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NUCLEAR PRODUCTION DEPARTMENT

November 7, 1983

Honorable Nunzio J. Palladino
Chairman, Nuclear Regulatory Commission
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

SUBJECT: Mark III Containment Hydrogen Control Owners Group (HCOG)
Final Degraded Core Hydrogen Control Rule
HGN-013

The Mark III Containment Hydrogen Control Owners Group (HCOG) understands that the Nuclear Regulatory Commission (NRC) staff will brief the full Commission on the proposed Final Degraded Core Hydrogen Control Rule on November 9, 1983 and that the full Commission will vote on issuance of this rule on November 10, 1983. The Background section of the proposed Federal Register publication has undergone numerous revisions and has not previously been available for public review and comment. The HCOG believes that one point in the Background section should be clarified before publication of the Federal Register notice and the Final Degraded Core Hydrogen Control Rule.

The second paragraph under "Systems and Components" in the Background section presently states in part:

> The Commission now believes, in view of the recent issuance of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety", that there is no significant difference between demonstrating survivability and demonstrating qualification. Paragraph (f) of 50.49 describes several methods, one of which must be used, for qualifying electrical equipment important to safety. For example, for those licensees which have already demonstrated survivability, as described in the Supplementary Information of the notice of proposed rule-making for this rule on hydrogen control requirements, (46 FR 62281, December 23, 1981), the qualification methods described in paragraphs (f) (2) and (f) (4) of 50.49 could be used to show that the systems and components have been qualified. In this regard, the margins considered adequate for a degraded core accident are less than those considered adequate for a design basis accident due to the lower probability of occurrence of a degraded core accident.

-REC'D CHRMN-

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11/8...To EDO for Appropriate Action..Cpys to: Chm,Cmrs,PE,OGC,SECY
RF...83-2476

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This needs to be clarified to reflect the staff's intent to extend existing environmental qualification to degraded core survivability. Based upon conversations with the staff, the HCOG believes that the following revised wording would provide the needed clarification. The underlined text reflects the HCOG's requested clarification:

> The Commission now believes, in view of the recent issuance of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety", that there is no significant difference between demonstrating survivability and demonstrating qualification. Paragraph (f) of 50.49 describes several methods, one of which must be used, for qualifying electrical equipment important to safety. For example, for those licensees which have already demonstrated survivability, as described in the Supplementary Information of the notice of proposed rule-making for this rule on hydrogen control requirements (46 FR 62281, December 23, 1981), the qualification methods described in paragraphs (f) (2) and (f) (4) of 50.49 could be used to show that the systems and components have been qualified. Existing LOCA qualification can be extended to survivability if it can be shown that the environment produced by hydrogen combustion does not exceed the previously established environmental qualification temperature. Individual instances where component thermal response exceeds equipment qualification temperature will be reviewed on a case-by-case basis. In this regard, the margins considered adequate for a degraded core accident are less than those considered adequate for a design basis accident due to the lower probability of occurrence of a degraded core accident.

The HCOG respectfully requests that the Commission incorporate the proposed clarifications to the Federal Register publication notice.

Yours truly,

S H Hobbs

S. H. Hobbs, Chairman
Hydrogen Control Owners Group

SHH:sap

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE SECRETARY

IN RESPONSE, PLEASE
REFER TO: M831109B

November 17, 1983

MEMORANDUM FOR: William J. Dircks, Executive Director for Operations

FROM: for Samuel J. Chilk, Secretary

SUBJECT: STAFF REQUIREMENTS - DISCUSSION OF HYDROGEN IGNITION SYSTEM AND FINAL RULE, 2:00 P.M., WEDNESDAY, NOVEMBER 9, 1983, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN TO PUBLIC ATTENDANCE)

The Commission was briefed by staff on the proposed final rule changes to Part 50 on hydrogen control, as outlined in SECY-83-357.

Chairman Palladino noted that the proposed rule does not contain provisions for addressing the survivability of equipment in large, dry containments nor does it contain an adequate justification for deferring that issue for consideration at a later date. Commissioner Gilinsky favored revision of the proposed final rule to include a provision that survivability be demonstrated for containments, including large dry systems, and to require automatic actuation of igniters.

Commissioner Roberts noted that he would submit, in writing, his questions to staff.

The Commission did not take final action on the proposal at this meeting.

cc: Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commission Staff Offices
PDR - Advance
DCS - 016 Phillips

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x OMB SR Comm Mtgs.

Case 2

. UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 22, 1981

MEMORANDUM FOR: Chairman Ahearne
Commissioner Gilinsky
Commissioner Hendrie
Commissioner Bradford

FROM: Edward J. Hanrahan EJH

SUBJECT: OPE REVIEW OF HYDROGEN CONTROL MEASURES FOR SEQUOYAH

Shortly, the staff will brief the Commission with regard to whether the January 31, 1981 license condition for Sequoyah has been satisfied, i.e., "TVA shall by testing and analysis show to the satisfaction of the NRC staff that an interim hydrogen control system will provide with reasonable assurance protection against breach of containment in the event that a substantial quantity of hydrogen is generated" (emphasis added). OPE comments with regard to a Commission decision on this license condition are provided below.

The immediate decision facing the NRC is whether "reasonable assurance of protection" required by the January 31, 1981 license condition has been obtained through use of the IDIS. In this regard, two principal aspects should be considered:

- Reasonable assurance against breach of containment due to direct over-pressure from hydrogen combustion, irrespective of equipment survivability.
- Reasonable assurance against breach of containment due to failure of essential equipment to survive the effects of hydrogen combustion with the subsequent inability to maintain core integrity, possibly leading to eventual containment failure.

Given the close connection of ice condenser containment plants and the potentially significance of hydrogen effects, whatever decision is reached on Sequoyah should be applied to all ice condenser containment plants.

In compliance with its license conditions, TVA submitted to NRR on December 1, 1980 its first quarterly report on the research program for hydrogen control and a revised Volume 2 of the Sequoyah Core Degradation Program Report which provides information on TVA's proposed Interim Distributed Ignition System (IDIS) as well as longer term efforts for a "final hydrogen control system." In early January, the staff prepared a draft "Supplement No. 4 to the Sequoyah Safety Evaluation Report (SER)" containing a preliminary evaluation of the TVA submittals.

CONTACT:
Jim Milhoan (OPE)
634-3295

8103230089

OPE Review

OPE has reviewed the above documents with the assistance of Dr. Roger Strehlow, a nationally recognized expert in gas dynamics with particular expertise in hydrogen combustion. Dr. Strehlow's evaluation report is attached.

Dr. Strehlow concluded that a well designed and maintained glow plug igniter system which is energized only for testing or during an event which has the potential of generating hydrogen is an effective way to protect the Sequoyah nuclear plants from the possibility of breaching the containment vessel due to inadvertent combustion of accumulated hydrogen. (Dr. Strehlow also identified additional research needs and provided comments on combustion dynamics.)

Dr. Strehlow's review was related primarily to the question of reasonable assurance against breach of containment due to direct overpressure from hydrogen combustion. In this regard, Dr. Strehlow has identified mechanisms which could lead to explosion if a continuous flame is able to propagate in an ice condenser type containment. Even though he concluded the glow plugs will virtually eliminate the possibility of detonation in the containment vessel, he recommended further research be accomplished. I recommend the staff address Dr. Strehlow's comments before reaching a decision on "final hydrogen control measures."

With regard to the second question (equipment survivability), Dr. Strehlow indicated that glow plug initiated burns will be much less dangerous than spark initiated burns because glow plugs will initiate burns at lower concentrations than sparks of the type that undoubtedly initiated the TMI burn. It appears that the lower the concentration at which hydrogen burns, the better chance of equipment survivability because of reduced flame propagation at low hydrogen concentrations. Thus, glow plugs should be an improvement with respect to equipment survivability.

Based upon our own review and that of Dr. Strehlow, I believe operation of the IDIS will reduce further any probability of breach of containment in the event that a substantial quantity of hydrogen is generated. The question of whether the "reasonable assurance" criterion has been satisfied appears to hinge on the question of equipment survivability. (Equipment survivability is certainly improved by use of glow plug igniters.) Equipment survivability will be addressed further in the next Supplement to the Sequoyah SER.

Enclosure:
As stated

cc: L. Bickwit
S. Chilk
R. Fraley
W. Dircks
H. Denton
R. Tedesco
W. Butler
C. Tinkler
C. Stahle

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Evaluation of the

Glow Plug

Igniter Concept

for use in the

Sequoyah Nuclear Plant

Prepared for

Mr. James Milhoan, P. E.

