Pollution & Environmental Problems, Inc.
P.O. Box 309
Palatine, Illinois 60067
March 22, 1981

Mr. Harold Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Docket Nos. 50-295
and 50-304

Dear Mr. Denton:

This letter refers to your letter of February 18, 1981 to Pollution and Environmental Problems, Inc. (PEP) which informed us that our petition of April 17, 1980 to suspend the license amendment nos. 52 and 49 to rerack and compact the spent fuel pool at the Zion Station Unit nos. 1 and 2 had been denied.

Your denial was "ex post facto", coming - as it did - after the reracking and spent fuel compaction had already begun at the Zion Station. Thus it appears that petitions to the Nuclear Regulatory Commission under Section 2.206 of the Code of Federal Regulations are treated by the NRC as mere formalities and not given the due consideration they deserve under the law.

On page six of your decision to deny our request, you note that "the second issue considered in the Salem proceeding which PEP sought to have examined for the Zion facilities, dealt with the potential loss of water from the spent fuel pool and the effect such a loss of water would have on a pool with expanded storage capacity."

PEP has reviewed and summarized the Salem transcript (see attached). We find in the testimony of NRC witnesses, Drs. Walter F. Pasadeg and Allan S. Benjamin, sufficient reason to deny Commonwealth Edison license to rerack and compact the spent fuel pool at Zion. The NRC's experts on spent fuel heatup revealed:

1. The spent fuel clad in the Salem pool or any spent fuel pool can undergo a self-sustaining and spreading oxidation. (Benjamin at 1398,1399,1401, 1411,1488. Pasadeg at 1580 said further analysis of spreading oxidation by radiant heat transfer is needed.)

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2. Four year old spent fuel could oxidize...(Benjamin at 1423; at 1571 he states further analysis is required)...the zirconium clad could melt...(Benjamin at 1423)...and the fission products within the clad could be released. (Benjamin at 1423).

3. The consequences of partial loss of cooling water on new or aged fuel in a spent fuel pool have not been thoroughly investigated. (Benjamin at 1429)

4. Spent fuel heatup experts have not completed all necessary research to determine the short or long term safety of spent fuel in pool storage. For example, Dr. Benjamin said:"The questions that are unanswered right now: is the question of clad relocation when melting begins and you have a crust of zirconium oxide over the top of the melting zirconium. Second, the question of heat transfer from new spent fuel elements to old spent fuel elements. The question of the partition of heating -- what percent of heat goes into melting fuel and newest spent fuel as opposed to heat that goes by thermal radiation into older spent fuel..." (Benjamin at 1436)

5. Melting of fuel pellets in fresh assemblies is a probability and is likely to happen in fuel one year old or less. (Benjamin at 1440,1441). The possibility of fuel pellets four years old or more melting is not known. (Benjamin at 1441)

6. The interest of public health and safety requires that an analysis be done on the propagation of oxidation in the spent fuel pool. Such a study could be done by one individual in several months. (Pasadeg at 1492)

7. Dr. Dana Powers of Sandia Lab is more qualified on the chemistry of zirconium than the NRC's expert witnesses. Powers was not present at the hearing. (Benjamin at 1546)

8. New spent fuel could produce hydrogen capable of exploding. (Benjamin at 1571). Further research and analysis is required on whether a zirconium reaction with water could produce hydrogen capable of exploding in the older assemblies. (Benjamin at 1571)

It is PEP's belief that the Salem discussion of spreading fire or flames in a spent fuel pool was entirely irrelevant and that the intervenors should not have pressed this point. In our opinion,

it is rapid oxidation in the form of sustained burning -- that causes the fuel clad to melt and the radioactivity to be released from the spent fuel. It was not necessary for the intervenors to prove spreading fire or flames in the pool to make their case; only that sustained burning of the fuel clad is credible. The NRC's witnesses, Drs. Benjamin and Pasedag, made the intervenors' case for them and it should be accepted as such. I refer you to the following exchange between hearing officer Milhollin and Dr. Benjamin at 1398:

Chairman Milhollin: "...I interpret what you say to mean that zirconium can melt and oxidize without flame."

