UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-250 OLA-4
FLORIDA POWER & LIGHT COMPANY	)	50-251 OLA-4
	)	
(Turkey Point Plant,	)	
Units 3 and 4	)	(P/T Limits)

AFFIDAVIT OF STEPHEN A. COLLARD ON CONTENTIONS 2 AND 3

My name is Stephen A. Collard. My business address is P.O. Box 14000, Juno Beach, Florida, 33408. I am employed by Florida Power & Light Company (FPL) as the Section Supervisor for the Codes and Programs Section of Materials, Codes and Inspections. A description of my professional qualifications is attached and is incorporated herein by reference.

My job responsibilities with FPL have included the development of programs to ensure that the materials in the reactor vessels for Turkey Point Units 3 and 4 will maintain sufficient integrity against postulated brittle fracture caused by neutron irradiation. As part of this responsibility, I performed a design verification of the calculation of the adjusted reference temperature (ART) that was used in calculating the pressure/temperature (P/T) limits for Turkey Point.

The purpose of this affidavit is to address Contentions 2 and 3 in the Turkey Point P/T limits proceeding.

Contention 2 states as follows:

CONTENTION 2:

> That the revised temperature/pressure limits that have been set for Turkey Point Unit 4 are non-conservative and will cause that reactor unit to exceed the requirements of General Design Criterion 31 of Appendix A to 10 CFR Part 50, which requires that the reactor coolant pressure boundary be designed with a sufficient margin to ensure that, when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a non-brittle manner and (2) the probability of a rapidly propagating fracture is minimized.
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> Petitioners contend that the new pressure/temperature limits could cause the reactor vessel to exceed these requirements because the Licensee has based its calculation of the predicted RT_{NDT} for Unit 4 partly on surveillance capsule V test results from Turkey Point Unit 3 rather than predicting the RT_{NDT} for Unit 4 based on Unit 4 capsule V surveillance capsule data--a practice which is not scientific, not valid, and could cause the Unit 4 reactor to behave in a brittle manner which would make the chances of a pressure vessel failure and resultant meltdown more likely. Petitioners contend that predictions of RT_{NDT} and pressure/temperature limits derived from the shift in nil-ductility transfer should be based only on plant-specific Unit 4 data, especially in light of the fact that the only tests ever performed on Unit 4 weld specimens demonstrated that the weld material in the Unit 4 vessel was 30% more brittle than that of Unit 3. Because Unit 4's weld material is more embrittled, Petitioners contend that the FPL Integrated Surveillance program does not meet the Requirements of 10 CFR Appendix G Parts V.A and V.B, and 10 CFR Appendix H, including Appendix H Parts IIC and IIIB. Finally, Petitioners contend that the surveillance capsule V for Unit 4 should be tested to establish the new pressure/temperature limits and should the testing indicate that the RT_{NDT} for Unit 4 has passed the 300-

> degree Fahrenheit screening criterion set by the NRC, Unit 4 should be shut down until it is demonstrated that the Unit 4 reactor pressure vessel can maintain its integrity beyond this limit.

In admitting Contention 2, the Licensing Board excluded any issue pertaining to the 300°F screening criterion and the acceptance of the Turkey Point integrated surveillance program in 1985. Additionally, the Board limited the scope of the Contention to the issue of whether "Licensee's conduct of the integrated surveillance test program at Turkey Point fails to meet the requirements of the program itself" and whether the "difference of less than five percent in the operating time between the two units is . . . significant." (Memorandum and Order (June 8, 1989), pp. 17-19).

Contention 3 states as follows:

<u>CONTENTION 3</u>:

> That the revised pressure/temperature limits that have been set for Units 3 and 4 are non-conservative and will not meet the requirements of General Design Criterion 31 of Appendix A to 10 CFR Part 50 which requires that the reactor coolant pressure boundary be designed with sufficient margin to ensure that, when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a non-brittle manner and (2) the probability of a rapidly propagating fracture is minimized. Petitioners contend that the sufficient safety margin required by GDC 31 does not exist because the P/T limits for Units 3 and 4 were not based on the most limiting value of RT_{NDT} as required by 10 CFR Part 50 Appendix G and H, for reactor vessel welds because the percentage of copper that was used in the RT_{NDT} calculation is non-conservative in that it is lower

> than the percentage of copper that was used in previous surveillance test reports and lower than the percentage of copper quoted in many of the earlier FPL documents. Petitioners contend that the use of this non-conservative estimate of copper content means that the adjusted RT_{NDT} is unrealistically low and that the current revised P/T limits are not restrictive enough to ensure than an adequate margin of safety against brittle fracture of the reactor vessel exists. This increases the possibility that the reactor vessels for Unit 4 will behave in a brittle manner resulting in a fracture of the vessel and subsequent meltdown of the reactor core.
>
> Petitioners further contend that if a more conservative and accurate estimate of copper content was used to calculate the RT_{NDT}, the P/T limits would be more restrictive and that in fact, there is a possibility that it could be discovered that the NRC screening criterion of 300-degree Fahrenheit has been reached and the Turkey Point Units 3 and 4 would have to be shut down because they do not meet the fracture toughness requirement of 10 CFR Part 50 Appendix G.

In admitting Contention 3, the Licensing Board excluded any issue pertaining to the 300°F screening criterion and whether the upper-shelf energy of the Turkey Point test specimens meets the requirements in 10 CFR Part 50 Appendix G. (Id., p. 24).

The remainder of this affidavit is divided into the following sections:

° Section I provides background information on Turkey Point, the purpose of P/T limits, and the regulatory provisions applicable to calculation of P/T limits.

- Section II describes how the P/T limits were calculated for Turkey Point.

- Section III addresses various issues raised by the Intervenors with respect to the P/T limits for Turkey Point.

- Section IV provides a conclusion.

I. Background

A. General Description of the Turkey Point Reactor Vessels

1. Turkey Point Units 3 and 4 are twin pressurized water reactors (PWRs) owned and operated by FPL. Units 3 and 4 received operating licenses from the Atomic Energy Commission, the predecessor to the Nuclear Regulatory Commission (NRC), in 1972 and 1973, respectively.

2. The Nuclear Steam Supply Systems (NSSS) for Turkey Point Units 3 and 4 were, in general, designed and manufactured by Westinghouse Electric Corporation (Westinghouse). However, the reactor vessels for both units were manufactured by Babcock & Wilcox (B&W). Turkey Point is one of five Westinghouse plants (with nine units) constructed in the late 1960s and early 1970s that have B&W reactor vessels.

3. The designs of the reactor vessels for Turkey Point Units 3 and 4 are identical. The reactor vessels are cylindrical in shape, with hemi-spherical domes at each end of the cylinders. The reactor vessels are approximately 40 feet high and 14 feet in diameter. The reactor vessels are constructed of carbon steel almost eight inches thick, with a .156 inch (minimum) stainless steel cladding on the inside wall.

4. The Turkey Point reactor vessels were manufactured by welding together several cylindrical shell forgings. Therefore, unlike most reactor vessels in this country, the Turkey Point reactor vessels only have circumferential welds and do not have any longitudinal welds.

5. The internal designs of the reactor vessels for Turkey Point Units 3 and 4 are also identical. Each reactor vessel has a reactor core with space for 157 fuel assemblies. Additionally, each reactor vessel has a thermal shield between the reactor core and the reactor vessel wall. The purpose of the thermal shield is to reduce the impact on the reactor vessel wall of neutrons escaping from the reactor core.

6. Each of the reactor vessels for Turkey Point Units 3 and 4 contains surveillance capsules. These capsules contain specimens of the material from the reactor vessel shell forgings

and reactor vessel welds. The capsules are located near the inside wall of the reactor vessel along the beltline region (i.e., mid-plane) of the reactor core. Therefore, the neutron fluence received by the capsules is representative of the fluence received by the reactor vessel. The capsules are periodically removed and tested to predict the impact of neutron irradiation on the materials in the reactor vessel wall. Since 1985, the individual surveillance programs for Turkey Point Units 3 and 4 have been integrated into a single program, and the results of this program have been used to predict the fracture toughness of the reactor vessels for both units. The integrated surveillance program for Turkey Point Units 3 and 4 is described in more detail in Section III.B.1, below.

B. Purpose of P/T Limits

7. The purpose of P/T limits is to ensure that, during normal operation (including reactor heatup, cooldown, and inservice and hydrostatic testing), the pressure and temperature of the reactor coolant are maintained within limits sufficient to ensure adequate margin against postulated brittle fracture of the reactor vessel. The ductility or ability of metals in reactor vessels to resist fracture (i.e., fracture toughness) is primarily a function of three factors: 1) the material properties of the metal; 2) the temperature of the metal; and 3) the amount of neutron irradiation of the metal. The effect of each of these factors is discussed below.

8. Temperature has a significant effect on the ductility or fracture toughness of the type of ferritic steels commonly used in reactor vessels, including the Turkey Point reactor vessels. In order to determine the effect of changing temperatures, the fracture toughness of a reactor vessel is determined by subjecting reactor vessel material specimens to what is known as Charpy V-notch tests over a range of temperatures. Such tests consist of an impact test in which a 10mm by 10mm by 55mm V-notched material specimen supported at both ends is struck behind the notch by a hammer that swings like a pendulum. The energy of the hammer absorbed in fracturing the specimen is calculated based upon the difference in energy corresponding to the height to which the hammer would have risen absent the specimen and the actual height to which the hammer rose during the impact test. The energy absorbed in fracturing the specimen is a measure of the fracture toughness of the specimen, with a higher absorbed energy corresponding to higher fracture toughness. Since the fracture toughness of a metal varies when the temperature of the metal changes, Charpy V-notch tests are performed over a range of temperatures to produce a curve of absorbed energy versus temperature.

