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SUBJECT: NA-C-UMS UNIVERSAL STORAGE SYSTEM FOR SPENT NUCLEAR FUEL

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To: "Bellamy, Ron" <rrb1@nrc.gov>, "Beranek, Ann - NUR...
Date: Mon, Apr 10, 2000 4:31 PM
Subject: NAC-UMS Universal Storage System for spent nuclear fuel

April 10, 2000

The following comments issued by the Governor of Maine, Angus King, on April 4, 2000, illustrate the reality that failed and damaged fuel assemblies, rather than only being a phenomena of past reactor operations, pose a continuing danger during the future operation of the Independent Spent Fuel Storage Installation (ISFSI) now proposed for construction at Wiscasset. Governor King should be complimented for making the state of Maine comments on dry cask storage available to the general public.

The comments by the Governor's consultants reference only slightly damaged fuel assemblies. The 66 failed fuel assemblies not mentioned in the Governor's report and which cannot qualify for a Certificate of Compliance have released an unknown quantity of fission products, some of which remain in the reactor vessel. The radiological characterization of the reactor vessel in the MYAPC No. GAZ-99-34 Attachment 2 Summary Report mentions only activation product analyses yielding a reactor vessel with "less than 50,000 curies (ci.)" GTCC (greater than class C) components with +/-3 million curies of radioactivity have been removed. In the 1987 MYAPC TLG report the GTCC wastes (235 cu. ft.; 4,047,879 ci. at two years cooling) were scheduled to be cut up and mixed with low-level wastes in 107 shipments (see TLG reactor vessel inventory). Where are the GTCC components now? If destined for the ISFSI, how will they be packaged and who will package them? Or will they be mixed with low-level wastes and shipped to Barnwell in smaller units to meet DOT guidelines as previously planned? Have they already been mixed and shipped? In addition to activation products in the metal components of the reactor vessel, how much radioactivity remains in the reactor vessel as dross, CRUD and debris as well as fission products that derived from the fuel cladding failures at MYAPC in 1973 and 1995-96? Don't federal regulations require accurate characterization of the fission products remaining in the reactor vessel now scheduled to be stabilized by being mixed with concrete and left in the reactor vessel? Why is the evasion of documentation of the quantities and locations of spilled fission products tolerated (e.g. in the reactor vessel, in plant water systems and in the sediments and soils around MYAPC)? Who benefits from the failure to document these losses-of-radiological controls?

Also of critical immediate interest: what is the environmental impact of segmentation of GTCC wastes out of the MYAPC reactor vessel? What quantities of gaseous effluents have been released by the use of robotic welding equipment to cut up highly radioactive reactor vessel internals? What liquid effluents have resulted from this process? How can these effluents be filtered and evaluated in a deconstructed environment? Were any GTCC segmentation derived liquids spilled or discharged into Montsweag Bay? How do GTCC wastes affect the water quality of the spent fuel pool? How will the GTCC wastes be packaged and removed from the spent fuel pool? If not disposed of as low-level wastes, how many casks will be needed? How does segmentation affect worker exposure versus safe storage?

More questions with respect to the Barnwell, South Carolina, destination of the reactor vessel which might leave the MYAPC site in the next few weeks: would accurate documentation of the isotopic profile of all the contents of the reactor vessel including debris, CRUD, hot particles and spilled spent fuel-derived fission products put the MYAPC reactor vessel also over the 50,000 ci. limit for Barnwell? (The 1987 TLG report listed reactor vessel low-level wastes as 109,709 ci. at two years cooling.) Above DOT transport regulations? What quantity of long-lived isotopes such as 239-Pu are still in the MYAPC reactor vessel? Doesn't the failure to document the inventories and locations of all spent fuel derived contamination show the NRC and its licensee, MYAPC, in the process of trying to pull a fast one by hoodwinking both the hapless public (ratepayers) and feckless state officials in Maine and South Carolina? Isn't there more in the MYAPC reactor vessel than just > 50,000 ci. of activation products?

The Governor's recognition that there may be some safety issues pertaining to the long term storage of slightly damaged fuel assemblies is a step in the right direction. Admission of problems with damaged fuel assemblies opens the door to discussions of the more serious issue of the 66 failed fuel assemblies and the quantities, destinations and current locations of the fission products they released. The reactor vessel is likely to be a primary repository for these fission products. The question is how much radioactivity leaked out of the failed and damaged fuel assemblies? Where is it now? Where is it going?

Excerpts from an April 4, 2000 letter to:
Mr. Richard A. Meserve, Esq.
Chair
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

from:
Angus S. King, Jr.
Governor [state of Maine]

"On behalf of the State of Maine (the 'State'), I submit the enclosed comments on the Commission's proposed rule, 65 Fed. Reg. 3397, January 21, 2000, that would amend 10 CFR § 72.214 to approve the NAC-UMS Universal Storage System for spent nuclear fuel (Certificate No. 1015)."

"...it now appears that DOE may not complete removal of all Maine Yankee's spent fuel for 20 to 30 years, or perhaps much longer. Thus, whatever storage system is chosen must assure the public's safety for an extended period..."

