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J. O'Brien

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OHIO DEPARTMENT OF HEALTH

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246 North High Street
Post Office Box 118
Columbus, Ohio 43266-0118

Telephone: (614) 466-3543

Bob Taft
Governor

J. Nick Baird, M.D.
Director of Health

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RULES & DIR. BRANCH
US NRC

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January 6, 2000

Mr. David L. Meyer, Chief,
Rules and Directives Branch
U.S. Nuclear Regulatory Commission
Washington, DC, 20555-0001

Attention: Rulemakings and Ajudications Staff

Subject: **NRC REQUEST FOR COMMENT ON REVISED CRITERIA FOR POST-ACCIDENT SAMPLING SYSTEMS**

Ref. 1: Federal Register Notice, Volume 64, Number 226, November 24, 1999, Page 66213

Ref. 2: Westinghouse Owners Group submitted topical report, WCAP-14986-P

Ref. 3: Combustion Engineering Owners Group submitted topical report, NPSD-1157

Dear Sirs:

The Ohio Department of Health (ODH) hereby submits its comments regarding the proposed elimination of the post-accident sampling system (PASS) from the licensing basis of Westinghouse and Combustion Engineering designed nuclear power plants. This is in response to the NRC request for comments, (Reference 1). In conducting its evaluation of the proposal, ODH had the benefit of reviewing the non-proprietary version of the Westinghouse Owners Group (WOG) topical report (Reference 2), and the Combustion Engineering Owners Group (CEOG) topical report (Reference 3). In addition, ODH had the benefit of discussing the subject in a special meeting of the Working Group of the Utility Radiological Safety Board of Ohio, of which ODH is a member agency. At this special meeting, the URSB Working Group discussed the value of PASS by teleconference with plant staff from the Perry Nuclear Power Plant, Davis-Besse Nuclear Power Station and Beaver Valley Power Station. However, the following comments are made by ODH and ODH in no way implies that they represent the opinions of these other organizations.

The Federal Register Notice (Reference 1) states that "before completing its review of the industry topical reports, the NRC is seeking public comment from its stockholders (sic). In particular, the NRC is seeking comment from offsite emergency response organizations who may have an interest in information regarding radionuclide concentrations in the reactor coolant, containment sump or containment atmosphere to support their emergency response activities (in particular protective action decision making)."

In summary of key points of our comments that follow in an attachment, ODH believes that for the most part, the PASS is rendered of secondary analytical value by virtue of the use of the Nuclear Energy Institute (NEI, formerly NUMARC) methodology for accident assessment that does not rely on analysis of plant fluids. ODH recognizes that other monitoring indicators throughout the plants can yield a variety of information as to the extent of core damage, (e.g., core exit thermocouples, reactor vessel water level monitoring, hot leg resistance temperature detectors, area radiation monitors, ex-core neutron detectors, etc.) In addition, a better understanding of degraded core behavior that is described in Severe Accident Management Guidance can supercede the need for formal core damage assessment. We are comfortable with the use of the NEI methodology for dose assessment purposes, because we believe it provides use with conservative source terms that we use for our dose calculations. Further, it prescribes default actions to be taken at a time that would be much earlier in the accident than waiting for analyses of physical samples. The time requirements placed on PASS sampling would yield little benefit in the early stages of an accident. The ODH review of the proposed justification for PASS removal indicates support for such

