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50-251 Turkey Point Plant, Unit 4, Florida Power and Light C 05000251
AUTH.NAME AUTHOR AFFILIATION
UHRIG,R.E. Florida Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
EISENHUT,D.G. Division of Licensing

SUBJECT: Forwards corrected Page 1 to attachment to util 811021 ltr responding to NRC 810821 ltr re pressurized thermal shock to reactor pressure vessels.

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FLORIDA POWER & LIGHT COMPANY

October 23, 1981
L-81-465

Office of Nuclear Reactor Regulation
Attention: Mr. Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Eisenhut:

Re: FPL Letter L-81-462
Dated October 21, 1981
ATTACHMENT CORRECTION

By our letter referenced above, we responded to questions of your letter dated August 21, 1981 regarding Turkey Point Units 3 & 4 relating to pressurized thermal shock to reactor pressure vessels.

The attached corrected page replaces Attachment Page 1 of our letter referenced above.

Very truly yours,

Jack E. Uhrig for

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU:DAC:cf

Attachment

cc: Mr. James P. O'Reilly, Region II
Mr. Harold F. Reis, Esquire

A049
S.1

8111020285

Pressurized Thermal Shock to Reactor Pressure Vessels

Question (1):

Provide the RT_{NDT} Values of the critical welds and plates (or forgings) in your vessel for:

(a) Initial (as built) conditions and location (e.g. 1/4T) and
(b) current conditions (include fluence level) at the RPV inside carbon steel surface.

Response (1):

		Material	Initial RT_{NDT}	RT_{NDT}+	Current RT_{NDT}
(a)	Intermediate Inner Forging*	123P481VA1	+50 F	+ 35 F	+ 85F
	Circumferential (Girth) Weld**	SA 1101	+ 3 F	+190 F	+193F
	Lower Forging*	122S180VA1	+40 F	+ 35 F	+ 75F

* 1/4 T

** Inner wall. The current RT_{NDT} (1/4 T) = +168 F. Value is based on Unit 3 data which has been shown to be more representative of Unit 4 than surveillance capsule removed from Unit 4 (L-77-113, dated April 11, 1977 and L-77-326, dated October 21, 1977).

\+ Based on the slope of prediction curves presented in proposed ASTM Standards "Predicting Neutron Radiation Damage To Reactor Vessel Material."

(b) There have been 5.61 Effective Full Power Years (EFPY) of operation as of September 30, 1981 at Turkey Point Unit 4.

The total fluence on the inner wall is 1.1×10^{19} n/cm^2 and 6.6×10^{18} n/cm^2 at 1/4 T.

Question (2):

At what rate is RT_{NDT} increasing for these welds and plate material?

Response (2):

RT_{NDT} is increasing at the rate of 7°F/EFPY for the next 10 years; for the remainder of life, 5°F/EFPY. The rate of change for the forgings is 3OF for the remaining design life of the vessel. These are based on the slope of prediction curves presented in proposed ASTM Standards "Predicting Neutron Radiation Damage To Reactor Vessel Material."

Question (5):

Provide a listing of operator actions which are required for your plant to prevent pressurized thermal shock and to ensure vessel integrity. Include a

9a

LEHIGH UNIVERSITY

Institute of Fracture and Solid Mechanics
Packard Lab. Bldg. #19
BETHLEHEM, PENNSYLVANIA 18015
Telex No. Lehigh Univ. UD 710-670-1066

G. C. Sih
Director

October 10, 1985

Attorney Martin H. Hodder
1131 N.E. 86th Street
Miami, Florida 33138

RE: Turkey Point Nuclear Power Plant Unit No. 4: Reactor Vessel Embrittlement and Surveillance Program

Dear Attorney Hodder:

In response to your letter dated August 29, 1985 and the above referenced subject matter, I have read the package of documents on the RPV embrittlement program at Turkey Point Unit No. 4. A number of supporting arguments with reference to the calculation of ΔRT_{NDT} are questionable, if not invalid from the scientific view point. In what follows, the SWRI report and the FPL letter shall be referred to as [1]* and [2]**, respectively.

(1) SWRI Prediction [1]

Based on the RPV material surveillance methodology, SWRI [1] estimated the shift in RT_{NDT} for Turkey Point Unit No. 4. The results pertaining to wall location 1/4T based on the data of Capsule T in terms of EFPY are summarized graphically on the sheet attached to this letter. The shift in RT_{NDT} is found to be approximately 324°F at 8 EFPY. This is beyond the NRC screening value of 300°F.