Benjamin: "Yes."

Milhollin: "And that you believe that oxidation can be propagated."

Benjamin: "I believe that oxidation can be propagated if the temperature reaches...self-sustaining temperatures."

Dr. Pasadeg (at 1596) agreed: "I think the clad in the Salem pool or any spent fuel pool can undergo a self-sustaining oxidation if the conditions are right as opposed to a fire. It doesn't require a fire in order for oxidation to occur."

Then again, (at citation unknown):

Milhollin: You can melt and oxidize without flame?

Benjamin: "Yes...oxidation can be propagated if the temperature reaches self-sustaining oxidation temperatures. It is a function of heat transfer and kinetics."

The Salem hearing was narrowly limited from the outset. PEP does not understand why. The hearing limitations outlined below did not serve the public interest.

1. Discussion was limited to a gross loss of water accident. Scientist Gordon Thompson with the Union of Concerned Scientists has long contended that a partial loss of water accident would have more dire consequences than a gross loss of water accident. Dr. Allan S. Benjamin in his SAND 77-1371 indicates that a partial loss of water could be a greater safety problem than a gross loss of water accident in a compact spent fuel pool.

2. The Salem hearing testimony narrowly focused on the differences in consequences between a gross loss of water accident in an unexpanded and an expanded spent fuel pool. It is PEP's opinion that a loss of water accident in either an expanded or unexpanded spent fuel pool could have unacceptable consequences on the surrounding environment and population. Common sense dictates that the more spent fuel in a given pool, the greater the potential adverse consequences. As Dr. Walter F. Pasadeg said on April 4, 1981: "The potential for radiological consequences from any accidental release of water from the spent fuel pool would be directly proportional to the fission and activation product concentrations in the water."

The above reasons and other testimony of the NRC's own experts provide compelling reasons to prohibit reracking and compaction of the Zion spent fuel pool, the Salem pool and any other spent fuel pool in the United States -- until appropriate and comprehensive research, as described by Drs. Pasadeg and Benjamin, has been carried to conclusion.

The testimony of Dr. Dana Powers should be added to the record. In addition, I urgently request that the NRC solicit testimony from Dr. Earl A. Gulbransen, research professor, School of Engineering, Department of Metallurgy and Materials Engineering, University of Pittsburgh. I am attaching a letter from Dr. Gulbransen responding to my summary of the Salem proceedings. Dr. Gulbransen is known throughout the world as a leading researcher and expert in the field of metallurgy. His concerns deserve your swift attention.

In conclusion, the evidence is not yet in. The case has not been settled. Salem has appealed. The citizens of the Zion area have appealed. This letter constitutes our appeal of your decision of February 18, 1981. Your denial to our original petition should not be final until the Salem appeal has been decided. In the interest of fairness to PEP and the citizens of Zion and northern Illinois, we urge you to reconsider your denial and delay your final decision on our appeal, pending the outcome of the Salem appeal and scientific research into those areas defined by your own witnesses.

Sincerely yours,

Catherine Quigg

Catherine Quigg, research director
Pollution & Environmental Problems, Inc.
(312/381-6695)

SELECTED EXCERPTS FROM U.S. NRC DOCKET #50-272

Public Service Electric & Gas Company

Salem 1, Salem, New Jersey

April 28, 1980

FROM: SALEM TRANSCRIPT

1. Testimony of Walter F. Pasedag, 4/28/80

"The potential radiological consequences from any accidental release of water from the spent fuel pool (SFP) would be directly proportional to the fission and activation product concentrations in the water."