Office of Policy Evaluation

Nuclear Regulatory Commission

Washington, D. C. 20555

Prepared by

Roger A. Strehlow

Consultant

January 9, 1981

Overall Evaluation

In my opinion, a well designed and maintained glow plug igniter system which is energized only for testing or during an event which has the potential of generating hydrogen is an effective way to protect the Sequoyah nuclear plants from the possibility of breaching the containment vessel due to the inadvertent combustion of accumulated hydrogen. Furthermore, it is my opinion that the implementation of this glow plug igniter technique will have no negative effects on overall safety in such a nuclear plant. I base this opinion on the following information that was supplied to me by the Nuclear Regulatory Commission:

Tennessee Valley Authority, Sequoyah Nuclear Plant Core Degradation Program, Volume I, Hydrogen Study, September 11, 1980.

News Release No. 80-159, USNRC, September 11, 1980.

News Release No. 80-163, USNRC, September 18, 1980.

Safety evaluation report related to the operation Sequoyah Nuclear Plant, Units 1 and 2, Docket No. 50-327 and 50-328, Tennessee Valley Authority, NUREG-0011, Supplement No. 3, September, 1980.

Memorandum for: ACRS members, from: J. C. Mark, Subject Notes on hydrogen burn with igniters, December 4, 1980.

Memorandum to: ACRS members, from: H. Etherington, Subject Memorandum P. G. Shemwon to ACRS members: "Quantity of H_2 at TMI-2 and source."

Tennessee Valley Authority, Sequoyah Nuclear Plant Core Degradation Program, Volume 2, Report on the Safety Evaluation of the Distributed Ignition System, December 15, 1980.

Tennessee Valley Authority, Sequoyah Nuclear Plant, Research Program on Hydrogen Combustion and Control, Quarterly Progress Report, December 15, 1980.

Draft copy of Supplement No. 4 to the Safety evaluation report by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission in the matter of Tennessee Valley Authority Sequoyah Nuclear Plant Units 1 and 2, Docket No's. 50-327 and 50-328, undated.

Attendance at the ACRS subcommittee meeting held in Washington, D. C. on January 6, 1981.

A meeting with Mr. Tinkler and Mr. Butler of the NRC staff on the morning of January 7, 1981.

Other open literature references which helped me form my opinion will be referenced in the detailed supporting statement that follows. I also have opinions concerning the dynamics of a combustion explosion in a Sequoyah type containment and new research and data accumulation efforts which would be necessary to strengthen and quantify the justification for using glow plug igniters as the only hydrogen control technique. These will also be disucssed below.

Effectiveness of the Glow Plugs.

The Singleton Lab., Fenwal and LLNL tests have shown the glow plugs that are being considered for the Sequoyah plant to be very effective igniters down to 5% hydrogen even in the presence of 15% dry steam. Thus, in a real accident we now know that the igniters would initiate a partial burn at 5% H_2 in the CV. Furthermore, the Singleton lab tests show that in a small vessel even with 3.5% H_2 present initially a five minute "burn" reduces the H_2 concentration to about 0.1%. This is very encouraging because it shows that a hot glow plug will act as an H_2 scavenger even outside the flammability limit for upward propagation of about 4% H_2. Furthermore, sparks of the type that undoubtedly initiated the Three Mile Island burn are not effective at such a low hydrogen

concentration.

It is important to note that glow-plug initiated burns will be much less dangerous than spark initiated burns. This is because between 4-8% hydrogen in air burns with a very lazy upward propagating flame which spreads at a maximum half angle of about 20 degrees and extinguishes when it reaches the top of the vessel. This means two things: 1) the pressure rise will be minimal for such a burn, and 2) the hot product gases will be confined to this cone-shaped volume and subsequently will spread along the ceiling. In other words, the flame will not contact and therefore not heat most equipment that is in the containment vessel. Also, if the rate of hydrogen generation were slow so that the fans produced a rather uniform hydrogen concentration, the burn would be almost continuous once the hydrogen content reached 4-5%.

On the other hand, a fast leak which caused a localized higher concentration of hydrogen would also not be dangerous when ignited by the glow plug. This is because glow plugs strategically placed above potential hydrogen sources would ignite a high hydrogen concentration plume on contact and only a localized high temperature burn would occur. It is well documented (Cubbage and Marshall, 1972) that such a partial burn yields a pressure rise in a vessel which is proportional to the energy released by the localized burn (Joules) divided by the <u>total</u> volume of the vessel (m^3). Thus, a small localized burn cannot cause a really large pressure rise.

In my opinion, properly located and functioning glow plug igniters would reduce the probability of a burn leading to a

transition to detonation to virtually zero. This is because the very weak flames produced by a 4-5% hydrogen burn cannot generate significant pressure waves or significant flow velocities ahead of the flame. This means that the mechanisms that lead to flame acceleration do not exist under these conditions. In other words, the weak 4-5% hydrogen flames will remain weak irrespective of the environment that they encounter.

Combustion dynamics in the Sequoyah containment vessel.

The Sequoyah containment contains three main compartments: 1) the upper compartment, 2) the lower compartment, and 3) the ice condenser. The upper and lower compartments both have a rather low length-to-diameter (L/D) ratio and therefore if they could be treated as independent vessels they would be capable of supporting only a simple over-pressure explosion. The containment at Three Mile Island was essentially of this type and that is what happened there when the hydrogen concentration reached about 8%. In such a case, the flame propagates slowly enough such that the pressure is relatively uniform spatially in the vessel during the burn and simply rises with time (approximately as a cubic of time; see Bradley and Mitcheson, 1978 a, b). This is true even if there is some acceleration due to turbulence generation. Under these conditions, there are essentially no pressure waves generated. Note that at TMI the transit time of a sound wave from top to bottom to top is about 0.2 seconds and the burn took about 10 seconds.

Unfortunately, in the Sequoyah configuration the upper and lower compartments are not independent but are connected by the

ice condenser. In my opinion, this is a very dangerous configuration because it would generate pressure waves which could possibly lead to local over pressures that could breach the containment. This is because the ice condenser contains hundreds of tubes (the spaces between the baskets) which have a very large L/D and which could cause significant flame acceleration and possibly even transition to detonation. This mechanism has been adequately documented by Urtiew et al (1965, 1967) and could occur after primary ignition at or above 8% in either the lower or upper compartment. The sequence, without detonation, is as follows: ignition in one compartment causes a slow pressure rise and starts a flow through the condenser, pressurizing the second compartment. The flame then gets into the ice condenser at some location and accelerates in this turbulent flow causing large turbulent jets to enter the second compartment. Once the flame reaches the second compartment, it is already pre-pressurized and the burning velocity is now so large that combustion in this compartment produces pressures that are up to a factor of 2-4 above the calculated maximum adiabatic constant volume pressure (Heinrich, 1974).

There is another more recently discovered combustion dynamics possibility. Knystantas et al (1979) have shown that large scale eddy folding of hot combustion products into an already turbulent jet of reactants can produce shockless initiation of detonation. Here the mechanism is that radicals in the product gases trigger combustion reactions in the mixing volume and as the system explodes the pressure increase augments the combustion process. This coupled augmentation eventually culminates in a detonation wave. For hydrocarbon-air mixtures, the critical eddy size is

large, about three meters in diameter. Note that at the exit of the ice condensus, conditions would be right for the formation of such a large mixing region. The required eddy size for hydrogen-air is not known but it would probably be smaller than the critical size for a hydrocarbon-air mixture.

Thus, in my opinion, the combustion dynamics of an explosion in which a continuous flame is able to propagate (i.e., in a mixture containing greater than 8% H_2) is a very dangerous situation and would have the potential to breach the containment vessel. We know that glow plugs have been shown to yield partial burns when the flame is lazy and not dangerous. This, coupled with the vulnerability of the facility to a dynamic combustion explosion, is one more point in favor of using glow plug igniters to protect the containment vessel from the adverse consequences of an accidental spark-ignited burn.

Research Needs.

Glow plug testing should be continued. Specifically, I agree with the LLNL recommendations for further work that was presented at the ACRS subcommittee meeting of January 6, 1981. I would also like to see some continuous burn tests at concentration less than 4% to determine how rapidly a glow plug will scavenge hydrogen at these low concentrations. In these tests, the effect of fan-induced flow across the plug should also be investigated.

Even though I feel that the glow plugs will virtually eliminate the possibility of detonation in the containment vessel, I still feel that some work on detonation limits should be performed.

