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SUBJECT: Provides responses to 960626 GL 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks," requesting assessment capability to maintain 5% Boraflex subcriticality margin for Units 1 & 2,respectively.

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CARL D. TERRY
Vice President
Nuclear Engineering

October 22, 1996
NMP1L 1146

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

RE:	Nine Mile Point Unit 1	Nine Mile Point Unit 2
	Docket No. 50-220	Docket No. 50-410
	DPR-63	NPF-69

Subject: *NRC Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks"*

Gentlemen:

The Commission issued NRC Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks" on June 26, 1996 to inform all addressees of issues concerning the use of Boraflex in spent fuel storage racks. Generic Letter 96-04 requested that each addressee that uses Boraflex as a neutron absorber in its spent fuel storage racks assess the capability of the Boraflex to maintain a 5-percent subcriticality margin and to submit, within 120 days, a plan describing its proposed actions if this subcriticality margin cannot be maintained because of current or projected future Boraflex degradation. Attachments A and B provide the responses to Generic Letter 96-04 for Nine Mile Point Unit 1 and Unit 2, respectively.

Very truly yours,

C. D. Terry
Vice President - Nuclear Engineering

CDT/JMT/kap
Attachments

A068/1

xc: Mr. H. J. Miller, NRC Regional Administrator
Mr. S. S. Bajwa, Acting Director, Project Directorate I-1, NRR
Mr. B. S. Norris, Senior Resident Inspector
Mr. D. S. Hood, Senior Project Manager - NRR
Records Management

UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
NIAGARA MOHAWK POWER CORPORATION	)	Docket No. 50-220
	)	Docket No. 50-410
Nine Mile Point Nuclear Station Units 1 and 2	)	

C. D. Terry, being duly sworn, states that he is Vice President, Nuclear Engineering of Niagara Mohawk Power Corporation; that he is authorized on the part of said Corporation to sign and file with the Nuclear Regulatory Commission the document attached hereto; and that the document is true and correct to the best of his knowledge, information, and belief.

NIAGARA MOHAWK POWER CORPORATION

By [signature]

C. D. Terry
Vice President - Nuclear Engineering

Subscribed and sworn to before me, a Notary Public in and for the State of New York and the County of Oswego, this 22nd day of October 1996.

[signature]
Notary Public in and for

Oswego County, New York

My Commission Expires:

4/2/98

Eunice B. Naklick #4964683
Notary Public, State of New York
Qualified in Jefferson County
My Commission Expires April 2 1998

Eunice R. Naklick # 96[illegible]

Notary Public, State of New York

Qualified in Jefferson County

My Commission Expires April 2[illegible]

ATTACHMENT A

NMP1

RESPONSE TO GENERIC LETTER 96-04

Requested Information

All licensees of power reactors with installed spent fuel pool storage racks containing the neutron absorber Boraflex are requested to 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 and state whether a subcritical margin of 5 percent can be maintained for the racks in unborated water. Monitoring programs or calculational models in effect or being developed, or an estimation of anticipated concerns on the specific rack design, are considered an appropriate basis for this response. All licensees are further requested to submit to the NRC a description of 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 it cannot be maintained. Licensees should 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. Chronological trends of pool reactive silica levels, along with the timing of significant events such as refueling, pool silica cleanups, etc., should be provided. Implications of how these pool silica levels relate to Boraflex performance should be described. All licensees are requested to submit the information to the NRC to ensure that the onsite storage of spent fuel is in compliance with GDC 62 for the prevention of criticality in fuel storage and handling and with the 5-percent subcriticality margin position of the NRC staff to assure compliance with GDC 62.

NMP1 Response

Niagara Mohawk Power Corporation (NMPC) has assessed the physical condition of the Boraflex used in the Nine Mile Point Unit 1 (NMP1) storage racks including the effects of gapping and dispersion. Analysis has shown that the NMP1 storage racks could be susceptible to gapping due to shrinkage. A criticality analysis was performed to determine the Δk_∞ of a worse case scenario for gapping. The effect of gapping was shown to be $+0.0056\ \Delta k$ which, when added to the rack k_∞ of 0.9247, results in a k_∞ of 0.9303. This is well within the Technical Specification requirement of $k_\infty \leq 0.95$ for the storage racks. The 0.95 criteria is also met for the accident analysis assumed in the original criticality analysis.

