The Light company
Houston Lighting & Power South Texas Project Electric Generating Station P. O. Box 289 Wadsworth, Texas 77483

October 17, 1996
ST-HL-AE-5481
File No.: G3.08
10CFR50.54(f)

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Units 1 & 2
Docket Nos. STN 50-498, STN 50-499
Response to Generic Letter 96-04,
"Boraflex Degradation in Spent Fuel Pool Storage Racks"

Pursuant to 10CFR50.54(f), the South Texas Project submits the attached response to Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Storage Racks." The response addresses the physical condition of the Boraflex, and confirms that a 5-percent subcriticality margin can be maintained for the life of the storage racks. Additional details are included as requested by the Generic Letter.

If there are any questions on this matter, please contact either Mr. D. F. Hoppes at (512) 972-8132 or me at (512) 972-8787.

J. H. Cloninger
Vice President,
Nuclear Engineering

PLW/lf 280052

A068 1/1

Attachments: 1) Status of Boraflex Applications in South Texas Project Spent Fuel Pools
2) Unit 1 Licensee Event Report 95-002, "Excessive Degradation of Boraflex Neutron Poison Found in the South Texas Project Spent Fuel Pool Storage Racks"

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AFFIDAVIT

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)		
	)		
Houston Lighting & Power	)	Docket Nos.	50-498
Company, et al.,	)		50-499
	)		
South Texas Project	)		
Units 1 and 2	)		

AFFIDAVIT

I, T. H. Cloninger, being duly sworn, hereby depose and say that I am Vice President, Nuclear Engineering, of Houston Lighting & Power Company; that I am duly authorized to sign and file with the Nuclear Regulatory Commission the attached response to Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks"; that I am familiar with the content thereof; and that the matters set forth therein are true and correct to the best of my knowledge and belief.

T.H. Cloninger
Vice President,
Nuclear Engineering

STATE OF TEXAS)
)
COUNTY OF MATAGORDA)

Subscribed and sworn to before me, a Notary Public in and for the State of Texas, this 17th day of October, 1996.

LINDA RITTENBERRY
Notary Public, State of Texas
My Commission Expires 10/9/97

Linda Rittenberry
Notary Public in and for the
State of Texas

ATTACHMENT 1

RESPONSE TO GENERIC LETTER 96-04

RESPONSE TO GENERIC LETTER 96-04

Status of Boraflex Applications in South Texas Project Spent Fuel Pool Storage Racks

General Information

South Texas Project Unit 1 and Unit 2 each has a spent fuel pool consisting of 288 Region 1 cells and 1681 Region 2 cell locations (although two Region 2 modules of 132 cells each are not installed). Region 1 racks are the "Flux Trap" type, as shown in Figure 1. In Region 1, the Boraflex panels are part of the removable water box that is positioned between the cells. Region 2 racks are the "Eggcrate" type, with the Boraflex panels permanently fixed between the cells, as shown in Figure 2. The Boraflex panels for both regions are 7-1/2 inches wide, 0.075 inches thick, and traverse the length of the storage cell.

The Boraflex configuration is identical in the two units, and both units employ the same pool chemistry guidelines and the same spent fuel pool loading strategies. Unit 1 is the source of most of the Boraflex-related information gathered to date, because of its lead in Boraflex radiation dose. Both units have intentionally accelerated the exposure of a selected number of Region 1 spent fuel pool cells in order to get an early assessment of potential Boraflex degradation. Under this plan, eight cells were loaded with newly discharged fuel at each refueling outage, and fuel remained in these cells until shortly prior to the next refueling outage.

REQUESTED INFORMATION:

Provide an assessment of the physical condition of the Boraflex, including any deterioration, on the basis of current accumulated gamma exposure and possible water ingress to the Boraflex.

RESPONSE:

Information about the physical condition of the Boraflex at the South Texas Project comes from the following sources: examination of a Boraflex surveillance coupon removed from the Unit 1 Region 1 racks; blackness testing of Unit 1 Region 1 and Region 2 racks; on-going monitoring of spent fuel pool reactive silica levels; and the preliminary results from the RACKLIFE model of the spent fuel pool. Each of these information sources is discussed in the following responses.

