May 16, 2000

Mr. Ralph Phelps, Chairman
CE Owners Group
Omaha Public Power District
P.O. Box 399
Ft. Calhoun, NE 68023-0399

SUBJECT: ACCEPTANCE FOR REFERENCING OF THE COMBUSTION ENGINEERING JOINT APPLICATIONS REPORT, CE NPSD-1157, REVISION 1, "TECHNICAL JUSTIFICATION FOR THE ELIMINATION OF THE POST-ACCIDENT SAMPLING SYSTEM FROM THE PLANT DESIGN AND LICENSING BASES FOR CEOG UTILITIES" (TAC NO. MA5661)

Dear Mr. Phelps:

By letter dated March 30, 2000, as supplemented April 14, 2000, the Combustion Engineering Owners Group (CEOG) submitted Topical Report CE NPSD-1157, Revision 1, "Technical Justification for the Elimination of the Post-Accident Sampling System from the Plant Design and Licensing Basis for CEOG Utilities."

The report is acceptable for referencing in licensing applications for CE plants subject to the limitations specified in the report and in the associated NRC staff's safety evaluation (SE), which is enclosed. The SE defines the basis for acceptance of the report.

The NRC staff does not intend to repeat its review of the matters described in the report, and found acceptable, when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters described in the report.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," the staff requests that the CEOG publish an accepted version of this topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be indexed such that information is easily located. Also, it must contain in appendices historical review information, such as questions, accepted responses, and original report pages that were replaced. The accepted version shall include an "-A" (designating acceptance) following the report identification symbol.

Should the NRC criteria or regulations change such that the conclusions as to the acceptability of the report are invalidated, ABB-CE and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

/RA by R. A. Gramm For/

Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 692

Enclosure: Safety Evaluation

cc w/encl:
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO COMBUSTION ENGINEERING OWNERS GROUP, JOINT APPLICATIONS REPORT CE NPSD-1157, REVISION 1, "TECHNICAL JUSTIFICATION FOR THE ELIMINATION OF THE POST-ACCIDENT SAMPLING SYSTEM FROM THE PLANT DESIGN AND LICENSING BASES FOR CEOG UTILITIES"

1.0 INTRODUCTION

By letter dated March 30, 2000, as supplemented by letter dated April 14, 2000, the Combustion Engineering Owners Group (CEOG) submitted Topical Report CE NPSD-1157 Revision 1, "Technical Justification for the Elimination of the Post-Accident Sampling System from the Plant Design and Licensing Basis for CEOG Utilities." CE NPSD-1157 evaluated information obtained from post accident sampling system (PASS) samples to determine its contribution to plant safety and accident recovery. The report considered the progression and consequences of core damage accidents and assessed the accident progression with respect to plant abnormal and emergency operating procedures, severe accident management guidance, and emergency plans. CE NPSD-1157 concluded that all of the current PASS samples specified in NUREG-0737, "Clarification of TMI Action Plan Requirements," may be eliminated. Specifically, CE NPSD-1157 recommended the following regarding the PASS:

1. Eliminate PASS sampling of reactor coolant system (RCS) dissolved gases,
2. Eliminate PASS sampling of RCS hydrogen,
3. Eliminate PASS sampling of RCS oxygen,
4. Eliminate PASS sampling of RCS pH,
5. Eliminate PASS sampling of RCS chlorides,
6. Eliminate PASS sampling of RCS boron,
7. Eliminate PASS sampling of RCS conductivity,
8. Eliminate PASS sampling of radionuclides in the RCS,
9. Eliminate PASS sampling of containment hydrogen,

10. Eliminate PASS sampling of containment oxygen,

11. Eliminate PASS sampling of radionuclides in the containment atmosphere,

12. Eliminate PASS sampling of containment sump pH,

13. Eliminate PASS sampling of chlorides in the containment sump,

14. Eliminate PASS sampling of boron in the containment sump, and

15. Eliminate PASS sampling of radionuclides in the containment sump.

2.0 BACKGROUND

The need for a PASS was one of the findings endorsed by the Commission following the accident at the Three Mile Island (TMI) plant. The Commission specified that all licensed plants have the capability of obtaining and analyzing post-accident samples of the reactor coolant and containment atmosphere, within specified times, without causing radiation exposure to any individual exceeding 5 rem to the whole body or 75 rem to the extremities. Detailed criteria for the PASS are specified in Section II.B.3 of NUREG-0737 including the following:

> *The licensee and applicant shall establish an onsite radiological and chemical analysis capability to provide, within a three-hour time frame, quantification of the following:*
>
> *a) Certain radionuclides in the reactor coolant and containment atmosphere*
>
> *b) hydrogen levels in the containment atmosphere*
>
> *c) dissolved gases (e.g., H_2), chloride, and boron concentration of liquids*

The TMI-related recommendations specified in NUREG-0737 were subsequently incorporated into 10 CFR 50.34(f)(2)(viii). However, this rule applied only to applications pending at that time (i.e., Perkins Nuclear Station, Units 1, 2, and 3; Allens Creek Nuclear Generating Station, Unit 1; Pebble Springs Nuclear Plant, Units 1 and 2; Black Fox Station, Units 1 and 2; Skagit/Hanford Nuclear Power Project, Units 1 and 2; and Offshore Power Systems).

