UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matte. of	) Docket Nos. 50-250-OLA-2
	) 50-251-OLA-2
FLORIDA POWER & LIGHT COMPANY	)
(Turkey Point Nuclear Generating	)
Station, Units 3 & 4)	) (Spent Fuel Pool Expansion)

Testimony of Eugene W. Thomas
On Contention Number 6

Q1: Please state your name and address.

A1: My name is Eugene W. Thomas. I am employed by Bechtel Eastern Power Corporation as Assistant Chief Civil Engineer. My mailing address is 15740 Shady Grove Road, Gaithersburg, Maryland 20877.

Q2: Please describe your professional qualifications and experience.

A2: A summary of my professional qualifications and experience is attached as Exhibit A and is incorporated herein by reference.

Q3: What is the purpose of your testimony?

A3: The purpose of my testimony is to address Contention 6. Contention 6 and the bases for that contention are as follows:

Contention 6

The Licensee and Staff have not adequately considered or analyzed materials deterioration or failure in materials integrity resulting from the increased generation heat and radioactivity, as a result of increased capacity and long-term storage, in the spent fuel pool.

<u>Bases for Contention</u>

The spent fuel facility at Turkey Point was originally designed to store a lesser amount of fuel for a short period of time. Some of the problems that have not been analyzed properly are:

(a) deterioration of fuel cladding as a result of increased exposure and decay heat and radiation levels during extended periods of pool storage.

(b) loss of materials integrity of storage rack and pool liner as a result of exposure to higher levels of radiation over longer periods.

(c) deterioration of concrete pool structure as a result of exposure to increased heat over extended periods of time.

Specifically, the purpose of my testimony is to address material deterioration or failure in materials integrity of the spent fuel pool liner and concrete pool structure due to heat from the increased capacity of the Turkey Point spent fuel pools. Other issues raised by Contention 6 are addressed in the Testimony of William C. Hopkins on Contention Number 6 (materials deterioration or failure in materials integrity of the liner and concrete pool structure due to radiation), the Testimony of Dr. Gerald R. Kilp and Russell Gouldy on Contention Number 6 (materials deterioration or failure in materials integrity of the fuel assemblies and storage racks), and the Testimony of William A. Boyd on Contention Number 6 (impact on K-effective of postulated gaps in the Boraflex plates in the Turkey Point spent fuel storage racks).

Q4: Please describe the Turkey Point spent fuel pool concrete structure and liner.

A4: The spent fuel pool structure is rectangular in shape with inside dimensions of 25'-4" by 41'-4" and with a height of approximately 40 feet. A four foot thick cross wall on one end of the pool separates the storage area from the refueling canal. The walls and floor are constructed of reinforced concrete with a 1/4" thick stainless steel liner plate system covering the entire inside surface of the pool. With the exception of a three foot length of wall on either side of the refueling canal which is 18" thick, the walls range from 3'-0" to 5'-6" thick. The floor of the pool, which also serves as a base mat at grade, ranges in thickness from 3' to 4'-6".

The spent fuel pool liner plate is ASTM (American Society for Testing and Materials) A-240 Type 304 stainless steel. Stainless steel shapes and bar are ASTM A-276 or A-479 (Type 304) or AISI (American Iron and Steel Institute) Type 302 or 304. Stiffeners and anchorage attachments for embedments (studs and threaded rods) are ASTM A-36. Concrete is manufactured in accordance with ACI (American Concrete Institute) 301. The main constituents of the concrete are ASTM C-150 Type II cement and aggregate meeting the requirements of ASTM C-33. Reinforcing steel is ASTM A-15, intermediate grade.

Q5: What issues would the generation of heat in the spent fuel pool raise regarding the integrity of the concrete pool structure and liner?

A5: Two issues would be raised. The first issue pertains to the thermal stresses induced in the structure as a result of the temperature differential between the pool water and ambient conditions, and the second pertains to materials integrity.

Q6: Did you perform an analysis of the thermal stresses on the concrete pool structure?

A6: Yes. The load carrying capacity of the pool structure was evaluated by conducting a detailed computer analysis as part of the overall evaluation of the pool for increased capacity. Using the ANSYS program, which is a public domain, industry recognized standard structural analysis technique, the pool structure was mathematically modeled as a large number of solid finite elements with sufficient detail to accurately capture response to load. All loads imposed on the structure were considered, including the effect of heat from the pool water as well as all postulated extreme environmental conditions, as addressed in the original licensing documents. There may also be nuclear heating of the concrete and steel as a result of radiation. Nuclear heating has the same mechanical effect on the concrete structures and liner plate as thermal heating. As discussed in the Testimony of William C. Hopkins on Contention Number 6, the magnitude of nuclear heating is insignificant as compared with thermal heating caused by the temperature of the pool water.