FIGURE 1
SOUTH TEXAS PROJECT
REGION 1 FUEL RACKS
"FLUX TRAP" TYPE

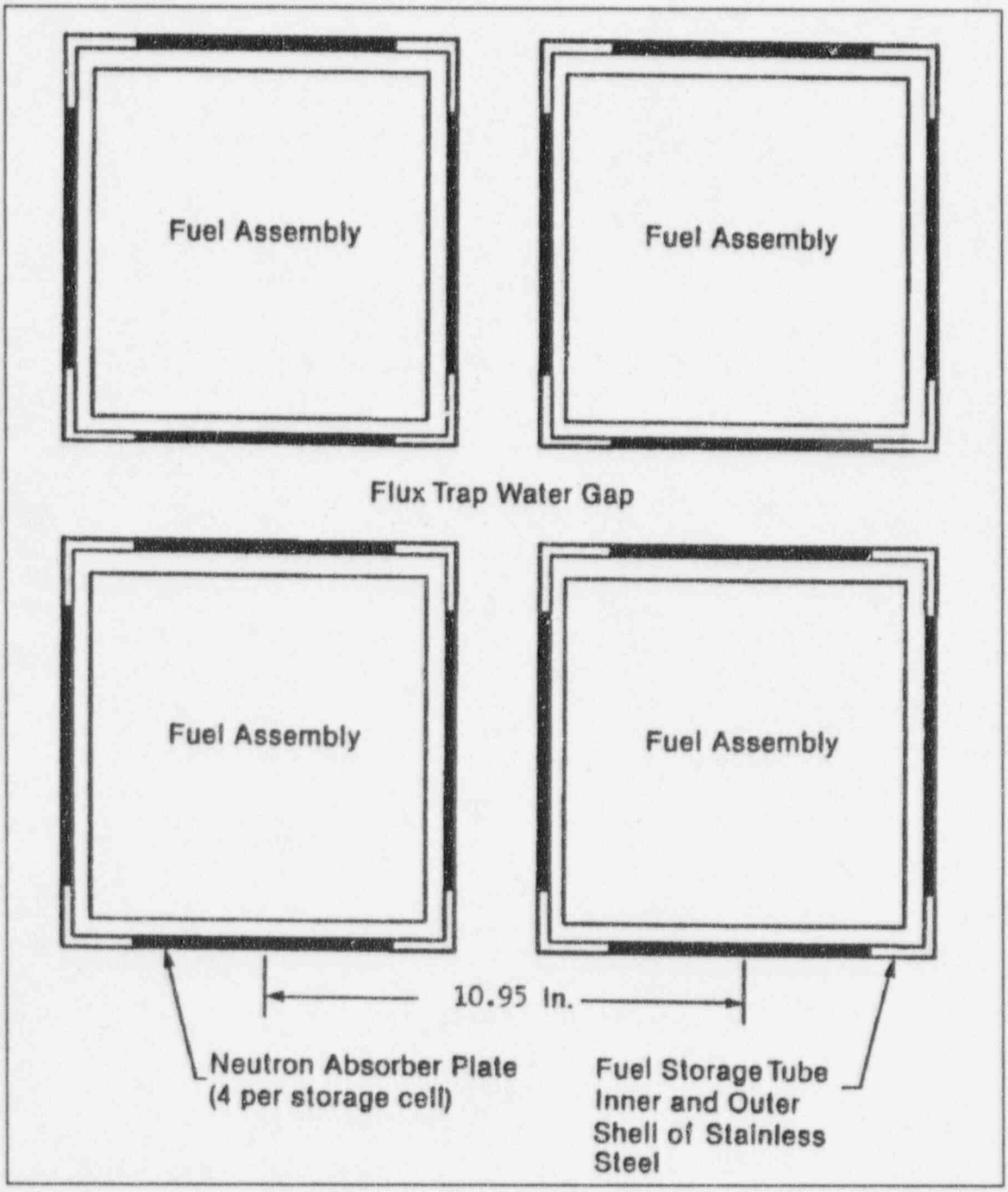
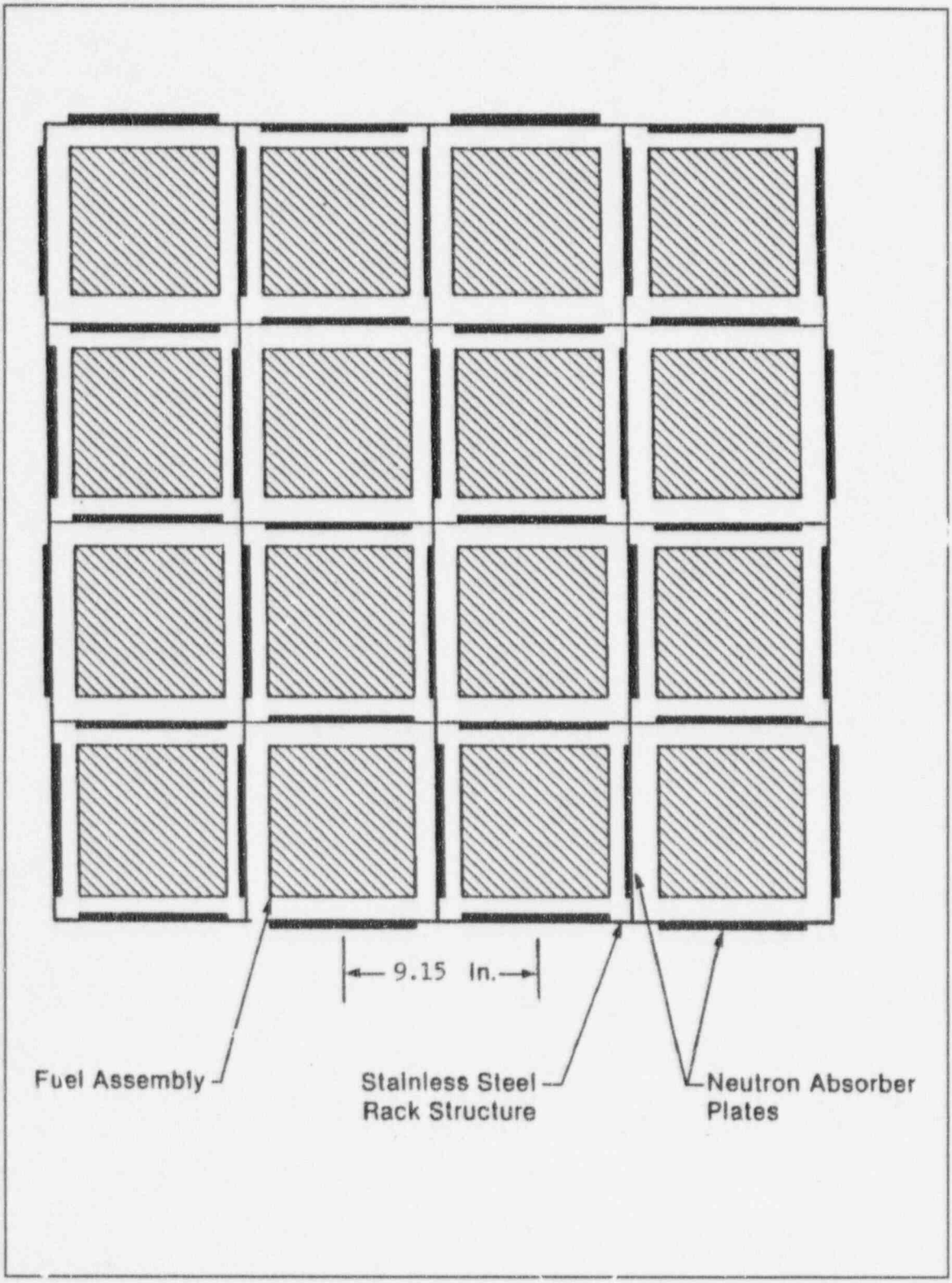


FIGURE 2
SOUTH TEXAS PROJECT
REGION 2 FUEL RACKS
"EGGCRATE" TYPE



Region 1 Racks

Surveillance Coupon. A surveillance coupon of Boraflex material was removed from the Unit 1 Region 1 racks in October 1994, after approximately five years of exposure to irradiated fuel in adjacent cell locations. This coupon had been centrally located in the group of eight cells that were designed to receive an accelerated dose. The coupon is approximately 7-1/2" by 15", and its weight is about 250 grams.

The coupon was delivered to Holtec International Co., where a series of tests were performed. On the basis of visual inspections and measurements made of the coupon, the coupon is considered to have suffered significant degradation and become friable and readily subject to mechanical damage. Cracks in the coupon generally showed well-defined edges with little evidence of erosion. This suggests that most of the cracks may have been generated in the process of removing the coupon from its stainless steel jacket and in transportation.

Neutron attenuation measurements were made at various locations on the coupon. The coupon attenuation results were compared to results for archive samples of the South Texas Project Boraflex, and to results for Boraflex samples of known boron-10 loadings. Results of the neutron attenuation measurements confirm that there was little or no loss of boron-10 in the non-degraded areas of the coupon, but significant loss of boron-10 in the areas of apparent erosion and thinning of the coupon. The average boron-10 loading of the archive samples and of the surveillance coupon (in the non-degraded areas) were both estimated to be 0.025 grams boron-10/sq cm. The boron-10 loading of the surveillance coupon was estimated to range as low as 0.017 grams boron-10/sq cm in the degraded areas. The spent fuel pool criticality analysis assumes a boron-10 loading of 0.02 grams boron-10/sq cm.

Dimensional measurements were made for the surveillance coupon and the archive samples. Pre-characterization measurements were not available, making it impossible to accurately determine the extent of shrinkage. However, if it is assumed that the average width of the archive sample (7.47 inches) is representative of the starting width of the surveillance coupon, then the coupon width measurement (7.325 inches) suggests that the shrinkage was about 2%, which would be reasonably consistent with the shrinkage expected for the high exposure coupon.

Weight and density measurements were made for the surveillance coupon and the archive samples. The density was measured to be 1.79 grams/cc for the archive samples (which is consistent with the value of 1.772 grams/cc as reported by the Boraflex manufacturer) as compared to 2.0 grams/cc for the surveillance coupon. The long-term saturation density of irradiated Boraflex is reported by Holtec to be 2.1 grams/cc. This indicates that the surveillance coupon has nearly reached the saturation gamma radiation level, based on density measurement.

Measurements of coupon hardness were made with a Shore A Durometer in accordance with ASTM D2240-85. All of the measurements indicated that the coupon was fully hardened within the error bands of the measurements. This is consistent with the fully-hardened condition expected for irradiated coupons that have received a radiation dose greater than about 10^9 rads gamma. There was no evidence of softening or sponginess in the coupons.