* E. B. Norris, "Reactor Vessel Material Surveillance Program for Turkey Point Unit No. 4: Analysis of Capsule T", Southwest Research Institute Technical Report No. 02-4221, June 1976.

** Letter, Uhrig, FPL, to Eisenhut, "Re: Turkey Point Unit 4, Docket Nos. 50-251, PTS to Reactor Pressure Vessels", January 21, 1982.

(2) FPL Response [2]

With reference to the material in Docket No. 50-251 on PTS of RPV as stated in [2], a lower ΔRT_{NDT} value of 211°F was obtained for Unit No. 4. This result, however, was obtained by application of the surveillance data taken from Turkey Point Unit No. 3. The justification was that the metallurgical properties of the beltline welds of the Turkey Points Units No. 3 and No. 4 are the same and that data on Unit No. 4 are not sufficient.

(3) Comments

The rate at which the beltline weld material deteriorates and/or embrittles depends on the *combined* effects of irradiation and pressurized thermal shock. It is plant-specific in the sense that the influence differs inherently from one unit to another. In other words, the metallurgical properties alone cannot determine the damage behavior of the welds. The *loading history* plays a major role. Unless the rates of irradiation, fluctuations in thermal gradients and time variation in pressure are exactly the same for both Units No. 3 and No. 4, one is not justified to assume that data collected in Unit No. 3 could be applied to predict the behavior of Unit No. 4. Hence, conclusions drawn on ΔRT_{NDT} for Unit No. 4 based on the data of Unit No. 3 cannot be considered valid.

I will not delve into the other details concerning the actual calculation of ΔRT_{NDT} as they are beyond the scope of our immediate concern.