I do not believe the 18% figure that is in the reports. I feel that the limit is much lower, possibly 12%. At any rate, this uncertainty can be relatively easily answered by a few rather simple tests that should be performed.

References

Bradley, D. and Mitcheson, A. (1978a), Comb and Flame 32, pp. 221-236.

Bradley, D. and Mitcheson, A. (1978b), Comb and Flame 32, pp. 237-255.

Cubbage, P. A. and Marshall, M. R. (1972), "Pressures generated in combustion chambers by the ignition of air-gas mixtures", I. Chem E. Symposium Series #33, Inst. of Chemical Engineers, London, pp. 24-31.

Heinrich, H. J. (1974), "Zum Ablanf von Gas explosionen in mit Rohleitungen verbundenen Behadtern", BAM Berichte #28, Berlin (August 1974).

Knystantas, R.; Lee, J. H.; Guirao, C.; Freuklach, M.; and Wagner, H. G., "Direct Initiation of detonation by a hot turbulent gas jet", 17th Symposium (International) on Combustion, The Combustion Institute, Pittsburgh, Pa., (pages unknown).

Utriew, P.A. and Oppenheim, A. K. (1967), "Detonation Initiation by Shock Merging", 11th Symposium (International) on Combustion, The Combustion Institute, Pittsburgh, Pa., pp. 665-676.

Utriew, P. A., Laderman, A. J. and Oppenheim, A. K. (1965), "Dynamics of the Generation of Pressure Waves by Accelerating Flames", 10th Symposium (International) on Combustion, The Combustion Institute, Pittsburgh, Pa., pp. 797-804.

To:
JTCII:
for review 9/9/83

Tilton

RULEMAKING ISSUE
(Affirmation)

August 26, 1983

SECY-83-357

For: The Commissioners

From: William J. Dircks, Executive Director for Operations

Subject: AMENDMENTS TO 10 CFR PART 50 RELATED TO HYDROGEN CONTROL

Purpose: To obtain Commission approval for publication of final amendments in the Federal Register.

Category: This paper covers a major policy question.

Issue: Whether applicants and licensees with Mark III BWRs and PWR ice condenser facilities should be required to:

a. Provide hydrogen control systems that can handle large amounts of hydrogen,

b. Demonstrate the survivability/qualification of containment and safety systems during and following a hydrogen burn, and

c. Perform and submit analyses concerning hydrogen control and survivability/qualification of containment and safety systems.

Discussion: During the Policy Session on September 16, 1981, the Commission was briefed by the staff on Interim Amendments to 10 CFR Part 50 Related to Hydrogen Control (SECY 81-245A). The discussion covered both a final and a proposed rule and resulted in several Commission comments that required resolution. The Commission approved publication of the final rule during Affirmation Session 81-41 on November 5, 1981 (Enclosure "A"). The final rule was published in the Federal Register on December 2, 1981 (46 FR 58484) and required inerted atmospheres for BWR Mark I and II containments, hydrogen recombiner capability for LWRs that rely on purge/repressurization systems as the primary means of hydrogen control, and high point vents

CONTACT:
M. Fleishman, RES
443-7615

SECY NOTE: This paper is identical to the one advanced on 8/26/83.

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for all LWRs. The Commission approved publication of the proposed rule during Affirmation Session 81-43 on November 24, 1981 (Enclosure "B").

The proposed rule (Enclosure "C") was published in the Federal Register on December 23, 1981 (46 FR 62281), and allowed 60 days for a public comment period which expired on February 22, 1982. A notice of extension of comment period (Enclosure "D"), including editorial corrections, was published on February 25, 1982 (47 FR 8203) and extended the comment period for an extra 45 days to April 8, 1982. The proposed rule would have required that:

a. Each boiling water reactor with a Mark III type containment and each pressurized water reactor with an ice condenser type containment be provided with a hydrogen control system capable of handling an amount of hydrogen, equivalent to that which would be generated if there were at least a 75 percent fuel cladding-water reaction, without loss of containment integrity;

b. Each boiling water reactor and each pressurized water reactor that does not rely on an inerted atmosphere for hydrogen control be provided with safety systems, needed to establish and maintain safe cold shutdown and maintain containment integrity, that can function after the burning of substantial amounts of hydrogen; and

c. Analyses be performed for the reactor categories mentioned above to justify the hydrogen control systems selected and to assure containment structural integrity and survivability of needed safety systems during a hydrogen burn.

In response to the notice of proposed rulemaking, comments were submitted by 28 persons having the following affiliation:

Nuclear Steam System Suppliers	3
Utilities	18
Architect/Engineer Firms	2
Industrial Associations	3
Individuals	2

A detailed summary of the comments is provided in Enclosure "E", including a list of commenters, and a paraphrase of each of 202 comments. The comments received covered all aspects of the proposed rule and there was a considerable amount of duplication among commenters. The following represents a distillation and paraphrasing of the more significant comments:

1. The implementation of the Hydrogen Control Rule should be deferred until the severe accident rulemaking when applicable research and probabilistic risk analyses (PRAs) will be completed.

   Resolution: The staff agrees with these comments relative to PWRs with large dry containments. Because of the greater inherent capability of the dry containment designs to accommodate large quantities of hydrogen (high design pressure and large volume), the staff believes that rulemaking with regard to hydrogen control can be safely deferred pending completion of NRC- and industry-sponsored research. With regard to systems and components that must be able to function during and following hydrogen burning, the fact that TMI-2 was shut down and maintained in a shutdown condition indicates that such systems and components did generally perform their functions following the burn event. In addition, design improvements that have been implemented as a result of NRC directives have served to reduce the likelihood of a degraded core accident.

   With regard to BWRs with Mark III containments and PWRs with ice condenser containments, the staff believes that the rulemaking should be carried forward. This will formalize Commission regulatory decisions currently being applied on a case-by-case basis. The Commission has requested the staff to prep:re this Hydrogen Control Rule to implement its position.

2. The 75 percent metal-water reaction required to be assumed for design and analysis is unreasonably high based on evaluation of the TMI-2 accident and analyses of recoverable degraded core accidents.

   Resolution: The staff agrees that the 75 percent metal-water reaction is greater than that which occurred during the TMI-2 accident. However, the primary intent of the rule is to require containment designs that can accommodate accident sequences in which hydrogen combustion poses a significant threat to containment integrity. Consequently, the staff believes it is prudent to specify a value sufficiently greater than that which was analyzed to have occurred at TMI-2 so that there will be an appropriate margin of safety. The staff feels confident that the 75 percent value is representative of a limiting case degraded core accident. Finally, the staff sees no significant benefit in reducing the metal-water reaction to a level such as 50 percent for those plants required to install a hydrogen control system since the basic design of the system would not change.

3. The requirement for a hydrogen control system should be revised to permit licensees the option of analytically demonstrating that additional hydrogen control systems are not necessary because of intrinsic design features that reduce the likelihood of hydrogen generation.

   Resolution: While the staff agrees that design features to reduce hydrogen generation are necessary and desirable, it still believes that, in order to cope with unexpected events, there should be a solution to the hydrogen issue that involves design features that assure containment integrity, even if a large amount of hydrogen is generated.

4. Since the primary function of the containment is to prevent excessive radiation dose to the public, the rule should be modified to preclude the loss of containment function rather than to preclude the loss of containment integrity.

   Resolution: The staff appreciates the fact that some nuclear plants are designed with a multi-building, multi-barrier concept that is intended to prevent the leakage of radiation by diverse methods such as filtering or scrubbing mechanisms, plate-out mechanisms and containment sprays. However, the Commission's safety philosophy has been that the containment should be designed to remain intact following a recoverable degraded core accident in order to provide additional assurance that excessive radiation will not be released. The staff supports this policy that the prevention of excessive radiation dose to the public can best be assured by maintaining a leak tight containment; and that this, in turn, can be provided by assuring that there is structural integrity with margin.

5. The criterion for containment structural integrity is unnecessarily restrictive. It should not be limited to the provisions of the ASME Boiler and Pressure Vessel Code, but should permit other methods such as realistic analyses using actual material properties.

   Resolution: The staff agrees with this comment and has modified the rule in this regard. The rule has been changed to indicate that "containment structural integrity must be demonstrated by use of an analytical technique that has been accepted by the NRC staff." The rule includes two alternative methods as examples but does not preclude other methods that may be shown to be acceptable to the Commission.

6. The rule should address only non-inerted, small-volume, low-pressure containments and should not impose requirements on the remaining containments since it would provide, at best, insignificant improvements in safety.