Blackness Tests. In addition to the measurements of the surveillance coupon, blackness testing was performed on Unit 1 Region 1 and Region 2 racks in August 1994. The detailed results of these tests were reported via Licensee Event Report 95-002, dated February 22, 1995; this report is attached. To summarize the results, twenty of the thirty-seven Region 1 cells that were tested showed some evidence of gaps and/or significant Boraflex panel degradation. The most significant degradations occurred in those panels that had received an accelerated exposure. The large degradations are postulated to be "washout"- accelerated dissolution of the Boraflex caused by pool water coolant flow through the panel enclosures.

Region 2 Racks

Blackness Tests. Blackness testing was also done for selected Unit 1 Region 2 racks in conjunction with the previously described testing of the Region 1 racks. A total of eight cells, comprising 32 panels, were tested in the Region 2 racks. These cells were all located near the north boundary of the Region 1 racks.

All of the Region 2 cells were found to be intact, with no detectable gaps or other degradations in the Boraflex panels. This is attributed to two factors: Region 2 racks had a lower cumulative gamma dose than the Region 1 racks at the time of the testing; and the Region 2 racks have a tighter mechanical design that allows less water flow through the enclosure.

RACKLIFE Program and Gamma Doses

RACKLIFE Program. In addition to the coupon surveillance and the blackness testing, analytical efforts are on-going to characterize the Boraflex condition in the South Texas Project spent fuel pools. The South Texas Project has been one of the utilities to test/use the beta-version of the Electric Power Research Institute-sponsored RACKLIFE program. RACKLIFE version 1.0 is now being used.

The RACKLIFE computer program was recently developed by Northeast Technology Corporation, through Electric Power Research Institute sponsorship. RACKLIFE tracks the behavior of each panel of Boraflex in the racks subject to the irradiation history of the individual panel and changes to the bulk conditions of the spent fuel pool (including temperature and silica level). RACKLIFE output includes the gamma doses to each panel and the quantity of Boraflex (and Boron-10) lost as a function of service history.

RACKLIFE models of both South Texas Project spent fuel pools have been created, reflecting details of the rack construction, the fuel movement histories, and the pool operating parameters. The RACKLIFE models have been used to calculate gamma doses to the individual rack panels, with the results shown below. In addition, RACKLIFE will be used to determine a silica release coefficient that will be used for predictions of future silica release and overall Boraflex loss.

Gamma Doses as calculated by RACKLIFE. Among the cells subjected to blackness testing, the peak Unit 1 Region 1 panel gamma exposure was 0.78 E10 rads. This panel was located near the center of the group of cells designated for accelerated exposure. The peak Unit 1 Region 2 panel gamma exposure was 0.19 E10 rads. The relatively low exposure for the Region 2 cells results from the practice of leaving discharged fuel in Region 1 for an extended time prior to movement to Region 2 in preparation for the next refueling.

As of September 1, 1996, the peak panel exposure values for both units and for both Regions are shown below.

Unit 1 Region 1	Peak panel exposure:	0.95 E10 rads
Unit 1 Region 2	Peak panel exposure:	0.26 E10 rads
Unit 2 Region 1	Peak panel exposure:	0.76 E10 rads
Unit 2 Region 2	Peak panel exposure:	0.27 E10 rads

REQUESTED INFORMATION:

State whether a subcritical margin of 5 percent can be maintained for the racks in unborated water.

RESPONSE:

A subcritical margin of 5 percent can be maintained for the racks in unborated water by restricting the usage of those Region 1 cells shown by blackness testing to have excessive degradation, and those Region 1 cells which have exposure levels at or above those of the degraded cells.

Cell Usage Restrictions. The South Texas Project has imposed restrictions on the use of the Region 1 cell locations that: (1) were shown to have significant degradation from the blackness testing; or (2) have exposure levels (for two of more panels) at or above the level shown from the blackness tests to cause significant degradation. This exposure level is 0.67 E10 rads gamma.

For the most recent refueling outage (Unit 1 Refueling Outage 6), fuel placement was administratively controlled such that the only fuel that could be placed in the restricted Region 1 cells was fuel defined by the South Texas Project Technical Specification 5.6.1 as "Category 4 Fuel". Category 4 fuel is defined by a curve (Figure 5.6-4) of fuel initial U-235 enrichment versus fuel assembly burnup. Category 4 fuel is the least reactive category of fuel as classified in the Technical Specifications. Criticality calculations show that Category 4 fuel close-packed in the Region 1 racks, with unborated water and **no credit for Boraflex**, results in a subcritical margin in excess of 5 percent.

For the most recent refueling outage, a total of 52 Unit 1 Region 1 cells were restricted as described above.

Currently, no restrictions are required in Region 2 because of the relatively low exposure levels. The practice of leaving discharged fuel in the Region 1 racks until preparations are made for the following refueling allows a long decay time prior to Region 2 placement; this ensures that the Region 2 racks will remain at relatively low gamma exposures for many years.

Fuel placement in the spent fuel pools of both units are being administratively controlled to ensure that a subcritical margin of 5 percent is maintained in unborated water. Currently, these storage controls are based on fuel residence time in the cells and fuel assembly reactivities. Beginning with the next Unit 2 refueling outage, these storage controls will be based on rack cell exposures and fuel assembly reactivities.

Other Actions Taken. When Boraflex degradation was first indicated during performance of blackness testing, the South Texas Project assessed the safety implications of the findings. A number of compensatory actions were taken to ensure that the subcritical margin is maintained. These actions remain in effect. They include:

- Maintenance of the soluble boron concentration of the spent fuel pool at or above 2500 ppm.
- Verification of the soluble boron concentration of the spent fuel pool by surveillance at least once per seven days.
- Administrative controls to control spent fuel pool dilution sources (spent fuel pool demineralizer beds, spent fuel pool makeup supply valves).
- Procedural changes to assure that boric acid is added should firewater be added during spent fuel pool fill.

- Procedural changes to assure that boron level is verified to have equalized to at least 2500 ppm across any mixed bed demineralizer prior to placing it in service in the spent fuel pool cooling and cleanup system.

REQUESTED INFORMATION:

Describe any proposed actions to monitor or confirm that this 5 percent subcriticality margin can be maintained for the lifetime of the storage racks and describe what corrective actions could be taken in the event that it cannot be maintained.

RESPONSE:

Continued monitoring of the Boraflex condition will be performed by application of the RACKLIFE program, as described above. Silica levels in the spent fuel pool water are trended as an indicator of Boraflex degradation. These methods, combined with restrictions on location of fuel assemblies in the spent fuel racks, will ensure that 5 percent subcriticality is maintained.

Soluble Boron Credit in Spent Fuel Pool Criticality Analyses: Use of soluble boron credit in the spent fuel pool criticality analyses is an important part of the long term plan to mitigate the effects of Boraflex degradation. The Westinghouse Owner's Group has developed a technically sound methodology to allow soluble boron credit. The methodology was previously presented to the Nuclear Regulatory Commission by Northern States Power in a license amendment request dated July 28, 1996. South Texas Project-specific analyses have been developed using this methodology.

The South Texas Project intends to submit a Technical Specification change to take credit for soluble boron in the spent fuel pool criticality analyses.

REQUESTED INFORMATION:

Describe the results from any previous post-operational blackness tests and state whether blackness testing, or other in-situ tests or measurements, will be periodically performed.

RESPONSE:

Previous blackness test results are summarized above, and the detailed results are included in the attached Licensee Event Report 95-002. The South Texas Project has no current plans to periodically perform further blackness tests or other in-situ testing.

REQUESTED INFORMATION:

Provide chronological trends of pool reactive silica levels, along with the timing of significant events such as refuelings, pool silica cleanups, etc. Implications of how these pool silica levels relate to Boraflex performance should be described.

