

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD



In the Matter of)

) Docket Nos. 50-250-OLA-2
) 50-251-OLA-2
)

FLORIDA POWER AND LIGHT COMPANY)

(Turkey Point Nuclear Generating)
Units 3 & 4))

) (Spent Fuel Pool Expansion)
)
)

AFFIDAVIT OF REBECCA K. CARR
ON CONTENTION NO. 7

1. My name is Rebecca K. Carr. I am employed by Bechtel Power Corporation, Eastern Power Division, as an engineer in the Operating Services nuclear licensing group. As part of my previous duties as Group Leader within the Radiation Analysis Group of the Nuclear Engineering Staff, I supervised radiological evaluations performed in support of the expansion of spent fuel storage capacity at Turkey Point Units 3 and 4. A summary of my professional qualifications and experience is attached as Exhibit A and is incorporated herein by reference.

2. The purpose of my affidavit is to address Contention 7. Contention 7 and the bases for the Contention are as follows:

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Contention 7

That there is no assurance that the health and safety of the workers will be protected during spent fuel pool expansion, and that the NRC estimates of between 80-130 person-rem will meet ALARA requirements, in particular those in 10 C.F.R. Part 20.

Bases for Contention

FPL's estimates of between 80-130 rem/person [sic] are much higher than the NRC's estimate for reracking of 40-50 person/rem [sic], and much higher than experience at other nuclear plants. Thus, there [sic] estimates are not ALARA.

Specifically, the purpose of my affidavit is to address the derivation of the estimates of occupational exposure for the Turkey Point spent fuel pool expansion. The Affidavit of Joseph L. Danek on Contention No. 7 addresses measures taken by Florida Power & Light Company at Turkey Point to assure that occupational doses are as low as is reasonably achievable (ALARA) during the expansion.

3. 10 CFR Part 20 of the regulations of the Nuclear Regulatory Commission (NRC) set forth numerical standards for protection against radiation. In general, these standards specify limits on exposures of individuals or limits on radiological effluents and do not specify numerical limits on collective occupational radiation exposures. However, 10 CFR § 20.1(c) does state that, in addition to complying with the requirements in Part 20, a licensee should make every reasonable effort to maintain radiation exposures as low as is reasonably achievable. Section 20.1(c) defines ALARA "as low as is reasonably achievable taking into account the state of technology, and the economics of

improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest." Consequently, although Part 20 does not place any limit on the collective occupational exposures that may be incurred during a spent fuel pool expansion, it does state that exposures in general should be maintained ALARA.

4. To evaluate the ALARA aspects of the plan to rerack the spent fuel pools for Turkey Point Units 3 and 4, an analysis was performed to estimate the total occupational exposure required to complete the reracking. This estimate was later revised in response to an NRC question to incorporate the best information available at the time.

5. The original and revised exposure estimates were based on the expected dose rates for each phase of the reracking operation and the expected person-hours necessary to complete each of these phases. Section I, below, generally describes these phases and the activities associated with the spent fuel pool reracking, and Sections II and III, below, describe the derivation of the original and revised occupational exposure estimates, respectively. Additionally, the reracking of the Turkey Point Unit 3 spent fuel pool has been completed, and Section IV, below, compares the revised estimate to the actual exposures incurred in reracking Unit 3.

I. Description of the Spent Fuel Pool Reracking Activities

6. The spent fuel pool reracking essentially consists of four types of activities: removal of the old racks, installation of new racks, transfer of spent fuel from the old racks to the new racks, and support services. Due to space limitations, it is not possible to install all of the new racks at one time. Consequently, the reracking operation is cyclical in nature, involving installation of several new racks, shuffling of spent fuel from several old racks to these new racks, removal of the old racks from which the fuel assemblies were transferred, and then installation of new racks in the space vacated by the removal of the old racks.

7. To promote the safe and efficient handling of the spent fuel racks, the spent fuel pool water level is lowered approximately 8 feet during rack handling operations but is restored to the normal level during fuel handling to provide additional shielding for workers. Once the water level has been lowered, a work platform is installed in the spent fuel pool as a base for further activities. Underwater work is performed using long-handled tools. As a result, it is not anticipated that the use of divers is necessary during reracking operations.

8. Each time the water level is lowered, the exposed spent fuel pool walls are decontaminated to reduce radiation exposures. Additionally, operation of the spent fuel pool cleanup system is dedicated to the spent fuel pool (rather than the refueling water storage tank) prior to and during the reracking operation to

lower the amount of radioactivity in the spent fuel pool water, except during those periods when the water level in the spent fuel pool is lowered.