9. Figure 1 (attached) depicts the typical relationship between fracture toughness of a metal (as measured by the absorbed impact energy during Charpy V-notch tests) and the

temperature of the metal. As this figure shows, the fracture toughness curve has three regions: 1) an upper shelf; 2) a lower shelf; and 3) a transition region between the lower and upper shelves.

10. The upper shelf is a plateau occurring at higher temperatures and corresponds to the region where the metal exhibits relatively high energy absorption or tough, ductile behavior. The ability of the metal to absorb impact energy along the upper shelf is not significantly affected by changes in temperature (hence, use of the term "shelf").

11. The lower shelf occurs at lower temperatures and corresponds to the region where the metal exhibits brittle behavior. The ability of the metal to absorb impact energy along the lower shelf also is not significantly affected by temperature changes.

12. As the name implies, the transition region occurs between the upper and lower shelves. In this region, the ability of a metal to absorb energy varies with temperature changes. In general, for typical reactor vessel materials, the transition region occurs over a range of approximately 150 to 200°F. Because the transition region generally is not sharp, there is not a single temperature where a metal's behavior turns from ductile to brittle.

13. As a result, several different measures have been developed to define a temperature within the transition region corresponding to a somewhat arbitrarily selected boundary between ductile and brittle behavior. One such measure is the Nil Ductility Transition Temperature (NDT), which is defined as the maximum temperature where a standard drop weight specimen breaks when tested per American Society for Testing and Materials (ASTM) Standard E-208. These tests are used to establish baseline information regarding the fracture toughness of a metal, and such test specimens generally are not included in reactor vessel surveillance capsules. Another measure is the Reference Temperature (RT_{NDT}) of a reactor vessel. The RT_{NDT} is defined by the American Society of Mechanical Engineers (ASME) Code, Section III NB 2331 as the greater of 1) the NDT, or 2) the temperature corresponding to 60°F less than the temperature where a sample exhibits 35 mils lateral expansion and can absorb 50 ft-lbs of impact during a Charpy V-notch test.

14. The fracture toughness of a metal is also affected by neutron irradiation. When fast neutrons (i.e., neutrons with energies equal to or greater than 1.0 Million Electron Volts (MEV)) collide with atoms within a metal, the neutrons dislocate

the atoms within the metallic lattice.1/ These dislocations reduce the fracture toughness and increase the RT_{NDT} of the metal. These effects become more pronounced with increases in the total neutron fluence (i.e., cumulative number of fast neutrons striking an area over time). Figure 2 (attached) depicts these changes graphically. The shift in RT_{NDT} (i.e., Delta RT_{NDT}) caused by irradiation is defined in 10 CFR Part 50 Appendix G.II.E as the temperature difference between the fracture toughness curves for an irradiated and unirradiated metal, when measured at 30 ft-lbs of absorbed energy.

15. In general, the incremental impacts of neutron fluence on ferritic steels are greatest when the fluence is on the order of 10^{18} n/cm^2 (neutrons per square centimeter). When fluences are on the order of 10^{19} n/cm^2, the neutron radiation damage tends to reach a saturation point and little additional damage occurs with increasing fluence.

16. Different chemical composition of metals affect the ductility of the metals when exposed to neutron irradiation. For

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1/ Neutrons with less than 1 MEV (including so-called "thermal neutrons") generally are insufficiently energetic to dislodge atoms from a metallic lattice, and therefore their existence may be neglected in considering neutron radiation impacts on metals. In general, the energy spectra of neutrons escaping from reactor cores do not vary greatly among commercial reactors. In a plant such as Turkey Point which has reactors with the same designs and fuel loading patterns, the neutron spectra on the reactor walls of the two units are essentially identical.

example, metals with more copper and nickel are more susceptible to radiation damage than the similar types of metals with lower copper and/or nickel content. As a result, when irradiated, metals with a relatively high copper and/or nickel content exhibit a higher Delta RT_{NDT} than metals with a relatively lower copper and/or nickel content.

17. The P/T limits for a reactor vessel are designed to assure that changes in the fracture toughness of the reactor vessel, as affected by the variables of temperature, neutron irradiation, and chemical composition, are taken into account. The P/T limits specify maximum operating pressures at various temperatures, such that the stresses induced by pressures and temperature changes do not exceed (with a considerable margin of safety) the fracture toughness of the reactor vessel. Thus, the P/T limits ensure that the pressure and temperature are maintained within limits sufficient to ensure an adequate margin against postulated brittle fracture of the reactor vessel.

18. The P/T limits take the form of parametric curves, which depict the maximum permissible pressure for any specific operating temperature. Since the fracture toughness of a reactor vessel changes as the reactor vessel is irradiated, it is necessary to periodically recalculate the P/T limits to account for the changes in the fracture toughness of the reactor vessel.

C. Regulatory Provisions Applicable to Calculation of P/T Limits

19. Calculation of P/T limits is governed by Section IV.A.2-5 of Appendix G to 10 CFR Part 50. This section states that P/T limits for a reactor vessel must be at least as conservative as those obtained by following the methods of analysis and the required margins of safety in Appendix G of the ASME Code, as supplemented by the provisions of Section V of Appendix G to 10 CFR Part 50. Section V states that the effects of neutron irradiation on the reference temperature of a reactor vessel are to be predicted based upon "the results of pertinent radiation effects studies in addition to the results of the surveillance program" for the reactor vessel. This section also states that the "highest adjusted reference temperature . . . of all the [reactor vessel] beltline materials must be used." Finally, this section postulates the existence of a pre-existing flaw in the reactor vessel and states that predictions of fracture toughness "are to be made for the radiation conditions at the critical location on the crack front of the assumed flaw."

20. Appendix G to the ASME Code provides a procedure for calculating P/T limits for a reactor vessel given the Adjusted Reference Temperature (ART) for the reactor vessel. The ART is defined as the RT_{NDT} of the reactor vessel after accounting for the shift in RT_{NDT} (or Delta RT_{NDT}) caused by neutron irradiation.

21. NRC Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials" (May 1988) (hereinafter "Regulatory Guide 1.99") identifies a procedure for calculating the ART. Regulatory Guide 1.99 is recognized by the nuclear industry as providing an appropriate and conservative method for calculating ART.

22. Regulatory Guide 1.99 provides the following procedure for calculating ART:

$$\text{ART} = \text{Initial } RT_{NDT} + \text{Delta } RT_{NDT} + \text{Margin}$$

Regulatory Guide 1.99 defines these terms as follows:

- Initial RT_{NDT} is the RT_{NDT} of the reactor vessel prior to being irradiated.

- Delta RT_{NDT} is given by the following equation:

  $$\text{Delta } RT_{NDT} = (CF)\ f^{(0.28-0.10 \log f)}$$

  where "CF" is a chemistry factor and "f" is the predicted fluence. Regulatory Guide 1.99 provides two alternative methods for calculating the chemistry factor. First, for plants that do not have surveillance capsule data, the chemistry factor is based upon the copper and nickel content of the reactor vessel. Second, for plants that have two or more credible surveillance capsule data sets, the chemistry factor may be based upon a "best fit" of the measured values of Delta RT_{NDT} and the actual fluences, using the equation identified above. Regulatory Guide 1.99 states that the value of ART obtained from the use of surveillance capsule data should be used unless it is lower than the value of ART obtained from using the copper and nickel content (in which case, either value may be used).

- The margin is a quantity to be added to obtain a conservative, upper-bound value of ART. The magnitude of the margin depends upon whether surveillance capsule test data or the content of copper and nickel are used to calculate the chemistry factor. The margin is smaller in the former case, because the use of plant-specific surveillance capsule data provides for a more precise calculation of Delta RT_{NDT} than the use of industry-wide correlations based upon copper and nickel content.

23. Several aspects of Regulatory Guide 1.99 should be noted. First, in accordance with 10 CFR Part 50 Appendix G.V, Regulatory Guide 1.99 states that the beltline materials that are

most likely to be most controlling with regard to radiation embrittlement (i.e., the "most limiting materials") are to be used in calculating ART. Second, also in accordance with Appendix G.V., the equations in Regulatory Guide 1.99 are based upon studies of surveillance capsule data from commercial power reactors. These studies established the relationship between ART and fluence for any given chemistry. The Regulatory Guide provides for the use of this relationship (rather than a relationship between fluence and measured Delta RT_{NDT} derivable only from surveillance data from the reactor in question), because of the relatively significant amount of scatter exhibited in surveillance capsule test data. To account for this scatter, the Regulatory Guide includes a margin to provide a conservative, upper-bound curve for the data scatter.

II. Calculation of the P/T Limits for Turkey Point

24. The Technical Specifications for Turkey Point Units 3 and 4 contain P/T limits. Prior to 1988, these limits were applicable to operation of each Turkey Point reactor up to ten Effective Full Power Years (EFPY) of plant operation.2/ The

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2/ An EFPY is defined as the amount of energy produced by operation at full power continually for one year. In general, due to outages and operation at less than 100% power, a reactor will produce less than 1 EFPY during a calendar year.

