UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
FLORIDA POWER & LIGHT COMPANY	)	
	)	Docket No. 50-335 OLA
(St. Lucie Plant, Unit No. 1)	)	
	)	ASLBP No. 88-560-01-LA

AFFIDAVIT OF DR. GERALD R. KILP
ON ADMITTED CONTENTION NO. 3 (KILP AFFIDAVIT 3a)

I, Gerald R. Kilp, being duly sworn, say as follows:

1. I am an Advisory Engineer in the Engineering Department of the Commercial Nuclear Fuel Division of the Westinghouse Electric Corporation. My business address is Westinghouse Electric Corporation, Monroeville Mall Office Building, P. O. Box 3912, Pittsburgh, PA 15230. A summary of my qualifications and experience is attached hereto as Exhibit A, which is incorporated herein by reference. I have personel knowledge of the matters stated herein and believe them to be true and correct. This affidavit is offered in support of "Licensee's Motion for Summary Disposition of Intervenor's Contentions," regarding Admitted Contention 3.

2. Admitted Contention 3 (originally Amended Petition Contention 6) states:

> The Licensee and Staff have not adequately considered or analyzed materials deterioration or failure in materials integrity resulting from the increased generation of heat and radioactivity as a result of increased capacity in the spent fuel pool during the storage period authorized by the license amendment.

The bases for Admitted Contention 3 were stated as follows:

> The spent fuel facility at the St. Lucie Plant, Unit No. 1, was originally designed to store a lesser amount of fuel for a short period of time. Some of the problems that have not been analyzed properly are:
>
> a. Deterioration of fuel cladding as a result of increased exposure and decay heat and radiation levels during extended periods of pool storage.
>
> b. Loss of materials integrity of storage rack and pool liner as a result of exposure to higher levels of radiation over longer periods.
>
> c. Deterioration of concrete pool structure as a result of exposure to increased heat over extended periods of time.

3. The purpose of my affidavit is to demonstrate that the impacts of radiation and heat on the materials used in the spent fuel pool liner and storage racks (exclusive of Boraflex materials) have been adequately considered. The impacts of radiation and heat on the concrete pool structure are treated in the Affidavit of Murray Weber, offered in support of "Licensee's Motion for Summary Disposition of Intervenor's Contentions," regarding Admitted Contention 3. The impacts of radiation and heat on the Boraflex material used in the storage racks are addressed in the Affidavit of Dr. K. P. Singh, offered in support of "Licensee's Motion for Summary Disposition of Intervenor's Contentions," regarding Admitted Contentions 3 and 6. The impacts of radiation and heat on the fuel cladding and fuel assembly materials are discussed in my other Affidavit, Kilp Affidavit 3b, offered in Support of "Licensee's Motion for Summary Disposition of Intervenor's Contentions," regarding Admitted Contention 3.

The Spent Fuel Pool Liner

4. The St. Lucie 1 spent fuel pool liner is made from Type 304 stainless steel. The floor and the bottom portions of the wall are nominally 1/4 inch thick; the remainder of the walls, except for the cask storage area in the Northeast corner, is 3/16 inch thick. The depression portion of the cask storage area in the mat is lined with 1/2 inch thick stainless steel plate on the walls. The floor of the cask storage area is lined with 1 inch thick stainless steel plate.

5. Type 304 stainless steel is a preferred material for use in applications such as spent fuel pool liners because of its ease of formability, weldability and exceptional corrosion resistance to high temperature water and/or steam. Type 304 stainless steel is also used for many other applications in nuclear power plants including fuel assembly components, piping, etc. There are also a few nuclear plants where it is being used for fuel rod cladding, a practice which has been going on for over 20 years. Many applications are for conditions more severe than those in a spent fuel pool.

The Non-Boraflex Materials in the Storage Racks

6. The spent fuel storage racks (excluding the Boraflex) are made from Type 304L stainless steel, except for the feet which are made from 17-4 PH stainless steel. The minimum thickness of the racks at any point is 0.080 inches. Type 304L stainless steel, which differs from Type 304 only in that the former has a slightly lower carbon content, was selected for the same reasons that Type 304 is used for the spent fuel pool liner. The Type 17-4 PH stainless steel, has comparable corrosion properties to Types 304 and 304L. It is used for the feet on the racks because it can be heat-treated to a designated hardness which makes it useful for threaded connections with Type 304L. The harder Type 17-4 PH prevents galling (adhesion of contacting surfaces) when threaded into Type 304L. Type 304L, Type 304, and 17-4 PH stainless steels are also used within the primary system of pressurized water reactors.