Add: J. O'Brien

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action; however, there are issues that remain a concern. The topical reports reviewed do not address the two Ohio plants, Perry Nuclear Power Plant, a General Electric design, and Davis-Besse Nuclear Power Station, a Babcock and Wilcox design. While we are comfortable with use of fixed plant instrumentation to infer core and other plant conditions that prescribe Emergency Action Levels, and then Protective Action Recommendations, in the post-accident, recovery phase, when time is not of the essence, quantitative knowledge of the physical conditions of the core and plant systems will be needed for realistic assessments of what it will take to render the plant permanently safe. This will be a State as well as an NRC issue. Thus, a sampling ability for non-released radioisotopes resident in the reactor coolant system, containment sump and containment vessel, as well as pH, hydrogen and oxygen concentrations and control will be needed for a realistic assessment. Toward that end, therefore, we suggest that rather than eliminate PASS entirely, the PASS should be decommissioned in place and moth-balled for future use, should it become necessary. In our view, our proposed option would be better than just eliminating maintenance of the PASS entirely and then having to jury-rig a sampling system during the recovery phase that could potentially result in greater dose to plant staff than with use of the PASS.

In our review of the two industry topical reports, particularly the WOG topical report, an ancillary issue was raised by statements in that (Reference 2) report, which we believe are health and safety issues of interest to the State. Further, since this ancillary issue was raised by the WOG in the course of their support for PASS elimination, we believe it is a legitimate issue for the NRC to consider in its review of PASS elimination. The WOG report indicates that large, dry containments have hydrogen recombiners that are insufficient to handle the volume and rapidity of hydrogen gas that would be expected in an accident that heats up the fuel cladding, resulting in zironium-water reactions and hydrogen generation. The WOG topical also indicates that in severe accidents, the volume and rapidity of hydrogen generated would be even greater than in design basis accidents, because of core-concrete interactions. Therefore, in consideration of the major role that the containment vessel plays as a barrier to release of fission products to the environment, in addition to ODH comments regarding the PASS elimination, ODH has included comments regarding the WOG statements relating to hydrogen generation and control. These WOG statements indicate that most large, dry containments are unable to deal with hydrogen generated in an accident, short of venting the contents of the containment atmosphere into the environment. Hydrogen explosion can rapidly breach the third (and last) barrier to fission product release to the environment, the containment vessel. This makes hydrogen control considerations, in our view, as important if not more important than knowing whether hydrogen in the containment can be sampled by PASS or monitored by a hydrogen monitoring system. And if an explosive mixture exists in the containment, whether the nuclear plant operator will have to deliberately vent the containment in order to preserve its integrity at the further risk to the public health and safety. If this hydrogen generation and control is not an issue of concern to the NRC, then we would like to understand why. Further ODH comments follow in the attachment.

Sincerely Yours,

Roger L. Suppes

Roger L. Suppes, Chief
Bureau of Radiation Protection

RLS/HBB/hb
File: emergres\pass research

Attachment

pc: Harvey Brugger, ODH
Steve Helmer, ODH
URSB Member Agencies
Vernon Higaki, PNPP

Note: The comments below are organized as follows. The basis for our comment, normally text in the industry topical , is summarized and labeled **Text Summary**. The location of that text being cited is given in *italic*. ODH comments are labeled **Comment**.

1. **Comment**: In the timeframe of an accident in process, ODH main concerns from an emergency response perspective are: conservatively estimating the radioisotopic inventory that can be released and how imminent is that release. We believe that the NEI methodology, which relies on fixed in-plant instrumentation for accident assessment will dictate a conservative inventory. That plant conditions rather than measurement of fluids with PASS will dictate actions in the early phase of the accident.

2. **Comment**: If the accident goes beyond a brief excursion and into a clad heat up to temperatures promoting zirconium-water reaction, we are concerned about the resulting hydrogen generation that might explode and breach the containment vessel, the last barrier to fission product release to the environment. We believe that a safety-grade, redundant hydrogen monitoring system can provide the containment hydrogen concentration a lot quicker than drawing and analyzing a PASS sample of the containment atmosphere.