Technical Specifications did not contain P/T limits applicable to operation after 10 EFPY.

25. In 1988, Turkey Point Units 3 and 4 each began to approach 10 EFPY of operation. As a result, FPL submitted an application to amend the P/T limits in the Turkey Point Technical Specifications to make them applicable for operation up to 20 EFPY.

26. In calculating the P/T limits for operation up to 20 EFPY, FPL used the methodology specified in Appendix G of the ASME Code and Regulatory Guide 1.99. The calculation of the P/T limits for Turkey Point was performed in two steps. First, FPL calculated and verified the ART for the Turkey Point reactor vessels by applying the methodology specified in Regulatory Guide 1.99. Second, Westinghouse also verified FPL's calculation of ART and, based upon FPL's calculation of the ART, determined the P/T limits utilizing a Westinghouse computer code that applied the methodology specified in Appendix G of the ASME Code.

27. In calculating the ART using Regulatory Guide 1.99, FPL utilized the following input and methodology:

- FPL calculated the ART for the most limiting material in the Turkey Point reactor vessels. This material is weld SA 1101, which is a beltline weld and which contains significantly more copper and nickel than the shell forgings of the reactor vessels. Because SA 1101 is a beltline weld, it receives the highest neutron fluence of the welds in the reactor. Additionally, because SA 1101 has more copper and nickel than the beltline shell forgings, it is more susceptible to neutron radiation damage than the shell forgings. Use of the term "weld" and "welds" in the remainder of this affidavit refer to weld SA 1101.

- In calculating the ART, FPL utilized the expected neutron fluence for the Turkey Point reactor vessels at 20 EFPY. This fluence was calculated based upon the actual fluence at the time of the calculation, plus the expected fluence up to 20 EFPY.

- FPL used the results of the Turkey Point integrated surveillance program to calculate the chemistry factor used in deriving the ART.

- The initial RT_{NDT} for Turkey Point Units 3 and 4 welds was determined to be 10°F, based upon actual tests of the weld material. This value was substituted for the assumed initial RT_{NDT} of 0°F provided in Regulatory Guide 1.99 in order to provide for an initial RT_{NDT} that is conservative and more representative of actual Turkey Point conditions.

28. In calculating the P/T limits for Turkey Point, FPL and Westinghouse utilized a number of conservatisms and margins of safety. Some of these conservatisms and margins are inherent in Regulatory Guide 1.99 and Appendix G of the ASME Code; others were introduced by Westinghouse and FPL. Examples of these conservatisms and margins of safety include the following:

- It was assumed that each of the Turkey Point reactor vessels contains a pre-existing flaw that is twelve inches long and two inches deep (or approximately one-fourth the thickness of the reactor vessel).3/ As required by the ASME Code, FPL conducted a ten-year inservice inspection of reactor vessels for Turkey Point Units 3 and 4 using ultra-sonic testing, which confirmed that no such flaws exist.

- It was assumed that the pre-existing flaw was in a longitudinal weld in the reactor vessel. As discussed

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3/ The ART of a reactor vessel wall varies throughout the width of the wall, due to the neutron shielding providing by the wall itself. Therefore, the ART continuously decreases from the inside surface to the outside surface of the reactor vessel wall. In calculating P/T limits, 10 CFR Part 50 Appendix G.V.B requires the use of the ART at the depth of the flaw.

above, the Turkey Point reactor vessels only have circumferential welds. Since the stresses in a longitudinal weld are twice the stresses in a circumferential weld (everything else being equal), this assumption introduced a safety factor of two.

- The reactor vessel stresses caused by the reactor coolant pressure were multiplied by a safety factor of two. Thus, in essence, it was assumed that the reactor would be pressurized up to approximately 5000 psi. This pressure far exceeds the design pressure of the reactor vessels and the pressure at which pressure relief valves would open, which are 2485 psi and 2335 psi, respectively.

- The stresses caused by thermal gradients in the reactor vessel walls were multiplied by a safety factor of 1.25.

- The shielding provided by the cladding on the inside wall of the reactor vessels was not taken into account in determining the neutron fluence inside the wall.

- In calculating the fluence at 20 EFPY, no credit was taken for the flux reduction measures to be taken for Turkey Point Unit 3 and Unit 4.

° In accordance with Regulatory Guide 1.99, the ART was calculated by adding a conservative, upper bound margin to the Initial RT_{NDT} and the Delta RT_{NDT} attributable to neutron irradiation. In the case of Turkey Point, this margin was 28°F.

For all of these reasons, the calculation of the ART and P/T limits for Turkey Point Units 3 and 4 was extremely conservative and reflects a large margin of safety.

III. Issues Raised by the Intervenors

A. Issues Related to Contention 3

29. In Contention 3, the Intervenors allege that FPL used a non-conservative value for the copper content of the Turkey Point reactor vessels in calculating RT_{NDT}. Specifically, in the Bases for Contention 3, the Intervenors allege that "[i]n their prediction of RT_{NDT}, FPL assumed a copper content of .26, while many earlier documents on Turkey Point assumed a copper content of .30 or above."

30. As discussed in more detail in Section I.C above, Regulatory Guide 1.99 identifies two alternative methods for determining the chemistry factor used in calculating the ART. First, the Regulatory Guide states that the copper and nickel

content are to be used to calculate the chemistry factor when surveillance capsule data are not available. Second, the Regulatory Guide states that surveillance capsule data are to be used to calculate the chemistry factor when two or more surveillance data points are available (unless the use of test data provides for a lower ART than the use of copper and nickel content, in which case either may be used).

31. As discussed in Section II above, Turkey Point has three surveillance data points as a result of its integrated surveillance program. Thus, in accordance with the provisions of Regulatory Guide 1.99, FPL calculated the chemistry factor for Turkey Point based upon surveillance capsule data for both Turkey Point Units 3 and 4. This chemistry factor was then used to calculate the ART and P/T limits applicable to both units. FPL was not required to, and did not, use any value of copper and nickel content in calculating the chemistry factor and ART for the welds and the P/T limits for Turkey Point Units 3 and 4.

32. As stated above, FPL did not use any value of copper content in calculating the P/T limits for Turkey Point. Nevertheless, if FPL had used a value of copper content to calculate the P/T limits, use of a copper content of 0.25% would have been appropriate under Regulatory Guide 1.99. Regulatory Guide 1.99 states that, when using a copper and nickel content to calculate the chemistry factor, the "best estimate" of the copper

and nickel content should be utilized. Regulatory Guide 1.99 defines "best estimate" as the mean of measured values. The "best estimate" of the copper content of the Turkey Point reactor vessel welds is 0.26%. This value is the "best estimate" because it represents the mean of 51 measured data points on the copper content of the type of material used in the Turkey Point reactor vessel welds. This value was also accepted for use by the NRC Staff in a Safety Evaluation for Turkey Point dated April 26, 1984.

33. It may be noted that Intervenors are correct in asserting that, at one time, FPL used a value of 0.30% and higher for the copper content of the Turkey Point reactor vessel welds. Prior to July 1983, FPL's estimate of the copper content of the Turkey Point reactor vessel welds was based upon only 5 data points of broken specimens tested by Westinghouse. However, in July 1983, B&W, the manufacturer of the reactor vessels for Turkey Point, released to FPL proprietary and previously unavailable data on the copper content of the material in the Turkey Point reactor vessel welds. Based upon the availability of this much larger data base of information, FPL recalculated the mean copper content of the Turkey Point reactor vessel welds and determined that the mean was 0.26%. FPL has used this value since its acceptance by the NRC Staff in 1984.

34. Finally, it should be noted that it is unnecessary and would be inconsistent with Regulatory Guide 1.99 to use a conservative value for copper content in calculating the chemistry factor, ART, and P/T limits. As discussed above, Regulatory Guide 1.99 specifies the use of a "best estimate" of copper content and the use of a "margin" to provide for a conservative, upper-bound value of ART. Use of both a conservative estimate of copper and the margin specified in Regulatory Guide 1.99 would result in a value of ART that would be unduly conservative and unnecessary to protect the health and safety of the public.

B. Issues Related to Contention 2

35. Contention 2 states that the P/T limits for Turkey Point are non-conservative because FPL has used the results of an integrated surveillance program (rather than unit specific surveillance data) to predict the RT_{NDT} of Turkey Point Unit 4. Specifically, in admitting Contention 2, the Licensing Board referred to the need for a contingency plan under Appendix H to 10 CFR Part 50 and questioned whether FPL's conduct of the integrated surveillance program for Turkey Point Units 3 and 4 fails to meet the requirements of the program itself because of the 5% difference in operating times between the two units. Additionally, in response to a discovery request, the Intervenors identified the following bases for this contention: 1) Unit 4

suffered from an overpressurization event while Unit 3 did not; 2) the capacity factors for Units 3 and 4 were 14% and 45%, respectively, in 1987; 3) the units have had different extended outages; and 4) FPL entered into the integrated surveillance program even though the initial test results for Unit 4 did not agree with predictions.

36. These issues are addressed in the following subsections. Subsection 1 describes the surveillance program for Turkey Point Units 3 and 4. Subsection 2 discusses the purpose of contingency plans under Appendix H to 10 CFR Part 50 and their relevance to calculation of P/T limits. Subsection 3 describes the operating history of Turkey Point Units 3 and 4 following NRC acceptance of the Turkey Point integrated surveillance program in 1985 and discusses whether this operating history indicates any need to utilize unit specific surveillance data to calculate the P/T limits for Turkey Point Unit 4. Subsection 4 discusses other issues not addressed in the other subsections. Finally, subsection 5 describes what the impact would have been if the results of the integrated surveillance program had not been used to calculate the P/T limits for Turkey Point Unit 4.