On March 17, 1982, the NRC issued Generic Letter (GL) 82-05, "Post-TMI Requirements," in which the NRC requested that licensees establish a firm schedule for implementing post-accident sampling. On November 1, 1983, NRC issued GL 83-36 and GL 83-37, "Technical Specifications," which provided guidance on how to address post-accident sampling in the technical specifications for boiling-water reactors (BWRs) and pressurized-water reactors (PWRs), respectively. In GL 83-36 and GL 83-37, the NRC indicated that all licensees should establish, implement, and maintain an administrative program that would include training of personnel, procedures for sampling and analyses, and provisions for sampling and analysis equipment. The licensees could elect to reference this program in the administrative controls section of the technical specifications and include its detailed description in the plant operation

manuals. However, the recommendations described in Section II.B.3 of NUREG-0737 were imposed as requirements for the majority of operating plants through license conditions or by orders.

Regulatory Guide 1.97, "Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident" (Revision 3, 1983), described acceptable means for licensees to comply with the Commission's regulations (General Design Criteria 13, 19, and 64 of Appendix A to 10 CFR Part 50) to provide instrumentation to monitor plant variables and systems during and following an accident. Regulatory Guide 1.97 included a list of variables to be monitored which included the samples specified in NUREG-0737 and the following additional samples:

- pH in the RCS
- boron, pH, chlorides, and radionuclides in the containment sump

Since these criteria for PASS have been issued, the NRC staff have performed three generic evaluations pertinent to the evaluation of CE NPSD-1157. These are discussed below.

In the mid 1980s, the staff sponsored a contractor to review regulatory requirements that may have marginal importance to risk. One of the issues reviewed was the NUREG-0737 criteria for PASS. The conclusion reported in NUREG/CR-4330, "Review of Light Water Reactor Regulatory Requirements" (May 1987), was that several of the PASS criteria could be relaxed without impacting safety. However, the staff did not take action to modify the PASS criteria based upon the contractor's conclusions.

In 1993, during its review of licensing issues pertaining to evolutionary and advance light water reactors, the staff evaluated requirements for PASS specified in 10 CFR 50.34(f)(2)(viii). The staff recommended to the Commission in SECY 93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-water Reactor (AWLR) Designs" (April 2, 1993), that: (1) elimination of hydrogen analysis of containment atmosphere samples is appropriate, given that the safety grade hydrogen monitoring instrumentation will be installed; (2) relaxation of dissolved gas (including dissolved hydrogen) sampling time to 24 hours is appropriate; (3) elimination of the mandatory requirement for chloride samples is appropriate; (4) relaxation of the boron sampling time to 8 hours after an accident is appropriate; and (5) relaxation of the sampling time for radionuclides (used to determine the degree of core damage) to 24 hours is appropriate.

In addition, in 1993, the staff evaluated the Combustion Engineering Owners Group Topical Report CEN-415, "Modifications of Post Accident Sampling System Requirements," (Revision 1, December 1991). In a letter dated April 12, 1993, the NRC approved: (1) deletion of pH measurement in the containment sump, (2) deletion of hydrogen sampling of the containment atmosphere, (3) deletion of sampling for iodine (if core damage assessment procedures are based on samples of xenon or krypton activities), and (4) deletion of oxygen analysis of reactor coolant.

Furthermore, in parallel with review of CE NPSD-1157, the staff is reviewing a Westinghouse Owners Group Topical Report (WCAP-14986-P, Revision 1, "Westinghouse Owners Group Post Accident Sampling System Requirements: A Technical Basis," (August 1998)) which requested similar changes to PASS requirements for Westinghouse pressurized water reactors.

Finally, the staff had published in the *Federal Register* on November 24, 1999 (64 FR 66213), a notice that requested public comment on the NRC's pending action to approve the industry topical reports justifying elimination of PASS. In particular the staff sought comment from offsite emergency response organizations so that any impact of the elimination of PASS on their response could be factored into the staff's evaluation. The Appendix attached to this safety evaluation contains a synopsis of the public comments received and the staff's evaluation of the comments.

The staff considered the conclusions (and the basis for the conclusions) from these generic evaluations and insights from public comments as part of its review of CE NPSD-1157.

3.0 EVALUATION

The NRC staff's review of the technical basis for each of the changes to PASS requirements proposed in CE NPSD-1157 is discussed below.

3.1 Eliminate PASS Sampling of Reactor Coolant Dissolved Gases

Dissolved gas sampling is specified in NUREG-0737 and Regulatory Guide 1.97. However, NUREG/CR-4330 suggests that it could be eliminated provided that vessel head gas vents and a reactor vessel level instrumentation system (RVLIS) are installed.

The main purpose of sampling for dissolved gases is to avoid the creation of voids in the vessel dome (and at the top of the steam generator U tubes) when depressurizing or even uncovering the core in case natural circulation needs to be used for decay heat removal. Because RVLIS (which is safety grade) provides an indication of water level and the vessel head vents (which are also safety grade) can vent non-condensable gases, both diagnosis and remediation is available. In addition, for plants not equipped with automated gas sampling systems, the delay between sampling and the availability of the results is long and of no practical significance in accident management.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of reactor coolant dissolved gases is acceptable.