2. Dr. A. S. Benjamin

pp 1391 -1392

"...on the basis of current knowledge...possibility cannot be ruled out that the oxidation of zirconium might propogate to older fuel elements even older than 4 years. I do not believe a zirconium fire would occur..."
"...what cannot be ruled out is possibility that by process of thermal radiation from fuel assembly to fuel assembly, it may be possible to propagate a zirconium reaction to the older fuel elements. I believe that this process would take hours, at least...my area of disagreement with Mr. Pasedag is that his statement that there is no credible mechanism for this propagation to occur."

p. 1393

Flame involves a great deal of convection and spreading of flames from fuel assembly to fuel assembly. Consulted with Dr. Lewis Baker, Argonnne, expert on subject and he says not possible for flame of this type to develop..."That any burning or oxidation that occurred might result in a brightness or a kind of white illuminosity about the fuel cans in the immediate vicinity of where this reaction...but that it would not result in flames." In Dr. Baker's opinion, it was oil in the bins containing zirconium scrap that caused these flames to occur and not the zirconium itself...don't believe rapidly spreading fire or deflagration possible.

p. 1397

"I interpret the word ignition to mean a burning that is initiated and which sustains itself because of an inability to remove heat fast enough in order to be able to put it out...our calculations for spent fuel pools say this will happen in the newest or hottest spent fuel elements, once they reach a temperature of approximately 900 deg.C. "We have continued our calculations beyond the 900 deg.C temperature up to and beyond the temperature of zirconium melting."

2. Dr. Benjamin (continued)

p.1397 "I interpret the word ignition to mean a burning that is initiated and which sustains itself because of an inability to remove heat fast enough in order to be able to put it out...our calculations ofr spent fuel pools say this will happen in the newest or hottest spent fuel elements, once they reach a temperature of approximately 900 deg. C. "We have continued our calculations beyond the 900 deg.C temperature up to and beyond the temperatures of zirconium melting."

CHAIRMAN MILHOLLIN:
"...I interpret what you say to mean that zirconium can melt and oxidizes without flame."

p. 1398 BENJAMIN:
"Yes."

MILHOLLIN:
"And that you believe that oxidation can be propagated."

BENJAMIN:

"I believe that oxidation can be propagated if the temperature reaches... self-sustaining oxidation temperatures."

p.1398 1399 Propagation of oxidation could not be ruled out. "It is my opinion that...if there is no change in geometry at all in the pool, no melting of zirconium...that the heat transfer would be such that propagation would be a distinct possibility, but when zirconium starts to melt in the hottest elements of the spent fuel pool, the geometry changes... it is predicted zirconium melting will occur before all the oxidation is completed." ..."The state of art involved in melting of Zircaloy is not well enough advanced to be able to determine a specific scenario by which the geometry changes.

p. 1401 BENJAMIN:

How ventilation affects fire or oxidation..."ventilation (at Salem) would be sufficient to provide oxygen to the zircaloy clad in order to sustain a propagation of zircaloy oxidation.

p.1402 "If you are going to light a charcoal fire...if charcoal hasn't reached its ignition temperature blowing on it will tend to cool it down and make it less likely to burn. If it has reached its ignition temperature, blowing on it will increase the fire, or increase the burning; so the availability of sufficient ventilation is a good way to try to prevent any of the fuel elements from reaching this self-sustaining oxidation temperature. Once it has reached that temperature, the availability of oxygen can work against you."

p.1403-1404 BENJAMIN (CONTINUED)

Dr. Webb has postulated a fire in which a rapid deflagration or fire would blow the roof off the building because of the rapid pressure transient that would occur.

"...I believe that the building, typical buildings for spent fuel storage are such that they tend to leak when pressure exceeds a certain level, somewhat less than a PSI. They don't tend to explode unless there is a rapid pressure excursion as might occur from some kind of explosion or something of that sort."

p.1410 FASEDAG:

"...I believe the geometry would change as the zirconium would start to oxidize, that melting would occur which would draw away a good bit of the heat and so that heat would not be available for spreading to
p.1411 the older fuel elements...the loading pattern is not the same all the time ...and zirconium oxide, once it does start to oxidize, changes from a metal to a very refractory type substance which tends to be a good insulator and the heating of the older elements would be done primarily from the radiation from the newer elements and therefore the heating is external to the rods for the older ones and the insulating air would reduce the amount of heat transferred...chances are very minimual that there would be a spreading oxidation to the old elements."