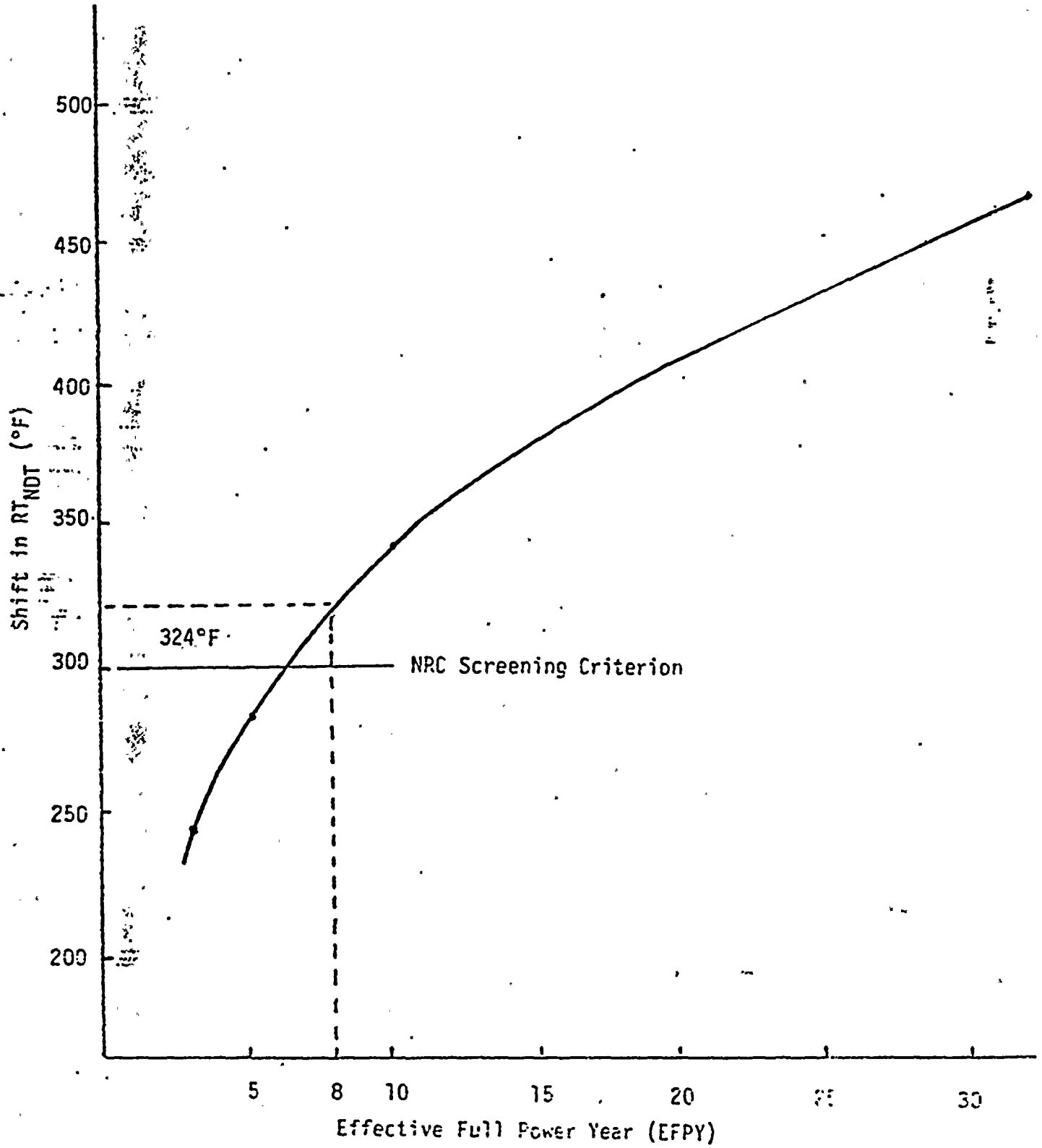
Very sincerely yours,

George C. Sih
Professor of Mechanics

GCS:bd

Enclosure

Data Reproduced from Table on Page 3 at Wall Location 1/4T, Report by E. B. Norris, "Reactor Vessel Material Surveillance Program for Turkey Point Unit No. 4: Analysis of Capsule T", Southwest Research Institute Technical Report No. 02-4221, June 1976.



Biography

of

Dr. George C. M. Sih

Professor of Mechanics and Director of the
Institute of Fracture and Solid Mechanics

Dr. Sih is currently Professor of Mechanics and Director of the Institute of Fracture and Solid Mechanics at Lehigh University, Bethlehem, Pennsylvania. He also holds the appointment of Adjunct Professor at The Hahnemann Medical College and Hospital of Philadelphia since 1972. He received his B.S. at the University of Portland; Oregon, 1953; his M.S. at New York University, 1957; and Ph.D. at Lehigh University, 1960; all of these degrees in Mechanical Engineering.

Dr. Sih has engaged in research in the interaction of mechanical deformation and heat flow (1960) supported by the Koppers Foundation, in Fracture Mechanics (1960 and 1961) for the Boeing Company Transport Division and (1962 to 1965) for the National Science Foundation, and as a member of the Technical Staff, Bell Telephone Laboratory (Summer 1961). He has been engaged as Principal Investigator in more than fifty projects at Lehigh University sponsored by the Office of Naval Research, Naval Research Laboratory, the National Aeronautics and Space Administration, the Air Force, the Army, etc., all of which are concerned with optimizing the use of high performance material with design, a discipline that has been frequently referred to as "Fracture Mechanics". Much of his work has been concerned with estimating the remaining life of material and structural components damaged by yielding and/or fracture. He specializes in developing computer software for predicting the mechanical behavior of structures and the stability of objects moving through fluid media. His more recent activities are concerned with the influence of moisture and temperature in composite materials, laser glazing techniques and non-destructive testing methods involving high-voltage electrophotography.

From 1953 to 1957, Dr. Sih was employed by Radio Corporation of America as a project and research engineer. He worked on the research and development of input and output devices for the first generation "Bizmark" computer system. Among the significant patents he obtained were:

1. Adjustable optical system for line printing.
2. Automatic magnetic disc printing device for the Xerox process.

In 1957 and 1958, Dr. Sih returned to the academic life and served at the City College of New York as Lecturer in Mechanical Engineering. He came to Lehigh University in 1958 as Instructor in Engineering Mechanics and was appointed Assistant Professor after completion of his doctorate. From 1965 to 1966, Dr. Sih held the position of Visiting Professor in Aeronautics at the California Institute of Technology and participated in an Air Force research project on the dynamics of crack propagation and size effects in the fracture of plates.

Dr. Sih assumed in 1970 the duties of Regional Editor, International Journal of Fracture Mechanics, and the responsibilities of soliciting and reviewing papers in the field of Fracture Mechanics. From 1971 to 1975, he served as an Associate Editor of the ASME Journal of Applied Mechanics. He is also on the Editorial Advisory Board of the Journal of Engineering Fracture Mechanics. He is also Editor-in-Chief of an International Journal of Theoretical and Applied Fracture Mechanics. Dr. Sih is a Fellow of the American Society of Mechanical Engineers and Honorary Fellow of the International Congress of Fracture. He is also a founding member of the International Cooperative Fracture Institute, an organization established to promote the interchange of ideas and information among active researchers in fracture mechanics.