RESPONSE:

Figures 3 and 4 provide the trends for reactive silica levels for each unit since 1991. The trend plots are annotated to show the refueling outages. The reduction in reactive silica levels at the refueling outages is due to mixing of the spent fuel pool water with silica-free water during the refueling operation. As can be seen on the plots, the silica level rises during the period of time between refueling outages due to Boraflex degradation. It is also noted that suspended silica started appearing in 1994. Suspended silica is removed using portable filtration systems to improve water clarity in the spent fuel pool on an as-needed basis. Removal of suspended silica has no significant effect on reactive silica levels.

The RACKLIFE program will be used to determine a silica release coefficient that will be used for predictions of future silica release and overall Boraflex loss for the South Texas Project spent fuel pools. Completion is anticipated by February 1, 1997.

FIGURE 3

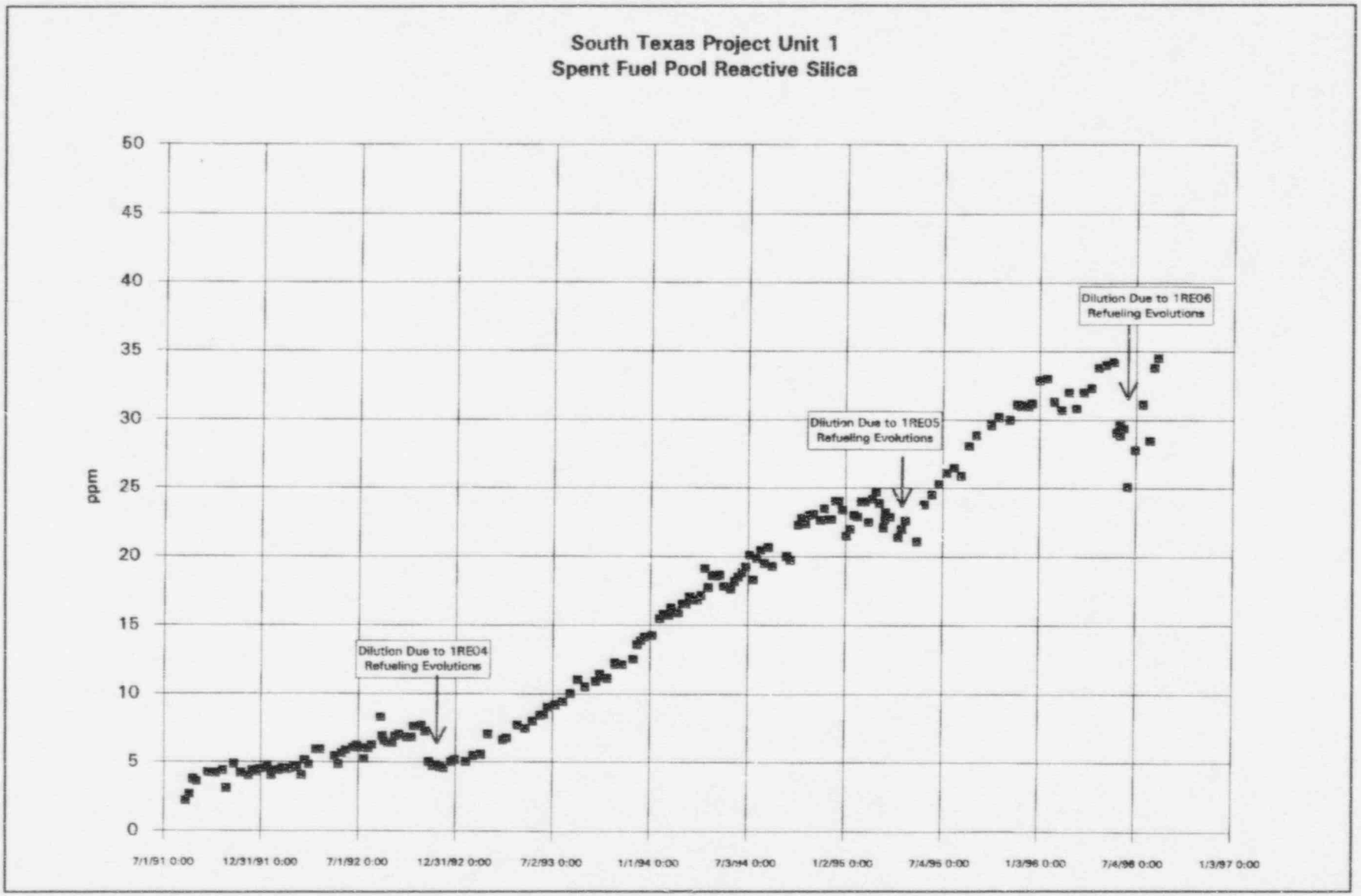
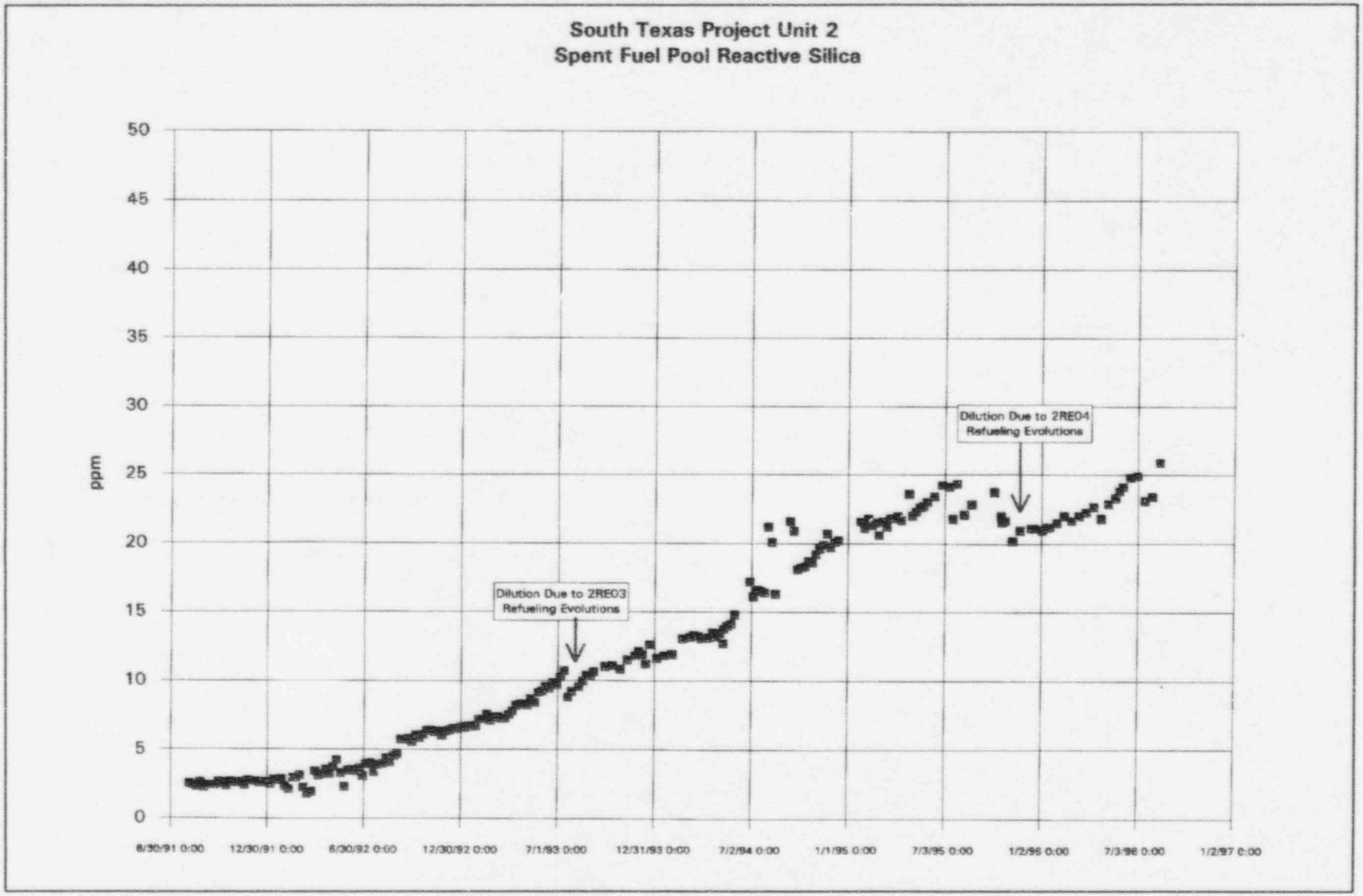