II. Original Estimate of Occupational Exposure

9. In the original estimate, the major contributors to occupational exposure were expected to be the radioactivity in the spent fuel pool water and the radioactivity on the exposed walls of the spent fuel pool. Each of these is discussed in more detail below. Even though the spent fuel pool water level is to be intermittently lowered, no significant dose contribution is expected from the stored spent fuel due to the shielding provided by the approximately fifteen feet of water covering the fuel assemblies.

10. Typically, the majority of radioactivity in spent fuel pool water occurs as a result of releases of radioactivity during refueling operations. This release generally occurs due to the mixing of the spent fuel pool water with reactor coolant system water and the dislodging of crud deposits on the fuel during transfer from the reactor core to the spent fuel racks. The reracking operation requires movement of both spent fuel and used spent fuel racks. Thus, it was assumed in the original exposure estimate that a significant amount of the crud deposits would be released to the pool during the reracking. During and after refueling operations, the spent fuel cleanup system reduces the concentration of radioactivity in the spent fuel pool. However,

because of the degree of fuel and rack movement and in-pool decontamination of the old racks, it was assumed in the original exposure estimate that the large quantity of crud released would cause an increase in the spent fuel pool area dose rates. In fact, to account for this effect, the measured spent fuel pool data was conservatively adjusted upward prior to use in the exposure evaluation, and no dose rate reduction credit was taken for operation of the spent fuel pool cleanup system.

11. Because of the quantity of spent fuel present and the age of the plant, significant crud deposition was expected on the spent fuel pool walls. This deposited crud was expected to be a significant dose rate contributor when the water level in the spent fuel pool was lowered. As a result, conservative estimates of the dose rates expected from this crud deposition were made.

12. The dose rate data which was used for the original exposure estimate is given in Table 1.

TABLE 1
TURKEY POINT SPENT FUEL POOL AREA DOSE RATES

<u>Location</u>	<u>Dose Rate (mRem/hr)</u>		
	<u>Original Estimate</u>	<u>Revised Estimate</u>	<u>Actual Unit 3 1/ (Average)</u>
General area dose rate around edge of spent fuel pool	10	5	1-3
General area dose rate around edge of spent fuel pool during fuel shuffle	20	10	3-5
General area dose rate in spent fuel pool	20	15	4-10
General area dose rate in spent fuel pool during rack washdown	20	20	4-10
General area dose rate during decontamination of spent fuel pool walls	20	20	1-3
Contact dose rate on old racks	50	30	10 <u>2/</u>
Dose rate 6 feet from old racks	10	5	2

1/ Taken from the Affidavit of Joseph L. Danek on Contention No. 7.

2/ The average dose rate was 10 mR/hr. Local contact dose rates were higher at some locations.

13. The number of person-hours necessary to complete all of the tasks associated with the reracking was difficult to predict accurately. Conservative time estimates were made by examining the tasks which had to be performed and then estimating the manpower necessary to accomplish each task based upon prior experience with this type of task.

14. Based on the dose rate described above, an estimate of occupational exposure necessary to perform the reracking was made. The original estimate was 109.3 person-rem per unit (see Table 2). This estimate contained a bias to ensure that the estimate was conservative and would not underpredict the actual exposures.

TABLE 2
TURKEY POINT OCCUPATIONAL EXPOSURE
FOR RERACKING OF THE SPENT FUEL POOLS

<u>Phase</u>	<u>Original Estimate</u>		<u>Revised Estimate</u>		<u>Actual Unit 3</u>	
	<u>Person-rem</u>	<u>% of Total</u>	<u>Person-rem</u>	<u>% of Total</u>	<u>Exposure 3/</u>	<u>% of Total</u>
Removal of old racks	57.8	53	32.5	55	4.99	38
Spent fuel shuffles	5.4	5	4.5	8	1.16	9
Installation of new racks	28.4	26	12.7	21	3.49	26
Support services	17.7	16	9.3	16	3.53	27
Total	109.3	100	59.0	100	13.17	100

3/ Taken from the Affidavit of Joseph L. Danek on Contention No. 7

III. Revised Estimate of Occupational Exposure

15. Following the receipt of NRC staff questions regarding the original estimate of occupational exposures for the Turkey Point spent fuel pool expansion, a review was performed of the original occupational exposure estimate. This review (and the subsequent preparation of the revised exposure estimate) focused on the conservative dose rate and person-hour estimates assumed in the original exposure estimate. Person-hour estimates were reviewed for possible reductions, including reducing the time spent in the immediate vicinity of the pool where dose rates would be higher. Finally, more recent operational data on the spent fuel pool cleanup system was reviewed in an effort to more accurately predict radionuclide concentrations and resulting dose rates during the reracking.