Radiation and Thermal Environment in the St. Lucie 1 Pool

7. Four types of radiation (alpha, beta, gamma, and neutron) will be present in the spent fuel pool to varying degrees. The alpha and beta radiations are of no concern because they cannot penetrate metal alloys such as Type 304 stainless steel to a significant depth. Hence, these radiations can have no effect on the bulk properties of the alloy components. In fact, since virtually all the isotopes generating alpha and beta radiation are contained within the fuel cladding, there will be insignificant alpha and beta radiation impinging on the spent fuel pool liner and the storage racks since these radiations cannot pass through the innermost surface of the fuel cladding.

8. The situation is different with respect to gamma and neutron radiations. Through the expiration of the St. Lucie 1 operating license (March 1, 2016), there could be a total integrated gamma dose of less than 1×10^{11} rads as discussed in the Affidavit of Dr. Stanley E. Turner.

9. There will also be a very low fast neutron flux present in the pool throughout its design lifetime. The maximum integrated fluence is very conservatively estimated to be less than 5×10^{15} neutrons/cm^2, as discussed in the Affidavit of Dr. Stanley E. Turner. The difference between reactor neutron fluences and the highest postulated spent fuel pool fluences is several orders of magnitude. To put it another way, the added neutron exposure after as long as 40 years in the pool is equivalent to less than two minutes in the reactor when it is at full power. From the foregoing, it is evident that any radiation effects from neutrons due to increasing the capacity of the pool is negligible compared to what the pool liner and rack type materials are routinely subjected to in other nuclear applications.

10. The spent fuel pool liner and rack materials will also be exposed to heat arising from the temperature of the pool water. While the normal pool temperature is expected to remain less than 134 degrees Fahrenheit, under loss of cooling conditions the temperatures could reach boiling as discussed in the Affidavit of John Houghtaling.

Portions of the racks could also be subject to slightly higher temperatures (a few degrees at most) due to localized gamma heating.

Radiation Effects on the Spent Fuel Pool Liner and Rack Materials

11. As noted above, the materials comprising the spent fuel pool racks (other than Boraflex) are Type 304L stainless steel and Type 17-4 PH stainless steel while the pool liner is made from Type 304 stainless steel. There are no anticipated effects from alpha and beta radiation because they are non-penetrating to metals and are essentially contained within the fuel rods anyway. Fast neutrons can affect the physical properties of metal alloys like those used here, but even at fluences many orders of magnitude higher than the worst postulated over the pool life, fast neutron effects can be tolerated. In fact, an integrated fast neutron fluence of 10^{17} to 10^{18} neutrons/cm^2 is needed before a measurable change in properties of such materials could be detected. This fluence level is what is referred to as the "threshold" level for induced change. The maximum integrated fluence for the St. Lucie 1 Pool was estimated to be less than 5×10^{15} neutrons/cm^2 which is at least an order of magnitude below the threshold level. Hence, it is readily evident that the fast neutron exposure even over the entire design lifetime of the St. Lucie pool will have essentially no effect on the pool liner and rack materials.

12. Gamma radiation, which is prevalent in the pool to a significant degree, has no physical effects on the materials being addressed here. The only direct effect on these materials is minor heating due to attenuation. This effect would only amount to a few degrees at most, and is negligible compared to the pool water temperatures of interest.

Materials Degradation due to the Thermal Environment

13. The highest pool temperature is postulated for loss of cooling conditions. Even if such temperatures were operative over the life of the plant, there would be no changes in materials properties since microstructural changes in stainless steel are not observed below 500 degrees Fahrenheit.

14. Corrosion in the spent fuel pool has been considered and judged to be of no concern. All of these materials have been shown by test and experience to be virtually immune to corrosion at spent fuel pool temperatures. Type 304 stainless steel for example, would not be expected to corrode more than 6/10000 inches after 100 years in an oxygenated, borated environment like the pool water. This is to be compared to the over 80/1000 inch minimum dimension of any of the pool liner and rack components. Additionally, since all these materials form protective oxide films, no significant galvanic attack is expected.

15. Hydriding is of no concern for stainless steels under the duties of interest here. It is a function of the corrosion rate which is extremely small. Thus, the hydriding rate in the pool will also be extremely small.

16. The possibility of stress corrosion cracking of sensitized Type 304 stainless steel adjacent to welds in the fuel pit liner is remote. However, should it occur it would be minor. Numerous studies of the actual performance of Type 304 stainless steel in fuel storage pools have been performed by organizations in the United States and throughout the world. From these studies, there is no evidence that stress corrosion cracking of Type 304 stainless, or any other stainless steel, is occurring to a significant degree, even after many years of pool water exposure.

17. The Type 304L stainless steel has virtually no possibility of stress corrosion cracking because the lower carbon utilized in this steel effectively prevents sensitization, even during welding. Hence, the fuel racks are considered to be immune to stress corrosion cracking.