South Texas Project Unit 1
Spent Fuel Pool Reactive Silica
ppm
50
45
40
35
30
25
20
15
10
5
0
Dilution Due to 1RE04 Refueling Evolutions
Dilution Due to 1RE05 Refueling Evolutions
Dilution Due to 1RE06 Refueling Evolutions
7/1/91 0:00
12/31/91 0:00
7/1/92 0:00
12/31/92 0:00
7/2/93 0:00
1/1/94 0:00
7/3/94 0:00
1/2/95 0:00
7/4/95 0:00
1/3/96 0:00
7/4/96 0:00
1/3/97 0:00

FIGURE 4


South Texas Project Unit 2
Spent Fuel Pool Reactive Silica
ppm
50
45
40
35
30
25
20
15
10
5
0
Dilution Due to 2RE03
Refueling Evolutions
Dilution Due to 2RE04
Refueling Evolutions
6/30/91 0:00
12/30/91 0:00
6/30/92 0:00
12/30/92 0:00
7/1/93 0:00
12/31/93 0:00
7/2/94 0:00
1/1/95 0:00
7/3/95 0:00
1/2/96 0:00
7/3/96 0:00
1/2/97 0:00

ATTACHMENT 2

LICENSEE EVENT REPORT 95-002

EXCESSIVE DEGRADATION OF BORAFLEX NEUTRON
POISON FOUND IN THE SOUTH TEXAS PROJECT
SPENT FUEL POOL STORAGE RACKS

The Light company
Houston Lighting & Power South Texas Project Electric Generating Station P. O. Box 289 Wadsworth, Texas 77483

February 22, 1995
ST-HL-AE-5005
File No.: G26
10CFR50.73

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Unit 1
Docket No. STN 50-498
Licensee Event Report 95-002
Excessive Degradation of Boraflex Neutron Poison Found in
the South Texas Project Spent Fuel Pool Storage Racks

Pursuant to 10CFR50.73, Houston Lighting & Power submits the attached Unit 1 Licensee Event Report 95-002 regarding excessive degradation of Boraflex neutron poison found in the South Texas Project Spent Fuel Pool storage racks. This event did not have an adverse effect on the health and safety of the public.

If you should have any questions on this matter, please contact Mr. J. M. Pinzon at (512) 972-8027 or me at (512) 972-8787.

T. H. Cloninger
Vice President,
Nuclear Engineering

JMP/lf

Attachment: LER 95-002 (South Texas, Unit 1)

9502270207 2pp

c:

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NRC FORM 366 (5.92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
South Texas Unit 1	05000 498	1 OF 20

TITLE (4) Excessive Degradation of Boraflex Neutron Poison Found in the South Texas Project Spent Fuel Pool Storage Racks

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
01	24	95	95	-- 002 --	00	02	23	95		05000
									FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	3
POWER LEVEL (10)	0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.402(b)		20.405(c)	50.73(a)(2)(iv)	73.71(b)
	20.405(a)(1)(i)		50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
	20.405(a)(1)(ii)		50.36(c)(2)	50.73(a)(2)(vii)	OTHER
	20.405(a)(1)(iii)		50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)	X	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
	20.405(a)(1)(v)		50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Jairo Pinzon - Staff Engineer	(512) 972-8027

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On January 25, 1995, Unit 1 was in Mode 3 at 0 % power. At approximately 1600 hours, an evaluation of a preliminary report on spent fuel storage rack Boraflex testing determined that at least one rack cell may be outside the design basis (no more than a 7.75 inch gap in the Boraflex panels on any two sides of a cell). The root cause of the event is use of the Boraflex material in the spent fuel pool environment. The mechanism of Boraflex degradation is not completely characterized, but it is known to be related to gamma flux (and to a small extent, neutron flux) which causes changes in the base polymer material characteristics leading to hardening and embrittlement, and exposure to the spent fuel pool environment (boric acid and forced coolant flow conditions) which may lead to more rapid deterioration. Corrective action includes placing restrictions on the use of the degraded Unit 1 Region 1 storage cells, developing a Long Term Boraflex Management Plan to address this issue, and developing a dose to degradation correlation to aid in establishing restrictions on future cell usage in Unit 1 and Unit 2.

EVENT DESCRIPTION

On January 25, 1995, Unit 1 was in Mode 3 at 0 % power. At approximately 1600 hours, an evaluation of a preliminary report on spent fuel pool storage rack Boraflex testing determined that at least one rack cell may be outside the design basis (no more than a 7.75 inch gap in the Boraflex panels on any two sides of a cell).

The South Texas Project spent fuel pool fuel storage racks consist of two regions with the fuel racks in Region 1 designed to store fuel assemblies with higher reactivity than are allowed in Region 2. The cells in both regions were designed with Boraflex neutron poison panels to ensure that adequate negative reactivity would be maintained when the pool was assumed to be flooded with unborated water. The Boraflex panels are about 7.5 inches wide and extend the height of the storage cell. Region 1 panels are removable and Region 2 panels cells are fixed in place. The general practice at the South Texas Project has been to off-load discharged fuel assemblies into the Region 1 spent fuel racks, where they remain until preparations begin for the next refueling outage. This practice has resulted in higher gamma exposure to the Region 1 spent fuel racks than the Region 2 spent fuel racks.

Blackness (neutron absorption) testing had been conducted in August 1994 on selected South Texas Project Unit 1 spent fuel pool storage racks. The tests were performed to determine the condition of the Boraflex neutron poison material and to quantify (i.e., determine size and location of) any gaps identified. The testing was performed by HOLTEC International using a specially-designed logging tool containing a Californium-252 neutron source and four boron trifluoride (BF_3) thermal neutron detectors. A summary of the test results is attached.

The testing involved 45 cells in Regions 1 and 2 of the Unit 1 spent fuel storage racks. In all eight cells tested in Region 2, no detectable gaps or other degradation of the Boraflex panels were found. In Region 1, 20 of 37 cells tested showed some evidence of gaps and/or more significant Boraflex panel degradation. Boraflex degradation exceeded the South Texas Project design limit for gap size (3.75 inch gaps in all four panels of a cell, 7.75 inch gaps in any two panels of a cell) in six Region 1 cells, and Boraflex panel end shrinkage in all four panels of one additional Region 1 cell may exceed the design limit.

In the South Texas Project Boraflex Surveillance Plan, eight cells had been designated to receive an accelerated dose, in order to develop an early assessment of long-term Boraflex degradation. Selected high-burnup fuel assemblies were loaded into these cells early at each refueling and left there until the next refueling. Five of these eight cells exhibited large areas of degradation, postulated to be 'washout' accelerated dissolution of the Boraflex material caused by pool water cooling flow through the poison enclosures. All eight designated cells showed faults on at least one side. More than two-thirds of the panels in these cells showed faults, ranging from relatively small gaps (< one inch) to large gaps (> four inches) and significant end shrinkage. In addition, large areas (three to 4.5 feet) of some panels indicated partial or significant loss of poison material.