Dispersion occurs after the Boraflex material has been exposed to sufficient gamma radiation ($>1\text{x}10^{10}$ rad). At this point, the material has undergone a chemical transformation and is now composed of approximately 45% silica, 5% organic material from the polymer, and 50% boron carbide. The rack construction is such that the Boraflex is exposed to flow, the silica which is soluble in water, can wash out, taking with it the neutron absorbing boron carbide. Therefore, NMPC cannot state that Boraflex integrity will be maintained for the life of the racks. NMP1 has a "tight" rack design in which the Boraflex panels are enclosed in a steel

box which allows for relatively small amounts of coolant to flow over the Boraflex. Spent fuel pool chemistry data for NMP1 shows a very low level of silica (<.35 ppm) and supports this conclusion. Chronological trend data on pool silica levels indicates that there is no appreciable silica dissolution occurring at NMP1 (attached). Although no post-operational blackness tests have been performed on the racks, neutron attenuation testing of the rack coupons to date have shown acceptable results. Based on the above, NMPC believes that the current physical condition of the Boraflex is adequate to maintain a subcritical margin of 5% in unborated water.

NMP1 has adopted the "defense-in-depth" philosophy recommended by Electric Power Research Institute (EPRI). This approach uses a multiple level defense strategy to address the potential for degradation of Boraflex. The first level of defense consists of coupon surveillance practices and trending silica concentrations in spent fuel pool water. The surveillance practices include visual inspection, dimensional measurements, dry weight and specific gravity, radioassay, shore A hardness, and neutron attenuation tests. These methods are currently in place at NMP1. Additionally, NMP1 is in the process of modeling the spent fuel racks with RACKLIFE. This analytical model for enhanced monitoring and rack management can be used to identify the most highly exposed cells in the spent fuel racks. This data can then be used to help plan the placement of high powered bundles and will result in a more even distribution of exposure for all the spent fuel rack cells. This type of rack management, in addition to the coupon surveillance program, will help ensure the safe use of these storage racks during their intended design life. Should the results from any one of these first level surveillance activities indicate questionable Boraflex performance, then the second level of defense may be implemented. The second level involves quantitative in-situ measurement of the boron-10 areal density of the Boraflex in spent fuel storage racks. In the event these measurements indicate that the design basis of the fuel racks cannot be assured or the boron areal density measurement technology is determined to be unreliable or impractical, then the third level of defense would be implemented. At the third level, mitigation measures are implemented. These measures may include further analyses to determine actual reactivity effect, developing administrative procedures that limit storage of fuel enrichment in a certain configuration or racks, researching and applying the use of additional credit for fuel burnup, or the use of fuel or rack absorber inserts. The application of one or more of these mitigation measures may be appropriate depending on the specific circumstances.

Several options are currently available to the industry in the event the 5% criticality margin cannot be maintained. These options are:

