UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

Oct. 23, 2000

MEMORANDUM TO: ACRS Members and Staff

MEMORANDUM #: AWC-113-2000

FROM: A. W. Cronenberg

SUBJECT: Summary Thoughts on Revised Spent Fuel Pool Risk Study per Subcommittee Meeting of Oct. 18, 2000

This memo summarizes my thoughts/comments related to participation at the Fuels Subcommittee Meeting of Oct. 18, 2000, where staff, industry, and public comments were made concerning the Revised Spent Fuel Pool Risk Study for Decommissioning Plants. It is provided to the ACRS in advance of the 477th ACRS meeting of Thursday, Nov. 2, 2000, where the full committee will hear similar presentations on the subject.

Overall Impressions: I felt the staff made a reasonable attempt to address ACRS concerns expressed in its letter of April 13, 2000. Notable improvements include source term estimates, a clearer statement of uncertainties in the ignition temperature for Zr-air reactions, and better attempt to quantify the risk (and delta risk) in regards to a change in Emergency Plans for shutdown plants. Nevertheless, I still have major concerns that this "*Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*" is not on firm enough footing to proceed with rule-making activities.

A major concern relates to the apparent commission direction to the staff to consider only a one year fuel decay time. It appears to me that a comparison of SFP risk, say for 1, 2, and 3 years decay, might have been more beneficial and shed more light on risk (and delta risk) for generic relief for shutdown plants. My concern stems from a review of several, of the 20 or so, prior SFP Exemption Requests. In these prior requests, licensee submittal analysis generally indicate spent fuel heatup temperatures under LOCA conditions exceeding or approaching 850 °C at decay times of one year (where 850 °C is the agency criterion or ignition temperature for auto-catalytic Zr-air oxidation). These heatup analysis indicate temperatures several hundred degrees less than this criteria if fuel is allowed to decay for 2 years or more. Thus, all prior exemptions, which had the benefit of plant-specific analysis for actual spent fuel pool storage configurations, have only been granted for decay times of 2 or more years decay (except Maine Yankee at 20 months). I'll talk more to this point below.

1) Consistency: I have a hard time with the consistency of conclusions reached in the subject report for the time period for generic relief from Emergency Plans and that for Insurance Indemnity. On one hand the staff presents risk arguments supporting generic relief from Emergency Plans for a one year decay period. The one year period is based on estimates of

the absolute and delta risks posed by spent fuel drain-down events owing to the low frequency of a seismic event causing catastrophic pool failure. On the other hand, the staff says a 5-year decay period is required before granting Insurance Indemnity relief. This 5-year period is based on staff assumptions of less than catastrophic pool failure, i.e. the potential for partial drain-down, blockage of fuel assemblies, and attendant fuel heatup to temperatures resulting in large-scale fuel rod failures (by whatever mechanism) and radio-nuclide release. The primary purpose of Emergency Plans is evacuation of the public in the event of large-scale radio-nuclide release from an accident. The purpose of Insurance Indemnity is to satisfy personal injury and property damage claims for the same type of accidents. Are these so dissimilar in purpose, that 1-yr decay is appropriate for one, but 5-yr appropriate for the other? I don't think so.

It should be noted that all prior exemptions were made based on a similar minimum 2-year fuel decay requirement for relief from both Emergency Plans and Insurance Indemnity. Maybe I'm missing something, but I don't think a clear technical case has been made in the subject risk study (as it now stands) for the two different decay time criteria to be used in rule making. There could be a.....*can't see the forest through the trees*... problem here.

2) Risk Calculations: Although I think Bob Palla's presentation on the risk for catastrophic pool failure for seismic events and impact of relief from Emergency Plans on risk (and delta risk) was an improvement over the last time around, I still have concerns here. These concerns stem from inherent assumptions in his risk calculations. First, only after questioning did Bob and the staff admit, that the consequence analysis (i.e. source term calculations) were indeed not bounding or generic, but rather based on Millstone-1 spent fuel pool inventory conditions for that particular plant. The risk study however is to support Generic rule making for future shutdown plants; which one could reasonably argue may have a larger inventory of high burnup spent rods than Millstone, have a tighter packing density of fuel assemblies, and have larger inventories of total spent rods, etc . The compound effect of such factors would lead to a higher fission product inventory conditions and thus a larger source term than used in the risk study. If this SFP Risk Study is to support generic rule-making for future Exemption Requests, than the source term analysis should be bounding of anticipated SFP fuel inventory conditions. I do not feel confident that the source term analysis using Millstone SFP inventory conditions does the job here.