Spreading oxidation -- "...it cannot be theoretically ruled out."

p. 1412 BENJAMIN:

"I can't at this time state that what he (Webb) postulates is true and I can't state it is false."

P. 1413 FASEDAG:

"...oxidation of the zirconium...would occur in the interior of the rod as soon as you have an oxide layer outside. The burning would not take place outside the oxide but it would take place at the interface with the metal itself...in a fire...combustion takes place external to the material itself in the flame. This does not happen here. The zirconium does not vaporize and burn outside the rod. It burns at the interface with the metal."

p.1414 "There is still some heat being generated within the rod, but that heat is nowhere near adequate to heat the rod to oxidation temperatures..."

"...the consequences of pool accident...would certainly be no worse than a full reactor core accident as postulated in WASH-1400."

p.1417 BENJAMIN: (CONTINUED)

The only way to prevent oxidation from propagating is to remove the heat by convection, natural convection from the fuel assemblies...if the zirconium oxidation were to initiate in the newest fuel elements which were not able to remove the heat fast enough, the amount of thermal radiation causing propagation to other fuel assemblies would be larger than that removed by natural air convection."

p.1423 MILHOLLIN:

Do you think 4 year old rods would reach a temperature sufficient to oxidize?

BENJEAMIN:

"...There is a greater possibility for that to happen than not to happen."

MILHOLLIN:

"If that should happen, would the cladding melt?"

BENJAMIN:

"The cladding would melt, at least a portion of the clad on the fuel assemblies would melt."

MILHOLLIN:

"ould the fission products within the cladding by released?

BENJAMIN:

"The fission products in the gap between the fuel currents and the cladding would be released."

p.1427 MILHOLLIN:

"If all the fuel in the pool were 3 years old or older, there would be no ignition?"

BENJAMIN:

"That's correct."

p.1429 PASEDAG:

"...in the absence of fuel any younger than one year, there is no chance the temperatures in the pool anywhere will go above 900 deg.C."

MILHOLLIN:

Does this conclusion assume total absence of water in pool -- so convection could occur by air coming under bottom of rack?

PASEDAG:

Yes.

MILHOLLIN:

If you assume some water is left in the bottom of the pool so air could not reach that area, would you still make that statement?

PASEDAG:

"I don't know about that scenario...I have not investigated it very thoroughly."

pp1429 1430 BENJAMIN:

"...it's possible to block off the air inlets at the bottom of the pool simply by having the water covering the base plates...so there is not enough space to have air come in to the bottom of the spent fuel racks and up through the fuel assembly...so the fuel will tend to overheat more readily in a situation like that than it will in a situation where air convection can be sustained...however oxidation is much less likely...because there is no way for air to get to the cladding -- so there's no ignition possibility."

p.1432 "(Zirconium) can react with steam to produce hydrogen. Of course it can't do that if it has been oxidized by air. The water would quench the zirconium."

MILHOLLIN:

Could 4 year old fuel or older melt if the inlets were blocked by water in the bottom of the pool?

BENJAMIN:

"I don't believe I can say whether it would or would not."

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April 29, 1980

p.1436 BENJAMIN:

The questions that are unanswered right now: is the question of clad relocation when melting begins and you have a crust of zirconium oxide over the top of the melting zirconium. Second, the question of heat transfer from new spent fuel elements to old spent fuel elements. The question of the partition of heating -- what percent of heat goes into melting fuel and newest spent fuel as opposed to heat that goes by thermal radiation into older spent fuel."

MILHOLLIN:

So...you are unsure whether clad on older elements would melt?

BENJAMIN:

Yes.

MILHOLLIN:

p.1440 Could fission products in fuel pellets themselves of the fresh fuel escape the spent fuel pool in a gross loss of water.