3.2 Eliminate PASS Sampling of RCS Hydrogen

PASS sampling of the reactor coolant for measurement of dissolved hydrogen is specified in NUREG-0737 and Regulatory Guide 1.97.

As in the case of dissolved gases, the main purpose of hydrogen sampling is identification of the potential of void formation in the vessel head and the top of the U tubes in the steam generators or uncovering the core when depressurizing in case natural circulation needs to be used for decay heat removal. In addition, the amount of the dissolved hydrogen could act as a

surrogate indicator for dissolved fission product and non-condensable gases. As in the case of dissolved gases, the vessel head vent and the RVLIS system can be used to both identify and vent non-condensables from the RCS when depressurizing in order to establish natural circulation. CE NPSD-1157 stated that information on dissolved hydrogen in the RCS may be used to refine core damage assessments but determined that this refinement is not needed. The staff concludes that only the identification of the type and a broad estimate of the degree of core damage is needed to respond to an accident and, therefore, agrees that refinements in core damage assessments which might be provided by knowledge of dissolved hydrogen is not necessary.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS hydrogen is acceptable.

3.3 Eliminate PASS Sampling of RCS Oxygen

PASS sampling of the reactor coolant for measurement of oxygen is only recommended in NUREG-0737, but is specified in Regulatory Guide 1.97, whenever concentration of chlorides exceeds 1.5 ppm. The NRC approved elimination of measurement of this parameter from PASS for CE plants in its safety evaluation of CEN-415.

High concentration of oxygen in the RCS can enhance stress corrosion cracking (SCC) of stainless steel components caused by the presence of chlorides. However, this type of corrosion can be mitigated by the control of reactor coolant pH without regard to the oxygen concentration. In addition, whenever needed, oxygen concentration can be estimated from the oxygen concentrations in the reactor water storage tank (RWST).

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS oxygen is acceptable.

3.4 Eliminate PASS Sampling of Reactor Coolant pH

PASS measurement of the reactor coolant pH is specified in Regulatory Guide 1.97. The NRC approved elimination of measurement of this parameter from PASS for CE plants in its safety evaluation of CEN-415.

Reactor coolant pH control is important for controlling SCC of stainless steel components and for iodine retention. In the post-accident environment of CE plants, the pH of coolant is maintained alkaline by either passive pH control, using trisodium phosphate, or by sodium hydroxide additive to the containment spray.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS pH is acceptable.

3.5 Eliminate PASS Sampling of RCS Chlorides

PASS sampling of the reactor coolant system for measurement of chlorides is specified in NUREG-0737 and Regulatory Guide 1.97.

High concentration of chlorides in the RCS can cause SCC of stainless steel components. Chlorides are introduced to the RCS by different sources which may include the containment sump. However, the pH of sump water is maintained alkaline and, therefore, the presence of chlorides will not cause corrosion damage. Also, operators are aware when contaminated water enters from other chloride containing sources and can take appropriate corrective actions to prevent corrosion damage.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS chlorides is acceptable.

3.6 Eliminate PASS Sampling of RCS Boron

PASS sampling of the reactor coolant for measurement of boron is specified in NUREG-0737 and Regulatory Guide 1.97. In addition, the staff recommended, in SECY 93-087, that the capability to obtain PASS samples of RCS boron within 8 hours of accident initiation be maintained for advanced light water reactors.

The topical report proposes to utilize emergency operating procedures for the identification of the boron dilution level through the transient. The topical report recognizes that boron measurement may be required, but states that corroborative evidence would suffice to prevent re-criticality. Control rod assembly position indication, startup rate or indication of high boron concentration flow into the vessel are examples of such corroborating evidence.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS boron is acceptable.

3.7 Eliminate PASS Sampling of RCS Conductivity

PASS sampling of the reactor coolant for measuring conductivity is not specified in NUREG-0737 nor Regulatory Guide 1.97.

The measurement of reactor coolant conductivity is only for verifying pH measurements. It was never required by the NRC. Therefore, the staff concludes that the proposal to eliminate PASS sampling for reactor coolant conductivity measurement is acceptable.

3.8 Eliminate PASS Sampling of RCS Radionuclides

For the purposes of this discussion, and as stated in the topical report, reactor coolant sample analysis capabilities are also applicable for the containment sump sample. PASS sampling of the reactor coolant for measurement of radionuclides is specified in NUREG-0737 and Regulatory Guide 1.97. PASS sampling of the reactor sump is specified in Regulatory Guide 1.97. NUREG-0737 specifies that the PASS have the capability to promptly (i.e., within 3 hours) quantify certain radionuclides that are indicators of the degree of core damage. Furthermore, Regulatory Guide 1.97 specifies that the isotopic analysis serves the purpose of accident release assessment.

The topical report states that post accident measurement of RCS radionuclides is currently used to perform core damage assessment and to classify fuel damage events at the Alert level. In regards to core damage assessment, the topical report states that measurement of radionuclides with PASS is not needed because there are four independent overlapping procedures for estimating core damage; the first three of which do not utilize RCS radionuclide information (and are simpler to perform). The fourth procedure is intended to be a detailed precise methodology for quantifying core damage based upon RCS radionuclide information. The topical report states that there is little expectation that the RCS sample will provide sufficiently accurate information to improve upon assessments performed by the simpler procedures. The topical report states that the core damage assessment procedure should be changed to eliminate the procedure involving radionuclide measurement.