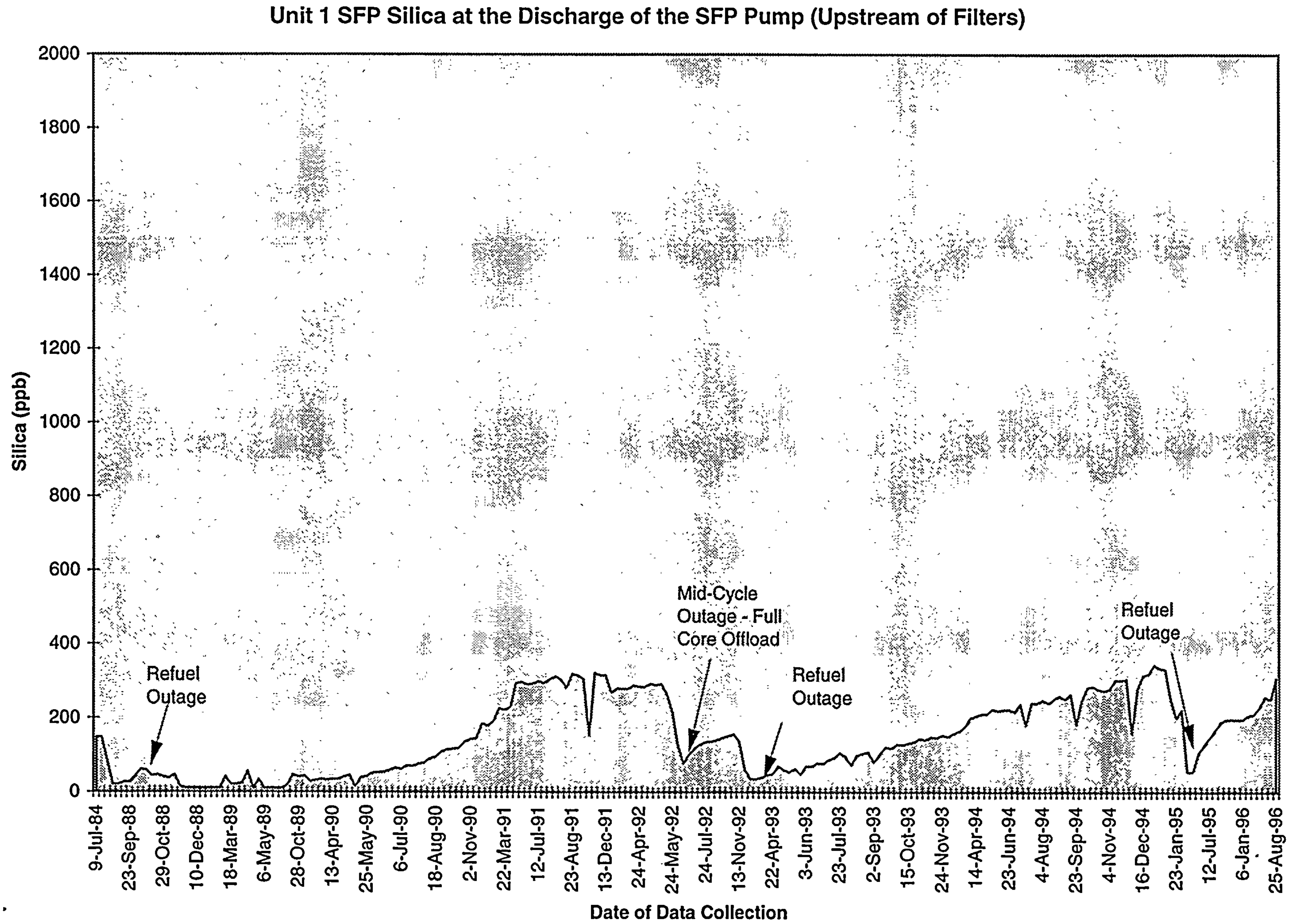
- The use of poison inserts in racks
- Reanalyze pool criticality based on actual measured boron loss
- Shuffle fuel to a checkerboard pattern

If pool silica, RACKLIFE projections, and coupon analysis indicated severe degradation may be occurring, then NMPC will assess the best method listed above to ensure that $k_\infty \leq 0.95$ is maintained. However, NMPC may want to select other and possibly more appropriate options that are in the process of being developed.

Conclusion

Although Niagara Mohawk cannot state that Boraflex integrity will be maintained for the life of the racks, NMP1 does have a coupon surveillance program in place for monitoring the condition of the Boraflex. All tests to date have shown acceptable results. Analysis has determined that the design can accommodate the worse case effects of gapping and a review of the rack design indicates that the racks are not highly susceptible to dispersion. Current silica data supports this conclusion.

Niagara Mohawk is continuing its participation in the EPRI Boraflex Working Group and will be making use of the EPRI RACKLIFE computer program. This analytical model can be used to identify the most highly exposed cells in the spent fuel racks. This data can then be used to indicate the placement of high powered bundles. The objective here is to evenly distribute the exposure in all spent fuel rack cells. Rack management of this nature, in addition to the coupon surveillance program, will help to ensure the safe use of these racks for their intended design life.