1. <u>Description of the Turkey Point Surveillance Program</u>

37. Turkey Point Units 3 and 4 each began operation with eight reactor vessel surveillance capsules containing material

specimens and dosimeters. In each unit, five of the eight capsules contained material specimens of the shell forgings of the reactor vessel; the remaining three capsules contained material specimens of the shell forgings, the reactor welds, and material in the heat affected zone around the welds.

38. The reactor vessel welds and the weld material specimens at Turkey Point and other plants are characterized by a heat number4/ and a flux lot number.5/ Table 1 below identifies the heat numbers and the flux lot numbers for the welds and weld specimens for Turkey Point Units 3 and 4. As this table shows, the heat numbers for the welds and weld specimens for Turkey Point Units 3 and 4 are identical. Additionally, the flux lot number for the welds for Turkey Point Units 3 and 4 and for the weld specimens for Turkey Point Unit 3 are identical; however, the flux lot number for the weld specimen for Unit 4 is different than the flux lot number for the weld for Unit 4.

4/ The heat of a metal is defined as all the material included in one original melt or production of a batch of metal. The material properties throughout each heat are essentially uniform, and each heat is designated by a unique number.

5/ Similar to the heat number, the flux lot number corresponds to all of the material included in the production of one batch of original flux mix. Flux is a material that is used to prevent, dissolve, or facilitate removal of undesirable oxide substances on the surfaces of welds.

Table 1
Heat Numbers and Flux Lot Numbers for the
Welds and Weld Specimens for Turkey Point Units 3 and 4

	Manufacturer Heat Number	Manufacturer Flux Lot Number
Unit 3 & 4 Reactor Vessel Welds and Unit 3 Weld Specimen	Page Wire # 71249	Linde 80, Lot 8445
Unit 4 Weld Capsule Specimen	Page Wire # 71249	Linde 80, Lot 8457

39. In terms of the number of capsules and types of material in the capsules, the Turkey Point reactor vessel surveillance program is typical of surveillance programs developed prior to 1972, when the first edition of ASTM Standard E-185 "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels" was issued.

40. As discussed above, the chemical composition of a weld is the primary factor in determining its susceptibility to radiation. The chemical composition of a weld and its associated properties are determinable through its heat number. Therefore, since the welds and weld specimens for Turkey Point Units 3 and 4 have the same heat number, the primary factors affecting their susceptibility to radiation damage are the same.

41. The impact of the difference in the flux lot number between the welds and weld specimens for Turkey Point Unit 4 is unclear. As discussed below, this difference may have caused a

higher than average ART for the one weld capsule tested from Unit 4. In any case, since the weld specimens for Turkey Point Unit 3 have both the same heat number and flux lot number as the welds for Unit 4, test results of the weld specimens for Unit 3 provide a more precise indication of the ART of the Unit 4 welds than do test results of the Unit 4 weld specimens.

42. To date, three capsules containing weld specimens have been removed from Turkey Point Units 3 and 4 (capsule T from Unit 4 and capsules T and V from Unit 3). Additionally, two capsules containing shell forging materials have been removed. Test results of the weld and the shell forging materials in the capsules indicate that the shift in RT_{NDT} for the shell forging material is much less than the shift in RT_{NDT} for the weld material. These results confirm that the welds are the critical material.

43. Table 2 below provides the test results for the weld capsules for Turkey Point Units 3 and 4. As this table indicates, the Delta RT_{NDT} for the Unit 4 weld capsule is higher than the Delta RT_{NDT} for the two Unit 3 weld capsules, even though the Unit 3 weld capsules have neutron fluences that are comparable to or greater than the fluences for the Unit 4 weld capsule. Given the similarity in fluence on and chemical composition of the welds for the reactor vessels for Turkey Point Units 3 and 4, it is unlikely that this discrepancy in Delta

RT_{NDT} for the test capsules reflects any real and significant difference in the fracture toughness of the welds. Instead, there are several possible explanations for this discrepancy that are unrelated to the actual fracture toughness of the welds in the reactor vessels for Turkey Point Units 3 and 4, including:

- Charpy V-notch test results exhibit significant scatter. For example, Regulatory Guide 1.99 states that the standard deviation for Delta RT_{NDT} for industry test data is 28°F. The discrepancy in the test results from Units 3 and 4 may be attributable to this scatter.

- As discussed above, the flux lot numbers are the same for the Unit 3 weld specimens and the welds from Units 3 and 4; however, the flux lot number for the Unit 4 weld specimens is different from the flux lot number for the Unit 4 welds. Although of secondary importance, variations in weld fluxes have been shown to affect ART. The discrepancy in test results may be attributable to this difference in weld flux number.

- When capsule T for Unit 4 was tested in 1975-76, not enough tests were performed in the transition region to precisely define the transition temperature. Because of this lack of data, the curve of absorbed energy versus temperature was conservatively determined for

for capsule T : Unit 4. This additional conservatism may account for the higher Delta RT_{NDT} for capsule T for Unit 4 than for the capsules for Unit 3.

- For some, but not all plants, the first surveillance capsule tested has exhibited an unusually high increase in RT_{NDT}. Subsequent, and more highly irradiated, capsules tested from the same plants have shown a more expected increase in RT_{NDT}. The phenomenon that is causing the unusually high shifts in RT_{NDT} for first capsules is not fully understood at this time. However, this phenomenon may be applicable to capsule T for Turkey Point Unit 4.

The data produced by capsule T from Unit 4 is conservative and its use results in added margins of safety. Since all of the surveillance data from Turkey Point Units 3 and 4, including data from capsule T of Unit 4, were used to calculate the P/T limits, these limits are conservative.

Table 2
Results of Charpy V-Notch Tests For Weld Capsules From Turkey Point Units 3 and 4

Unit	Capsule	Date of Test	Capsule Fluence (n/cm^2)	Delta RT_{NDT}*
3	T	1975	5.68×10^{18}	155°F
4	T	1975-76	6.05×10^{18}	225°F
3	V	1985-1986	1.229×10^{19}	180°F

*(Measured at 30 ft-lbs)

44. In early 1985, FPL submitted an application in accordance with 10 CFR Part 50 Appendix H.II.C to amend the Technical Specifications for Turkey Point Units 3 and 4 to permit the use of an integrated surveillance program. The NRC accepted the Turkey Point integrated surveillance program in a Safety Evaluation and issued the requested amendments on April 22, 1985.

45. The Turkey Point integrated surveillance program contains two primary provisions. First, because the shell forging is not the critical material, specimens containing shell forging material are being held in standby and are not being removed from the reactor vessels and tested. This provision will reduce radiation exposure to workers without resulting in the loss of any critical information. Second, the integrated surveillance program specifies a schedule for removing and testing weld specimens and for combining the results of the tests of the weld specimens from Units 3 and 4. This schedule is shown in Table 3 below. Combining the surveillance capsule test data from Units 3 and 4 will maximize the results of the tests of the surveillance capsules from the units.

TABLE 3
Turkey Point Weld Capsule Removal and Test Schedule

Unit	Capsule	Elapsed Time (Years)	Approximate Year
3	V	12	1985-1986 (actual date)
4	V	24	1997
3	X	33	2005
4	X	Standby	---

46. As the basis for acceptance of the Turkey Point integrated surveillance program, the NRC's Safety Evaluation stated:

- The program would reduce radiation exposure to plant personnel.
- As documented in the Final Safety Analysis Report (FSAR) for Turkey Point Units 3 and 4, the materials and designs for the core, thermal shield, core barrel and vessel are the same for each unit, and the fuel management and cycle lengths have been similar. Therefore, the neutron spectra for both reactors should be equivalent.
- Each unit has used in-capsule and in-cavity dosimetry to verify the neutron spectra and neutron fluence.
- Each unit has its own capsules and is capable of independently predicting and monitoring radiation damage. Therefore, the surveillance program will not be significantly jeopardized by operations at reduced power levels or by an extended outage of either unit.
- Since both units have common management, there should be adequate data sharing between units.

Additionally, although not specifically discussed in the Safety Evaluation, FPL had informed the NRC on several occasions prior to issuance of the Safety Evaluation of the discrepancy in the tests results for the weld capsules from Turkey Point Units 3 and 4. (See, for example, FPL Letter L-82-26 to the NRC, dated January 21, 1982).

47. Turkey Point is somewhat atypical among plants that have NRC-accepted integrated surveillance programs. Most of the individual plants involved in integrated surveillance programs do not have surveillance capsules in their reactor vessels. Instead, surveillance capsules for these plants have been placed in the reactor vessels of two or more other plants, known as "host" plants. Therefore, to make predictions of fracture toughness, these plants must rely upon surveillance capsules irradiated in host plants or must rely upon correlations of industry-wide data accepted by the NRC.