16. More recent spent fuel pool cleanup system operational data was used in the preparation of the revised exposure estimate, and these data are provided, in Table 3. These data demonstrated that operation of the cleanup system for a short period of time could significantly reduce isotopic concentrations in the spent fuel pool and resulting dose rates. It was concluded from this data that the dose rates in and around the spent fuel pool could be conservatively reduced by 25 percent to 50 percent below those assumed in the original exposure estimate.

TABLE 3
1984 SPENT FUEL POOL ACTIVITY AND
GAMMA DOSE RATE DATA

UNIT 3 SPENT FUEL POOL (SFP)

<u>Date</u>	<u>Total Gamma Activity</u> <u>(μCi/ml)</u>	<u>Dose Rate Above SFP</u> <u>(mrem/hour)</u>	<u>Dose Rate on SFP Operating Deck</u> <u>(mrem/hour)</u>	<u>Activity in Progress</u>
Jan. 5	1.4×10^{-2}	12	8	See Note 1
Jan. 12	1.6×10^{-2}	18	10	See Note 1
Jan. 19	8.2×10^{-2}	25	14	See Note 1
Jan. 26	2.2×10^{-2}	12	6	See Note 1
Feb. 2	2.3×10^{-2}	20	10	See Note 1
July 19	5.9×10^{-2}	60	20	See Note 1
July 26	6.6×10^{-2}	48	30	See Note 1
Aug. 2	5.2×10^{-3}	6	3	See Note 2

UNIT 4 SPENT FUEL POOL

<u>Date</u>	<u>Total Gamma Activity</u> <u>(μCi/ml)</u>	<u>Dose Rate Above SFP</u> <u>(mrem/hour)</u>	<u>Dose Rate on SFP Operating Deck</u> <u>(mrem/hour)</u>	<u>Activity in Progress</u>
Mar. 29	5.9×10^{-3}	6	5	See Note 3
Apr. 5	5.9×10^{-3}	8	5	See Note 3
Apr. 12	4.8×10^{-3}	8	4	See Note 3
Apr. 26	7.0×10^{-3}	8	4	See Note 3
May 3	1.5×10^{-2}	12	6	See Note 3
May 10	3.2×10^{-2}	30	14	See Note 4

Notes:

1. No fuel handling - Demineralizer in service to Unit 3 Refueling Water Storage Tank.
2. No fuel handling - Demineralizer in service to Unit 3 Spent Fuel Pool.
3. Refueling conditions - Demineralizer in service to Unit 4 Spent Fuel Pool.
4. No fuel handling - Demineralizer in service to Unit 4 Refueling Water Storage Tank.

17. The resultant dose rates used for the revised exposure estimate are shown in Table 1. Table 4 provides a detailed comparison of the original and revised exposure estimates, including a breakdown by activity of the person-hours, dose rates and person-rem.

18. As can be seen from Table 4, there were three tasks for which the person-hours used in the revised exposure estimate were reduced from those assumed in the original exposure estimate:

- i) positioning of the old racks onto the support stand
- ii) embedment pad elevation measurements, and
- iii) positioning and leveling of the new racks.

These reductions in estimated person-hours were possible after the procedures for installing and positioning the new racks were finalized and greater details were known regarding these tasks.

19. Table 4 also illustrates the reductions in estimated occupational exposure that resulted from the more detailed review of the time that would be spent in higher radiation areas. For the revised exposure estimate, there were seven tasks for which it was determined that a portion of the work would not be performed in a relatively high dose rate area (e.g., in the immediate vicinity of the spent fuel pool), but instead would be located in an area where the general area dose rate was lower.