BENJAMIN:

Melting of fuel pellets in fresh assemblies is a probability.

MILHOLLIN:

You think it is likely to happen?

p.1441 BENJAMIN:

Yes...in fuel about one year old or less.

MILHOLLIN:

Would fuel pellets 4 years old or more melt?

BENJAMIN:

Can't answer.

p.1448 PASEDAG:

"I believe calculations for WASH-1400 would be appropriate estimates of releases..."If the 1/3 core most recently discharged melts..."then the consequences would be very similar to those postulated for a reactor accident in WASH-1400 except it would be 1/3 of the core instead of full core." ... any oxidation of older assemblies would be very limited and probably not lead to melting of cladding. The number of assemblies would be small; only those in close proximity to very fresh fuel and depends on storage configuration.

MILHOLLIN:

"So you testimony is there would be some release of gap activity, perhaps, but no release of activity contained in fuel itself of the older assemblies?"

PASEDAG:

"Yes, that's correct."

p.1472 BENJAMIN:

Oxidation of zirconium means the reaction of zirconium with oxygen to form zirconium oxide or with an oxygen carrier such as steam to form zirconium oxide. It doesn't imply anything about propagation or continuance of that reaction. Ignition implies a situation in which this reaction not only occurs but sustains itself generally leading to increase in temperatures. Fire...implies existence of flames and significant conductive currents that produce a propagation of burning through the spread of flames...the latter would not happen in a spent fuel pool...oxidation occurs gradually until the temperature gets to about 900 deg. C in the spent fuel pool. At about that temperature, ignition occurs. That is the reaction becomes self-sustaining in those fuel rods in which the temperature of about 900 deg.C has been sustained. Then, at that point, the temperature in those fuel rods fairly rapidly increases.

p. 1475 "Once oxidation occurred, ventilation would tend to sustain oxidation by providing oxygen; whereas in a pool without ventilation, it would be difficult to sustain oxidation for a lengthy period of time because of a depletion of oxygen in the building." ...with no ventilation, overheating would occur, resulting in temperatures that could produce clad rupture and release the fission products.

.1482 ...the primary way for heat to propagate from assembly to assembly is by thermal radiation. Some convection could play a part.

p.1488 BENJAMIN:

"I think that the possibility of clad oxidation propagation is significant enough to warrant its consideration in determining whether there is a difference between one special spent fuel geometry and another."

p.1490 "...the Boral would melt if the steel (racks) melted, certainly."

p.1491 PASEDAG:

p.1492 "...we are sticking with the invented scenario...namely an instantaneous loss of water. Without the water, we wouldn't have any criticality problems."

p.1492 "...the Board has conclusively established that the interest of public health and safety would require an analysis to be done which would take a few months to do by one individual on the propagation of oxidation in the spent fuel pool."

p.1502 PASEDAG:

"The proposed high density rack configuration would result in less convective heat transfer effectiveness and therefore would increase the possibility of overheating the newly discharged fuel."

p. 1504 "...the heatup of several fuel elements in a bundle is a part of the German core melt research program" ...It is a semi-annual progress report from the Kernforschungszentrum Karlsruhe dated KFS 2130, May 1975. (No English translation available). Involved a test of a few rods heated up to 2000 deg. and there was no flame that jumped from fuel rod to fuel rod in the assembly.

1509 VALORE:

"Do I understand one thing that you and Dr. Benjamin definitly agree on, is that if there was oxidation of some or all of the new spent fuel, under no circumstances would we be dealing with a situation where we would have explosions and flames shooting 50 feet high and the roof going off the spent fuel building. Is that correct?

PASEDAG:

"That is correct."

VALORE:

Have you read Dr. Lewis Baker's Chapter 17, Technology of Nuclear Reactor Safety, Volume 2, published by Thompson & Beckerly?"

1509 PASEDAG:

That fire (Bettis) included the oxidation of many materials, of which zirconium was one.