48. Because some plants participating in integrated surveillance programs do not have capsules being irradiated in their reactor vessels, Appendix H to 10 CFR Part 50 requires that integrated surveillance programs have a contingency plan. In particular, Appendix H.II.C.3 of 10 CFR Part 50 requires an integrated surveillance program to include "a contingency plan to assure that the surveillance program for each reactor will not be jeopardized by operation at reduced power level or by an extended

outage of another reactor from which data are expected." The purpose of this requirement in Appendix H is to ensure that, even if one host reactor in the integrated program has an extended outage or period of low power operation, surveillance test data from another host reactor in the integrated program will be available to support future projections of the effects of neutron irradiation on the other reactor vessels in the integrated program that do not contain surveillance capsules. Turkey Point Units 3 and 4 are in a better position than the plants without surveillance capsules in their reactor vessels, because each of the Turkey Point units has surveillance capsules in its reactor vessel. Therefore, Turkey Point does not rely upon a host reactor.

49. In compliance with Appendix H.II.C.3 of 10 CFR Part 50, Turkey Point has a contingency plan. Each of the Turkey Point units has at least one surveillance capsule with weld material with fluence comparable to the fluence on the reactor vessel for the unit. In the event that either unit were to experience an extended outage or period of low power operation, the contingency plan consists simply of allowing each unit to utilize its own surveillance capsules.

2. Relevance of Contingency Plans and Extended Outages and Periods of Low Power Operation

50. As discussed above, in admitting Contention 2, the Licensing Board questioned whether FPL should have implemented a contingency plan under 10 CFR Part 50 Appendix H because of a difference in the EFPY for Turkey Point Units 3 and 4.

51. The validity of the Turkey Point P/T limits for periods up to 20 EFPY would be unaffected by an extended outage or period of low power operation of one Turkey Point unit, or by a difference in EFPY, capacity factor, or neutron fluence between Turkey Point Units 3 and 4. In brief:

- The current Turkey Point P/T limits are based upon the results of tests of surveillance capsules that have already been removed from the Turkey Point reactor vessels. These surveillance test data are sufficient to predict the fracture toughness of the Turkey Point reactor vessels and to calculate P/T limits for up to 20 EFPY.

- Hypothetically, an extended outage or period of low power operation of one of the Turkey Point units (and any differences in EFPY or capacity factors between the units) might affect the total fluence on the remaining surveillance capsules in the reactor vessel for this unit. As a result, the fluence on the surveillance capsules in this unit might be significantly less than the fluence on the reactor vessel of the other unit. However, such a difference would not affect the validity of the P/T limits for up to 20 EFPY based upon the currently-existing surveillance capsule data.

This is explained in more detail below.

52. Appendix G.V to 10 CFR Part 50 requires a licensee to make predictions of the fracture toughness of its reactor vessels using the results of surveillance programs conducted pursuant to Appendix H to 10 CFR Part 50. By their nature, these predictions must be based upon existing test results from surveillance capsules, extrapolated to account for the effects of future irradiation.

53. In general, schedules for removal and testing of surveillance capsules are designed to confirm the existing fracture toughness of reactor vessel materials and to support periodic predictions of the fracture toughness of materials in the future. The intervals between tests are set such that data from tested surveillance capsules will exist for a relatively wide range of neutron fluences. Use of test results from capsules with a range of neutron fluences provides for more

precise predictions of the future fracture toughness of reactor vessel materials.

54. The assumptions used in developing the test schedule for an integrated surveillance program could be jeopardized if one of the units with surveillance capsules in the integrated program has an extended outage or period of low power operation. In this event, the surveillance capsules in the unit would not have received the expected neutron fluence at the time scheduled for removal and testing of the capsule. As a result, if other units in the integrated program continued to operate and accumulate fluence, it is possible that the neutron fluence of the tested capsule would be much less than the fluence received by the operating units. Consequently, test data from the unit which experienced the extended outage or period of low power operation would correspond to a relatively low fluence and might not be sufficient to confirm the existing fracture toughness and to support projections of the future fracture toughness of the reactor vessels of the other units that had continued to operate and accumulate fluence.6/

6/ Such capsule test data would nevertheless still be sufficient to predict the fracture toughness of the unit from which the capsule was removed, because the fluence on the capsule and the reactor vessel of the unit would be comparable.

55. To mitigate this possibility, Appendix H to 10 CFR Part 50 requires each integrated surveillance program to have a contingency plan. In essence, the purpose of the contingency plan is to ensure that, if one unit in the integrated program has an extended outage or period of low power operation, surveillance capsule test data will be available with fluences comparable to the fluences being accumulated by the other operating units in the integrated program. Without such data, the operating units might not be able to confirm the fracture toughness of their reactor vessels or to make predictions of the future fracture toughness of their reactor vessels. Thus, a contingency plan ensures that sufficient surveillance capsule data will be available in the _future_ to support determinations of fracture toughness of a reactor vessel. The need for, or implementation of, a contingency plan does not affect the validity of _existing_ surveillance capsule data or predictions made from such data.

56. In the case of Turkey Point, FPL currently has three existing surveillance capsules data points. The fluence for these capsules ranges from approximately 6×10^{18} n/cm^2 to 1.2×10^{19} n/cm^2. This range is sufficient for predicting the ART of the Turkey Point reactor vessels at 20 EFPY, when the fluence on

the inside of the reactor vessel walls is expected to be approximately 2 x 10^{19} n/cm^2.7/

57. The sufficiency of this surveillance capsule data for predicting the ART at 20 EFPY can be demonstrated in several ways. For example, as discussed in Section II above, the P/T limits for Turkey Point were calculated assuming the existence of a flaw extending through one-fourth of the thickness (i.e., 1/4T) of the reactor vessel wall, and the P/T limits were calculated based upon the ART at 1/4T at 20 EFPY. The ART of the wall at 1/4T is less than the ART at the inside of the wall, because less fluence reaches the 1/4T location due to shielding provided by the wall itself. In particular, using the shielding factor provided in Regulatory Guide 1.99, the fluence at 1/4T for the Turkey Point reactor vessels is calculated to be approximately 60% of the fluence at the inside wall. Thus, at 20 EFPY, the fluence at 1/4T is predicted to be 1.26 x 10^{19} n/cm^2, which is essentially equivalent to the fluence of one of the capsules at Turkey Point that has been removed and tested. Given the equivalence between the fluence of the tested surveillance capsule and the fluence at 1/4T at 20 EFPY, the surveillance

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7/ The accumulated fluence at Turkey Point Units 3 and 4 is not linerally related to EFPY, because FPL has initiated flux reduction programs to reduce the fluence on the reactor vessel walls.

capsule data are sufficient for predicting the ART at 1/4T for the reactor vessel at 20 EFPY.8/

58. The calculation of the Turkey Point P/T limits for up to 20 EFPY was based upon surveillance capsules removed from the reactor vessels in 1985 or earlier. If an extended outage or period of low period operation were postulated to have occurred at one of the Turkey Point units since 1985, or if a difference in capacity factors or EFPY were postulated to have occurred between the two units since 1985, it would be possible for the remaining capsules in one of the Turkey Point units to have significantly less fluence than the fluence on the reactor vessel of the other unit. As a result, future testing of the remaining capsules from one unit might not provide sufficient data to confirm the fracture toughness or to support future predictions or extrapolations of the fracture toughness of the other unit. However, such a result would only affect the ability to make predictions or extrapolations beyond 20 EFPY, since currently-existing surveillance data are sufficient for predictions or calculations up to 20 EFPY.9/ Therefore, the Turkey Point P/T

8/ This is a very conservative analysis because it is possible to make reliable extrapolations of ART at a fluence that is higher than the maximum fluence of a tested surveillance capsule.

9/ Outages or periods of low power operation would only affect the time at which 20 EFPY would be reached; they would not affect the fluence at 20 EFPY or the fracture toughness of the reactor vessel at 20 EFPY. This is explained further in the following section.

limits up to 20 EFPY would be unaffected by any postulated extended outage or period of low power operation, or by any postulated difference in capacity factors or EFPY, or by any need to implement the Turkey Point contingency plan based upon either of these postulates.

3. Operating Histories Since 1985

59. In 1985, when the Turkey Point integrated surveillance program was accepted by the NRC, the lifetime fluences and EFPY for Turkey Point Units 3 and 4 were very similar. As shown in Table 4 below, the differences between the units with respect to these figures was less than ten percent.

Table 4
Fluence and EFPY
For Turkey Point Units 3 and 4 as of March 30, 1985

Unit	Fluence10/	EFPY	Capacity Factor
3	1.26×10^{19}	8.07	66.6
4	1.16×10^{19}	7.62	67.2

60. As explained in the previous section, any extended outages or periods of low power operation of Turkey Point since 1985 would not be relevant to the validity of the current P/T

10/Fluence at the inside surface of the reactor vessel wall.

limits based upon existing surveillance capsule data. In any event, as discussed below, the operating histories of Turkey Point Units 3 and 4 since 1985 have been very similar and the differences have not been significant. Therefore, the operating history of Turkey Point since 1985 does not provide any reason to invoke the use of the contingency plan in the integrated surveillance program or bring into question the use of surveillance capsules from one unit to help predict the fracture toughness of the other unit.

61. In determining the effects of neutron irradiation in a commercial power pressurized water reactor such as Turkey Point, the total amount of fluence (and not the rates or duration of accumulation) is of importance. Outages, EFPY, capacity factors, and operation at low power are of significance to fracture toughness only to the extent they affect total fluence. Therefore, as long as the current fluences for Turkey Point Units 3 and 4 are comparable, historical information concerning operation and outages of each unit is insignificant.

