage mechanism. As ECT is a technique for inspecting tubing remaining in service as part of the primary pressure boundary, the role of eddy current inspection for the TMI-1 steam generators is the same as for generators at any other operating plant.

The existing once-through steam generator (OTSG) Technical Specification requirements for ECT at TMI-1 implement NRC's Regulatory Guide 1.83, Rev. 1. The requirements are the same as those for other nuclear plants in that they require at least 3% of the total number of tubes in the steam generators to be examined at each inspection (certain criteria on tube selection are included). The Technical Specification testing frequency is specified to be not more than 24 months after the previous inspection with provisions that the interval could be extended to a maximum of once per 40 months, contingent on prior inspection results. Further conditions are imposed on the inspection frequency if there are primary to secondary tube leaks, degradation is in excess of Technical Specification limits, and/or a loss of coolant accident or a main steam line or feedwater line break has occurred. If, in the course of inspecting the steam generators, more than 5% of the total tubes inspected are found to be degraded (imperfections equal to or greater than 20% through-wall) or any of the tubes inspected are defective (greater than 40% through-wall), then the sample size of the inspection is increased.

Licensee has adopted supplements to the TMI eddy current test program which the NRC has incorporated into proposed license conditions. These supplements will act as a precautionary confirmation of Licensee's conclusion that crack initiation or propagation is not anticipated by chemical or mechanical means following return of the steam generators to

service. What has been proposed is that either 90 days after reaching full power or 120 calendar days after achieving 50% power (whichever occurs first), the plant would be shut down for eddy current inspection of the generators. In addition, ECT would be done at the subsequent shutdown refueling. The plant currently is loaded with fuel which would permit full power operation for a little less than one year.

In establishing the above recommended change in eddy current test frequency, we considered the conditions of the generator, the type of repairs performed within the generator, the damage mechanism leading to the repairs, and our expectation that if any new damage were to occur, it would be at a slow rate. In addition, there are considerations other than those relating to the steam generators, i.e., the overall question of plant accessibility, other operational sequences being conducted, and prudent operating practices, which dictate that the opening of steam generators, with its attendant exposure to oxygen, should be minimized.

With regard to TMI-1 specifically, there is considerable detailed information available on the state of the generator, and its recent repair. We have in place a special ECT differential probe characterization of all tubes remaining in service (approximately 29,000 tubes) and special absolute probe ECT data on over 800 tubes. We have a clear understanding of the type of damage which occurred in the generator and the reasons therefor. We have an extensive qualification program on the

repair which has tested kinetically expanded joints out to five years of load cycling and 15 years of thermal cycling. We have a general industry understanding of experience with explosively expanded tubes in tubesheets for other applications. In addition, we are performing lead corrosion tests to provide advanced confirmatory corrosion and crack behavior data.

This information has been used to draw a number of conclusions on the predicted behavior of the tubes remaining in service:

1. The initial intergranular stress-assisted cracking (IGSAC) of the steam generator tubes occurred with reduced sulfur species and with the plant cooling down or cold. Steps have since been taken to reduce levels of sulfur through chemical cleaning, stringent controls on primary system water chemistry (less than 100 ppb sulfur) and elimination of potential sulfur contamination sources. Tests have shown that the failure mechanism is inoperative in the absence of sufficiently high levels of reduced sulfur species, and that IGSAC will not reinitiate under the TMI-1 operating conditions. Thus, there is reasonable assurance that the rapid IGSAC which caused the original damage will not affect the steam generators in the future.

2. There currently exists hot operational experience on the repaired steam generator of about 40 days with no indication of leakage in excess of Licensee's new, stringent administrative limits on primary-to-secondary leak rate. This

available test data supports the conclusion that unforeseen rapid or gross changes are not taking place.

3. The long term corrosion lead tests support the conclusion that under the conditions attendant to operation, rapid chemical attack is not predicted.

4. The possibility of steam flow-induced mechanical vibration propagation of small cracks was examined analytically and found to be non-significant.

5. No mechanism has been identified relating to other mechanical crack propagation scenarios while operating at full power. Crack propagation due to thermal cycling has been shown to be small and to occur principally during the act of cooling down. Thus, mechanical crack propagation is not expected to change tube condition during operation.