Thermal effects were not a specific concern since the increased capacity of the pool results in only minor variations from the original design condition, but were included to provide an entire load identification of the structure. Water temperatures in the pool for the operating, abnormal and postulated boiling conditions (212° F) were considered. Since the most severe loads on the structure due to heat are caused by temperature gradients (i.e., large temperature differences on opposite sides of the pool walls), the ambient temperature outside the pool was assumed to be as low as 30° F, resulting in a gradient of as much as 182° F through the wall thickness for analytical purposes.

The 30° F temperature specified on the outside surface of the pool is extremely conservative for the site environment of Southern Florida. A review of 33 years of meteorological records for that area indicated that the lowest mean five consecutive days temperature was 48° F. Thermal conductivity analysis shows that for a three foot thick wall, a steady state temperature gradient condition for the worst postulated temperatures would take five days to develop. The review of the 33 years of records also indicated that the lowest recorded temperature was 31° F, which lasted only three hours.

Using methods addressed in ACI Committee 349 report, "Criteria for Reinforced Concrete Nuclear Containment Structure," ACI Journal, January 1972, the loads from the computer analysis were converted into reinforcing steel and concrete stresses at various critical locations on each of the walls and the floor. These stresses were shown to be within the licensing condition imposed on the original design as identified in the Turkey Point Units 3 and 4, "Updated Final Safety Analysis Report," Docket Nos. 50-250 and 50-251, Appendix 5A. Further, the analysis shows that the pool maintains its structural integrity even under severe conditions of postulated boiling water combined with the effects of the design basis earthquake.

Q7: Did you evaluate thermal stresses on the spent fuel pool liner plate?

A7: Yes. The liner plate was conservatively not considered to provide structural capability in the structural analysis of the pool concrete structure. However, a separate analysis was conducted to determine the effects of thermal, hydrostatic and hydrodynamic loads on the functionality of the liner plate system. This analysis reviewed the buckling potential of the liner plate, as well as stresses in welds and embedded metal associated with the liner system. The analysis showed that there would be no loss of function under all postulated conditions.

Q8: Do you have a conclusion with respect to thermal stresses on the concrete pool structure and the liner plate?

A8: Yes. The pool was analyzed considering the thermal and mechanical effects of the increased spent fuel capacity for normal, abnormal and postulated boiling water conditions, in conjunction with postulated accident conditions as specified in the Updated Final Safety Analysis Report. The results of the analysis demonstrate that the pool structure and liner plate meet the original licensing acceptance conditions and maintain their structural integrity under all of these conditions.

Q9: Was the effect of temperature on the integrity of the Turkey Point concrete pool structures and liner plates considered during the initial design process?

A9: Yes. The thermal environment was taken into consideration in the selection of materials during the initial design process. The increased capacity of the pool does not raise a new issue regarding deterioration of the concrete pool structure, including the liner plate, as a result of exposure to increased temperatures over extended periods of time.

Q10: Please describe the effect of temperature on the stainless steel in the liner plate.

A10: Stainless steel was chosen for the liner plate because of its demonstrated ability to perform in various nuclear power plant applications, including those subject to much more severe thermal environments than that of the spent fuel pool. Stainless steel maintains its integrity and long-term stability at temperatures in excess of 1,000° F, which is far above the temperature expected in the spent fuel pool. Reductions in strength occur with increased steel temperature; however, for the temperature under consideration (212° F and less), no appreciable reduction occurs, as reflected in the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, Division I, Appendix I.

Q11: Please describe the effect of temperature on the concrete and reinforcing steel of the spent fuel pool.

All: The concrete and reinforcing steel of the spent fuel pool are also capable of maintaining their integrity, durability and long-term stability under the thermal environment imposed by the increased pool capacity. Concrete exposed to elevated temperatures will exhibit some changes in its characteristics. Such changes are dependent on the type and nature of the concrete constituents and on the proportions in which these constituents are combined. For concrete materials, such as those in the Turkey Point spent fuel pool structure, which have met the minimum requirements of the controlling ASTM standards and are combined in accordance with appropriate ACI guidelines, temperatures below approximately 300° F have an insignificant effect on their properties. A limestone type aggregate and portland cement, both of which meet appropriate ASTM standards, were used in the Turkey Point spent fuel pool. ACI guidelines as previously identified were employed for proportioning and mixing processes.

Free water, which is the result of excess water available in the wet concrete mix not utilized in the hydration process, can be a concern for some structures with temperatures above approximately 200° F. However, in the case of the Turkey Point spent fuel pool concrete structure, more than adequate time (the plant has been in operation for more than a dozen years) has been available for any free water, which was not utilized in the hydration process, to egress. Therefore, free water does not present a concern with respect to the concrete pool structures at Turkey Point, and these structures will not be adversely affected by the heat generated in the spent fuel pools. Unless the concrete is saturated with moisture (which is not the case at Turkey Point), temperature on the order of 300° F will have an insignificant effect on the mechanical properties of the concrete including its strength.