   Resolution: The staff agrees for the reasons indicated above and has, accordingly, revised the rule to apply only to Mark III BWRs and ice condenser PWRs.

7. The rule ignores those post-TMI suggested improvements which have been implemented and which reduce the likelihood of a degraded core accident.

   Resolution: The staff does not agree that the post-TMI improvements have been ignored. However, with respect to PWRs with large dry containments, the staff feels that the post-TMI improvements, along with the inherent strength of the containments, have indeed provided sufficient safety to permit the delay of any additional rulemaking until completion of ongoing research programs.

8. In view of the small probability of occurrence of local detonations as a result of various design features, the rule should permit licensees the option of demonstrating that local detonations cannot occur in lieu of evaluating the effects of local detonations.

   Resolution: The staff agrees with this comment and has modified the rule appropriately.

9. The requirement that systems and components be provided for safe cold shutdown is unnecessary and is inconsistent with the licensing basis for most operating plants which requires only safe shutdown. It should not be an issue with regard to hydrogen control but should be considered in another forum.

   Resolution: The staff agrees with this comment and has modified the rule appropriately. Because of the fact that a degraded core accident is less likely than a design basis accident, the staff believes that the requirement for cold shutdown may be overly conservative. The licensing basis for most plants is, in fact, safe shutdown. The issue of safe shutdown versus safe cold shutdown is expected to be addressed within the context of the resolution of Unresolved Safety Issue (USI) A-45, "Shutdown Decay Heat Removal Requirements," which is scheduled for completion by October 1984.

10. The implementation schedules should be made more realistic so that design changes logically follow after the required analyses are completed.

Resolution: The staff agrees. The greatest relief, of course, has come by deferring implementation of the rule for PWRs with large dry containments. However, the rule has also been revised to specify that each applicant or licensee subject to the rule shall propose a schedule, to the Commission, for meeting the requirements. A final schedule for implementing the requirements shall be mutually agreed upon by the licensee and the NRC staff. It is anticipated that most applicants and licensees will be able to implement the requirements within two (2) years.

11. In the Supplementary Information accompanying the rule, it was stated that the selection of the hydrogen control system should be supported by comparative analyses of alternative systems to show their relative advantages and disadvantages. This guidance is inconsistent with Commission practice and is unnecessary. The only requirement should be a demonstration that the selected system is suitable for its intended application.

Resolution: The staff agrees that this is inconsistent with Commission practice in the case of NTOLs and ORs and has modified the guidance accordingly. The rule has also been modified to delete the implication that comparative analyses are required and to indicate that the analysis is intended to support the design of the hydrogen control system selected.

12. The two-step approach to equipment survivability, described in the Supplementary Information section of the notice of proposed rulemaking, is unwarranted and will unnecessarily escalate the costs to industry.

Resolution: The staff agrees with this comment, particularly in view of the smaller likelihood of a degraded core accident as compared to a design basis accident; this has been reduced further by post-TMI improvements. The Commission requested comments on the two-step approach when the proposed rule was issued. The consensus of the comments received was overwhelmingly against the two-step approach. Many commenters felt that a straightforward survivability approach would be appropriate provided reasonable criteria are specified. The staff now believes, in view of the

recent issuance of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety," that there is no significant difference between demonstrating survivability and demonstrating qualification. Paragraph (f) of §§ 50.49 describes several methods, one of which must be used, for qualifying electrical equipment important to safety. For example, for those licensees which have already demonstrated survivability, as described in the Supplementary Information of the proposed rule, the same type of qualification methods given in paragraphs (f)(2) and (f)(4) of §§ 50.49 could be used to show that the systems and components have been qualified. In this regard, the margins considered adequate for a degraded core accident are less than those considered adequate for a design basis accident due to the lower probability of occurrence of a degraded core accident. The staff now views "qualification" as the generation and maintenance of evidence using tests and analyses to assure that systems and components will operate on demand to meet system performance requirements. In the case of a hydrogen burn environment, this means that there must be adequate evidence that systems and components necessary to establish and maintain safe shutdown and to maintain containment integrity are capable of performing their functions during and after exposure to the environmental conditions created by the postulated accident including the burning of hydrogen. Qualification may be demonstrated in a manner acceptable to the staff using a combined approach of analysis and testing. Thus, an acceptable thermal analysis would have to be performed for the containment in order to determine the thermal response of the components during a hydrogen burn. This thermal response would then be compared to the thermal response the components had during their qualification testing. The licensee would then demonstrate that the qualification thermal response envelops the thermal response during a hydrogen burn. Selected tests would also be performed at predicted hydrogen burn conditions (or, other tests previously performed may be referenced if demonstrated to be applicable) to convince the staff that the systems and components are qualified to perform their functions during and following a hydrogen burn.

It should be noted, in regard to this matter, that the ACRS has recently recommended that the NRC staff consider the need for equipment to be qualified to survive a large hydrogen burn in large, dry PWR containments. In response, the staff has indicated that current equipment qualification requirements for the MSB/LOCA accident environments provide

high assurance of survivability in the event of hydrogen burning. Furthermore, NRC and industry sponsored research programs are currently in progress and completion is expected by the end of FY 1984. As a result, the staff has recommended that further consideration of survivability requirements for large, dry PWR containments be deferred pending completion of the research programs. Both the ACRS letter and our response are included in Enclosure I.

Along with the proposed rule, the Commission included a description of three different approaches concerning the supplementary guidance to be provided for performing the required analyses for the design of the hydrogen control system. These were (a) analyses of different accident scenarios, (b) analyses of a single accident scenario with variation of key parameters, and (c) analyses using an "envelope of time histories of hydrogen and steam release rates" to be supplied by the Commission. The Commission requested comments concerning which of the approaches was preferred as well as suggestions regarding improvements or other alternatives.

There was no preponderance of comments leaning toward a particular approach; however, the first two approaches appeared to have greater support. Furthermore, many commenters felt that there should be flexibility in the approach to be used and in the selection of the accident scenarios. It was also suggested that the accident scenarios should be considered in order of importance using PRA techniques.

Based on the comments received and in consideration of the improved calculational data base now available, the staff is recommending that the Commission adopt the second approach and that licensees and applicants need not use the first or third approaches. It should be left to each licensee or applicant to identify to the staff which base sequence it wishes to use and to arrive at a mutually agreeable method with the staff for performing the analyses.

Since the Commission has already considered the PWR ice condenser plants during its deliberations on the McGuire and Sequoyah cases acceptable accident scenarios are established. However, for BWR Mark III plants this is not the case. The NRC staff has been meeting with the owners of the Grand Gulf plant, the lead BWR Mark III, and the Hydrogen Control Owners Group (HCOG) to discuss the

specification of acceptable accident scenarios. This has included a review of new experimental and analytical results, as well as a discussion of the appropriate hydrogen production rates to be used in the analysis of a degraded core accident. The Commission will be informed of the review status of this aspect of the Grand Gulf docket at the rule briefing.

The above and all other suggestions from the commenters were reviewed and considered by the staff in preparing the final rule. The final rule, included in the Federal Register notice (Enclosure "F") incorporates changes that reflect the above discussed resolutions and the other comments that were received. The regulation has been printed in comparative text for ease in identifying the changes. A Regulatory Analysis of the final rule is provided by Enclosure "G".

The major changes in the rule from those originally proposed are as follows:

1. The rule has been restricted to Mark III BWRs and ice condenser PWRs with rulemaking for LWRs with large dry containments deferred to the time of the severe accident rulemaking decision.

2. The rule has been revised to require a schedule that has been mutually agreed upon by the licensee and the NRC staff.

3. The method for demonstration of containment structural integrity has been revised to broaden the options available. It is indicated that an analytical technique that has been accepted by the NRC staff is required rather than limiting consideration only to the ASME Boiler and Pressure Vessel Code. The code is included as an example of one of the acceptable methods.

4. The requirement for systems and components that must be able to function following a hydrogen burn has been revised to include "safe shutdown" rather than "safe cold shutdown."

5. The requirement to include the effect of local detonations has been modified so that they would not have to be included if it is shown that local detonations are unlikely to occur.

6. The rule has been modified to eliminate the need for comparative analysis of alternative hydrogen control

systems. The rule now indicates that the analyses only have to support the design of the selected hydrogen control system.

At present, the distributed igniter systems have been selected to meet the hydrogen control requirements. One of the questions associated with these systems has been that of manual versus automatic actuation of the igniters. Enclosure "J" presents a discussion of the advantages and disadvantages of automatic versus manual actuation of the igniters and reaffirms the staff's previous conclusion that manual actuation is acceptable. Based on this discussion, the staff sees no need to further address this issue in this rulemaking.