Dr. Sih is also a member of the following societies:

1. Society of Sigma Xi
2. ASTM Committee E-24 on Fracture Testing of Materials
3. International Society of Engineering Science
4. American Society of Civil Engineering
5. American Society of Mechanical Engineering
6. International Society for the Interaction of Mechanics and Mathematics

Dr. Sih is the Editor of three book series. Seven volumes on the Mechanics of Fracture series have been or are about to be published:

Volume I - Methods of Analysis and Solutions to Crack Problems, 1973

Volume II - Three-Dimensional Crack Problems, 1974

Volume III - Plates and Shells with Cracks, 1976

Volume IV - Elastodynamic Crack Problems, 1976

Volume V - Stress Analysis of Notch Problems, 1976

Volume VI - Cracks in Composite Materials, 1980

Volume VII - Experimental Evaluation of Stress Concentration and Intensity Factors, 1980

The two other series are Fatigue and Fracture:

Volume I - Fatigue and Fracture, S. Kocanda, 1978

Volume II - Fracture Micromechanics of Polymer Materials, V. S. Kushenko and V. P. Tamuzh, 1980

and Engineering Application of Fracture Mechanics:

Volume I - Fracture Mechanics Methodology: Evaluation of Structural Components Integrity, edited by G. C. Sih and L. Faria

Volume II - Mixed Mode Crack Extension by E. E. Gdoutos

Volume III - Fracture Mechanics of Concrete: Material Characterization and Testing, edited by A. Carpinteri and A. Ingraffea

Volume IV - Fracture Mechanics of Concrete: Numerical Analysis and Structural Application by G. C. Sih and A. DiTommaso

Volume V - Bonded Repair of Aircraft Structure by A. A. Baker and R. Jones

Volume VI - Crack Growth and Material Damage in Concrete: Limit Load and Brittle Fracture by A. Carpinteri

Dr. Sih has also served as principal organizer and editor of proceedings of several conferences:

1. International Conference on "Dynamic Crack Propagation", (1972), Lehigh University
2. International Conference on "Prospects of Fracture Mechanics", (1974), The Netherlands
3. Conference on "Linear Fracture Mechanics", (1975), Lehigh University
4. International Conference on "Fracture Mechanics and Technology", (1976), Hong Kong
5. 14th Annual Meeting of the Society of Engineering Science, (1977), Lehigh University
6. First USA-USSR Symposium on "Fracture of Composite Materials", (1978), USSR
7. International Conference on "Fracture Mechanics in Engineering Applications", (1979), India
8. International Conference on "Analytical and Experimental Fracture Mechanics", (1980), Italy
9. International Conference on "Defects and Fracture", (1980), Poland

10. International Conference on "Mixed Mode Crack Propagation", (1980), Greece
11. International Conference on "Absorbed Energy and/or Specific Strain Energy Density Criterion", (1980), Hungary
12. International Conference on "Defects, Fracture and Fatigue", (1982), Canada
13. International Conference on "Fracture Mechanics Technology Applied to Material Evaluation and Structure Design", (1982), Australia
14. International Conference on "Application of Fracture Mechanics to Materials and Structures", (1983), Germany

Dr. Sih has approximately two hundred publications principally in the area of solid and fracture mechanics. He has authored and co-authored a total of three books.

1. Handbook of Stress Intensity Factors, 1973
2. Three Dimensional Crack Problems (with M. K. Kassir), 1974
3. Cracks in Composite Materials (with E. P. Chen), 1980

Dr. Sih received the 1975 Achievement Award from the Chinese Institute of Engineers in the United States and the 1984 Achievement Award from the Chinese Engineers and Scientists Association of Southern California for his accomplishments in research and teaching in fracture and solid mechanics.

Dr. Sih has also been active in serving as members of national committees. Among them are the National Materials Advisory Board concerning with the Dynamic Response of Materials Subjected to High Strain Rate Loading; Ship Materials Fabrication and Inspection; and other committees concerning Nuclear Reactor Components.

The Miami News
A Cox Newspaper Friday Afternoon, October 25, 1985 40 Pages

9(b

Nuke reactor walls called 'embrittled' at Turkey Point

ELLEN HAMPTON
Miami News Reporter

A metals engineer who reviewed a 1976 Florida Power & Light Co. report on two nuclear reactors at Turkey Point maintains that the walls of one of the reactors has "gone into embrittlement" and should be promptly inspected.