62. FPL currently has data on the total predicted fluence for the inside surface of the reactor vessel walls for Turkey Point Units 3 and 4 through the end of cycles in 1990. Table 5 below identifies this total for each unit. As this table indicates, the totals for both units are very close, differing by less than 4×10^{17} n/cm^2, or less than 3%. Differences of this

magnitude are insignificant in determining whether the fluence on a capsule for one unit is sufficient to predict the fracture toughness of another unit participating in an integrated surveillance program. For example, this difference only represents approximately 0.5 EFPY.

Table 5
Fluence, EFPY, and Capacity Factors
For Turkey Point Units 3 and 4

	Fluence (n/cm^2) 11/		EFPY		Capacity Factor	
Unit	Lifetime	1985-90	Lifetime 12/	1985-88	Lifetime 13/	1985-88
3	1.413×10^{19}	2.288×10^{18}	10.2	2.08	63.0	51.9
4	1.377×10^{19}	2.527×10^{18}	9.7	2.18	63.3	54.4

63. For the sake of comparison, Table 5 also provides data on the amount of fluence received by the reactor vessel of each unit for the three cycles from 1985 to 1990. As this table indicates, the fluence on each reactor vessel has not differed significantly since the NRC accepted the integrated surveillance program in 1985.

64. Table 5 also presents data on the total EFPY and total capacity factors for Turkey Point Units 3 and 4 throughout their lifetimes and during the years 1985 to 1988. Although such

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11/ Through the cycle ending in 1990, at the inside surface of the reactor vessel wall

12/ Through August 23, 1989

13/ Through the end of 1988.

factors are not directly relevant to fracture toughness of the reactor vessels, there is an indirect relationship between these factors and fluence and therefore an indirect relationship between these factors and fracture toughness. As this table shows, the total EFPY and capacity factors for Turkey Point Units 3 and 4 are similar during their lifetimes and during 1985-88. Given the relatively small impact of these differences on the total fluence, these differences are not sufficient to call into question the use of surveillance capsules from one unit to help predict the fracture toughness of the other unit.

65. Finally, a comparison of the lifetime EFPY and fluence in 1985 when the NRC accepted the integrated surveillance program (see Table 4) with the current lifetime EFPY and fluence (see Table 5) demonstrates that the operating histories of Units 3 and 4 are even closer today than they were when the NRC accepted in the integrated program in 1985. This demonstrates the acceptability of the current differences in EFPY and fluences for Units 3 and 4.

66. It is difficult to state with certainty when the differences in EFPY between reactors would be sufficient to require implementation of a contingency plan or to require each unit participating in an integrated surveillance program to rely only upon its own surveillance capsule test data. For example, there is no regulatory guidance or precedent that interprets the

terms "extended outage" or period of "operation at reduced power levels," as used in Appendix H to 10 CFR Part 50. However, as explained above, as long as the fluence on a surveillance capsule equals or exceeds the fluence at the 1/4T location, it is possible to make reliable determinations of the fracture toughness of the reactor vessel wall at the 1/4T location. This suggests that the terms "extended outage" and period of "operation at reduced power levels" could be defined as at least the length of time required to accumulate fluence equal to the difference between the fluence of the surveillance capsule and the fluence at the 1/4T location.14/ In the case of Turkey Point, the maximum fluence of a tested capsule is 1.229×10^{19} n/cm^2 and the maximum fluence at the 1/4T location currently is less than 0.878×10^{19} n/cm^2 (using the fluences specified in Table 5 and the methodology in Regulatory Guide 1.99). The difference between these numbers is 0.351×10^{19} n/cm^2 which, depending upon a number of variables, is approximately equal to five EFPY at the current flux. As discussed above, the actual difference in length of operation of the Turkey Point units is far less than this number; i.e., only about 0.5 EFPY. Therefore, even if the very conservative definition given above were

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14/ This would be a very conservative definition, because it is possible to make reliable extrapolations of ART at a fluence that is higher than the maximum fluence of a tested surveillance capsule. Therefore, it would not be necessary for a plant to implement a contingency plan merely because the maximum fluence on a capsule in the integrated surveillance program is less than the fluence at the 1/4T location.

adopted, there would be no need to implement the contingency plan at Turkey Point.

4. Other Issues Raised by Intervenors

67. Most of the issues raised by the Intervenors have been dealt with above. This section discusses the few remaining issues identified by the Intervenors.

68. In response to a discovery request, the Intervenors identified as a basis for Contention 2 that in 1987 Unit 3 had a capacity factor of 14% and Unit 4 had a capacity factor of 45%.15/ As discussed in the previous section, the capacity factor during any particular period is not significant in determining the validity of continued application of an integrated surveillance program. It is not unusual for units to have different capacity factors from year to year. As long as the total fluences for the units are comparable, continued implementation of an integrated surveillance program for the units is appropriate. Since the total fluences for Turkey Point Units 3 and 4 are comparable, the difference in capacity factors during 1987 is of no importance.

15/ The actual capacity factor for Unit 3 in 1987 was 15%.

69. In response to this discovery request, Intervenors also claimed as a basis for Contention 2 that Unit 4 had an overpressure event while Unit 3 did not. Presumably, the Intervenors are referring to two events that occurred at Unit 4 in 1981 in which the pressure in the reactor coolant system exceeded technical specification limits by approximately 700 psi and 325 psi, respectively. Subsequent inservice inspection of the Unit 4 reactor vessel did not identify any defects. Additionally, in a report issued in March 1984 (before the NRC accepted the Turkey Point integrated surveillance program), the NRC concluded that these events did not affect the structural integrity of the Unit 4 reactor vessel.

70. Furthermore, as explained in Section I.B above, the fracture toughness of a metal is dependent upon the chemical properties of the metal, its temperature, and its neutron fluence. Factors such as applied pressure, thermal and mechanical cycling, and other operational events do not significantly affect the fracture toughness of a metal as long as operational parameters are within design limits. Other than the overpressure events in Unit 4 in 1981, the reactor vessels for Turkey Point Units 3 and 4 have been operated within their design limits throughout their lifetime and therefore the factors mentioned above are not relevant to the fracture toughness of the reactor vessels.

5. Calculation of Hypothetical P/T Limits for Unit 4

71. Contention 2 in essence alleges that it is inappropriate to utilize the results of the Turkey Point integrated surveillance program to calculate the P/T limits for Turkey Point Unit 4. As discussed above, use of the results of the integrated surveillance program is appropriate for calculating the P/T limits for both Units 3 and 4. However, for the purpose of litigation, FPL also performed a calculation to determine the impact on the P/T limits for Unit 4 if the results of the integrated surveillance program had not been utilized.

72. In performing this calculation, FPL utilized the methodology in Regulatory Guide 1.99 to calculate a hypothetical ART. Using this ART, FPL then calculated hypothetical P/T limits using the Electric Power Research Institute (EPRI) Pressure Temperature Appendix G Curve Calculator.16/

73. As discussed in Section III.B.1 above, there is only one surveillance capsule data point for Turkey Point Unit 4. Regulatory Guide 1.99 states that chemistry content is to be used

16/ The EPRI Curve Calculator uses a somewhat different methodology than was utilized by Westinghouse in calculating the P/T limit curves for Turkey Point Units 3 and 4. However, the EPRI Curve Calculator complies with Appendix G of the ASME Code and produces similar results to the Westinghouse method. Additionally, to provide a uniform basis for comparison, FPL also used the EPRI Curve Calculator to recalculate the P/T limits using the results of the integrated surveillance program.

to calculate the chemistry factor unless two or more credible surveillance capsule data sets are available. Therefore, in accordance with Regulatory Guide 1.99, FPL utilized chemistry content in calculating the chemistry factor for use in determining the hypothetical P/T limits for Unit 4. Specifically, in accordance with Regulatory Guide 1.99, FPL utilized the "best estimate" or the mean values of .26% copper and .60% nickel in calculating the hypothetical P/T limits for Unit 4.

74. Figure 3 shows the results of the calculation of the hypothetical P/T limits for Unit 4 and the P/T limits for Units 3 and 4 based upon the results of the integrated surveillance program (as calculated using the EPRI Curve Calculator). As this figure depicts, the hypothetical P/T limits for Unit 4 and the P/T limits for Units 3 and 4 based on the results of the integrated surveillance program are almost identical. Therefore, it is of little significance whether the P/T limits for Unit 4 are calculated based upon the results of the integrated surveillance program or based upon unit specific data; the P/T limits are essentially the same in either case.

75. It should be noted that, for several reasons, it would be inappropriate to calculate P/T limits for Turkey Point Unit 4 using only the one surveillance capsule data point for Unit 4. First, such an approach would be inconsistent with Regulatory

Guide 1.99. Second, it is not possible or appropriate to perform an extrapolation based upon a single data point. Finally, since Charpy V-notch test results in general exhibit a significant amount of scatter, the results of Charpy V-notch testing of a single capsule contain a large degree of uncertainty.17/

IV. Conclusion

76. FPL utilized the methodology in NRC-accepted industry standards and NRC Regulatory Guide 1.99 to calculate the P/T limits for Turkey Point Units 3 and 4. The methods are extremely conservative and resulted in P/T limits that contain a large margin of safety.

77. FPL did not calculate the Turkey Point P/T limits using 0.26% copper content or any other value of copper content. Instead, in accordance with Regulatory Guide 1.99, FPL utilized surveillance capsule data to calculate the P/T limits.