3. **Text Summary**: In accidents where there is extensive clad damage from zironium-water reactions leading to rapid hydrogen generation, there is a great potential for hydrogen escape through reactor coolant system breaks into the containment or by depressurizing of the reactor coolant system through relief into the containment. In a typical PWR, a fuel heat up rate of 5 deg. F per second can result in an explosive mixture in 5 minutes. Most Westinghouse plants have hydrogen recombiners that burn hydrogen at a controlled rate. However, depending on the rapidity of the zironium-water reaction and gas release into the containment, most Westinghouse plant hydrogen recombiners may have inadequate capacity to recombine hydrogen at the rate it is being accumulated in the containment. Consequently the risk of a sudden overpressurization of the containment and its failure due to a hydrogen explosion is substantial. Hydrogen also adds substantially to the noncondensible gases in the reactor coolant loop that can cause a gas bubble sufficient to block natural circulation of cooling water thereby aggravating the core heat up. *(See Ref. 2, Section 2.1, Page 17-18.)*
   Comment: We believe that in reviewing specific applications for PASS elimination, the NRC should be assured by the licensee that they can bleed off this gas using head vent systems or other methods.

4. **Comment**: A molten core can slump into the bottom of the reactor vessel and pour through penetrations in the bottom head. Molten core pouring onto the bottom of a flooded containment can cause a steam explosion that also has the capability of overpressurizing the containment. When the molten core interacts with the concrete base mat of the containment, it will release substantial hydrogen and other flammable gases that can also overpressurize the containment by explosion. *(See Ref. 2, Section 2.1, Page 18.)* We therefore believe that hydrogen control is an important issue for the NRC to address in review of licensee applications for PASS elimination

5. **Comment**: Without sampling capability, a heavy reliance is put upon the nuclear plant operator to know that he is injecting unborated or low boron concentration water that has the potential for causing recriticality and to understand from available neutron flux detectors that the core is approaching recriticality. *(See Ref. 2, Section 2.2, Page 20.)* We therefore believe that a fool-proof way of keeping fluids highly borated is an important issue to address in review of licensee applications for PASS elimination.

6. **Text Summary**: Overpressurizing and breaching the containment by a hydrogen explosion can result from the transfer of very rapidly generated hydrogen from a zirconium-water reaction into the containment via depressurization of the RCS. This can occur in 10-15 minutes. A hydrogen burn in the containment atmosphere is predicted to consume the hydrogen in 10-15 seconds. An uncooled

reactor can go from the onset of significant hydrogen generation (at about 1800 deg. F) to core melting in a matter of about 30 minutes. *(See Ref. 2, Section 2.5, Containment Hydrogen, Page 22.)*
Comment: Because of the rapid, explosive burn of hydrogen, the containment can be rapidly overpressurized leading to its breach. Further, core damage makes available significant amounts of volatile fission products to the containment atmosphere and through the containment breach to the environment.