Unit 1 SFP Silica at the Discharge of the SFP Pump (Upstream of Filters)
Silica (ppb)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Refuel Outage
Mid-Cycle Outage - Full Core Offload
Refuel Outage
Refuel Outage
9-Jul-84
23-Sep-88
29-Oct-88
10-Dec-88
18-Mar-89
6-May-89
28-Oct-89
13-Apr-90
25-May-90
6-Jul-90
18-Aug-90
2-Nov-90
22-Mar-91
12-Jul-91
23-Aug-91
13-Dec-91
24-Apr-92
24-May-92
24-Jul-92
13-Nov-92
22-Apr-93
3-Jun-93
23-Jul-93
2-Sep-93
15-Oct-93
24-Nov-93
14-Apr-94
23-Jun-94
4-Aug-94
23-Sep-94
4-Nov-94
16-Dec-94
23-Jan-95
12-Jul-95
6-Jan-96
25-Aug-96
Date of Data Collection

SIL-U1.XLS

ATTACHMENT B

NMP2

RESPONSE TO GENERIC LETTER 96-04

Requested Information

All licensees of power reactors with installed spent fuel pool storage racks containing the neutron absorber Boraflex are requested to 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 and state whether a subcritical margin of 5 percent can be maintained for the racks in unborated water. Monitoring programs or calculational models in effect or being developed, or an estimation of anticipated concerns on the specific rack design, are considered an appropriate basis for this response. All licensees are further requested to submit to the NRC a description of 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 it cannot be maintained. Licensees should 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. Chronological trends of pool reactive silica levels, along with the timing of significant events such as refueling, pool silica cleanups, etc., should be provided. Implications of how these pool silica levels relate to Boraflex performance should be described. All licensees are requested to submit the information to the NRC to ensure that the onsite storage of spent fuel is in compliance with GDC 62 for the prevention of criticality in fuel storage and handling and with the 5-percent subcriticality margin position of the NRC staff to assure compliance with GDC 62.

NMP2 Response

Niagara Mohawk Power Corporation (NMPC) has assessed the physical condition of the Boraflex used in the Nine Mile Point Unit 2 (NMP2) storage racks including the effects of gapping and dispersion. Analysis has shown that the NMP2 storage racks could be susceptible to gapping due to shrinkage. The visual inspection of the full length coupon showed gaps at the four notched sections along the length of the panel. A criticality analysis was performed to determine the Δk_∞ of a worse case scenario for gapping. The effect of gapping was shown to be +0.0232 Δk which, when added to the rack k_∞ of 0.9137, results in a k_∞ of 0.9369. This is well within the Technical Specification requirement of $k_\infty \leq 0.95$ for the storage racks. The 0.95 criteria is also met for the accident analysis assumed in the original criticality analysis.

Dispersion occurs after the Boraflex material has been exposed to sufficient gamma radiation ($> 1 \times 10^{10}$ rad). At this point, the material has undergone a chemical transformation and is now composed of approximately 45% silica, 5% organic material from the polymer, and 50%

boron carbide. The rack construction is such that the Boraflex is exposed to flow, the silica, which is soluble in water, can wash out taking with it the neutron absorbing boron carbide. Therefore, NMPC cannot state that Boraflex integrity will be maintained for the life of the racks.

Based on EPRI RACKLIFE computer program, the peak panel exposure at NMP2 is predicted to below $1x10^{10}$ Rad (i.e., $7x10^{9}$ Rad). Spent fuel pool chemistry data for NMP2 shows silica levels of about 2 ppm. NMP2's spent fuel pool silica concentrations show an increasing trend in silica (attached). This is indicative of some amount of Boraflex degradation. The amount of degradation at NMP2 is primarily due to an "open" rack design that allows for a relatively large amount of coolant to flow over the Boraflex. However, based on RACKLIFE, NMP2's surveillance coupon analysis, and comparing NMP2 silica data to other plants that use Boraflex, NMP2s' Boraflex has not observed any indication of severe degradation. The best indicator of the condition of Boraflex at NMP2 is the full length coupon. This coupon design is unique in that it was constructed from the same material that was used in the actual spent fuel racks and the encased stainless steel is a full length representation of the actual poison panels. Although no post-operational blackness tests have been performed on the racks, neutron attenuation testing of the rack coupon to date have shown acceptable results. Based on the above, NMPC believes the current physical condition of the Boraflex is adequate to maintain a subcritical margin of 5% in unborated water.