But an FP&L spokesman said the conditions of the reactor walls are within federally set safety standards and do not warrant immediate inspection, an assessment the Nuclear Regulatory Commission agrees with, an NRC spokesman said.

The issue of the reactor's embrittlement, or lack of ductility (pliability) caused by age and stress, was raised at a press conference yesterday by Joette Lorion, a freelance writer-researcher who founded and serves as the sole member of the Miami-based Center for Nuclear Responsibility, a nuclear watchdog group.

Lorion obtained the FP&L report from the NRC in August and sent it to Dr. George Sih, director of the Institute of Fracture and Solid Mechanics at Lehigh University in Bethlehem, Pa., for analysis.

Sih said in a telephone interview that after reviewing the FP&L report, he concluded that the walls on the Unit Four reactor at Turkey Point reached a condition of embrittlement in 1981.

"According to the report, the material has gone into embrittlement," Sih said.

Sih, who was named a fellow of the American Society of Mechanical Engineers in 1973 for distinguished work, said he pioneered the field of assessing the life span and strength of metals and has conducted many assessments on nuclear plants nationwide in the past decade.

FP&L spokesman Dave Wolverton said he has read Sih's report and "we have found his assessment was a limited assessment with a limited amount of information. Some of it in fact was old. It was not a comprehensive study of the whole situation."

Sih said he could not discuss whether Unit Four is potentially dangerous because of the many factors that contribute to safety at a nuclear power plant. But he said the information in the FP&L report called for further study.

"They should seriously re-evaluate the situation," Sih said. "According to their assessment, it has passed beyond the limits. The public deserves an answer on that basis."

Brittle walls can become dangerous during sudden changes of temperature. If a minor accident were to occur and Unit Four had to be cooled down quickly with water, the walls could shatter. A cracked reactor would result in a meltdown, Lorion said, and NRC scientists agree.

And a meltdown at Turkey Point, according to a report by Sandia Labs for the NRC, could be expected to cause immediate death to anyone within a 20-mile radius of the plant and radioactive contamination to a 70-mile radius. Turkey Point is just north of Homestead in deep South Dade.

Wolverton said that Unit Four walls have not become dangerously embrittled. He said there is some embrittlement of the walls, but that it has not exceeded federal safety standards.

"We contend that the plant is safe or we wouldn't run it," Wolverton said.

NRC spokesman Frank Ingram said his agency had studied the potential for embrittlement at Turkey Point and was satisfied that "embrittlement would not be a problem for either reactor for some time, possibly even up to the end of its 40-year life span."

He said the NRC currently is reviewing FP&L's 1976 report as part of a hearing request by Lorion's group on the embrittlement issue. The report, based on a 1975 test by Southwest Research Industries Inc. of Texas, said that Unit Four would exceed federally set safety standards for brittleness between its fifth and tenth "effective full power year," which is measured in time at full operating power.

Southwest Research Industries filed an additional report in 1979 equating seven effective full power years at Turkey Point to 10 calendar years. It suggested that another brittleness test be conducted in seven full-power years. Unit Four, currently in its eighth full power year, was scheduled for a brittleness inspection this year.

But FP&L requested permission from the NRC to delay the test. In its request, FP&L said it wanted to begin an integrated program of testing between Unit Three and Unit Four, thus reducing employee exposure to radiation and avoiding possible power outages.

The NRC approved the delay and FP&L's plan to test material from Unit Three to evaluate conditions in Unit Four based on several criteria. Among them, the NRC said, the units must be "sufficiently similar to permit accurate comparisons" and there must be "substantial advantages" to personnel and power clients in reduced radiation exposure and outages.

FP&L responded that Units Three and Four are identical in design, modifications and material and are operated under the same conditions. FP&L acknowledged a difference in embrittlement between the two units and attributed it to different levels of usage.

The Southwest Research Industries Inc. tests showed considerably lower embrittlement levels for Unit Three than for Unit Four, Sih said. Unit Three, for example, was not expected to exceed federal safety standards even after 10 full power years.

Martin Hodder, attorney for Lorion's group, said that with the approved delay embrittlement of Unit Four's walls would not be examined for another 14 years. Wolverton said he couldn't say how long the extension is for in required testing.

Litigation between FPL and the Center for Nuclear Responsibility began in 1981, when Lorion complained to the NRC about Turkey Point.