Recommendations: That the Commission:

1. Approve the publication of final amendments, as set forth in Enclosure "F", which would require for Mark III BWRs and ice condenser PWRs, hydrogen control systems, assurance of containment structural integrity and systems and components that can perform their functions during and following a hydrogen burn, and supporting analyses.

2. Note:

   a. That these amendments are applicable to Mark III BWRs and ice condenser PWRs whose CPs were issued prior to March 28, 1979. Other related amendments pertaining to applicants with pending CP and manufacturing license applications were published on January 15, 1982 and are also described in NUREG-0718, Rev. 1, dated July 14, 1981. Requirements for future generations of LWRs are under development.

   b. That the notice of final rulemaking in Enclosure "F" will be published in the Federal Register to be effective 30 days after publication.

   c. That pursuant to § 51.5(d) of Part 51 of the Commission's regulations, neither an environmental impact statement nor a negative declaration need be prepared in connection with the amendment since the amendment is nonsubstantive and insignificant from the standpoint of environmental impact.

   d. The reporting requirements in connection with the analyses required by the rule (Enclosure "F") impose information collection requirements that are subject to the Paperwork Reduction Act. The requirements were approved by OMB.

e. That pursuant to the Regulatory Flexibility Act of 1980 the rule contains a statement that the Commission certifies that the rule will not, if promulgated, have a significant economic impact upon a substantial number of small entities and a copy of this certification will be forwarded to the Chief Counsel for Advocacy, SBA by the Division of Rules and Records, ADM.

f. That the Subcommittee on Nuclear Regulation of the Senate Committee on Environment and Public Works, the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs, the Subcommittee on Energy Conservation and Power of the House Committee on Energy and Commerce, and the Subcommittee on Environment, Energy and Natural Resources of the House Committee on Government Operations will be informed.

g. That a Regulatory Analysis is attached as Enclosure "G".

h. That a public announcement will be issued (Enclosure "H").

i. That copies of the Notice of Final Rulemaking will be distributed by TIDC, ADM to each affected licensee and other interested parties.

j. That the staff recommends the paper be placed in the PDR.

k. That the paper has been reviewed with the ACRS Class 9 Subcommittee on April 26, 1983, and they did not indicate that they had any problems with the rule.

Scheduling: Recommend affirmation at an open meeting. No specific circumstance is known to the staff which would require Commission action by any particular date in the near term.

William J. Dircks
Executive Director for Operations

Enclosures:
"A" - Memorandum Chilk to Dircks, dtd 11/6/81
"B" - Memorandum Chilk to Dircks, dtd 11/27/81
"C" - Notice of Proposed Rulemaking
"D" - Notice of Extension of Comment Period
"E" - Summary of Public Comments on Proposed Amendments
"F" - Notice of Final Rulemaking
"G" - Regulatory Analysis
"H" - Draft Public Announcement
"I" - ACRS Letter Ebersole to Dircks, dtd 4/29/83, and Memorandum Dircks to Ebersole, dtd 6/7/83
"J" - Manual vs. Automatic Actuation of Hydrogen Igniter Systems

Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Friday, September 9, 1983.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Friday, September 2, 1983, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time for analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

This paper is tentatively scheduled for consideration at an Open Meeting during the Week of September 5, 1983. Please refer to the appropriate Weekly Commission Schedule, when published, for a specific date and time.

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ENCLOSURE "A"

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE SECRETARY

November 6, 1981

MEMORANDUM FOR: William J. Dircks, Executive Director for Operations
Leonard Bickwit, Jr., General Counsel
Forrest Remick, Director, Policy Evaluation

FROM: Samuel J. Chilk, Secretary

SUBJECT: STAFF REQUIREMENTS - AFFIRMATION SESSION 81-41, 3:00 P.M., THURSDAY, NOVEMBER 5, 1981, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN TO PUBLIC ATTENDANCE)

I. Draft Order for Oral Presentation in the Waste Confidence Proceeding

The Commission unanimously approved an order specifying procedures for oral presentations to the Commission in the waste confidence proceeding. A majority of the Commission (Commissioners Gilinsky and Bradford disapproving) voted to delete Item 3 on page 13 of the order, which invited comment on the generic subject of accident waste disposal and specifically on the nuclear waste resulting from the TMI-2 accident. (OPE)

(Subsequently, the Order was signed by the Secretary.)

II. NFS Request for a Stay of a Hearing on License Amendment to West Valley License

The Commission, by a vote of 3-1 (Commissioner Ahearne dissenting and Commissioner Roberts abstaining), approved an order which denies NFS's motion for a stay of the license amendment and instructs the ASLBP to initiate a proceeding on the request for a hearing. Commissioner Ahearne's separate views will be included in the order. (OGC)

(Subsequently, the Order was signed by the Secretary.)

III. SECY-81-245A -- Interim Amendments to 10 CFR Part 50 Related to Hydrogen Control

The Commission unanimously approved for publication in the Federal Register a final rule to require inerted atmospheres for BWR Mark I and II containments and hydrogen recombiner capability for LWRs that rely on purge/repressurization systems as the primary means of hydrogen control. (RES) (SECY Suspense: 11/20/81)

Enclosure "A"

The Commission requested that:

1. the appropriate Congressional committees be informed; (RES) (SECY Suspense: 11/20/81)

2. a public announcement be issued; (OPA/RES) (SECY Suspense: 11/20/81)

3. notices of the final rule be distributed to affected licensees and other interested parties. (ADMIN/RES) (SECY Suspense: 11/20/81)

A proposed rule on hydrogen control in Mark III and ice condenser containments will be acted upon at a later date.

cc: Chairman Palladino
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commissioner Roberts
OPA
Public Document Room

Enclosure "A"

ENCLOSURE "B"

REFER TO: MC111124A

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE SECRETARY

November 27, 1981

ACTION - Minogue
Cys: Dircks
Cornell
Rehm
Stello
Fleishman
Jamgochian
Denton
Michelson
DeYoung
Shapar
Felton
Philips
Woolley
Kerr, SP

MEMORANDUM FOR: William J. Dircks, Executive Director for Operations
Leonard Bickwit, Jr., General Counsel

FROM: Samuel J. Chilk, Secretary

SUBJECT: STAFF REQUIREMENTS - AFFIRMATION SESSION 81-43, 10:05 A.M., TUESDAY, NOVEMBER 24, 1981, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN TO PUBLIC ATTENDANCE)

I. SECY-81-245A - Interim Requirements Related to Hydrogen Control (Proposed Rule)

The Commission unanimously approved for publication in the Federal Register the attached proposed rule to require improved hydrogen control systems for BWRs with Mark III containments and PWRs with ice condenser type containments. Also included are requirements related to the functioning of safety systems during and following a hydrogen burn.

The Commission, by a vote of 4 to 1 (Commissioner Bradford disapproving), voted not to include additional modifications proposed by Commissioner Bradford. The Commission requested that:

1. The reporting requirements in connection with the analyses required by the proposed rule be submitted for OMB review and approval under the Paperwork Reduction Act;

2. the appropriate Congressional committee be informed;

3. a public announcement be issued; and
(RES) (SECY Suspense: 12/14/81)

4. copies of the Notice of Proposed Rulemaking be distributed to affected licensees and other interested parties.
(RES/ADM) (SECY Suspense: 12/14/81)

II. SECY-81-598 - Proposed Amendments (A) to 10 CFR 50.54, Implementing the Immediate Notification Requirements Mandated in Section 201 of NRC's FY 1980 Authorization Act, and (B) to 10 CFR 50.72, Revising the Immediate Reporting of Significant Events at Operating Nuclear Power Reactors

The Commission unanimously approved for publication in the *Federal Register* proposed amendments to its regulations concerning immediate notification

Rec'd Off. EDO
Date 12/1/81
Time 8:30

Enclosure "B"

to the NRC of significant events that occur at operating nuclear power plants. The Commission requested that:

1. The appropriate Congressional committees be informed;

2. a copy of the FRN be sent to all applicants, licensees and State Governments; and

3. the information collection requirements of this proposed rule be submitted to the OMB for review under the Paperwork Reduction Act. (RES) (SECY Suspense: 12/14/81)

III. SECY-81-619 - Request for Hearing on Big Rock Point

The Commission unanimously approved issuance of an Order denying the request for a hearing. By a vote of 3 to 2 (Commissioners Gilinsky and Bradford disapproving), a majority of the Commissioners denied staff review of a separate safety concern regarding the location of the spent fuel pool and reactor vessel within the same containment. (OGC)

(Subsequently, the Order was signed by the Secretary.)