17/ In Contention 2, the Intervenors have argued that an additional surveillance capsule from Unit 4 should now be removed and tested to provide additional data points for use in calculating RT_{NDT}. Such an action would be inconsistent with the schedule in the Turkey Point integrated surveillance program and would violate the Technical Specifications for Turkey Point. Additionally, such an action would have the effect of depriving Turkey Point of its only standby surveillance capsule containing weld material. As a result, Turkey Point would not have a capsule available in the future to perform additional testing if events should warrant it.

78. The Turkey Point integrated surveillance program has provided sufficient surveillance capsule data to calculate the P/T limits for up to 20 EFPY. Any extended outages or periods of low power operation subsequent to the removal of these capsules would not affect the validity of the data used to calculate the P/T limits for up to 20 EFPY. In any case, the operating histories of Turkey Point Units 3 and 4, since acceptance of the integrated surveillance program in 1985, have been very similar and do not cast doubt upon the continued utilization of the integrated surveillance program or the use of surveillance test data from one unit to help predict the fracture toughness of the other unit. Finally, even if the results of the integrated surveillance program had not been utilized to calculate the P/T limits, the impact of the P/T limits would have been insignificant.

District of Columbia)
)
City of Washington)

Stephen A. Collard, being first duly sworn, deposes and says that the foregoing information is true and correct to the best of my knowledge, information, and belief.

Stephen A. Collard

Stephen A. Collard

Dated September 11, 1989

Subscribed and sworn to
before me this 11th day of
September, 1989.

Ruth A. Davis

Notary Public

RUTH A. DAVIS, Notary Public
District of Columbia

My Commission Expires: My Commission Expires January 31, 1994

STATEMENT OF PROFESSIONAL QUALIFICATIONS
OF STEPHEN A. COLLARD

EDUCATION

Polytechnic Institute of Brooklyn - B.S. Metallurgical Engineer - 1967

New York University, Post Graduate - Studies in Metallurgy - 1968

St. John's University Law School - Studies in Law - 1971

EXPERIENCE

1982 - 1989 Florida Power and Light Company

1970 - 1982 Consolidated Edison Company of New York

1968 - 1970 U.S. Army 1Lt.

1967 - 1968 Consolidated Edison Company of New York

1967 - 1982 Assistant Engineer - Division Engineer

Performed metallurgical failure analysis on nuclear and fossil generation and transmission and distribution equipment. Developed non-destructive examination capability of Consolidated Edison's laboratory, including the use of eddy current testing for nuclear steam generators and fossil heat exchangers and infrared testing of transmission and distribution and power plant components. As Division Engineer, supervised the laboratory operation of failure analysis, non-destructive examination, budgeting and scheduling.

1982 - present Senior Engineer - Section Supervisor

Established failure analysis laboratory for Florida Power & Light. Managed the reactor surveillance materials program. Managed the vessel integrity program. Supervised inservice inspection programs.

PUBLICATIONS AND PRESENTATIONS

"Establishing a Failure Analysis Laboratory in the Power Industry", Reliability Conference for the Electric Power Industry, Miami, FL 1979

"Root Cause Failure in Electric Transmission and Distribution Equipment", Reliability and Maintainability Symposium, San Francisco, CA 1980

FIGURE 1

VARIATIONS IN FRACTURE TOUGHNESS WITH CHANGES IN TEMPERATURE.

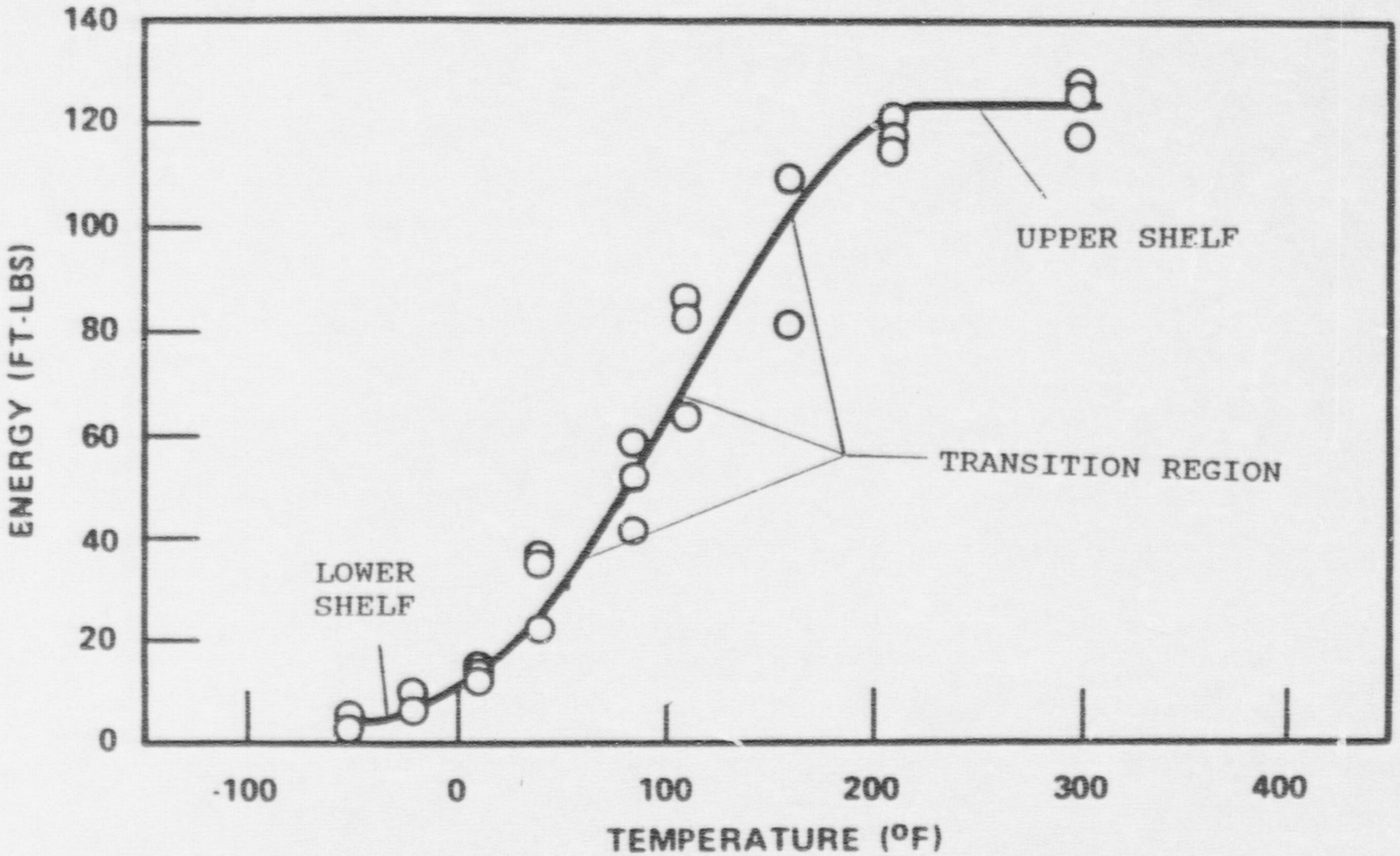


FIGURE 2

VARIATIONS IN FRACTURE TOUGHNESS OF PRESSURE VESSEL STEELS WITH CHANGES IN FLUENCE.