NMP2 has adopted the "defense-in-depth" philosophy recommended by EPRI. This approach uses a multiple level defense strategy to address the potential for degradation of Boraflex. The first level of defense consists of coupon surveillance practices and trending silica concentrations in spent fuel pool water. The surveillance practices of the short coupons consists of a visual inspection, dimensional measurements, shore A hardness, dry weight and specific gravity, radioassay and neutron attenuation. The surveillance of the full length coupons consists of a visual inspection, panel dimensions, and high resolution 35 mm photography. These methods are currently in place at NMP2. Additionally, NMP2 will continue to model the spent fuel racks with RACKLIFE. This analytical model is used to identify highly exposed cells in the spent fuel racks. This data is then used to help plan the placement of high powered bundles and will result in a more even distribution of exposure for all the spent fuel rack cells. This type of rack management, in addition to the coupon surveillance program, will help ensure the safe use of these racks during their intended design life. Should the results from any one of these first level surveillance activities indicate questionable Boraflex performance, then the second level of defense may be implemented. The second level involves quantitative in-situ measurement of the boron-10 areal density of the Boraflex in spent fuel storage racks. In the event these measurements indicate that the design basis of the fuel racks cannot be assured or the boron areal density measurement technology is determined to be unreliable or impractical, then the third level of defense would be implemented. At the third level, mitigation measures are implemented. These measures may include further analyses to determine actual reactivity effect, developing administrative procedures that limit storage of fuel enrichment in a certain configuration or racks, the use of fuel or rack absorber inserts, or researching and applying the use of additional credit for fuel burnup. NMP2's criticality analysis assumes a fuel burnup corresponding to the peak fuel

reactivity (i.e., the point of gadolinia poison burnout typically 8 to 12 GWD/MTU). EPRI believes that the effects of assuming actual discharge exposure can provide a further reduction in fuel reactivity of 0.05 to 0.07 in Δk_∞. (The use of actual fuel burnup is being accounted for in PWRs criticality analysis, however, burnup credit beyond peak reactivity has not yet been applied in BWRs.) The application of one or more of these mitigation measures may be appropriate depending on the specific circumstances.

Several options are currently available to the industry in the event the 5% criticality margin cannot be maintained. These options are:

- The use of poison inserts in racks
- Reanalyze pool criticality based on actual measured boron loss
- Shuffle fuel to a checkerboard pattern

If pool silica, RACKLIFE projections, and coupon analysis indicated severe degradation may be occurring, then NMPC will assess the best method listed above to ensure that $k_\infty \leq 0.95$ is maintained. However, NMPC may want to select other and possibly more appropriate options that are in the process of being developed.