TABLE 4

COMPARISON OF ESTIMATED OCCUPATIONAL EXPOSURES DURING RERACKING

	Original Estimate			Revised Estimate		
	Total ⁽¹⁾ Person-Hours	Dose Rate (mrem/hr)	Person-Rem	Total ⁽¹⁾ Person-Hours	Dose Rate (mrem/hr)	Person-Rem
<u>Removal of Old Racks</u>						
Removal of interferences in spent fuel pool area	590	20	11.8	320 ⁽³⁾	5	1.60
Decontamination of spent fuel pool walls ⁽²⁾	-	-	-	96	20	1.92
Installation of temporary ⁽²⁾ extension of spent fuel pool cooling suction line	-	-	-	20	15	0.30
Installation of temporary construction crane and support stand	64 8	20 20	1.28 0.16	64 8	5 15	0.32 0.12
Transfer/positioning of temporary construction crane	160	20	3.2	96 64	10 5	0.96 0.32
Positioning/removal of support stand	18	20	0.36	18	10	0.18
Positioning of old racks onto support stand	432	20	8.64	288	15	4.32
Decontamination of old racks in spent fuel pool	540	20	10.8	324 216	20 15	6.48 3.24
Wipe down and decontamination of old racks prior to bagging and package for shipment	24 24	10 50	0.24 1.2	24 24	5 30	0.12 0.72
Transfer of old racks to temporary shed	48	10	0.48	48	5	0.24
Laydown, packaging and loading of old racks onto truck	168 168	10 50	1.68 8.4	168 168	5 30	0.84 5.04
Construction of packing crate on truck prior to shipping	192	50	9.6	192	30	5.76
Total for removal of old racks			57.84			32.48

TABLE 4

COMPARISON OF ESTIMATED OCCUPATIONAL EXPOSURES DURING RERACKING

	Original Estimate			Revised Estimate		
	Total ⁽¹⁾ Person-Hours	Dose Rate (mrem/hr)	Person-Rem	Total ⁽¹⁾ Person-Hours	Dose Rate (mrem/hr)	Person-Rem
<u>Spent Fuel Shuffles</u>						
Operators on bridge crane	180	20	3.6	300	10	3.0
	90	10	0.9			
Fuels engineer	90	10	0.9	150	10	1.5
Total for spent fuel shuffles			5.4			4.5
<u>Installation of New Racks</u>						
Embedment pad elevation measurements	72	20	1.44	12	15	0.18
				12	10	0.12
Rack positioning and leveling	1296	20	25.92	432	15	6.48
				432	10	4.32
Reinstallation of removed interferences	50	20	1.0	320 ⁽³⁾	5	1.60
Total for installation of new racks			28.36			12.70
<u>Support Services</u>						
Health physics personnel for spent fuel pool	900	10	9.0	900	5	4.50
Health physics personnel for rack disposal	270	10	2.7	270	5	1.35
	90	50	4.5	90	30	2.70
Quality assurance/quality control personnel	150	10	1.5	150	5	0.75
Total for support services			17.7			9.3
GRAND TOTAL			109.3			58.98

Notes:

1. Includes only work involving radiation exposure.
2. These tasks were not scoped at the time original estimate was completed.
3. Total hours split between removal and reinstallation.

These tasks were:

- i) removal and reinstallation of interferences
- ii) installation of the temporary crane and support stand
- iii) transfer/positioning of the temporary crane
- iv) decontamination of the old racks in the spent fuel pool
- v) wipe down and decontamination of the old racks
- vi) embedment pad elevation measurements, and
- vii) rack positioning and leveling.

20. In sum, the revised occupational exposure estimate was approximately 59 person-rem per unit. The revised estimate was less than the original estimate primarily due to:

- i) More recent operational data on the spent fuel pool cleanup system which allowed for more accurate predictions of radionuclide concentrations and resulting dose rates
- ii) Reductions in the estimated person-hours necessary to complete some tasks, and
- iii) A more detailed accounting of the work to be performed in lower dose rate areas.

As with the original estimate, the revised estimate also contained biases to ensure that the estimates were conservative and would not underpredict the actual exposures.

IV. Actual Occupational Exposure

21. The reracking of the Unit 3 spent fuel pool was completed in March 1985.

22. The actual occupational exposure expended to complete the rerack operation of Unit 3 was 13.17 person-rem (see Table 2). Thus, both the original and the revised exposure estimates have been demonstrated to be conservative. The primary reasons for the overpredictions were:

- i) underpredicting the ability of the pool cleanup system,
- ii) overpredicting the difficulty associated with both removing and installing the racks,
- iii) underestimating the degree to which the spent fuel pool walls could be decontaminated, and
- iv) overpredicting the amount of crud that would be on the old racks.