Since the ECT program is designed to characterize change, there is a need to allow reasonable operating time on the generators to allow any unforeseen mechanism to cause change. It is clearly a matter of judgment as to the period of time required, but several factors considered by Licensee support the 90 days/next refueling intervals proposed:

1. Eddy current examination should take place after chemical equilibrium is obtained within the system. An extended period of time may be necessary for this to occur, given the time associated with gradual dissolution of the residual sulfur in the oxide films and its removal from the reactor coolant system (RCS). The full benefits of eddy current testing can,

again, only be obtained after operation at some period of time to allow the system to approach chemical equilibrium.

2. Mechanical propagation due to flow induced vibration at steady state operation, if any, will only occur at full or near-full steam flow conditions. To confirm these analytic conclusions the generator must be operated at full steam flow. Thus, a period of time of OTSG operation at power is required if eddy current examination is to be most meaningful.

3. The plant extended startup and power escalation program is designed to maximize operator training, plant re-familiarization, and allow non-OTSG related performance testing along the way. This same extended power escalation program allows significant time to be accumulated on the generators at reduced power. The period of time at reduced power is also a means of accumulating generator experience when the consequences of any hypothetical crack propagation are reduced.

4. Detailed technical assessments of the repair within the tubesheet do not reveal mechanisms which could lead to catastrophic failure.

The above facts and experience suggest a minimal period of several months of initial operation is necessary to ensure that sufficient data can be obtained during the inspections to trend conditions within the steam generators. Licensee's proposed augmented eddy current test program is a judgment based on the available facts regarding generator condition and potential failure mechanisms, and includes consideration of general

industry experience. Because special probes and techniques were developed for TMI-1, the condition of the TMI-1 steam generators is probably known with greater precision than for comparable steam generators at other plants. The proposed supplemental steam generator ECT program for the inspections during the operating cycle after restart will continue to utilize these special probes and techniques. It is a program which can reasonably be carried out without undue, unnecessary risk to the plant and will provide the requisite degree of insight on changes, if any, in the generator.

PROFESSIONAL QUALIFICATIONS

Richard F. Wilson
Vice President, Technical Functions
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Engineering, Design, Licensing and Technical Support of all nuclear generating stations for the GPU System. The position manages the technical resources of GPU Nuclear including day-to-day support for plant operations.

Previously was Acting Director for TMI-2 from September, 1979, to about March, 1980, and before that was Director of the Engineering and Quality Assurance Departments within the GPU Service Corporation. Between 1975 and 1977, was Manager of Quality Assurance for the GPU Service Corporation with responsibilities for design and construction Quality Assurance.

Other Experience:

Prior work experience included two years (1973-1975) as Manager of Manufacturing Engineering for Offshore Power Systems, Jacksonville, Florida. Responsibilities included activities associated with manufacturing planning, tooling, industrial engineering, manufacturing engineering, and technical support to the planned manufacturing facility. Prior to joining Offshore Power Systems, held a number of positions at the Atomic International Division of Rockwell International, 1954 to 1973. Some of these positions included Engineering Supervisor, Department Manager, Chief Project Engineer, Program Manager, and Chief Program Engineer on a wide variety of Atomic International programs. The last position was Program Manager for the Atomic International work on the fast breeder program. Performed and supervised work in almost every facet of reactor engineering, physics, facility design, safety, reactor operations, etc.

Committee affiliations have included the EEI QA Task Force, the AIF Committee on Power Plant Design, Construction and Operation, B&W Plant Owners and BWR Owners Groups, EPRI Nuclear Divisional Committee, etc. Outside the utility industry has served on a number of company and company/government advisory groups as related to specific programs.

Education and training includes a B.S. degree in Mechanical Engineering, University of California at Berkeley, 1951; an M.S. degree in Mechanical Engineering, University of Michigan, 1953; and one year attendance at the former Oak Ridge School of Reactor Technology in 1954. Has attended a large number of management and other courses, including the University of Michigan Public Utility Executive Program.