In regards to the use of radionuclide sample information for classifying events involving failed fuel, the topical report states that the event can be classified based upon the recognition of the initiating condition which caused the fuel failure rather than measurement of the degree of fuel failure. Furthermore, the topical report states that other indications of failed fuel such as letdown radiation monitors, can be correlated to the degree of failed fuel.

The staff considers radionuclide sampling information to be useful in estimating the degree of core damage, but recognizes that there are limitations associated with its use, in particular regarding the time needed to obtain the sample. Therefore, the staff considers it more appropriate for emergency response purposes to estimate the degree of core damage based upon real-time indications.

In addition, the staff considers radionuclide sampling information to be useful in classifying certain type of events (such as reactivity excursion or mechanical damage) which could cause fuel damage without having an indication of overheating on core exit thermocouples. However, the staff agrees with the topical report contention that other indicators of failed fuel such as letdown radiation monitors (or normal sampling system), can be correlated to the degree of failed fuel. (See Section 4.1 Licensee required action, item 1).

Notwithstanding the topical report's justification that RCS sampling is not necessary to support emergency response decision making, the staff considers that, if core damage were to occur, sampling of the RCS to ascertain the radionuclide content would be beneficial. This information would provide the public additional confidence that the licensee understood the condition of the core and the magnitude of any remaining threat that the accident may pose. The staff considers that, in light of the lack of need of RCS sampling to support emergency response decision making during the initial phases of an accident, it is not necessary to have dedicated equipment to obtain this sample in a prompt manner. However, the staff does conclude that contingency plans should be developed to support taking RCS samples post accident. These plans should detail the plant's existing sampling capabilities and what actions (e.g., assembling temporary shielding) may be necessary to obtain and analyze highly radioactive samples. (See Section 4.1, Licensee Required Action, Item 2).

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of RCS radionuclides is acceptable.

3.9 Eliminate PASS Sampling of Containment Atmosphere Hydrogen Concentration

PASS sampling of the containment atmosphere for hydrogen measurement is specified in NUREG-0737 and Regulatory Guide 1.97.

Redundant, safety-grade, containment hydrogen concentration monitors are required by 10 CFR 50.44(b)(1), NUREG-0737 Item II.F.1, and Regulatory Guide 1.97, and are relied upon to meet the data reporting requirements of 10 CFR Part 50, Appendix E, Section VI.2.a.(i)(4). NUREG-0737, Item II.F.1, recommends the monitors to be functional within 30 minutes of the initiation of safety injection. Regulatory Guide 1.97 specifies that the monitors have a range of 0 to 10 volume percent. The quantity of hydrogen released to containment in most severe accidents would result in concentrations within this range. However, in the event that random or spontaneous ignition does not occur, continued hydrogen production from such mechanisms as core concrete interactions and radiolysis of reactor coolant could result in the concentration exceeding the range of the monitors late in an event. Hydrogen concentration measurements for concentrations greater than 10 volume percent are necessary to support assessment of the hydrogen combustion threat to containment in the CEOG severe accident management guidelines (SAMG). In the absence of this information, severe accident management decision-making would rely on default hydrogen production assumptions contained in the SAMG. Since grab sample analysis provides the only viable means of determining the actual hydrogen concentration once the hydrogen concentration exceeds the range of the monitors, there is some value to retaining the capability for long term hydrogen concentration analysis of containment atmosphere grab samples.

The staff concludes that during the early phases of an accident, the safety-grade hydrogen monitors provide an adequate capability for monitoring containment hydrogen concentration and are an acceptable alternative to maintaining the capability to obtain and analyze containment atmosphere samples for hydrogen within 3 hours. In view of the value of grab samples for complementing the information from the hydrogen monitors in the long term (i.e., by confirming the indications from the monitors and providing hydrogen measurements for concentrations outside the range of the monitors), licensees should consider retaining the capability for hydrogen analysis of containment atmosphere samples during the later stages of accident response. (See Section 4.1, Licensee Required Action, Item 4).

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of containment atmosphere hydrogen concentration is acceptable.

3.10 Eliminate the PASS Sampling of Containment Oxygen

PASS sampling of the containment atmosphere for oxygen measurement is specified in Regulatory Guide 1.97.

Containment oxygen measurement serves to ensure that the oxygen level does not reach the limit of deflagration or detonation with the generated hydrogen. Since in the post-accident environment the only source of oxygen is radiolysis of sump water, it is not expected that this source will cause significant increase of oxygen concentration above that initially existing in the containment atmosphere. When needed, oxygen concentration in the containment can be

readily estimated by knowing hydrogen concentration and partial pressure of steam in the containment.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of containment oxygen is acceptable.

3.11 Eliminate PASS Sampling of Containment Atmosphere Radionuclides

PASS sampling of the containment atmosphere for radionuclide measurement is specified in NUREG-0737 and Regulatory Guide 1.97. NUREG-0737 specifies that the PASS have the capability to promptly quantify certain radionuclides that are indicators of the degree of core damage. Furthermore, Regulatory Guide 1.97 specifies that the isotopic analysis serves the purpose of accident release assessment.