7. **Text Summary**: The WOG topical states: "Most plants have hydrogen recombiners for controlling the containment hydrogen concentrations from a design basis accident where the in-vessel zirconium water reaction is very limited. For these design basis accidents, the containment hydrogen that must be controlled to prevent flammable containment conditions is the very slow hydrogen generation (tens of pounds per hour) from metal corrosion in the containment sump and from radiolysis of water circulating through the reactor vessel. Thus, the recombiners have a very limited capacity (e.g., 100 cubic feet of containment atmosphere per minute) for eliminating hydrogen from the containment atmosphere. Analyses have shown that recombiners have no impact on containment hydrogen concentration during the early stages of a core damage accident. Because of the small containment volume of the ice condenser containments, those plants have installed hydrogen igniters which keep hydrogen levels in containment at very low levels following a core damage accident." *(Ref. 2, Section 2.5, Containment Hydrogen, Page 24.)*
Comment: This situation dictates the need not to just measure hydrogen by a PASS or hydrogen monitoring system, but instead to ignite it in a controlled burn, automatically. Westinghouse ice condenser plants, such as Donald C. Cook Nuclear Plant, have hydrogen igniters that can handle much larger volumes of hydrogen then the hydrogen recombiners in non-ice condenser containments. Large, dry containments, such as those at the Beaver Valley Power Station, have hydrogen recombiners that are insufficient for the task of dealing with hydrogen generated in an accident. The WOG and CEOG have both proposed eliminating PASS and submitted topical reports to support that request. However, the WOG topical report clearly indicates that the Westinghouse provided hydrogen recombiners are inadequate. Given this WOG topical report information, it is incumbent on the NRC in its consideration of elimination of the PASS requirement to also consider requiring the upgrading of the hydrogen recombiner capability to handle not tens of pounds of hydrogen per hour, but the very rapid generation expected from core damage accidents, of several hundred pounds of hydrogen per hour. Venting the containment to avoid its overpressurization is an unacceptable alternative, since it is a deliberate breach of the last barrier between the public and the accident fission products being contained. While the fission products are being contained, there exists an opportunity to scrub the radioactive iodines and other fission products out of the containment atmosphere by operation of the containment spray system that utilizes water doped with sodium hydroxide. Venting the containment exactly during the accident phase when the majority of the fission products are being volatilized from the core is equivalent to not having a containment vessel. This would make the public health and safety consequences of the inability to cope with hydrogen generation equivalent to the consequences of an accident at a Russian RMBK reactor, such as Chernobyl, which did not have a containment vessel. In consideration of the tens of millions of dollars that would allegedly be saved by elimination of the PASS requirements, upgrading the ability to keep the containment vessel integrity as a barrier to release of fission products to the atmosphere is a small price to pay for correction of the serious design insufficiency of the current hydrogen recombiners in large, dry containment vessels.

8. **Text Summary**: If sump water pH is too low, radioactive iodine could evolve from the water and return to the containment atmosphere where it could be more easily released to the environment. *(See Ref. 2, Section 2.4, Reactor and Containment Sump pH Levels, Page 12.).*
Comment: We believe that in reviewing specific applications for PASS elimination, the NRC should be assured by the licensee that there is a fool-proof way of buffering recirculation water, in order to keep radioactive iodines in solution. This can be accomplished with a containment spray system doped with sodium hydroxide or another way that automatically adds sodium hydroxide to the containment sump water that is being recirculated.

9. **Text Summary**: Following a small break loss of coolant accident that does not automatically actuate the containment spray system containing sodium hydroxide, it is important that containment sump pH

is checked and adjusted to preclude chloride induced stress corrosion cracking or long term evolution of radioactive iodine caused by the containment sump water. *(See Ref. 2, Section 4.17, Containment Sump pH, Page 38)*
Comment: Each licensee referencing the generic WOG topical as a basis for requesting PASS elimination at their plant should be required to specifically address the strategies and alternative methods by which they would accomplish checking and controlling pH in the sump, without a functional PASS. Those strategies and alternative methods for checking and correcting sump pH should result in staff doses less than the doses that would be expected using their current PASS.

10. **Text Summary**: WOG severe accident management guidance (SAMG) relies on fixed in-plant instrumentation to diagnose the plant state for purposes of emergency response, initiation of recovery strategies, and the attainment and maintenance of long term plant stability. One of the challenges to the integrity of the containment following a core damage accident is from the containment pressure increase associated with burning hydrogen that has accumulated in the containment. The severity of the challenge to the containment integrity is a function of the hydrogen and steam concentrations in the containment and the containment pressure. WOG SAMG relies on the on-line containment hydrogen monitor as the primary means of measuring containment hydrogen concentration. However, default values of hydrogen concentration are provided that represent bounding conditions, and can be useful until a sample of the containment atmosphere can be drawn and analyzed for hydrogen. *(See Ref. 2, Section 4.2, Severe Accident Management Strategies, Page 39)*
Comment: The problem with the explanation provided in the WOG topical report is that it neglects to consider the potential for rapid hydrogen accumulation during the accident phase, which would preclude rigging a sampling method in time for the sample analysis to be of value in decision making. Any plant requesting PASS elimination should be required to explain how they would accomplish containment atmosphere sampling with less personnel dose than had they maintained a functional PASS.