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

STATEMENT OF QUALIFICATIONS AND EXPERIENCE

F. SCOTT GIACOBBE

I, F. Scott Giacobbe, am employed by General Public Utilities Nuclear Corporation as Manager, Materials Engineering/Failure Analysis. I have been in this position since July of 1982.

My education includes a Bachelor's Degree in Mechanical Engineering from Villanova University in 1970 and a Master's Degree in Materials Engineering from Drexel University in 1975.

My work experience has provided me many years of direct involvement in the materials evaluation and failure analysis of power plant components; early in my career it also provided a very intense involvement in heat exchanger tubing evaluations.

In 1970, I began my employment with Westinghouse Electric Corporation in their Heat Transfer Division as a Materials Engineer. In this position I worked on the materials selection, corrosion evaluations and failure analysis of heat exchanger components such as feedwater heaters, condensors, radioactive waste evaporators and other secondary side heat exchangers. In particular, I was responsible for assuring that tubing utilized in the Westinghouse heat exchangers was properly specified and manufactured. This function provided me with in-depth knowledge of heat exchanger tubing fabrication practices, corrosion resistant properties and failure mechanisms.

In 1977 I left Westinghouse to join General Public Utilities as a Senior Engineer in their metallurgical laboratory. This position afforded me the opportunity to expand my areas of expertise to include materials selection, corrosion evaluation and failure analysis of other components of both nuclear and fossil power plants, and to gain a broader understanding of power plant operation.

In 1978 I was promoted to supervisor of the metallurgical laboratory. This was a first line supervising position which gave me the responsibility for the daily operation of the laboratory and supervision of the technicians and engineers reporting to me. This position also carried with it a large technical responsibility which kept me heavily involved in the day-to-day materials engineering problems.

My career took on a slight change in direction in 1980 when the company reorganized and formed the Nuclear Corporation. At that time I became Materials and Welding Manager in the Nuclear Assurance Division. With this position I essentially had the same functions as before, with the added responsibility for welding at the nuclear power stations. While in this position I was responsible for the technical and metallurgical aspects of the development of the Nuclear Corporation welding program. During this time I was still supervising all failure analysis activities, including the TMI spent fuel pool pipe cracking incident.

In July 1982, another reorganization took place. At this time my section merged with the materials engineering section in the Technical Functions Division and I took over management of that newly formed section. In this position I now had functional responsibility for the materials configuration control of both GPU nuclear power plants as well as welding engineering and failure analysis. In addition, my section still provided failure analysis services to the fossil companies.

I have been involved in the steam generator tube failure issue from the beginning. I participated directly in the initial decision-making regarding the tube sampling and removal operations and was present to perform the initial visual evaluations of the removed tubing. I personally planned and oversaw the failure analysis activities performed by the outside laboratories. I also developed the corrosion testing programs which GPUN implemented to gain insight and understanding into the failure mechanism and responsible corrodants. It was also my responsibility to coordinate the input from all our technical consultants as well as plant experience and formulate the current failure scenario.

During the steam generator repair, my section also provided materials evaluation and consultation on all aspects of the repair including explosive expansion, flushing, peroxide cleaning, and so forth. My section also developed and implemented the long term corrosion testing program and is evaluating the results as the testing progresses.

Lastly, during the course of the steam generator repairs, I was responsible for making all presentations to the NRC on corrosion testing and failure analysis activities.

Over the years I have kept fully abreast with the state-of-the-art in corrosion technology through my attendance and participation in technical seminars and conferences, and through attending training sessions. I am a member of the Edison Electric Institute Materials, Piping, Welding and Corrosion Task Force, a group of industry representatives who meet to share and develop solutions to corrosion problems in the field of materials and welding in the power industry. In addition, I am a member of the American Society for Metals.

Publications

1. F. S. Giacobbe, "Examination, Evaluation and Repair of Stress Corrosion Cracking in a PWR Borated Water Piping System", NACE Corrosion 81.

2. F. S. Giacobbe, J.D. Jones, R. L. Long, D. G. Slear, "Repairs of TMI-1 OTSG Tube Failures" Plant/Operations Progress AICHE, July 1983, Vol. 2, No. 3.