IV. SECY-81-620 - Request for Hearing on Turkey Point

The Commission unanimously approved an Order denying a request for a hearing for which opportunity had been offered in a confirmatory Order of the Director, Division of Licensing, NRR, imposing certain requirements related to the TMI Action Plan on Florida Power & Light Company's Turkey Point plant. (OGC)

(Subsequently, the Order was signed by the Secretary.)

V. SECY-81-632 - Amendments to Part 2 (Express Mail; Oral Responses to Motions to Compel)

The Commission unanimously approved for publication in the Federal Register final amendments to Part 2 that permit licensing boards to require that answers to motions to compel responses to discovery be provided orally. (OGC)

(Subsequently, the Order was signed by the Secretary.)

cc: Chairman Palladino
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commissioner Roberts
Commission Staff Offices
Public Document Room

Enclosure "B"

ENCLOSURE "C"

7 CFR Part 1135

[Docket No. AO-380-A1]

Milk in the Southwestern Idaho-Eastern Oregon Marketing Area; Decision on Proposed Amendments to Marketing Agreement and Order

Correction

In FR Doc. 81-36068, appearing at page 61480 in the issue of Thursday, December 17, 1981, the citation in parentheses in lines 12 and 13 of the second paragraph of column two on page 61480 should have read, "(46 FR 32873)".

BILLING CODE 1505-05-M

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

Interim Requirements Related to Hydrogen Control

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission is considering amending its regulations to improve hydrogen control capability during and following an accident in light-water reactor facilities.

The amendments would require improved hydrogen control systems for boiling water reactors with Mark III type containments and for pressurized water reactors with ice condenser type containments. All light-water nuclear power reactors not relying upon an inerted atmosphere for hydrogen control would be required to show that certain important safety systems must be able to function during and following hydrogen burning.

DATES: Comment period expires February 22, 1982. Comments received after that date will be considered if it is practical to do so, but assurance of consideration cannot be given except as to comments received on or before that date.

FOR FURTHER INFORMATION CONTACT: Morton R. Fleishman, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, telephone 301-443-5981.

ADDRESS: Written comments or suggestions for considertion in connection with the proposed amendments should be submitted to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Copies of comments received may be examined in the Commission's Public Document Room at 1717 H Street NW., Washington, D.C.

SUPPLEMENTARY INFORMATION: The accident at Three Mile Island, Unit 2 (TMI-2) resulted in a severely damaged or degraded reactor core, a concomitant release of radioactive material to the primary coolant system, and a fuel cladding-water reaction which resulted in the generation of a large amount of hydrogen. The Nuclear Regulatory Commission has taken numerous actions to correct the design and operational limitations revealed by the accident. Included in these actions are several rulemaking proceedings intended to improve the hydrogen control capability of light-water nuclear power reactors. On October 2, 1980, the Nuclear Regulatory Commission published in the Federal Register (45 FR 65466) a notice of proposed rulemaking on "Interim Requirements Related to Hydrogen Control And Certain Degraded Core Considerations" (Interim Rule). The notice concerned proposed amendments to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," to improve hydrogen management in light-water reactor facilities and to provide specific design and other requirements to mitigate the consequences of accidents resulting in a degraded reactor core.

On March 23, 1981, the Commission published in the Federal Register (46 FR 18045) a notice of proposed rulemaking on "Licensing Requirements for Pending Construction Permit and Manufacturing License Applications." The notice proposed a set of licensing requirements applicable to construction permit applications that stemmed from lessons learned from the TMI-2 accident. On May 13, 1981, the Commission published in the Federal Register (46 FR 26491) a notice of proposed rulemaking on "Licensing Requirements for Pending Operating License Applications" (OL Rule).

As a result of the various activities and considerations relative to the October 2, 1980 notice, the Commission decided to split the Interim Rule into two parts. One part was to be included in the OL Rule. The other part, limited only to hydrogen control, was to be issued separately. The details of this split are described in the companion Federal Register notice published on December 2, 1981 (46 FR 58484) concerning hydrogen control related to inerting, hydrogen recombiner capability and high point vents.

The Commission has also been considering the ability of all light-water reactors, particularly pressurized light-water reactor facilities with ice condenser type containments and boiling light-water reactor facilities with Mark III type containment, to withstand an accident with the concomitant generation of large amounts of hydrogen, such as the type which occurred at Three Mile Island, Unit 2 (TMI-2). As a result, three new amendments to the regulations are being proposed for public comment.

Hydrogen Control for Mark III BWRs and Ice Condenser PWRs [§ 50.44(c)(3)(iv)]

It is proposed that boiling water reactor (BWR) facilities with Mark III type containments and pressurized water reactor (PWR) facilities with ice condenser type containments, for which construction permits were issued prior to March 28, 1979, be required to install hydrogen control systems capable of accommodating an amount of hydrogen equivalent to that generated from the reaction of 75% of the fuel cladding (surrounding the active fuel region) with water, without loss of containment integrity. This new requirement is being contemplated as a result of safety issues raised during licensing reviews of new ice condenser and Mark III plants. In these reviews, it has become clear that additional protection is required to provide assurance that large amounts of hydrogen can be safety accommodated by these plants. The particular type of hydrogen control system to be selected is left to the discretion of the applicant or licensee; however, it must be found acceptable by the NRC based upon suitable programs of experiment and analysis. The selection should be supported by comparative analyses of alternative systems to show their relative advantages and disadvantages. These comparisons are to be submitted as part of the analyses required under § 50.44(c)(3)(vi). At present, a distributed igniter system has been found acceptable for the Sequoyah plant with an ice condenser containment, but only as an interim solution while the hydrogen control matter is studied further. A post-accident inerting system has also been discussed for the ice condenser and Mark III containments. Whatever systems are finally proposed and approved for the long term, large amounts of hydrogen must be safely accommodated, and operation of the system, either intentionally or inadvertently, must not further aggravate the course of an accident or endanger the plant during normal operations. The amount of hydrogen to be assumed in the design of the

Enclosure "C"

hydrogen control system is that amount generated by assuming that 75% of the fuel cladding surrounding the active fuel region reacts with water. The 75% is judged to be representative of the maximum amount of hydrogen likely to be generated in an accident in which the threat to the containment is limited to the threat posed by the combustion of hydrogen. Events with metal-water reactions in excess of 75% are judged to be associated with core-melt accidents which could pose a threat to containment greater than the combustion of hydrogen. This 75% value also appears to be reasonable because it is sufficiently greater than the fuel cladding-water reaction analyzed to have occurred at TMI-2 to provide a conservative estimate for the cladding reaction that may occur during a TMI type degraded core accident. It is expected that the 75% value will permit plants that are either completed or are well along in the construction stage to have a hydrogen control system added without the need for major modifications to their containment structures. Research now in place will, over the next several years, yield data on the likelihood of termination of sequences with large amounts of cladding interaction.

The Commission would particularly welcome comments on whether the percent of fuel cladding that reacts with water should be less than, equal to, or greater than the 75 percent value being proposed for use in the rules covered by this notice. Supporting analyses, as available, would also be welcome.

Owners of Mark III BWR's now under construction have been surveyed by the NRC staff to determine the effect on their plant designs of the requirement that they do not exceed ASME Service Level A Limits or the Service Load Category during inadvertent full inerting of a post-accident inerting system. This survey was conducted because a post-accident inerting system (rather than a distributed ignition system) was thought to be the preferred approach for the Mark III containments. Based on their responses, the Commission has concluded that there would be no significant impact in specifying these requirements for inadvertent full inerting. Modest deviations from these ASME criteria will be permitted if good cause is shown. A comparable survey was not conducted for ice condenser plants because the distributed ignition system apparently is the approach preferred by the owners of these plants.

There are ongoing programs of reasearch in a number of areas of hydrogen generation, release, burning, and control. These include the analysis of accident sequences, the chronology of hydrogen and steam injection (from the primary system into containment), the analysis of operations to recover coolability, and an assessment of equipment survivability. These studies are expected to reveal the advantages and disadvantages of various hydrogen control systems, including those that involve deliberate burning of the hydrogen within containment. Based on the state of technology as of August 1981, the Commission believes that control methods that do not involve burning provide protection for a wider spectrum of accidents than do those that involve burning.