PASS measurements of the containment atmosphere radionuclide concentration are used to estimate the degree of core damage and to refine the source term used in dose assessments. In turn, core damage estimates and dose assessments are used in evaluating the type and extent of public protective actions which may be warranted. The topical report states that PASS sampling of containment atmosphere radionuclides can be eliminated because these samples are not representative of the concentration of radionuclides which may be released to the environment. The basis for this conclusion is that the concentration of the radionuclides at the sample point may not be representative of the concentration in containment, the potential for revolitization of fission products upon containment depressurization, plate out of aerosols (e.g., CsI) in the sample lines, and time delays associated with obtaining, processing and interpreting the sample during non-stable phases of the accident. In addition, the topical report stated that samples of the containment atmosphere could be obtained and analyzed without reliance on the PASS.

The staff recognizes that, as described in Supplement 3 to NUREG-0654, initial protective action recommendations (PARs) should be based upon plant indications of actual or projected severe core damage. Following this initial PAR, the licensee should continue assessment of the accident to determine whether the PAR should be modified (relaxation of the PAR should not occur until the source of the threat is clearly under control). In NUREG-0654, the NRC indicated that licensees' capability to perform this assessment should include the post accident sampling capability. Therefore, the staff's evaluation of the topical report's recommendation for elimination of sampling the containment atmosphere for radionuclides focused on the need for this information to support whether initial PARs should be modified.

The staff agrees with the topical report's assessment regarding the limitations associated with obtaining representative samples of the containment atmosphere. The staff considers that these limitations should be taken into account when determining how to utilize the containment atmosphere sample information during an event. However, the staff position is that due to these limitations, information obtained from PASS samples would not be a primary factor in licensee and offsite emergency response decision making regarding PARs during the early phases of an accident. The public comments received on the proposed staff action to eliminate PASS support this position. However, the staff considers that containment atmosphere sample information would provide the public additional confidence that the licensee understood the magnitude of any remaining threat that the accident may pose after the accident had stabilized.

Therefore, the staff also concludes that a plan should be developed for sampling the containment atmosphere. The staff does not consider it necessary to have dedicated equipment to obtain this sample in a prompt manner. These plans should detail the plant's existing sampling capabilities and what actions (e.g., assembling temporary shielding) may be necessary to obtain and analyze highly radioactive samples. (See Section 4.1, Licensee Required Action, Items 2 and 5).

Based on the above, the staff concludes that the proposal to eliminate PASS sampling and measurement of containment atmosphere radionuclides is acceptable.

3.12 Eliminate PASS Sampling of Containment Sump pH

PASS sampling of the containment sump for measurement of pH is specified in Regulatory Guide 1.97.

The containment sump pH plays an important role in controlling the post-accident chemistry of the containment sump water. If it becomes acidic, it can significantly affect chloride induced SCC of stainless steel components and retention of iodine in sump water. In most cases, the post-accident sump pH is maintained in an alkaline range either by passive pH control or by spray additives. However, there may be some accident sequences when the containment spray is not activated, and sump pH may then become acidic. In these cases, however, its value can be estimated with a sufficient degree of accuracy from the volumes and chemistries of the water incoming from different external sources.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling and measurement of containment sump pH is acceptable.

3.13 Eliminate PASS Sampling of Containment Sump Chlorides

PASS sampling and measurement of the containment sump for chlorides is specified in Regulatory Guide 1.97.

High concentration of chlorides in the containment sump can cause SCC of stainless steel components and affect retention of iodine. For plants with fresh water cooling systems, the problem is minimal; but for the plants with brackish water it may be a significant issue. However, the volumes and chloride concentrations of the incoming water from different sources are known and the resulting concentration of chloride in the sump water can be estimated with a sufficient degree of accuracy.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of containment sump chlorides is acceptable.

3.14 Eliminate PASS Sampling of Containment Sump Boron

PASS sampling of the containment sump for measurement of boron concentration is specified in Regulatory Guide 1.97.

The purpose of measuring boron concentration in the containment sump is to assure the reactor would remain subcritical should sump water be used in the recirculation mode to cool the core. The water in the RWST and the accumulators have sufficient boron concentration to assure subcriticality at any time in the fuel cycle. Should unborated water be introduced in the containment sump for emergency core cooling, the sump boron concentration will be lower. However, the sump level (and the corresponding amount of water) and sump water temperature are known which allow an estimate to be made for the boron concentration.

Based on the above, the staff concludes that the proposal to eliminate PASS sampling of containment sump boron is acceptable.

3.15 Eliminate PASS Sampling of Containment Sump Radionuclides

This is discussed in Section 3.8.

4.0 SUMMARY AND CONCLUSIONS

The staff concludes that CEOG Topical Report CE NPSD-1157 provides a sufficient technical basis to allow for elimination of requirements made to obtain the following PASS samples specified in NUREG-0737 and Regulatory Guide 1.97:

1. RCS dissolved gases
2. RCS hydrogen
3. RCS oxygen
4 RCS pH
5. RCS chlorides
6. RCS boron
7. RCS conductivity
8. RCS radionuclides
9. Containment atmosphere hydrogen
10. Containment atmosphere oxygen
11. Containment atmosphere radionuclides
12. Containment sump pH
13. Containment sump chlorides
14. Containment sump boron
15. Containment sump radionuclides

4.1 Licensee Required Actions

The staff has identified the following actions which need to be taken by licensees seeking approval of elimination of the PASS utilizing the justification provided in this topical report:

1. Establish a capability for classifying fuel damage events at the Alert level threshold (typically this is 300 μCi/ml dose equivalent iodine). This capability may utilize the normal sampling system or correlations of sampling or letdown line dose rates to coolant concentrations.