EVENT DESCRIPTION: (Continued)

Above design basis degradation (washout) was found in one Region 1 cell which had been designated to have a long-term exposure in the surveillance plan (i.e., a single discharged assembly remained in the cell rather than being transferred to Region 2). In addition, significant washout was found in one other cell of Region 1. This cell had been designated to have a long-term exposure in the surveillance plan; i.e., a single discharged assembly remained in the cell rather than being transferred to Region 2. The degradation in this cell was similar to other washout observed, but did not exceed the design basis gap distribution.

A Justification for Continued Operation was prepared August 16, 1994, as a precaution in response to the first indications of degradation of the Boraflex neutron poison. It was determined that the required subcriticality can be assured, without Boraflex, provided that soluble boron concentration in the spent fuel pool is kept above 2500 ppm. Steps were taken to establish and maintain the boron concentration in the spent fuel pool. Additional operational and surveillance requirements were established to control dilution and ensure that an adequate margin of safety will be maintained.

AUSE OF THE EVENT

The root cause of the event is use of the Boraflex material in the spent fuel pool environment. The mechanism of Boraflex degradation is not completely characterized, but it is known to be related to the following factors:

1) Gamma flux (and to a small extent, neutron flux) causes changes in the base polymer material characteristics, leading to hardening and embrittlement.

2) Exposure to spent fuel pool environment (boric acid and forced coolant flow conditions) may lead to more rapid deterioration.

ANALYSIS OF THE EVENT:

This excessive degradation of Boraflex neutron poison found in the South Texas Project Spent Fuel Pool storage racks is being reported as a condition that was discovered to be outside the design basis of the plant and is reportable pursuant to 10CFR50.73(a)(2)(ii).

The South Texas Project spent fuel pool racks use high density storage racks fabricated by U.S. Tool and Die Co. The racks are of two regions, with the fuel racks in Region 1 (288 cells) designed to store fuel assemblies with higher reactivity than are allowed in Region 2 (1417 installed cells). The cells in both regions were designed with Boraflex neutron poison panels to ensure that adequate negative reactivity would be maintained when the pool was assumed to be flooded with unborated water. The Boraflex panels are approximately 7.5 ches wide and extend the height of the storage cell. Region 1 panels are removable, and Region 2 panels cells are fixed in place.

ANALYSIS OF THE EVENT: (Continued)

Because pool water analysis had for several years indicated a slight, but increasing, level of reactive silica (now approximately 20-25 ppm), it was assumed that gradual deterioration of Boraflex was underway due to exposure to gamma radiation. In light of industry experience, the probable degradation was judged to be typical because of the levels of South Texas Project measured silica were less than or comparable to other plants known to have Boraflex deterioration and typical "gapping" caused by tearing of the shrinking material.

A Justification for Continued Operation was prepared August 16, 1994, as a precaution in response to the first indications of greater than typical degradation of the Boraflex neutron poison panels between storage cells in the spent fuel pool racks. Pending completion of test results evaluation by the offsite consultant/contractor, there was concern that the South Texas Project Technical Specification 5.6.1.1.a (which requires that the spent fuel pool racks remain subcritical k_{eff} less than or equal to 0.95, when flooded with unborated water) might not be satisfied. The Justification for Continued Operation cites engineering analyses to show the racks meet Technical Specification 5.6.1.1.a with no Boraflex, as long as soluble boron concentration is maintained > 2500 ppm. A criticality analysis shows that 1300 ppm is sufficient for criticality control of the most reactive fuel allowable for the South Texas Project. An additional 700 ppm is added to provide margin for accident conditions (such as mispositioned or dropped assemblies); an additional 500 ppm is added for margin to safety.

The Justification for Continued Operation also specifies short-term compensatory measures: confirmation of frequency of surveillances of spent fuel pool boron concentration, caution tags to control dilution pathways to the spent fuel pool, caution to maintain boron concentration if circumstances force the use of firewater around the spent-fuel pool, and a caution to pre-borate (minimum 2500 ppm) new mixed-bed demineralizers in the spent fuel pool cooling & cleanup system.

The Justification for Continued Operation and related analyses apply to both of the South Texas Project units. Additionally, the locations of fuel assemblies in the Unit 2 spent fuel pool racks were evaluated. It was determined that the assemblies located in the designated accelerated exposure cells of Unit 2 racks were either low reactivity assemblies with significant burnup or assemblies with moderately higher reactivity but with rod cluster control assemblies stored in them. Thus, the Unit 2 subcriticality requirements are satisfied for the designated accelerated exposure cells, even if all Boraflex were degraded and the soluble boron were lost.

CORRECTIVE ACTIONS:

1. Restrictions will be placed on the use of the degraded Unit 1 Region 1 storage cells to assure compliance with design basis.

2. A Long Term Boraflex Management Plan is being developed to address this issue.

3. A dose-to-degradation correlation will be developed to aid in establishing restrictions on future cell usage in Units 1 and 2. Restrictions will be established, as necessary, to ensure compliance with the design basis.

ADDITIGNAL INFORMATION:

There have been no similar events reported by the South Texas Project. However, the degradation of Boraflex has been previously reported by other nuclear plants; the most closely related incident of Boraflex degradation would be that reported by Palisades (Palisades Licensee Event Report 93-007). This referenced report noted up to 90 percent disintegration or complete deterioration of Boraflex material in surveillance coupon holders.

Nuclear Regulatory Commission has issued Information Notice 93-70, "Degradation of Boraflex Neutron Absorber Coupons" on this issue.

ATTACHMENT 1

SOUTH TEXAS PROJECT BLACKNESS TEST RESULTS SUMMARY

This section summarizes the results of the blackness testing performed in August, 1994, and its implications as far as rack criticality. A summary of the condition of the panels tested is presented in Table 2.

BASIS FOR CRITICALITY CONCLUSIONS

The criticality analysis of record (performed by Westinghouse) for the Region 1 and 2 racks serves as the basis of conclusions reached on criticality concerns. The assumptions of this analysis are summarized below:

Table 1

Boraflex Damage	Region 1	Region 2
Gaps on 4 of 4 sides (in)	3.75	3.00
Gaps on 2 of 4 sides (in)	7.75	6.25
End shrinkage, 4 of 4 sides (in)	8.75	7.50
Max Close-packed enrich.	4.0 w/o	1.7 w/o

Note that in the criticality analysis, the gaps are assumed to occur in a similar fashion around every cell in the rack. This is a quite conservative assumption.

Evidence of End-Shrinkage

The ends of panels not at 179" are usually within the ±3" elevation measurement uncertainty of the blackness test equipment. The largest shrinkage indicated is on the north panel of cell 1P83. The top of this panel is reported at 168" ±3". Since only one panel is affected, however, the criticality analysis results are not exceeded. Cells 1K84, 1L85, and 1F80, exhibit the same type of indications on one or two panels out of four.

Cell 1C84 has indications of end shrinkage in all four panels. The tops of these panels are indicated at 173" ±3". Depending on the actual panel end elevations, the end shrinkage in this cell could also be outside the design limit.

Several panels had top elevations which exceeded 179". However, most of these were within 182" and are more probably an indication of measurement errors.