As a result of the review of the deliberate ignition systems installed at Sequoyah and McGuire, the staff has identified issues which need to be investigated further. A spectrum of degraded core accident scenarios, including those which may lead to inadvertent suppression of combustion in the lower compartment due to a steam rich atmosphere, and several hydrogen combustion phenomena are continuing to be reviewed. In addition, there is incomplete verification of analytical models and equipment survivability. These issues are being addressed in ongoing research by NRC and the nuclear industry. The Commission concludes, based on available information, that the issues are sufficiently resolved to warrant interim approval of deliberate ignition systems for ice condenser plants. However, the Commission has required in individual licensing proceedings and in the section of this rule on analyses (§ 50.44(c)(3)(vi)) that studies of alternative hydrogen management systems be performed prior to the long-term approval of any particular method.

Standards for Safety Systems and Components That Must Function During or After Hydrogen Burn [Sec. 50.44(c)(3)(v)]

The Commission is considering a two-step approach to address qualification of essential equipment during and after a hydrogen burn. As a first step, essential equipment must be demonstrated to "survive" the hydrogen burn and continue to be able to perform its safety function. In this context, the equipment would not have to meet the more rigorous standards of the NRC's equipment qualification program but a different standard as defined below. As a second step, the Commission would require "qualification" of essential equipment.

The Commission feels a two-step approach is justified in light of our lack of knowledge of the probabilities of hydrogen-producing accident scenarios, the environmental conditions during a hydrogen burn, and the effect this environment has on different equipment. The Commission will develop "survivability" criteria which are intended as an interim step to assure the quality of essential equipment until enough information is accumulated from ongoing research to suitably define what equipment performance standards are appropriate. After sufficient information is developed, the Commission may propose long-term standards that are more stringent than the short-term or "survivability" standard being proposed.

The differences in concept between equipment demonstrated to meet the "survivability" standard and equipment that meets the "qualification" standard are described below. The Commission specifically seeks comment on the use of the two step approach for defining equipment standards, the "survivability" and "qualification" standards themselves, and proposals for implementation schedules developed on a well informed basis. Equipment required to be qualified (Eq) and equipment for which survivability must be demonstrated (Es) can be compared as follows:

(a) *Environmental Conditions*—The environmental conditions under which Eq must operate would be calculated using a model that has been demonstrated to be conservative by comparison with numerous experiments and by a long history of usage. For Es, the calculational model contains some conservatisms, but the level of assurance is generally not comparable to that for the Eq model due to a lack of available experimental data for verification.

b. *Testing Conditions*—For Eq, the test conditions would be more severe than the environmental conditions due to extra margins added to account for uncertainties in the test environment, inaccuracies of the measuring devices, variability of the test specimens, etc. For Es, the test conditions need not provide margin beyond the conservatively calculated environmental conditions.

c. *Operability*—Eq and Es would both be required to perform their functions during and after being exposed to their respective test conditions.

d. *Performance*—During and following a test, Eq would be required to perform to specifications determined by accident analyses performed prior to the test; however, for Es, a relaxation of these specifications would be permitted, as defined on a case-by-case (e.g., more instrument drift would be tolerated

Enclosure "C"

during a hydrogen burn than during normal operations).

Another possible difference is the criteria used to select test specimens, e.g., individual type testing for Eq versus generic testing for Es. It should also be noted that if the test condition for Eq for a LOCA can be shown to envelope the predicted test condition for a hydrogen burn then the LOCA qualification test would be sufficient to demonstrate survivability.

This requirement would apply to all BWRs and PWRs, for which construction permits were issued prior to March 28, 1979, that do not have an inerted containment atmosphere for hydrogen control. That is, plants for which there exists the possibility that substantial amounts of hydrogen can be burned in the containment will be covered by the proposed new requirement. Safety systems provided on these plants that are needed (a) to shut down the reactor and bring it to and maintain it in a safe cold shutdown condition, and (b) to prevent loss of containment integrity, must meet the "survivability" criteria in the near term and may be required to meet "qualification" criteria in the long term. Thus, for example, if a distributed igniter system is selected for controlling large amounts of hydrogen, the applicants or licensees must assure in the near term that the specified safety systems can survive and continue to perform their needed safety functions during and following hydrogen burning. In the long term the equipment may be required to meet a more stringent equipment qualification standard, considering the environmental effects of hydrogen burning. If no new hydrogen control system is required, as is likely to be the case for PWRs with large dry containments, these applicants and licensees would still have to perform analyses to: (1) Show containment structural integrity, as defined in § 50.44(c)(3)(iv) can be maintained; and (2) assure that the specified safety systems can continue to perform their needed safety functions during and following hydrogen burning and local detonations. The new criteria for certain identified essential systems are needed because the environmental pressures and temperatures associated with hydrogen burning and local detonations can be more severe than the conditions for which the equipment has been previously qualified.

Analyses [§ 50.44(c)(3)(vi)]

The proposed Interim Rule required that for all PWR and BWR plants, except the Mark I and II BWRs, design analyses must be performed for new hydrogen control measures. Many commenters indicated that the description of the design analyses was not precise enough to elicit the desired response. Furthermore, several commenters have suggested that it is inappropriate to have a regulation requiring hydrogen control design studies in view of the fact that unambiguous event descriptions and acceptance criteria are not supplied. The Commission agrees with these comments in part. As a result, the Commission intends to provide supplementary guidance concerning acceptable procedures that should be used, both for design of the hydrogen control systems per § 50.44(c)(3)(iv), for the demonstration of equipment survivability per § 50.44(c)(3)(v), and for the analysis of containment structural integrity.

The Commission is considering three different approaches concerning the supplementary guidance to be provided for performing the analyses. In all of these approaches, licensees are not restricted to the specified scenarios. If because of unique plant design features, other scenarios are known to present a greater risk than those identified by the Commission, the analyses should be based on the scenarios known to present the greatest risk. For example, if for a particular plant an intermediate break LOCA results in a greater risk than the scenarios in Table I, the licensee should base his calculations on the intermediate break LOCA scenario.

In the first approach, the Commission would identify accident sequences or scenarios which are found by probabilistic risk assessment techniques to be significant contributors to the likelihood of core degradation and thus pose a significant hydrogen threat. The licensee would then perform analyses, using these sequences, to determine the time variation of the hydrogen and steam release rates to the containment building. The analyses, which would include the failure assumptions of the different scenarios as well as the accident recovery phase and allowances for uncertainties, would provide the pressure and temperature histories to which the containment would be exposed. A list of possible accident sequences being considered under this approach is given in Table I. The scenarios include the production of substantial amounts of hydrogen as part of core-melt sequences; they were selected, based on experience and engineering judgment, because they are the more probable severe accident sequences which could be terminated short of primary vessel melt-through with available recovery techniques.

In the second approach, a base sequence would be chosen by the Commission based on its significance and characteristics from the standpoint of hydrogen threat. Key aspects of this scenario would then be parametrically varied, by the licensee, in determining the acceptability of the hydrogen control system or the containment response. This would provide a wider range than that of the selected base sequence alone. The acceptability of the analyses used in this approach would depend on the selection and range of the parameters being varied. The range must be chosen to include the effects of physically realistic degraded core accident scenarios with recovery. If licensees have determined that because of their own plant design another scenario presents a greater risk than the small break LOCA, the scenario presenting the greater risk should be chosen for parametric study. The variables and values studied should be determined on a case-by-case basis depending on the particular scenario. Table II represents a preliminary list of parameter variations that appear to provide reasonable extensions of a PWR small-break scenario (Item 1 of Table I). A corresponding BWR list has not yet been prepared.

In the third approach, the Commission would use a set of accident sequences as in Table I, and perform analyses which would define a reasonable envelope of time histories of hydrogen and steam release rates into the containment building. This envelope definition could be based on variations in the progression of different sequences and/or variations due to uncertainties within a particular sequence. The envelope of hydrogen and steam source terms to the containment would then be provided to all licensees for use in subsequent analyses. This approach would avoid the need for case-by-case sequence analyses using codes like MARCH and involving extensive iterative review of the MARCH analyses with the Commission. The intent would be for the Commission to provide hydrogen and steam source terms generic to each reactor type (BWR or PWR) and let the licensees' and NRC's ensuing attention be on the containment analysis. (The staff intends to publish for comment these generic source term analyses during the comment period for this proposed rule.)

Enclosure "C"

TABLE I.—ACCIDENT SEQUENCES LEADING TO A SIGNIFICANT HYDROGEN THREAT

PWR	1. Small LOCA with temporary loss of emergency core cooling (ECC) injection.
	2. Transient with temporary loss of all feedwater and the high pressure ECC system.
	3. Interruption of all AC electric power with failure of the auxiliary feedwater system.
BWR	4. Transient with reactor isolation and temporary failure of all coolant make-up systems.
	5. Small LOCA with temporary failure of ECC injection.
	6. Transient with failure of reactor shutdown systems and interruption of ECC systems.