2. Develop contingency plans for obtaining and analyzing highly radioactive samples of reactor coolant, containment sump, and containment atmosphere.

3. The staff does not consider that changes as discussed in this topical report will result in a decrease in the effectiveness of the emergency plan, however the licensee must determine that no decrease in the effectiveness of the emergency plans will result from the removal/downgrade of the PASS.

4. Containment hydrogen monitors required by 10 CFR 50.44(b)(1) may not be eliminated. The staff recommends that licensees maintain the capability to sample and analyze hydrogen in the containment atmosphere in order to support severe accident management guidelines.

5. Licensees will maintain offsite capability to monitor radioactive iodines.

The staff concludes, based upon the justification provided in this topical report, that there is reasonable assurance that the health and safety of the public will not be endangered by operation of Combustion Engineering designed nuclear power plants without PASS.

Attachment: Analysis of Public Comments

Principal Contributors: P. Milligan, DIPM
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Date: May 16, 2000

APPENDIX

Analysis of Public Comments and Staff Response

In a notice published in the *Federal Reigster* on November 24, 1999 (64 FR 66213), the NRC requested comments on its pending action to approve two industry-developed topical reports concerning the elimination of the PASS. The NRC received 19 comment letters. Nine letters were from nuclear power plant utilities (supporting the proposed action), six letters were from State government organizations (four supporting and two opposing the proposed action), two letters were from private citizens (one supporting and one opposing the proposed action), one from an industry representative (supporting the proposed action) and one from the Federal Emergency Management Agency (supporting the proposed action). The staff grouped specific individual comments from each of the letters into a number of issue categories. These issues, the comments pertinent to the issue, and NRC response to insights provided in the comments are described below. Following the analysis of specific individual comments, a summary of all comments (general and specific) and the staff's response is provided.

1. Analysis of Specific Comments

Accuracy of PASS Results

One commenter agreed with the topical reports' contention that physical phenomena such as plateout and deposition in sample lines may cause PASS samples to underpredict the fission product inventories that are potentially available for release. A second commenter disagreed with the topical reports' contention on this issue, in particular regarding plateout of iodine in the sample lines and stated that an equilibrium will be reached (deposition equal to re-evolution) after the containment atmosphere has been circulated through the sample lines for a period of time.

The NRC considers the difficulty of obtaining representative samples to be a major shortcoming of the PASS system. The deposition of iodine is particularly problematic since iodine is the best indicator (from the PASS) for evaluating core damage and potential significance of health consequences from a release of the containment atmosphere. The amount of deposition of iodine will be a function of its chemical form. At the time that the PASS criteria were developed in NUREG-0737, the majority of iodine in the containment atmosphere from a potential severe accident was believed to be in elemental form. Since that time, severe accident research has shown that the chemical form of iodine is expected to primarily be Cesium Iodide (CsI) (as an aerosol). Collection of correct samples of the CsI aerosols poses significant problems. There will be a tendency for the particles to deposit on the cooler walls of sampling lines due to thermophoresis and Stefan flow, if steam is present. All these mechanisms will be present at all times during sampling operation and it is not expected that an equilibrium state between deposition and removal of the CsI aerosols will ever be reached.

Alternate Sampling Capability

Two commenters agreed with the topical reports' contention that samples could be obtained from non-PASS systems if an accident occurred. One commenter disagreed with the topical Reports' contention that samples could be obtained from non-PASS systems if an accident

occurred. The opposing commenter stated that there would be problems related to elevated hydrogen for rigging a sampling method. Furthermore, the commenter stated that any licensee requesting PASS elimination should be required to explain how they would accomplish containment atmosphere sampling with less personnel exposure than if they had a PASS.

The NRC is basing its decision on the acceptability of the proposal to eliminate PASS on the benefit that the information obtained from PASS would provide in accident management and emergency response. If this information was considered to be necessary and, therefore, planned to be obtained shortly after a severe accident, then a PASS would be prudent to ensure that samples could be taken promptly and exposure minimized. However, as described further in the summary to this Appendix, the information is not considered to be beneficial for accident management or emergency response. Therefore, there is considered to be sufficient time to establish an alternate sampling capability if samples were considered to be beneficial in the longer term.

Boron Sampling

One commenter disagreed with the topical reports' contention that boron sampling was not needed.

The NRC considers there are sufficient sources of borated water for injection by safety systems. Unborated water sources would only be used in an extremely unlikely circumstance and the use of unborated core cooling water would be balanced with the diminished potential for recriticality (given the core configuration). Furthermore, instruments are available for monitoring any potential recriticality. Knowledge of boron concentration is not a prerequisite of performing emergency operating procedures (EOP) or severe accident management (SAM) procedures.

Core Damage Assessment

Three commenters agreed with the topical reports' contention that PASS was not needed for performing core damage assessment (CDA). Two commenters raised concerns with the elimination of the use of PASS measurements for assessing the degree of core damage. The comments in support of the topical reports stated that other indicators exist which can be used for CDA. The comments disagreeing with the topical reports described the following shortcomings associated with these alternative indications.