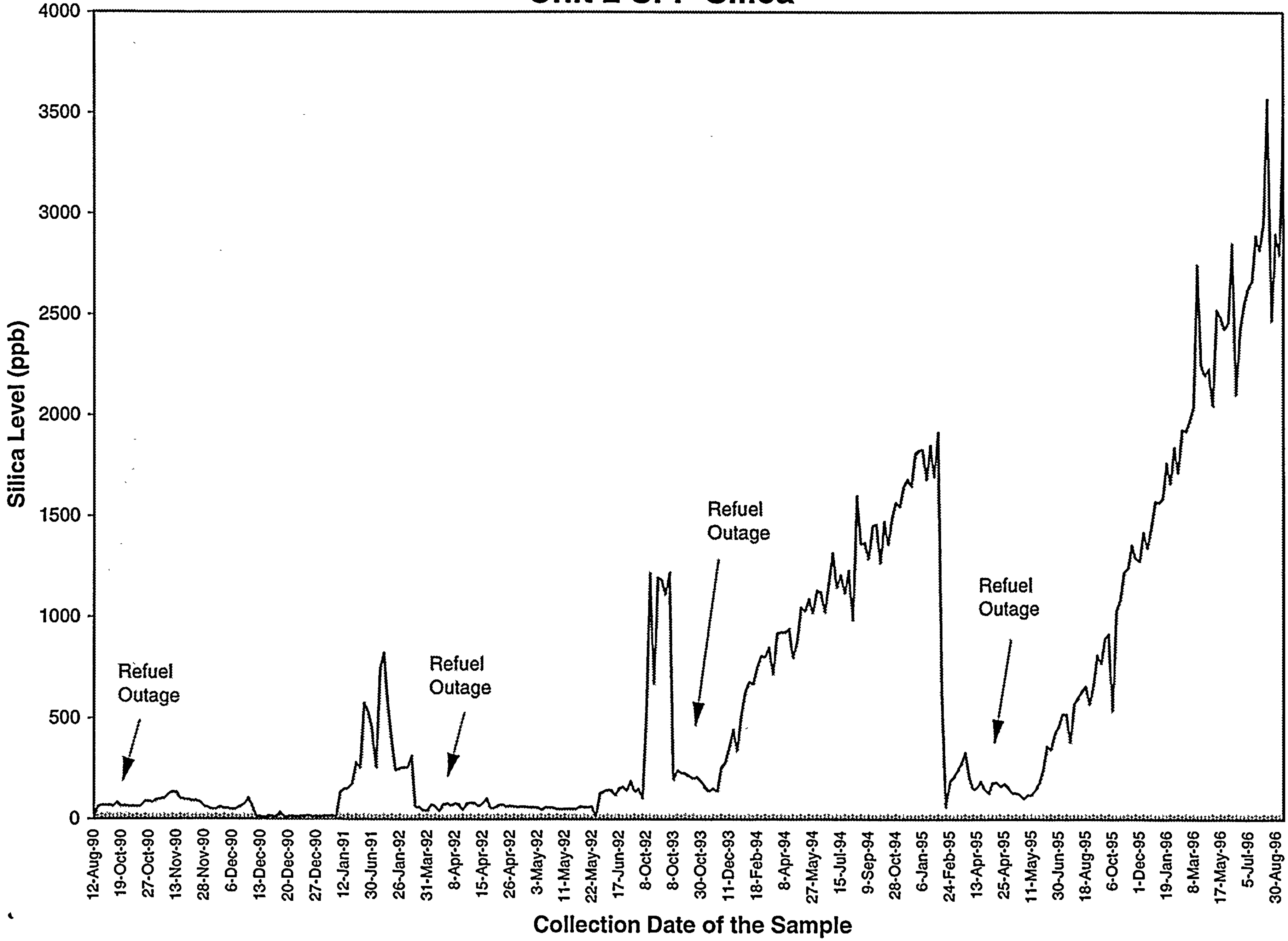
<u>Conclusion</u>

Although Niagara Mohawk cannot state that Boraflex integrity will be maintained for the life of a rack, NMP2 does have a coupon surveillance program in place for monitoring the condition of the Boraflex. All tests to date have shown acceptable results. Analysis has determined that the design can accommodate the worst case effects of gapping. The improved coupon surveillance assemblies at NMP2 will provide an accurate indication of actual Boraflex condition. Additionally, NMP2 periodically performs an analysis of spent fuel pool water to determine silica concentrations. A review of current silica data does not indicate that severe dissolution of Boraflex is occurring.

Niagara Mohawk is continuing its participation in the EPRI Boraflex Working Group and will continue making use of the EPRI RACKLIFE computer program. This analytical model for enhanced monitoring and rack management can be used to identify the most highly exposed cells in the spent fuel racks. This data can then be used to manage the placement of high powered bundles in order to achieve a more even distribution of exposure for all the spent fuel rack cells. This type of rack management, in addition to the coupon surveillance program, will help to ensure the safe use of these racks for their intended design life.

It is important to note that a recent criticality analysis performed for NMP2 calculates the k_∞ to be equal to 0.9137. A separate analysis calculates the effects of gapping increases k_∞ by 0.0232. The combined k_∞ is well within the Technical Specification requirement of ≤ 0.95.

Unit 2 SFP Silica



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