11. **Text Summary**: The WOG SAMG does not rely on reactor coolant system sampling for boron concentration for maintaining subcriticality. Rather it relies on the availability of directly monitoring with ex-core neutron detectors. However, the WOG SAMG also provides guidance to inject water into the reactor coolant system from any source in order to arrest the progression of a core damage accident. *(See Ref. 2, Section 4.2, Page 41- 42)*
Comment: ODH concern here is the potential for a second plume after initial stability is achieved, due to a return to criticality. We believe that there is sufficient boron chemical shim in emergency boration water supplies at the onset of emergency water injection so that even without control rods, the core can be kept subcritical, once it is shutdown. However, if the accident occurs at end of core life, when boron concentrations are low, the ability to deliver highly borated water becomes more critical. The PASS would provide assurance that the boron has been delivered. Also, if normal water injection or recirculation flow paths fail, after a first plume release, the nuclear plant operator can draw on unborated water from say the fire protection system. In this case, the knowledge of reactor coolant system boron concentration is valuable in predicting a second plume, even if monitoring of a recriticality could be accomplished with ex-core detectors. The report claims that refilling the RWST with unborated water from the fire protection system and cooling the core with it would not cause a power excursion. Any licensee making this claim should submit calculations to prove that assertion is not erroneous.

12. **Test Summary**: The WOG suggests operators need not rely on the analysis of any samples of plant fluids, therefore the requirement for post-accident sampling to support core damage assessment capability no longer exists. Instead, the WOG suggests operators rely on fixed in-plant instrumentation in order to make a quantitative estimate of the amount of core damage that has occurred: core exit thermocouples and containment high range area radiation monitors. *(Section 4.3.1, Core Damage Assessment, Page 42.)*
Comment: In a severe core accident, with loss of fuel rod integrity and high core temperatures, even if core exit thermocouples survive, one cannot be sure what they are measuring. Therefore, reliance on core exit thermocouples for diagnosing core damage may be faulty.

13. **Text Summary**: The WOG topical report, *(Ref. 2, Section 5.11, Containment Airborne Radioactive Samples, Page 56)*, states that "the purpose of sampling the containment for radionuclide content is to enable offsite dose assessments to be made from both post-accident containment leakage, as well as the potential for a sudden release of the containment inventory of radionuclides."
Comment: The State needs to know the actual containment volume radioactive contents, in order to potentially make additional protective action recommendations, including potentially new evacuations of the public, if there is the possibility of a second plume. This second plume could be caused by an intentional (nuclear plant operator venting) or unintentional release of the containment atmosphere contents of volatile radionuclides during the recovery phase. It is interesting to note that the post-accident sampling capability to measure the containment radionuclide inventory is a requirement in both NUREG-0737 and Regulatory Guide 1.97; and that this requirement is also applied to advanced light water reactors by SECY-93-087 and EPRI Utility Design Requirements document for advanced light water reactors. The NRC would have to resolve these documentation inconsistencies.

14. **Text Summary**: 10 CFR 50, Appendix E, Section VI.1.a (1), Element 5 includes the requirement that in the event of an accident, the plant must be capable of transmitting specified data to the NRC Emergency Response Center, including reactor coolant system activity. This data would be input into the Emergency Response Data System (ERDS). *(See Ref. 3, Page 7.)*
Comment: Without the PASS, how would ERDS data on reactor coolant system activity be obtained?

15. **Text Summary**: The CEOG topical report, *(see Ref. 3, Page 49)*, discusses long term recovery from an accident. It relates that the only feature of the PASS that CEOG believes has value would be sample dilution capability. Long term recovery actions would attempt to use PASS to minimize occupational exposure to personnel.
Comment: PASS should be decommissioned in place and mothballed for future use, should it become necessary. This proposed option would be better than just eliminating maintenance of the PASS entirely and then having to jury-rig a sampling system during the recovery phase that could potentially result in greater dose to plant staff than with use of the PASS.