- Radiochemical analysis of the coolant, containment sump and containment atmosphere is the most accurate method for performing CDA.

- A limitation of performing CDA based upon containment radiation monitor is that it is based upon the radiation monitor response to an assumed mixture of radionuclides. Since the nuclide mix varies greatly from one accident scenario to the next, the actual monitor response may vary by orders of magnitude.

- A limitation of performing CDA based upon core exit thermocouples (CETs) is that CETs cannot be used to determine whether fuel overheat or pellet melting has occurred.

- A limitation of performing CDA based upon hydrogen monitor readings is it can only assess whether the fuel is overheating (not whether the fuel has melted) and there are uncertainties associated with the hydrogen generation rate and mixing of the hydrogen in containment.

The staff recognizes that there are limitations with the individual indications used for CDA which is why current guidance relies on a number of instrument indications to diagnose and evaluate core damage. The staff agrees that radiochemical analysis is more accurate than other available indications but it too has limitations. At the time of PASS design, the iodine chemical form was assumed to be predominantly in elemental gaseous form (91 percent). The staff's current understanding is documented in NUREG/CR-5732, which indicates that iodine entering the containment is at least 95 percent particulate CsI. Once the iodine enters containment, however, additional reactions are likely to occur. In an aqueous environment, as expected for LWRs, iodine is expected to dissolve in water pools or plateout on wet surfaces. This can bias the radionuclide samples obtained from PASS and lead to underestimates of the extent of core damage.

The staff agrees that the nuclide mix varies greatly from one accident scenario to the next which affects radiation monitor response. Revised CDA guidance relies on CETs, RCS pressure and containment spray system status to sufficiently narrow the accident scenario being assessed and the expected variation in the nuclide mix.

The approach for converting instrument readings into core damage estimates is consistent with the current understanding of clad and fuel damage characteristics, and accounts for fission product and hydrogen retention/holdup in an approximate fashion. Specifically, containment radiation monitoring readings are compared to plant-specific radiation levels for 100 percent clad damage or fuel over-temperature damage, CET readings are compared to values typically associated with clad damage and fuel over-temperature damage, and containment hydrogen concentration is compared to the amount expected in containment for 100 percent over-temperature damage. CET readings that exceed the setpoints or the operating limits of the thermocouples are interpreted as core damage in that region of the core. The core damage estimates derived separately from different indicators (containment radiation, CET, and containment hydrogen concentration readings) are compared and reconciled, thereby improving the confidence in the core damage estimate.

The staff has concluded that the revised CDA guidance, that does not rely on PASS, provides the capability to assess the degree of core damage with a sufficient level of accuracy and timeliness to support emergency response decisionmaking. The revised guideline represented an improvement over the existing methodology which relied on PASS sampling. It is both simpler and more timely, and accounts for improved understanding of fission product behavior inside containment. By making core damage information available earlier in an event, such that it can be used to refine dose assessments and confirm or extend initial protective action recommendations, implementation of the revised CDA guidance should increase the effectiveness of the emergency response organization.

Dose Assessment

Two commenters agreed with the topical reports' contention that PASS was not needed for performing dose assessment. One commenter raised concerns with the elimination of the use of PASS measurements as inputs for dose assessments. The comments in support of eliminating this PASS measurement stated that installed instrumentation, which provides real time information from diverse parameters, is much better than PASS samples and that computer models although useful need to be verified by offsite field team measurements. The commenter disagreeing with the topical reports stated that field team measurements have inaccuracies associated with atmospheric transport, field team measurements may not be timely, and that there is a large uncertainty associated with source term estimate based upon in-plant instrumentation.

The NRC expects dose assessments to be timely and accurate in order to support decisions on protective actions for the public. However, the NRC recognizes that there are limitations on the accuracy and timeliness of dose assessments. Therefore, the NRC guidance (reference NUREG-0654, Supplement 3) specifies that initial protective action recommendations should be based upon plant conditions which indicate that there is actual or projected severe core damage. This initial PAR is followed by dose assessments which may be used to expand the area covered by the initial PAR. Initial dose assessments will likely be based upon an assumed source term. This source term may be refined based upon plant indications or core damage assessments. This source term can be further refined based upon offsite field team measurements. (A benefit of using field team measurements is that the source term being estimated is that released from containment rather than the source term in containment which could be altered prior to being released from containment). PASS results are another potential input to refinements to the source term. However, there are concerns with the accuracy of source term estimates based upon PASS because of the potential for the sample not to accurately represent the source term in containment and with the time needed to obtain and analyze these samples.

The NRC believes that PASS results will not have an important role in source term refinements for use in dose assessments because indications such as core exit thermocouple and containment radiation monitor (in conjunction with correlations of these indications to core damage assessments) will be more timely for refining source term estimates and indications such as field team measurements will be more accurate in refining the source term estimates.

Event Classification

Two commenters agreed with the topical reports' contention that PASS was not needed for classifying events.

The NRC agrees that other indications are available for classifying events involving fuel damage and these other indications are available in a more timely manner than PASS.