A second point concerns Palla's delta-risk analysis. He compared the delta risk for retention of Emergency Plans for Operating Reactors (EP-OR), versus that for relief from EP requirements based on Industry Decommissioning Commitments (IDCs) Commitments and Staff Decommissioning Assumptions (SDA). The salient point to note is that the only impact considered in his delta-risk analysis was the timing of warning to the public, that is 5-hours warning for retention of full-EP versus 10 hrs for relaxed-EP with IDCs\SDAs. All other factors such as the total number of people evacuated, the distance of evacuation, actions to secure water supply, medical and public security assistance, etc., were all taken to be the same for full EP and relaxed EP. I don't think this accurately reflects the real impact on risk for full-EP versus relaxed-EP. This point was not addressed in the report and was only clarified by Palla after questioning.

If this study is to be the technical underpinning for risk insights to support generic rule making, then the risk numbers need to be on firm ground, or at least bounding for future SFP conditions. At this point they are not.

3) Why 1-yr Decay: As mentioned above, it appears to me that a comparison of SFP risk, for 1, 2, and 3 years fuel decay, might have been more beneficial and shed more light on risk (and delta risk) for generic relief from EP and Insurance Indemnity. Below I give the predicted decrease in decay power with time based on NUREG/CR-5625 (*Technical Support for Proposed Decay Heat Guide Using SAS2H/ORIGEN-S Data,* Herman, Parks, *Renier, 1994).* The point to note is the decay power at 1 year decay (proposed for EP relaxation) versus the two or more years of decay required in prior exemptions. NUREG/CR-5625 predictions for 1, 2, and 3 year decay periods are as summarized. For the PWR case of 60 GWD/t-U, the decay heat at two years is shown to be almost half that at one year. This is the underlying physical reason why all prior EP and Insurance relief for shutdown plants were only granted for decay times of 2-yrs or more (except Maine Yankee at 20 mo).

As more fully discussed in my upcoming report on the subject, decay time buys you a lot in terms of SFP risk. I can't understand the rush to go forward with generic rule-making for a 1-yr decay, when prior plant-specific analysis indicate SFP-LOCA fuel heatup problems for so short a decay period. I'm coming to the conclusion that the 1-year decay is not advisable for EP exemptions, at least until a stronger technical case has been made to justify it.

With regards to arguments of undo burden on the industry for retention of full-EP for an additional year or so beyond the 1-year considered in the subject risk study, I note comments made at the subcommittee that what we are talking is 5 or so additional plants that may request relief in the near future (7-10 years). Not a large number of plants. In a similar vain, Lynnette Hendricks of NEI indicated a cost of about $500,000/plant for full-EP retention for an additional year (as best she could estimate off the top of her head). Not a prohibitive cost. What's the rush here to go with a generic rule for EP relaxation after only 1 year decay. I don't see it.

Fuel Decay	Predicted Decay Power from NUREG/CR-5625			
Time (yr)	PWR Decay Power (Watts/t-U)		BWR Decay Power (Watts/t-U)	
	60 GWD/t-U	30 GWD/t-U	40 GWD/t-U	30 GWD/t-U
1 yr	≅ 1.5E+4	≅ 0.9 E+4	≅ 0.9 E+4	≅ 0.65E+4
2 yr	≅ 0.8E+4	≅ 0.45E+4	≅ 0.5 E+4	≅ 0.35E+4
3 yr	≅ 0.6E+4	≅ 0.30E+4	≅ 0.35E+4	≅ 0.25E+4

4) Reductions in Safety Margins for Separate Actions: One last point is with regards to the concern of Mario Bonaca, regarding potential reductions in safety margins due to the compounding effects of separate actions. A similar concern was expressed in my Power Uprate Report related to synergistic effects. As noted by the last speaker at the subcommittee, Mr. G. Thompson of the Institute for Resource and Security Studies, a significant part of the spent fuel heatup problems under LOCA conditions relates to past NRC actions allowing for a much more densely packed pools than proposed in original FSARs. The adverse effects of highly packed pools are primarily twofold: (1) the potential for criticality, which is taken care of by use of absorber plates, and (2) exacerbated fuel heatup under off-normal SFP conditions. My report points to studies that clearly show the impact of fuel rod packing density on heatup, which is significant. Another point with regards to Mario's concern relates to allowing ever higher discharge burn-ups, which again add heat load to the pool. The risk study does not adequately address such compounding (synergistic) effects.

My report conclusions basically come down to the recommendation that the present approach of requiring plant-specific heatup analysis for EP and Insurance relief should be continued. A generic rule, particularly if it is 1-year based, should be delayed until such time as the technical issues on fuel heatup, Zr-air reactions, and source term uncertainties have been more adequately addressed.

In summary, my bottom-line input is that the report "*Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*" has significant deficiencies and less than adequate to support rule-making activities at this time.