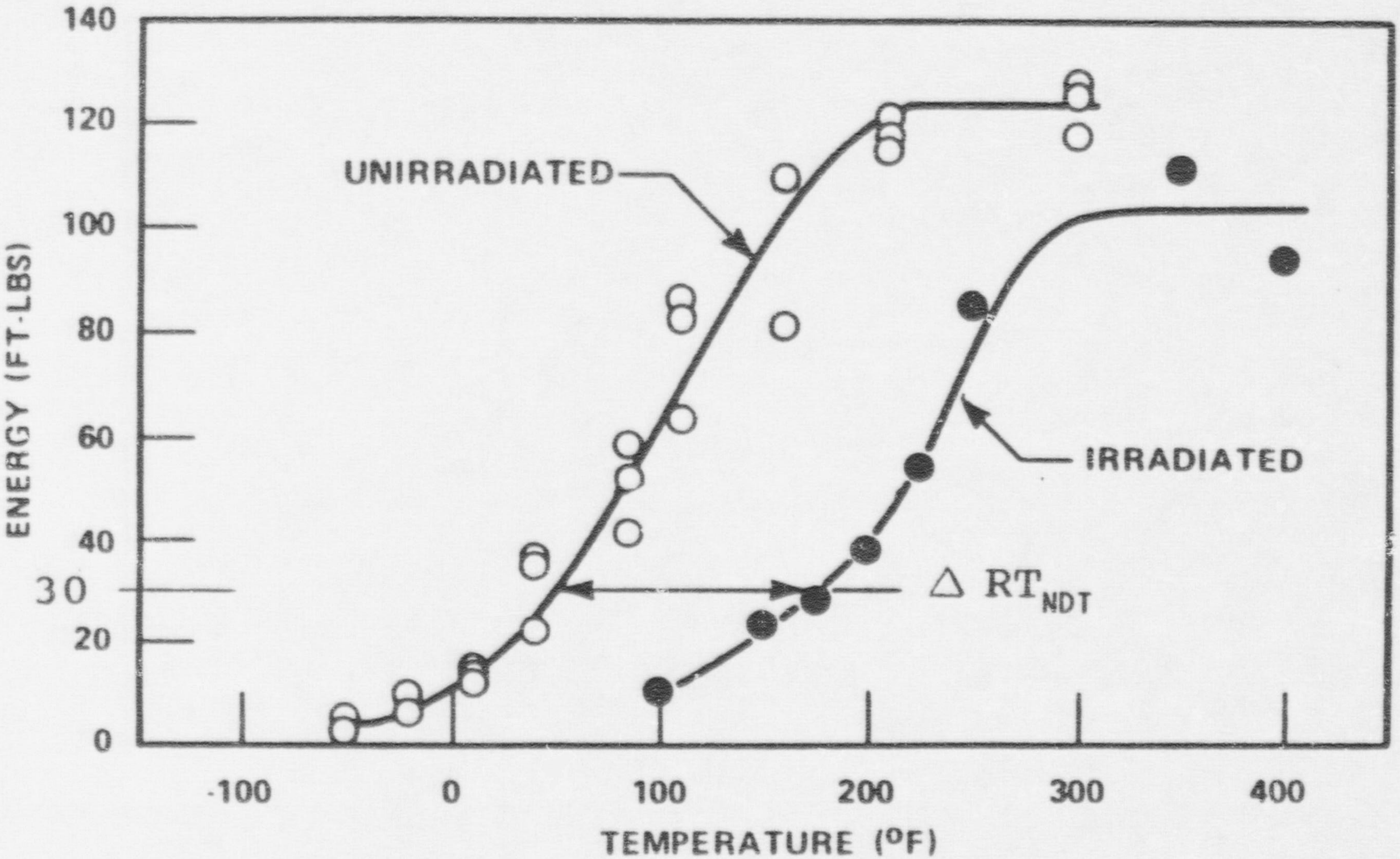
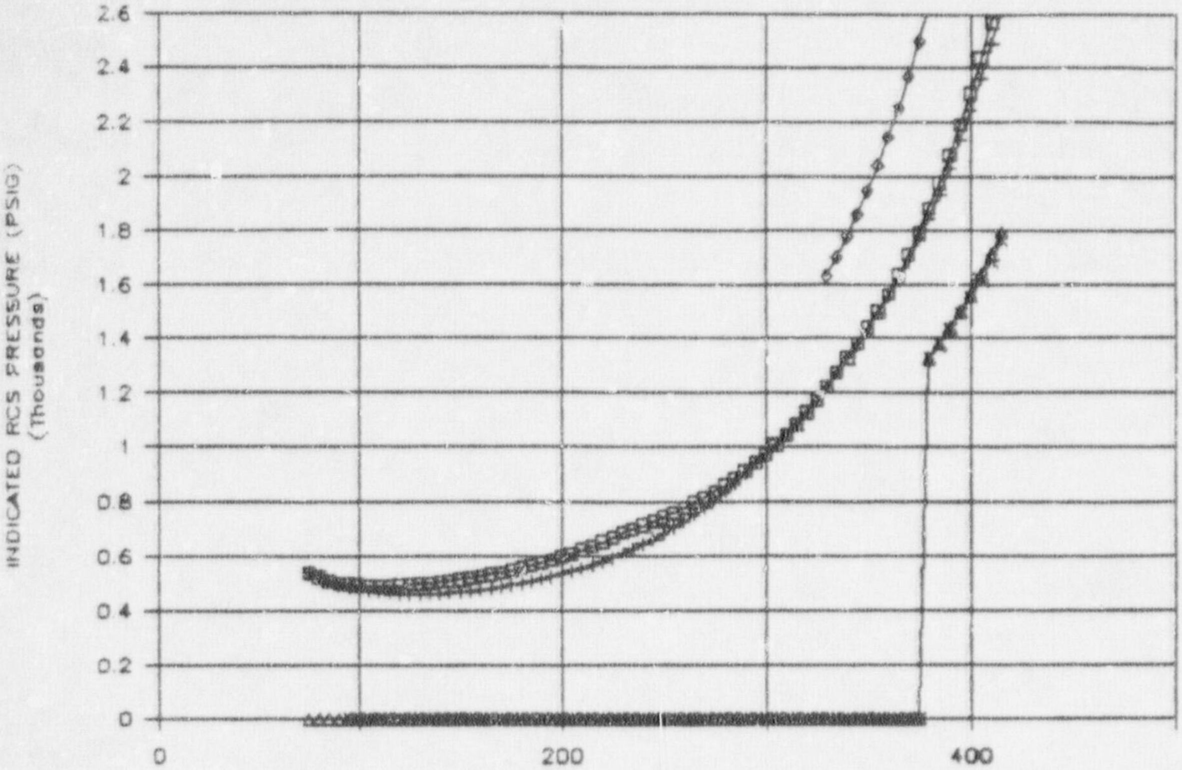
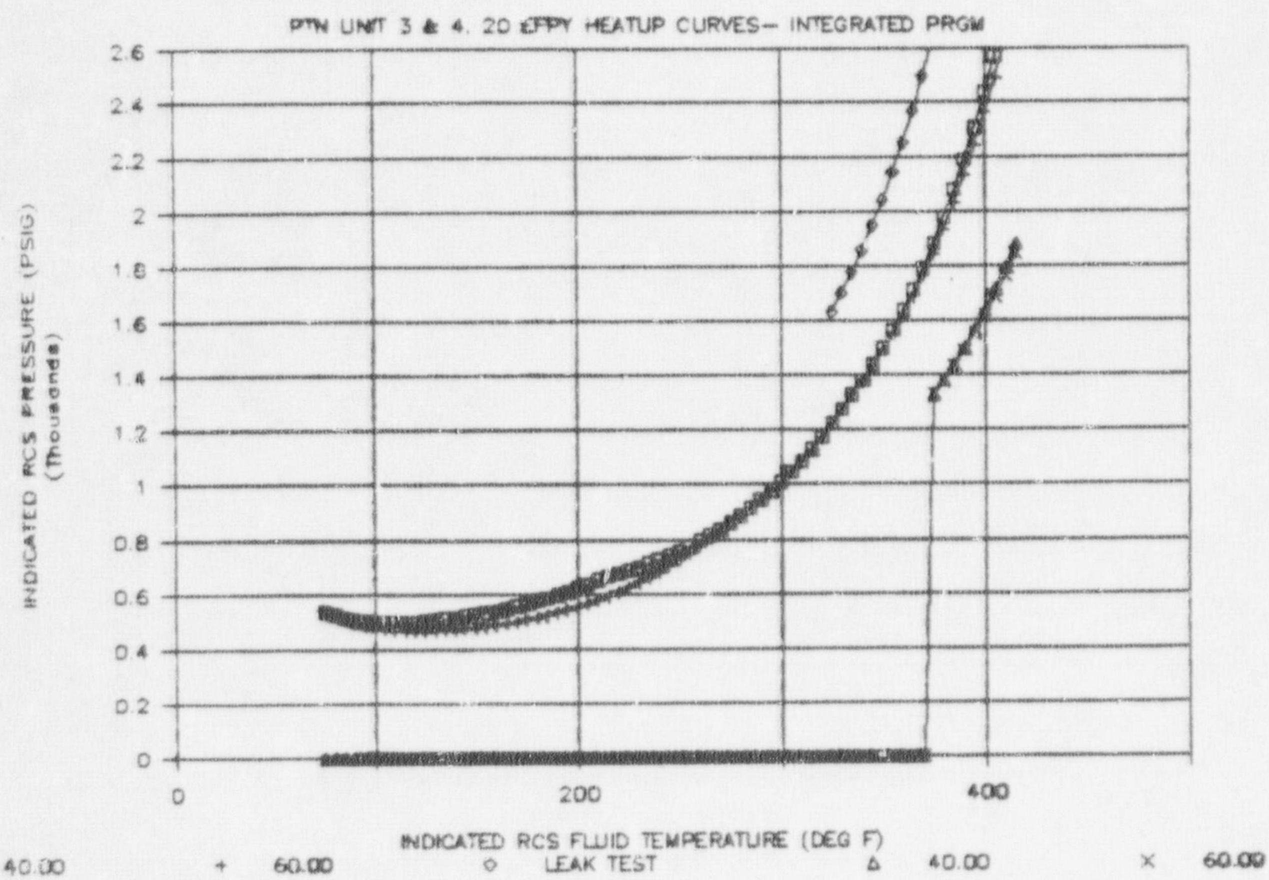


FIGURE 3

TURKEY POINT   20 EFPY   HEAT UP P/T LIMIT
CURVES USING 0.26% COPPER AND 0.60% NICKEL





*NOTE: Both curves were generated using the EPRI Curve Calculator for similar comparison

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

'89 SEP 12 P5:27

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

In the Matter of	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 50-250 OLA - 4
	)	50-251 OLA - 4
	)	
(Turkey Point Plant, Units 3 and 4	)	(P/T Limits)

CERTIFICATE OF SERVICE

I hereby certify that copies of:

1. Letter from Steven P. Frantz to Licensing Board Members (September 11, 1989).

2. Licensee's Motion For Summary Disposition Of Intervenors' Contentions (September 11, 1989).

3. Licensee's Statement Of Material Facts As To Which There Is No Genuine Issue To Be Heard With Respect To Intervenors' Contentions (September 11, 1989).

4. Affidavit Of Stephen A. Collard On Contentions 2 and 3 With Attachments (September 11, 1989).

in the above captioned proceeding were served on the following by deposit in the United States mail, first class, properly stamped and addressed on the date shown below.

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Attention: Chief, Docketing and Service Section
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Dated this 11th day of September 1989.

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