Hydrogen Measurement

One commenter agreed with the topical reports' contention that PASS was not needed for hydrogen measurement and one commenter raised concerns with elimination of PASS

hydrogen monitoring. The comment in support of eliminating hydrogen sample measurement was that the hydrogen monitoring system provided measurement of hydrogen in containment and that this measurement is much quicker than measurements using PASS. The opposing comment was that the hydrogen sample from PASS provides an independent method of determining the hydrogen concentration.

The NRC considers that hydrogen measurement utilizing the PASS system is not needed because the hydrogen monitoring system can provide the same information in a more timely manner. The hydrogen monitoring system is subject to quality assurance requirements and is a redundant system.

Plant Access/Post Accident Leakage/Personnel Exposure

Two commenters provided comments in support of the topical reports contention that elimination of PASS will prevent the potential for restriction of plant access following a PASS sample, will reduce personnel exposure, and will eliminate a potential post accident leakage path.

The NRC agrees with these comments. However, the NRC recognizes that the PASS was to be designed to prevent the potential problems and that the decision to obtain a PASS sample would take into account the benefit of the PASS sample in light of the potential for restricting plant access, exposure of personnel and leakage.

Protective Action Recommendations

Six commenters agreed with the topical reports' contention that development of protective action recommendations will not be affected by the deletion of PASS. Two commenters disagreed with the topical reports' contention on this issue.

The comments in support of eliminating PASS stated that PASS samples are not useful in protective action decisionmaking because these decisions are based on plant indications (real-time monitoring instruments and system operability) and offsite field surveys.

The comments against eliminating PASS stated that offsite officials need to know the actual volume of radioactive material inside of containment (not just the inferred source term) to make additional protective action recommendations.

The NRC considers that PASS may be useful in making subsequent protective action recommendations (or confirming the initial PAR) after the initial protective action recommendation has been made. However, the NRC considers that there is adequate information on the actual (or potential) consequences of a release of radioactive material from field team measurements and containment atmosphere radiation monitors to support assessment of protective action recommendations.

Resources

Four commenters agreed with the topical reports' contention that obtaining and analyzing PASS samples may divert resources from other important emergency response activities.

The NRC does not consider the potential for diverting resources to be a problem because the decision to obtain PASS should be based upon an evaluation of what is the most important activities to perform during a given plant and accident conditions.

Severe Accident Management Guides

One commentator disagreed with the topical reports' contention that PASS is no longer required during emergency response in part because of the implementation of Severe Accident Management Guidelines (SAMGs) at nuclear power plants.

The staff does not consider SAMGs to be a replacement for PASS. The SAMGs were intended to provide guidance to the plant operator under severely degraded accident conditions that are outside the plant design and licensing basis. Based on in-plant instrument readings, the core damage state is classified as "in-vessel" or "ex-vessel". Because of PASS limitations, the staff concludes that core damage assessment can be provided with a sufficient level of accuracy and timeliness to support emergency response decision making and SAMG implementation without the PASS. The basis for this conclusion is summarized in the above "Core Damage Assessment" section of this document.

Sump pH

Two commenters disagreed with the topical reports' contention concerning the need for pH measurement from PASS. One commenter stated that knowledge of sump pH will confirm or deny that pH was within design limits and that this information will allow emergency response staff to address pH concerns or to be free to address more pressing concerns (if pH is adequate). The second commenter stated that the NRC should be assured that there is a fool-proof way of buffering recirculation water.

The NRC considers that the chemicals added to the sump water by either trisodium phosphate stored in the sump or sodium hydroxide added to the spray water will provide sufficient buffering action to account for the effect of the major acidic chemicals present in the containment sump after an accident. It is not expected that any unaccounted for acidic substances generated in the sump will significantly lower its pH. Its reevaluation during the accident will not, therefore, be needed, especially since no additional means for pH control will then be available.

System Operation Verification

The commenter stated that PASS data can be used to verify that safety features are operating as designed.

The NRC considers that there may be some benefit to PASS in providing information on the effectiveness of system operation. However, the NRC considers that there are alternative indications which are available in a more timely manner for this purpose.

2. Summary

In addition to the specific comments extracted from the comment letters, many commenters provided a general assessment of the need for PASS. The commenters in support of elimination of PASS stated that PASS information is not used in emergency response and will not adversely affect emergency response, that resources are better used in other areas of emergency response, and that the cost of PASS does not warrant maintaining the system. Commenters opposing elimination of PASS stated that PASS will provide information useful in emergency response.

The NRC appreciates the time and effort taken by all the commenters. Input from the public stakeholders is an important part of the NRC's decision making process. The NRC concludes, as detailed in the body of this safety evaluation, that the PASS has a small benefit in emergency response. The primary benefit is in confirming other indications used to make emergency response decisions. The benefit of PASS is limited by time needed to obtain the samples and problems with obtaining accurate samples (in particular radioisotopic samples of the containment atmosphere). The NRC concludes that elimination of PASS will not pose a significant hazard to the public and that, considering the cost of maintaining PASS, continued imposition of NRC orders requiring PASS is not warranted.

It is expected that licensees will utilize the industry topical reports and the NRC's safety evaluation in requesting elimination of PASS at their plants. The NRC will provide the public an opportunity to comment on plant requests for elimination of PASS as part of the license amendment process. Therefore, the public will have the opportunity to raise any site-specific concerns related to elimination of PASS at that time.