1521 "...in the spent fuel pool...we have fuel rods with solid zirconium cladding. As opposed to chips or milling. You could get zirconium
1524 fires with small or finely ground material -- but not with zircaloy rods.

1525 VALORE:

"...if you get zirconium oxidation you might create powders and you might create bits of zirconium other than large pieces."

PASEDAG:

I do not believe so. I know of no mechanism that creates small particles, bits of zirconium.

VALORE:

What about a fission gas plenum?

1526 PASEDAG:

"...less than 10 percent of the total fission product inventory would be in the gap between the fuel element, the fuel pellets and the zirconium clad."

VALORE:

(Referred to Nuclear Science & Engineering, Vol. 15, pp. 395-403 in 1963 article called "Burning Velocities of uranium and zirconium in air by L. Leibowitz et. al.and pp. 388-394 article "Burning Temperature of uranium and zirconium in air" by Edward Mouriain and Lewis Baker, Jr.

p.1537 PASEDAG:

"If you denied all water to the pool...you would start to oxidize the outer surfaces of zirconium at temperatures much below the 900 deg.... and it would be a slow build up of oxide on the metal surface. Similar to a layer of rust on steel or iron.

1546 BENJAMIN:

Dr. Dana Powers of Sandia would be more qualified to answer questions on chemistry of zirconium reaction than I would.

1548 VALORE:

Articles in Nuclear Engineering deal with propagation of fire in a single piece or strip of zirconium. Did Dr. Baker ever carry that analysis further into aggregates of zirconium?

1555 BENJAMIN:

If calculations showed that zirconium vapor being formed, I would have to take into consideration the possibility of burning in an air environment.

1556 BENJAMIN:

By deflagration, I mean a rapid spreading of a fire.

1571 VALORE:

"...Wouldn't you say that the safety and health of the public is put more in jeopardy by having larger amounts of spent fuel ...in the context of possible hydrogen explosion in the event of a loss of water accident."

BENJAMIN:

The newest spent fuel could produce it by reaction of steam with zirconium. The only way for older ones to produce hydrogen would be the propagation of oxidation across the fuel assemblies. And whether this occurs or not is a matter that requires analysis.

1573 PASEDAG:

"The event we have been postulating thus far has been a complete instantaneous loss of all water from the spent fuel pool. We don't believe it is credible...We have not identified any possible accident scenario, combination of effects, which would...first of all empty out the pool and secondly prevent you from refilling the pool." ...within plenty of time to prevent an overheating of the rods...even if you did postulate that the pool water was instantaneously lost and...you cannot 1577 refill the pool, it is still not credible that the fire in the spent fuel pool would occur or would spread to the old fuel rods.

1580 PASEDAG: (CONTINUED)

"I agree with Dr. Benjamin, that in the absence of having done the more detailed calculations, it cannot be theoretically disproven at this point that zirconium would oxidize in the pool and that such oxidation would spread in the pool by radiant heat transfer."

1596 "I think the clad in the Salem spent fuel pool or any spent fuel pool can undergo a self-sustaining oxidation if the conditions are right, as opposed to a fire. It doesn't need a fire in order for oxidation to occur."

1598 MILHOLLIN:

Would the ventilation be turned off to reduce emissions outside the building?

PASEDAG:

To my knowledge, there is no system to automatically turn the ventilation system off if you started clad oxidation or if you lost water in the pool.... it would be more desirable to keep it running because it would filter the effluents from the building....what I would do is not worry about the ventilation system -- but get a hose and put water in the pool.

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Participants:

Dr. Allan S. Benjamin, US-NRC staff expert
Dr. Walter F. Pasedag, US-NRC staff witness
Carl Valore, Jr., Esq., intervenor
Gary L. Milhollin, Esq., chairman, Atomic Safety and Licensing Board.

SALEM TESTIMONY: APRIL 28, 1980

Extracted without page references

MILHOLLIN:

Zirconium can melt and oxidizes without flame?