"Based on its consultation with leading experts, the State has serious concerns about long-term spent fuel storage. The Commission's proposed Certificate of Compliance (Appendix A at A1-1) and NAC's Preliminary Safety Analysis Report (Table 1-1 at 1-4) permit fuel with pinholes or hairline cracks in the cladding to be treated as if it were 'intact,' without analyzing the impact of those defects over the 20-year license period much less over the likely storage duration. Emerging research shows that incomplete drying of the spent fuel before storage, combined with demonstrated physical processes, can enlarge those defects and 'unzip' the cladding thus breaching a primary containment barrier for the fuel. The absence of any mechanism in the NAC-UMS system to verify the condition of the fuel during storage and prior to transport intensifies the State's concerns."

"Failure to provide concerted answers now based on rigorous, scientific analysis may create additional, more serious problems for future generations."

STATE OF MAINE COMMENTS ON
NAC-UMS SPENT FUEL STORAGE SYSTEM
April 4,2000
General Comments
The State of Maine (the "State") offers these comments based on its detailed review of the Preliminary Safety Evaluation Report ("PSER," ML993230106), relevant portions of the Preliminary Safety Analysis Report ("PSAR," ML003683264), and proposed Certificate of Compliance ("CoC," ML993230106) No.1015, including Appendices A and B for the NAC-UMS. The State's comments rely on analysis conducted by Deist Associates, Inc. and by John A. Nevshemal. Dr. Charles Hess and Dr. George Chabot, members of the State's Technical Advisory Panel on nuclear power issues, reviewed the analysis and these comments.

Based on the State's analysis, NAC International has not yet provided reasonable assurance that its NAC-UMS transfer and storage system will maintain the required level of confinement integrity in the proposed dry storage installation under the known, normal conditions. NAC has not provided the required assurance that the single failure-proof confinement requirements for cladding and cask integrity will be unimpaired during the expected storage interval. In particular, NAC has not provided assurance that the integrity of the primary confinement barrier (i.e., the cladding) will be maintained during the licensed period from cask closure until relicensing or shipment. Until NAC provides that assurance, the NAC-UMS spent fuel storage system should not be approved. To the extent that the NRC approves the NAC-UMS application without a further empirical demonstration of such assurance, the NRC should provide a demonstrable scientific basis to justify its approval.

Specific Comments
Comment 1
The CoC defines "Intact Fuel Assembly" and "Intact Fuel Rod" as "a fuel assembly [or rod] without known or suspected cladding defects greater than a pinhole leak or hairline crack.." (CoC, App. A at A1-1) Such cladding penetrations indicate cracks in the cladding and the pinhole is merely the first point of penetration. Thus, it is inappropriate to rely on the partially breached cladding to provide the necessary confinement barrier during long-term storage. Fuel rods with cladding that has been compromised by pinhole leaks or hairline cracks may "unzip" during dry storage due to the known, expected fuel pellet expansion caused by oxidation. Test data compiled by the Pacific Northwest National Laboratory ("PNNL") suggest that small defects -- perhaps at the location of permissible cladding defects in 'intact" fuel -- may open up during dry storage, creating a loss of primary confinement. See "Spent Nuclear Fuel Integrity During Dry Storage - Performance Tests and Demonstrations," Pacific Northwest National Laboratory, June 1997. The PNNL study was based on data covering only seven years of dry storage, and cladding degradation over a 20-year licensed life would be expected to be greater. NAC and the Commission have not analyzed the long-term implications of pinholes and hairline cracks.

Moreover, the PSER does not provide a rationale to explain scientifically why permitted cladding defects in the form of pinholes and hairline cracks do not compromise the cladding as a confinement barrier. Neither the PSER nor the PSAR specify a cause for the pinhole or hairline crack, but necessarily assume that they were created by mechanisms external to the fuel rod (i.e., that there is no ongoing mechanism that would exacerbate the defect over time). It is equally plausible, however, that these defects stem from internal rod (cladding) stress corrosion cracking. If so, that mechanism may persist through the dry storage period, further compromising the cladding. Neither Interim Staff Guidance - 1, Damaged Fuel, nor the Nuclear Energy Institute's June 30, 1999 fuel classification protocol address the scientific (i.e., physical cause) rationale for classifying fuel with cladding pinholes and hairline cracks as "intact fuel". Without this analysis, the application does not satisfy the requirements of 10 CFR § 72.236(b), (e), and (1), and the Commission may not approve the proposed rule

Comment 2

Neither the PSER nor the PSAR explains how consolidated fuel assemblies that have been canned will maintain confinement in the NAC-UMS system. (See PSAR Section 6.6.1.3.1.) For such assemblies, the primary confinement barrier (i.e., cladding). has been compromised and has been replaced by a can. The can is not a true confinement barrier, however, because the top and bottom are merely screens that will not confine the powder form of the fuel, U3O8. (See PSAR, App. 12A at 12A1-6.) Furthermore, the process of consolidation itself (as defined by ANSI/ANS-57.10, Design Criteria for Consolidation of LWR Spent Fuel) is expected (Design Event II) to produce broken/damaged rods (i.e., cladding penetrations). Therefore, the requirement for a primary confinement barrier will not be met if the can in which the individual rods are loaded has screens. This absence of a primary barrier -- especially when damaged fuel rods are loaded in the can -- violates the single failure requirement in 10 CFR § 72.236(e) for confinement of the radioactive material (fuel).