23. As stated earlier, the radioactivity in the water in the spent fuel pool was expected to be the dominant dose rate contributor, and only minimal credit was taken for the cleanup system in the revised estimate and no credit was taken in the original estimate. However, the actual measured dose rates that existed in the spent fuel pool during the reracking were significantly lower than the estimated values, as shown in Table 1. The major reason for this reduction was the performance of the spent fuel pool cleanup system,

which was enhanced by the new resin installed prior to the reracking operation and dedicated operation of the system throughout the reracking effort.

24. As shown above, the original and revised occupational exposure estimates made for replacing the spent fuel pool storage racks were higher than those actually experienced. This fact demonstrates the conservatism inherent in the two estimates. Additionally, the conservative estimates served a useful purpose in that they identified where the ALARA efforts should be focused. Thus, these estimates lent support to FPL's decision to dedicate the operation of the spent fuel pool cleanup system to the spent fuel pool in order to reduce the fuel pool isotopic concentrations. As a direct result of these efforts, the actual exposure was lower than estimated and is in agreement with industry experience (about 25 person-rem for two units).

V. CONCLUSIONS

25. In summary, the actual occupational exposure resulting from reracking the spent fuel pool at Turkey Point Unit 3 was substantially lower than the original and revised estimates, thereby demonstrating their conservatism. Additionally, the actual exposures are in agreement with industry experience. The successful effort to reduce the spent fuel pool area dose rates is an indication that ALARA philosophy was effectively implemented at Turkey Point.

FURTHER AFFIANT SAYETH NOT

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

Rebecca K. Carr
Rebecca K. Carr

STATE OF MARYLAND)
COUNTY OF MONTGOMERY)

Subscribed and sworn to before me this 22 day of January, 1986. My Commission expires: ~~My Commission Expires July 1, 1986~~

Rebecca B. Curren
NOTARY PUBLIC

EXHIBIT A

STATEMENT OF PROFESSIONAL QUALIFICATIONS
OF REBECCA K. CARR

POSITION Project Licensing Engineer, Bechtel Power Corporation

EDUCATION BS, Nuclear Engineering, Pennsylvania State University, 1980

SUMMARY OF EXPERIENCE WITH BECHTEL:

Project licensing engineer, 1984-Present
Staff group leader, shielding, 1983-1984
Staff engineer, radiation analysis, 1980-1983

EXPERIENCE WITH BECHTEL

Ms. Carr is currently serving as licensing engineer with the Operating Services Group. This group provides engineering services to utilities with operating nuclear power plants, including the North Anna Power Station, Surry Power Station, and Millstone Nuclear Power Station. Her responsibilities include safety reviews of design changes to ensure compliance with NRC requirements, FSAR criteria, and plant technical specifications. Ms. Carr is also involved with licensing the steam generator replacement at Indian Point Station Unit 3, the independent spent fuel storage installation at Surry Power Station, and the spent fuel pool reracking at Turkey Point Plant.

Prior to this, Ms. Carr served as an engineer in the nuclear licensing group for the two-unit Grand Gulf Nuclear Station (Mark III). She was responsible for coordinating implementation of regulatory requirements, safety reviews and staff analyses for the operating Unit 1. While supporting the Unit 2 design effort, she was the lead engineer for the computer based licensing commitment tracking system.

Previously, Ms. Carr served as group leader - radiation analysis, on the Nuclear Engineering Department staff. In this capacity, she was responsible for shielding and dose analyses in support of both BWR and PWR projects in the construction and operating phases. Plants included the Grand Gulf Nuclear Station, Edwin I. Hatch Nuclear Plant, Wolf Creek Generating Station, Callaway Plant, Joseph M. Farley Nuclear Plant, Turkey Point Plant, and Calvert Cliffs Nuclear Power Plant. Work included operating and accident

doses, equipment qualification (radiation), spent fuel pool reracking, low level waste processing and storage, and steam generator replacement.

As a staff engineer, Ms. Carr was involved in the analysis of airborne radiation releases and doses within plants and in the environment resulting from normal operation and postulated accidents. This included control rooms and emergency facilities. She also performed shielding analyses, including neutron streaming, and fulfilled a licensing assignment at the Three Mile Island jobsite. In addition, Ms. Carr participated in several audits of design and analysis work done by projects.

PROFESSIONAL MEMBERSHIPS

American Nuclear Society and Society of Women Engineers