BENJAMIN:

Yes...oxidation can be propagated if the temperature reaches self-sustaining oxidation temperature. It is a function of heat transfer and kinetics.

PASKDAG:

Potential radiological consequences from any accidental release of water from spent fuel pool would be directly proportional to the fission and activation product concentrations in the water... For fresh spent fuel, continued denial of water cooling capability may eventually lead to oxidation and failure of the clad, and to overheating of the uranium oxide fuel, with the potential for the release of fission products in the uranium oxide fuel in either the present or expanded pool.

According to NUREG/CR-0649: spent fuel like Salem's cannot reach self-sustaining oxidation if its age (since removal from the reactor) exceeds 280 days.

BENJAMIN:

No oxidation after one year decay.

"The possibility cannot be ruled out that the oxidation of zirconium might propagate to older fuel elements, even older than 4 years old. I do not believe that a zirconium fire would occur, there would not not be a deflagration that would lead to a rapid consumption of the zirconium in the pool, but what can't be ruled out is the possibility that by process of thermal radiation from fuel assembly to fuel assembly, it may be possible to propagate a zirconium reaction to the older fuel elements...This process would take hours, at least.

I consulted with Dr. Lewis Baker, Argonne expert on zirconium and he said "it would not be possible for a flame to develop."

Therefore, any burning or oxidation that occurred might result in brightness or a kind of white illuminosity about the fuel cans in the immediate vicinity where this reaction is occurring — but it would not result in flames...the difference is that in zirconium powders... there is a much larger surface to volume ration... According to Dr. Baker, at Bettis, there was oil present — In his opinion, it was oil in the bins containing the zirconium scrap that caused these flames to occur and not zirconium itself...I believe it is possible to have hotness in vicinity where oxidation in occurring and possible to transfer heat from fuel assembly to fuel assembly by the process of thermal radiation, but I don't believe that deflagration and fire with flames and rapidly spreading fire is possible in a spent fuel pool.

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University of Pittsburgh

SCHOOL OF ENGINEERING
Department of Metallurgical and Materials Engineering

June 20, 1980

Mrs. Catherine Quigg
Pollution and Environmental Problems
838 Harriet Lane
Barrington, Illinois 60010

Dear Mrs. Quigg:

I have your note of June 2, 1980 and the statement of Walter F. Pasedag concerning Docket No. 50-272 "Proposed Issuance of Amendment to Facility Operating License No. DPR-70", also the comments of Dr. A. S. Benjamin. Both are NRC staff experts and witnesses. It is unfortunate that Mr. Carl Valore, Jr., as an intervenor did not have available his own technical witnesses in addition to Dr. Richard Webb. Dr. Webb is a nuclear engineer and a very knowledgeable one but not a materials expert.

Dr. Benjamin and Mr. Pasedag assume with the NRC staff and industry the Baker - Just parabolic rate law to describe the kinetics and heat effects of the zirconium-steam reaction and conventional data for the air oxidation of zirconium. The Baker - Just equation for example is based on a series of studies on the steam-zirconium reaction without adequately considering the influence of steam flow which can have a major influence on the kinetics of the reaction. Grain boundary penetration of oxygen greatly accelerates the deterioration of the unreacted zirconium tube. Also the development of the Baker - Just equation is based on very dubious extrapolations. In addition oxygen raises the α-β transition temperature which leads to spikes of brittle oxygen-saturated α-Zr crystals into the β structure.

My criticism of the testimony which you kindly sent to me is that they have not used the proper rate equations and that zirconium probably reacts much faster than that predicted by the Baker - Just equation. The same would hold true for the air - oxidation. Both nitrogen and hydrogen present in the zirconium can lead to blowing out of small particles of zirconium igniting neighboring fuel rods and spreading the reaction.

I hope the above comments answer your questions.

Very truly yours,

Earl A. Gulbransen

Earl A. Gulbransen
Research Professor

/ps

P.S. Send Dr. Webb's testimony if it is available.

848 BENEDUM HALL, PITTSBURGH, PA. 15261