ATTACHMENT 1

SOUTH TEXAS PROJECT BLACKNESS TEST RESULTS SUMMARY

Panel Gaps and "Washouts"

Thirty seven (37) cells in Region 1 and eight (8) cells in Region 2 racks were tested. Of these 45 cells, 20 cells in Region 1 and no cells in Region 2 exhibited any evidence of degradation. Therefore, the following discussion only refers to the Region 1 racks. As an initial discriminator, only panels exhibiting gaps or washouts in excess of 3.75" are considered. This results in the list of panels presented in Table 3.

This list is then refined to produce Table 4. Most of the gaps which are approximately 3" to 5" can be eliminated from consideration since gaps do not appear on all four sides at the same elevation. While the gaps are larger than the 3.75" for Region 1, the k_{eff} of the cell would not be expected to exceed 0.95 since gaps do not appear on all four panels. Other areas of washout, which retain more than 60% absorption are probably not of concern. Per the current criticality analysis of record, the boron loading could decrease by 62% before $_{eff}$ exceeds 0.95.

Table 4 lists the panels exhibiting "excessive gaps and/or washouts". Of these, several merit discussion:

Panel 1B81S (cell 1B81, south panel)

The 17" gap at 104" is opposite a 52" gap at 104" on panel 1B82N. These large gaps most likely would cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel.

Panel 1B82N

The 14" gap at 35" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

The 52" gap at 104" is discussed on panel 1B81S. The two gaps over 7.75" in one cell was the cause for the original reporting of excessive Boraflex degradation.

Panel 1B82W

The 4" gap at 38" is coincident with similar gaps on 2 other panels. This is approaching the 4 panels with a gap scenario in the criticality analysis.

The 34" gap at 126" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

ATTACHMENT 1

SOUTH TEXAS PROJECT BLACKNESS TEST RESULTS SUMMARY

Panel 1C82N

The 18" gap at 28" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

Panel 1C82E

The 43" washout at 97" and the 10" washout at 174" would allow checkerboard loading in these cells, but probably not the loading of fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

anel 1C82S

The damage at 21" results in degradation on 3 of 4 sides of the cell. However, the amount of degradation is difficult to quantify.

The 36" washout at 85" would allow checkerboard loading in these cells, but probably not the loading of fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

Panel 1C83N

The 10" gap at 27" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion. The opposing panel (1C82S) has some degradation in this area. However, the amount is difficult to quantify.

Panel 1C83E

There is a region from 62" to 118" elevation which has been degraded to only 30-70% of the original absorption capabilities. This amount of degradation could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

Panel 1B83N

The 14" gap at 99" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

ATTACHMENT 1

SOUTH TEXAS PROJECT BLACKNESS TEST RESULTS SUMMARY

Panel 1C91E

The 33" gap at 149" far exceeds the 3.75" size. This large gap could cause k_{eff} to exceed 0.95 when the cells are loaded with fresh, 4.0 w/o fuel. Specific analysis would be needed to confirm this conclusion.

While the defects in the panels listed above are cited as possible locations which could cause k_{eff} to exceed 0.95 when those cells are loaded with fresh, 4.0 w/o fuel, this is a conservative determination. Specific analysis would be required to confirm these suspicions. To determine if "$k_{eff} < 0.95$ with unborated water" were ever actually exceeded in STP operating history, specific analyses would be needed, using the fuel assemblies actually placed in the suspect cells.

Table 2: Summary of Gap Data

					% Boron		
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
1G81	W	53.0	1.1	0%	53.5	52.4	53.0
1E81	E	177.0	4		179.0	175.0	177.0
1C81	E	149.0	2.1		150.0	147.9	149.0
		7.8	3		9.3	6.3	7.8
	S	30.0	1.3		30.6	29.3	30.0
		33.0	2.7		34.3	31.6	33.0
		72.0	1.8		72.9	71.1	72.0
		84.9	24	83%	96.9	72.9	84.9
		8.3	4		10.3	6.3	8.3
1B81	N	178.5	1		179.0	178.0	178.5
	E	178.5	1		179.0	178.0	178.5
	S	31.6	6	80%	34.6	28.6	31.6
		35.0	1.3		35.6	34.3	35.0
		38.6	6	80%	41.6	35.6	38.6
		60.0	1.3		60.6	59.3	60.0
		71.0	1.2		71.6	70.4	71.0
		104.0	17		112.5	95.5	104.0
	W	177.5	3		179.0	176.0	177.5
1B82	N	27.0	2	75%	28.0	26.0	27.0
		35.0	14		42.0	28.0	35.0
		52.0	1		52.5	51.5	52.0
		104.0	52		130.0	78.0	104.0

Table 2: Summary of Gap Data

					% Boron		
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
	E	87.0	1.2		87.6	86.4	87.0
	S	59.0	0.5		59.2	58.7	59.0
		72.0	1.4		72.7	71.3	72.0
		77.0	8.6	50%	81.3	72.7	77.0
		83.0	3.4		84.7	81.3	83.0
		93.7	18	80%	102.7	84.7	93.7
	W	24.0	24	90%	36.0	12.0	24.0
		38.0	4		40.0	36.0	38.0
		61.0	2.5		62.2	59.7	61.0
		68.0	1		68.5	67.5	68.0
		76.0	1		76.5	75.5	76.0
		84.0	0.7		84.3	83.6	84.0
		126.0	34	10%	143.0	109.0	126.0
1C82	N	28.0	18		37.0	19.0	28.0
		41.0	1.8		41.9	40.1	41.0
	E	22.0	1.3		22.6	21.3	22.0
		97.0	43	65%	118.5	75.5	97.0
		174.0	10	65%	179.0	169.0	174.0
	S	21.0	1		21.5	20.5	21.0
		30.0	2.1		31.0	28.9	30.0
		40.0	1		40.5	39.5	40.0
		58.0	1		58.5	57.5	58.0

Table 2: Summary of Gap Data

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		85.0	36	50%	103.0	67.0	85.0
1S82	W	78.0	0.6		78.3	77.7	78.0
1P83	N	173.5	11		179.0	168.0	173.5
	E	145.0	1.4		145.7	144.3	145.0
1J83	E	96.0	1.6		96.8	95.2	96.0
1G83	N	14.0	2.7		15.3	12.6	14.0
	S	178.0	2		179.0	177.0	178.0
1C83	N	13.0	1.2		13.6	12.4	13.0
		14.6	2		15.6	13.6	14.6
		27.0	10	95%	32.0	22.0	27.0
	E	24.0	1.1		24.5	23.4	24.0
		25.5	2	90%	26.5	24.5	25.5
		29.0	1.6		29.8	28.2	29.0
		68.0	12	30%	74.0	62.0	68.0
		75.5	3	0%	77.0	74.0	75.5
		83.0	12	40%	89.0	77.0	83.0
		90.5	3	0%	92.0	89.0	90.5
		98.0	12	50%	104.0	92.0	98.0
		105.5	3	0%	107.0	104.0	105.5
		112.5	11	70%	118.0	107.0	112.5
	S	24.0	0.9		24.4	23.5	24.0
		93.0	1.5		93.7	92.2	93.0

Table 2: Summary of Gap Data

		% Boron					
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		95.2	3	70%	96.7	93.7	95.2
1B83	N	34.0	1.7		34.8	33.1	34.0
		36.8	4	70%	38.8	34.8	36.8
		66.3	2	70%	67.3	65.3	66.3
		68.0	1.3		68.6	67.3	68.0
		70.1	3	70%	71.6	68.6	70.1
		85.0	0.5		85.2	84.7	85.0
		90.0	0.5		90.2	89.7	90.0
		99.0	14		106.0	92.0	99.0
	E	74.0	1.1		74.5	73.4	74.0
		76.0	3	80%	77.5	74.5	76.0
	S	75.0	1.5		75.7	74.2	75.0
1B84	N	81.0	2.4		82.2	79.8	81.0
	E	77.0	0.8		77.4	76.6	77.0
	S	87.0	1.8		87.9	86.1	87.0
1C84	N	70.0	1.1		70.5	69.4	70.0
		176.0	6		179.0	173.0	176.0
	E	176.0	6		179.0	173.0	176.0
	S	176.0	6		179.0	173.0	176.0
		6.6	0.6875		7.0	6.3	6.6
	W	176.0	6		179.0	173.0	176.0
1K84	E	175.5	7		179.0	172.0	175.5