Comment 3

Since the inception of the dry storage concept, designers and regulators have been concerned about oxidation of the radioactive fuel (initially UO2) due to moisture that remains in the canister after fuel has been loaded from the pool. Because of this concern, extraordinary attention must be given to removal of the pool water from the loaded canister. The proposed NAC-UMS canister drying process (CoC, Table A3-1; SER Section 8.1.3) calls for producing and holding a vacuum of 3 torr (3 mm Mercury) for 30 minutes through two cycles. Upon completion of the drying process the fuel canister is backfilled with an inert gas (helium) and sealed. This proposed drying process will not remove the water completely. Ideal gas law theory alone indicates that this proposed vacuum drying process cannot remove all of the water, even if the fuel rods do not have cladding penetrations (i.e., pinholes and/or hairline cracks). In addition, It is a fact that the water inside those rods with allowed cladding penetrations (i.e., "intact" fuel rods) will not be removed by the vacuum drying process, thus adding to the amount of water available to react with the fuel material (UO2) during storage.

Water will react with UO2 based fuel to form bonded hydrated phases (UO3-H2O), which cannot be removed by vacuum drying. The oxygen will cause continued oxidation of the fuel, resulting in U3O8 phase, which is highly expansionary (i.e. low density). This phase is able to "unzip" the cladding at already damaged cladding points (stress corrosion cracking) that extend inside the cladding from a pinhole. Because U3O8 is essentially a powder, it is highly dispersible. The oxidation reaction is a time-at-temperature process that will proceed based on the temperature of the fuel pellets. Moreover, hydrated phases can increase the oxidation rate of the fuel, typically by a factor of five. For these reasons, it is highly doubtful that the NAC-UMS dry storage system will be able to maintain the necessary condition of the fuel rods over the 20-year license period, and the application does not satisfy the requirements of 10 CFR § 72.236(b), (e), and (l).

Comment 4
The NAC-UMS system does not provide for a capability to verify periodically whether or not the storage conditions have changed, thus requiring canning or other remedial measures for fuel that has developed further damage during storage. Due to the highly dispersible nature of U3O8 verification inspection cannot take place in a pool but requires a hot cell with remote handling capabilities. The only available non-destructive verification process would he an assay approach similar to gamma scanning, but gamma scanning is not adequate to determine whether storage conditions have changed. In any case, the NAC-UMS storage system is not amenable to such a scanning technique. Thus, the fuel containing canisters may need to be opened periodically in a hot cell and visually inspected. An ISFSI site using the NAC-UMS system may require such a facility because the canisters may not be shipped under Part 71 without verification of fuel rod integrity. The PSER inappropriately accepts verification based solely on the lack of external events --not on the actual condition of cladding -- even though there is an established potential for in-storage cladding degradation. The PSER should define verification requirements for the NAC-UMS system prior to shipment under Part 71 and evaluate the applicant's verification methods. Without such an analysis, the application does not satisfy the requirements of 10 CFR § 72.236(g), (j), and (m).

Comment 5
The NAC-UMS system proposes to use a borated polymer (NS-4-FR) as a neutron slowing/absorbing material for the storage cask (PSER Section 9.1.3). This raises a concern because of problems with radiation hardening experienced with a similar material, Boraflex. See NRC Generic letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks," June 26, 1996. There is no evidence -- and the PSER does no analysis -- to establish NS-4-FR's ability to maintain form over the expected lifetime integrated neutron flux. The analysis does not satisfy 10 CFR § 72.236(c), (d), and (g).

Comment 6
The heavy load lifting ability of the transfer and storage systems (described in PSER Section 3.2.3) appears to be inadequately supported. The systems are not redundant, either for attachment or lift capability, and, therefore, do not satisfy the requirements for single failure of the lifting equipment. Similarly, the transfer and storage cask lifting trunnions are not redundant and do not satisfy the requirements for single failure or the requirements of 10 CFR § 72.236(h).

Comment 7
The NAC-UMS system dissipates heat via conduction from the center of the fuel assembly-filled canister to the canister walls and away from the

canister through the natural convection via air circulation over the canister's outer surface. The analysis of the expected configuration described in the PSER Section 4.4.1.2 is based on an unrealistic physical model that assumes concentrically centered fuel assemblies. In fact, conduction is radial (not axial) and is based solely on the physical contact of the fuel assembly with the basket holding the assemblies. Because the NAC-UMS system is a vertical storage system. there is a potential for non-uniform physical contact between the basket and the fuel assembly (i.e., the heat source). For this reason, hot spots may develop along the axial direction of the fuel rod. The PSER does not analyze the degradation effects of these hot spots to assure cladding integrity throughout the license storage period. Thus, the application does not satisfy the requirements of 10 CFR § 72.236(b), (e), (f), and (l).

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