Overall Conclusions

18. Based on the above discussions of the thermal and radiation environment to be expected in the St. Lucie 1 pool, it is concluded that there are no corrosion or radiation threats to the long term integrity of the liner and rack materials. Over the period extending from the present to the expiration of the St. Lucie 1 license (March 1, 2016), any corrosion is expected to be very superficial, amounting to much less than 6/10000 inch. There are essentially no radiation effects of concern from neutrons, because the integrated dose would be so low. Gamma, alpha, and beta radiations are of no consequence for these materials. Hydriding and stress corrosion cracking of the Type 304 stainless steel liner was considered and judged to be highly unlikely. Even if small cracks were assumed to occur and extend through the liner, the leak rates would be well within the capabilities of the pool makeup system.

19. Support for the above conclusions are drawn from the extensive experience accumulated all over the world in spent fuel pools similar to the St. Lucie 1 pool. There is already over 40 years of industry experience with wet storage and it is a fully-developed technology with no known technological problems. Examinations of spent fuel assembly components (including Type 304 stainless clad pressurized water reactor fuel pins) and other components stored in spent fuel pools have essentially shown no detectable changes after decades of storage.

20. I, therefore, conclude that since there are no material degradation concerns for either the pool liner or the rack materials in the St. Lucie 1 fuel storage pool, these materials can be safety used in the pool from the present to the expiration of its operating license on March 1, 2016.

FURTHER AFFIANT SAYETH NAUGHT

The foregoing is true and correct to the best of my knowledge, information, and belief.

Gerald R. Kilp

Gerald R. Kilp

STATE OF PENNSYLVANIA)

COUNTY OF ALLEGHENY)

Subscribed and sworn to before me this 22nd day of July, 1988.
My commission expires 12-14-91.

Lorraine M. Piplica

Notary Public

LORRAINE M. PIPLICA, NOTARY PUBLIC
MONROEVILLE BORO, ALLEGHENY COUNTY
MY COMMISSION EXPIRES DEC. 14, 1991
Member, Pennsylvania Association of Notaries

EXHIBIT A

STATEMENT OF PROFESSIONAL QUALIFICATION OF
GERALD R. KILP

My name is Gerald R. Kilp. My business address is Westinghouse Electric Corporation, P. O. 3912, Pittsburgh, Pennsylvania, 15230. I am an Advisory Engineer for the Fuel Performance Engineering Section of the Westinghouse Commercial Nuclear Fuel Division, Westinghouse Electric Corporation. I have served in this function since November, 1983. In this capacity, I am responsible for selected Materials Development programs and act as a general advisor on materials performance questions for the Westinghouse Nuclear Fuel Division.

I graduated from Missouri Valley College, Marshall, Missouri, in 1952 with a Bachelor of Science degree in Chemistry. In 1957, I received a Doctorate of Physical Metallurgy from Iowa State College (since renamed to Iowa State University).

From 1952 to 1957, I was a Graduate Assistant at the Ames Laboratory for Atomic Research, an AEC supported laboratory at Iowa State College. During this period, I worked on binary phase diagrams and evaluated methods for protection of uranium metal from water corrosion.

From December, 1957 to May, 1962, I was a Senior Engineer and, later a Fellow Engineer, at the Westinghouse Atomic Power Department where I worked on thermoelectric and thermionic materials for application in nuclear reactors.

In May, 1962 and until September, 1968, I acted as supervisor and later Manager of Fuel Evaluation on the NERVA Reactor Project at the Westinghouse Astronuclear Laboratory at Large, Pennsylvania. In September, 1968, and until May, 1972, I served as the Engineering Manager of the Astronuclear Fuel Facility at Cheswick, Pennsylvania. In this capacity, I was responsible for process development for fabrication of NERVA reactor fuel as well as reactor fuel performance evaluation.

In May, 1972, I transferred to the Westinghouse Nuclear Fuel Division of Westinghouse Nuclear Energy Systems, in Monroeville, Pennsylvania. From then to May, 1980, I served as the Manager of Materials Design. This group had the basic responsibility for materials R&D, and approval of materials for use in Westinghouse Pressurized Water reactors. The duties further included determination of the necessary and sufficient requirements for reactor coolant and pool storage chemistries needed to assure satisfactory performance under all warranted conditions. All reactor and out-reactor corrosion testing evaluations were done under the cognizance of this group.

From May, 1980, and until November, 1983, I worked at the Westinghouse Advanced Energy Systems Division where I served as the Manager of Materials Interactions. These activities were primarily concerned with addressing materials selection and evaluation for application in long term storage of light water reactor fuel in underground and above-ground facilities.

Since 1979 I have also been a member of the American Society for Testing and Materials (ASTM) C26 Committee on the Nuclear Fuel Cycle. At the present time I am the Chairman of Sub-committee C26.02 (Fuel and Fertile Materials Specifications), serve on C26.03 (Neutron Absorber Materials Specifications) and am 2nd Vice-chairman of the C26 Main Committee.