Table 2: Summary of Gap Data

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
1L85	E	176.0	6		179.0	173.0	176.0
1G85	W	78.0	0.7		78.3	77.6	78.0
1F80	E	122.0	0.7		122.3	121.6	122.0
		176.0	6		179.0	173.0	176.0
	S	154.0	0.8		154.4	153.6	154.0
		175.5	7		179.0	172.0	175.5
		7.1	1.68		8.0	6.3	7.1
1F81	S	7.8	3		9.3	6.3	7.8
1F83	S	175.0	3.2		176.6	173.4	175.0
1F87	S	69.0	1.2		69.6	68.4	69.0
1U89	N	46.0	1.1		46.5	45.4	46.0
		104.0	0.4		104.2	103.8	104.0
		164.0	2.5		165.2	162.7	164.0
	E	112.0	1		112.5	111.5	112.0
1M88	E	15.0	3.1		16.5	13.4	15.0
		17.0	2		18.0	16.0	17.0
		20.0	0.5		20.2	19.7	20.0
		82.5	3	75%	84.0	81.0	82.5
		84.5	1	0%	85.0	84.0	84.5
		86.5	3	75%	88.0	85.0	86.5
		88.5	1	0%	89.0	88.0	88.5
		90.5	3	75%	92.0	89.0	90.5

Table 2: Summary of Gap Data

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		93.0	2	0%	94.0	92.0	93.0
		94.5	1	75%	95.0	94.0	94.5
1C91	E	77.0	0.6		77.3	76.7	77.0
		138.5	19	75%	148.0	129.0	138.5
		149.0	2	50%	150.0	148.0	149.0
		156.0	12	75%	162.0	150.0	156.0
	W	113.0	0.5		113.2	112.7	113.0

Table 3: Panels Exhibiting Gaps or Washouts in Excess of 3.75"

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
1B81	S	31.6	6	80%	34.6	28.6	31.6
		35.0	1.3		35.6	34.3	35.0
		38.6	6	80%	41.6	35.6	38.6
		104.0	17		112.5	95.5	104.0
1B82	N	27.0	2	75%	28.0	26.0	27.0
		35.0	14		42.0	28.0	35.0
		104.0	52		130.0	78.0	104.0
	S	72.0	1.4		72.7	71.3	72.0
		77.0	8.6	50%	81.3	72.7	77.0
		83.0	3.4		84.7	81.3	83.0
		93.7	18	80%	102.7	84.7	93.7
	W	24.0	24	90%	36.0	12.0	24.0
		38.0	4		40.0	36.0	38.0
		126.0	34	10%	143.0	109.0	126.0
1C82	N	28.0	18		37.0	19.0	28.0
	E						
		22.0	1.3		22.6	21.3	22.0
		97.0	43	65	118.5	75.5	97.00
		174.0	10	65%	179.0	169.0	174.0
	S	21.0	1		21.5	20.5	21.0
		30.0	2.1		31.0	28.9	30.0

Table 3: Panels Exhibiting Gaps or Washouts in Excess of 3.75"

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		40.0	1		40.5	39.5	40.0
		58.0	1		58.5	57.5	58.0
		85.0	36	50%	103.0	67.0	85.0
1C83	N	13.0	1.2		13.6	12.4	13.0
		14.6	2		15.6	13.6	14.6
		27.0	10	95%	32.0	22.0	27.0
	E	24.0	1.1		24.5	23.4	24.0
		25.5	2	90%	26.5	24.5	25.5
		29.0	1.6		29.8	28.2	29.0
		68.0	12	30%	74.0	62.0	68.0
		75.5	3	0%	77.0	74.0	75.5
		83.0	12	40%	89.0	77.0	83.00
		90.5	3	0%	92.0	89.0	90.5
		98.0	12	50%	104.0	92.0	98.0
		105.5	3	0%	107.0	104.0	105.5
		112.5	11	70%	118.0	107.0	112.5
	S	93.0	1.5		93.7	92.2	93.0
		95.2	3	70%	96.7	93.7	95.2
1B83	N	34.0	1.7		34.8	33.1	34.0
		36.8	4	70%	38.8	34.8	36.8
		66.3	2	70%	67.3	65.3	66.3
		68.0	1.3		68.6	67.3	68.0

Table 3: Panels Exhibiting Gaps or Washouts in Excess of 3.75"

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		70.1	3	70%	71.6	68.6	70.1
		99.0	14		106.0	92.0	99.0
	E	74.0	1.1		74.5	73.4	74.0
		76.0	3	80%	77.5	74.5	76.0
1M88	E	15.0	3.1		16.5	13.4	15.0
		17.0	2		18.0	16.0	17.0
		20.0	0.5		20.2	19.7	20.0
		82.5	3	75%	84.0	81.0	82.5
		84.5	1	0%	85.0	84.0	84.5
		86.5	3	75%	88.0	85.0	86.5
		88.5	1	0%	89.0	88.0	88.5
		90.5	3	75%	92.0	89.0	90.5
		93.0	2	0%	94.0	92.0	93.0
		94.5	1	75%	95.0	94.0	94.5
1C91	E	138.5	19	75%	148.0	129.0	138.5
		149.0	2	50%	150.0	148.0	149.0
		156.0	12	75%	162.0	150.0	156.0

Table 4: Panels Exhibiting Excessive Gaps or Washouts

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
1B81	S	35.0	1.3		35.6	34.3	35.0
		104.0	17		112.5	95.5	104.0
1B82	N	35.0	14		42.0	28.0	35.0
		104.0	52		130.00	78.0	104.0
	W	38.0	4		40.0	36.0	38.0
		126.0	34	10%	143.0	109.0	126.0
1C82	N	28.0	18		37.0	19.0	28.0
	E	22.0	1.3		22.6	21.3	22.0
		97.0	43	65%	118.5	75.5	97.0
		174.0	10	65%	179.0	169.0	174.0
	S	21.0	1		21.5	20.5	21.0
		30.0	2.1		31.0	28.9	30.0
		40.0	1		40.5	39.5	40.0
		58.0	1		58.5	57.5	58.0
		85.0	36	50%	103.0	67.0	85.0
1C83	N	27.0	10	5%	32.0	22.0	27.0
	E	68.0	12	30%	74.0	62.0	68.0
		75.5	3	0%	77.0	74.0	75.5
		83.0	12	40%	89.0	77.0	83.0
		90.5	3	0%	92.0	89.0	90.5
		98.0	12	50%	104.0	92.0	98.0
		105.5	3	0%	107.0	104.0	105.5

Table 4: Panels Exhibiting Excessive Gaps or Washouts

				% Boron			
Cell	Side	Elevation	Length	Remaining	Top	Bottom	Center
		112.5	11	70%	118.0	107.0	112.5
1B83	N	99.0	14		106.0	92.0	99.0
1C91	E	138.5	19	75%	148.0	129.0	138.5
		149.0	2	50%	150.0	148.0	149.0
		156.0	12	75%	162.0	150.0	156.0