Finally, the reinforcing steel in the concrete structure is similar to other steels in that it maintains its integrity and stability at temperatures far above that which will be experienced by the pool structure. Consequently, any reduction in strength of the reinforcing steel as a result of the heat loads experienced in the spent fuel pool will be insignificant.

Q12: Does Florida Power & Light Company have a materials surveillance or monitoring program to detect any heat-induced degradation of the Turkey Point spent fuel pool liners and concrete pool structures?

A12: No. Such a program is unnecessary for the following reasons:

- The Turkey Point spent fuel pool liners and concrete structures were designed and licensed to store spent fuel for the lifetime of the plant. The spent fuel pool expansion increases the amount of fuel stored but not the duration of use of the spent fuel pools.
- The concrete pool structure and liner have been shown to be capable of withstanding, without significant effect upon their properties, temperatures exceeding those to which they will be exposed during the lifetime of the plant.

Q13: Would you please summarize your testimony?

A13: The concrete pool structure and liner were evaluated to determine whether they could withstand the thermal stresses and heat loads expected as a result of the spent fuel pool expansion. This evaluation demonstrates that the concrete pool structure and liner will maintain their integrity for the maximum temperature differentials expected for the Turkey Point spent fuel pool. Furthermore, both the liner and the pool structure consist of materials which are widely used in the nuclear industry and which have a proven ability to withstand the heat loads expected in the Turkey Point spent fuel pool.

EXHIBIT A

STATEMENT OF PROFESSIONAL QUALIFICATIONS OF EUGENE W. THOMAS

CURRENT POSITION	Assistant Chief Civil Engineer, Bechtel Eastern Power Corporation
EDUCATION	BSCE, Drexel Institute of Technology, 1964 MSME, Drexel Institute of Technology, 1969

SUMMARY

1/2 Year	Assistant Chief Civil Engineer, Bechtel, 1987-Present
5 Years	Civil staff supervisor, Bechtel, 1982-1987
2-1/2 Years	Civil group supervisor, nuclear power plant, Bechtel, 1979-1982
3-1/2 Years	Deputy civil group supervisor, nuclear power plant, Bechtel, 1976-1979
2-1/2 Years	Group leader, nuclear power plant, Bechtel, 1973-1976
3-1/2 Years	Engineering specialist, nuclear power plants, Bechtel, 1970-1973
6 Years	Senior dynamics engineer and dynamics engineer, Boeing, 1964-1970

EXPERIENCE WITH BECHTEL

Mr. Thomas is currently serving as Assistant Chief Civil Engineer in the Civil Engineering Department. In this position, he provides technical assistance to the chief civil engineer, reviews the technical adequacy of engineering design for both fossil and nuclear power plant projects, develops design methods and standards, and acts as a consultant to the various projects in resolution of difficult or unusual problems. Mr. Thomas is also a member of Bechtel's Dynamics Committee, which establishes criteria for seismic analyses and design criteria for vibrating and rotating equipment.

Mr. Thomas served as the civil staff supervisor prior to this with duties and responsibilities similar to those in his current position.

Previously, Mr. Thomas was assigned as civil group supervisor for the multi-unit SNUPPS project, 1150 MW PWR nuclear units, involving several utilities. He was responsible for design of the powerblock and safety-related site structures, technical resolution of field problems, preparation of specifications and bid packages, technical evaluation of bids, and review of vendor drawings for civil related items.

In earlier assignments to SNUPPS, Mr. Thomas was deputy group supervisor and reactor building group leader.

As an engineering specialist, Mr. Thomas was involved in piping whip restraint design, miscellaneous concrete and structural steel design, and FSAR preparation for Millstone Nuclear Power Station's 870 MW PWR Unit 2 for Northeast Nuclear Energy Company. He also worked on pipe whip restraint design for the Davis-Besse Nuclear Power Station 900 MW PWR Unit 2 project for the Toledo Edison Company/The Cleveland Electric Illuminating Company; seismic analysis for the auxiliary and control buildings, pipe hanger design and miscellaneous concrete and structural steel design for the 693 MW PWR Turkey Point Plant Units 3 and 4 for Florida Power & Light Company; and seismic analysis of the containment for the Edwin I. Hatch Nuclear Plant, two 800 MW BWR units for Georgia Power Company.

EXPERIENCE WITH BOEING

Prior to joining Bechtel, Mr. Thomas was a senior dynamics engineer and dynamics engineer. Using flight test data, finite element and other analytical methods, he determined dynamic characteristics of air frames. He also prepared computer programs for predicting rotor dynamic loads on helicopters and for determining structural natural frequencies for large models.

PROFESSIONAL MEMBERSHIPS

National Society of Professional Engineers, American Concrete Institute

REGISTRATION

Registered Professional Engineer in Maryland, Missouri, and Kansas