TABLE II.—PARAMETRIC VARIATIONS OF A PWR SMALL-BREAK SCENARIO

Rate of H_2 release[2] (lb/min)	Timing of H_2 release	Rate of steam/enthalpy release (lb/min (millions of Btu/min))	Concurrent failures and recoveries
2	Starting at time.		
10	of Uncovering of Top.	800(1)	Fans.
30	of core	3,600(6)	Containment.
100	Prior to major steam release.	[1] 10,000(16)	Sprays.
1,000	Concurrent with major steam release.		All AC power.
	Following major steam release.		Recirculation.

[1] This high rate of steam release may occur for about 10 min. during ECC recovery.
[2] These rates should be assumed to be constant during the period of release and represent release from the primary system to the containment building.

The Commission particularly welcomes comments concerning which of the above approaches is preferred as well as suggestions regarding improvements or other alternatives.

The proposed rule has also been modified to clarify the types of analyses required. They can be grouped into four classes, depending upon containment design, as follows:

1. BWRs with Mark I and II type containments are required to be inerted by the companion rule on inerted containments appearing elsewhere in this issue. (See Table of Contents under NRC Rules and Regulations.) There are no further anslyses required of these plants.

2. Effective [one year after the effective date of the rule], or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later, analyses would be required for BWRs with Mark III type containments and PWRs with ice condenser type containments to demonstrate that the installed hydrogen control system is adequate and will perform its intended function in a manner that provides adequate safety margins. Analyses should also be performed to assess the effectiveness of alternative systems.

3. Effective [one year after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later, additional analyses, described under item 4, would be required for BWRs with Mark III type containments and PWRs with ice condenser type containments, to show that safe shutdown will be assured and containment structural integrity maintained during degraded core accidents.

4. Owners of all other containments would be required to perform and submit by [two years after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later: (i) Analyses to assure that during degraded core accidents containment structural integrity will be maintained; and (ii) equipment survivability analyses to assure continued containment integrity and safe shutdown capability. These degraded core accidents will be assumed to produce hydrogen releases to the containment resulting from the containment reaction of up to and including 75% of the fuel cladding surrounding the active fuel region with water for a range of time periods consistent with the accident scenarios analyzed.

The analyses required by this section serve two purposes. First, they support continued reliance on the interim requirements of this rule. Second, the results will be considered in a longer term rulemaking on degraded cores.

Paperwork Reduction Act

The proposed rule will be submitted to the Office of Management and Budget for clearance of the application requirements that may be appropriate under the Paperwork Reduction Act (Pub. L. 96–511). The SF–83 "Request for Clearance," Supporting Statement, and related documentation submitted to OMB will be placed in the NRC Public Document Room at 1717 H Street NW., Washington, D.C. 20555. The material will be available for inspection and copying for a fee.

Regulatory Flexibility Act

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission hereby certifies that this rule will not, if promulgated, have a significant economic impact on a substantial number of small entities. This proposed rule affects only the licensing and operation of nuclear power plants. The companies that own these plants do not fall within the scope of the definition of "small entities" set forth in the Regulatory Flexibility Act or the Small Business Size Standards set out in regulations issued by the Small Business Administration at 13 CFR Part 121. Since these companies are dominant in their service areas, this proposed rule does not fall within the purview of the Act.

Accordingly, notice is hereby given that, pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and section 553 of title 5 of the United States Code, adoption of the following amendments to 10 CFR Part 50 is contemplated.

PART 50—DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

1. The authority citation for Part 50 reads as follows:

Authority: Secs. 103, 104, 161, 182, 183, 189, 68 Stat. 936, 937, 948, 953, 954, 955, 956, as amended (42 U.S.C. 2133, 2134, 2201, 2232, 2233, 2239); secs. 201, 202, 206, 88 Stat. 1243, 1244, 1246 (42 U.S.C. 5841, 5842, 5846), unless otherwise noted. Section 50.78 also issued under sec. 122, 68 Stat. 939 (42 U.S.C. 2152). Sections 50.80–50.81 also issued under sec. 184, 68 Stat. 954, as amended: (42 U.S.C. 2234). Sections 50.100–50.102 issued under sec. 186, 68 Stat. 955; (42 U.S.C. 2236). For the purposes of sec. 223, 68 Stat. 958, as amended; (42 U.S.C. 2273), § 50.54(i) issued under sec. 161i, 68 Stat. 949; (42 U.S.C. 2201(i)). §§ 50.70, 50.71 and 50.78 issued under sec. 161o, 68 Stat. 950, as amended, (42 U.S.C. 2201(o)) and the Laws referred to in Appendices.

2. In § 50.44, paragraph (c) is amended by adding new subparagraphs (3) (iv), (v) and (vi) to read as follows:

§ 50.44 Standards for combustible gas control system in light water cooled power reactors.

* * * * *

(c) * * *

(3) * * *

(iv) Effective [one year after effective date of the rule], or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later, each boiling light-water nuclear power reactor with a Mark III type containment and each pressurized light-water nuclear power reactor with an ice condenser type containment, for which a construction permit was issued prior to March 28, 1979, shall be provided with an acceptable hydrogen control system justified by suitable programs of experiment and analysis. The hydrogen control system must be capable of handling an amount of hydrogen equivalent to that generated from the

Enclosure "C

reaction of 75% of the fuel cladding surrounding the active fuel region (excluding the cladding surrounding the plenum volume) with water, without loss of containment structural integrity (i.e., steel containments must meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsubarticle NE-3220, Service Level C Limits, except that evaluation of instability is not required, considering pressure and dead load alone. Concrete containments must meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division 2, Subsubarticle CC-3720, Factored Load Category, considering pressure and dead load alone. These subsubarticles have been approved for incorporation by reference by the Director of the Federal Register. A notice of any changes made to the material incorporated by reference will be published in the Federal Register. Copies of the ASME Boiler and Pressure Vessel Code may be purchased from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017. It is also available for inspection at the Nuclear Regulatory Commission's Public Document Room, 1717 H Street NW., Washington, D.C.) If the hydrogen control system relies on post-accident inerting, the containment structure must be capable of withstanding the increased pressure (A) during the accident, where it must not exceed Service Level C Limits or the Factored Load Category (as previously specified in this paragraph) and (B) following inadvertent full inerting that may occur during normal plant operations, where it must not exceed either Service Level A Limits (for a steel containment) or the Service Load Category (for a concrete containment). Equipment required to establish and maintain safe cold shutdown and containment integrity must be designed and qualified for the environment caused by post-accident inerting. Furthermore, inadvertent full inerting during normal plant operations must not adversely effect systems and components needed for safe operation of the plant. Modest deviations from these criteria will be considered by the Commission if good cause is shown.

(v) Each light-water nuclear power reactor, for which a construction permit was issued prior to March 28, 1979, that does not rely upon an inerted atmosphere to control hydrogen inside the containment, shall be provided with systems necessary to establish and maintain safe cold shutdown and maintain containment integrity that are capable of performing their functions during and after being exposed to the environmental conditions created by the burning (or local detonation) of hydrogen. The amount of hydrogen to be considered is equivalent to that generated from the reaction of 75% of the fuel cladding surrounding the active fuel region (excluding the cladding surrounding the plenum volume) with water. This requirement shall be effective as follows: for each boiling light-water nuclear power reactor with a Mark III type containment and each pressurized light-water nuclear power reactor with an ice condenser type containment, on [one year after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later; for every other light-water nuclear power reactor that must meet this requirement, on [two years after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later.

(vi) Analyses shall be performed and submitted to the Director of Nuclear Reactor Regulation for each light-water nuclear power reactor, for which a construction permit was issued prior to March 28, 1979, to evaluate the consequences of large amounts of hydrogen generated after the start of an accident (hydrogen resulting from the reaction of up to and including 75 percent of the fuel cladding surrounding the active fuel region with water) including consideration of hydrogen control measures as appropriate. Each analysis must include the period of recovery from the degraded condition. The accident scenarios to be used in the analyses must be acceptable to the NRC staff. The scope and implementation requirements for the analyses for the various types of light-water nuclear power reactors are as follows:

(A) For each boiling light-water nuclear power reactor with a Mark III type containment and each pressurized light-water nuclear power reactor with an ice condenser type containment, analyses shall be performed that justify the selection of the hydrogen control system required by § 50.44(c)(3)(iv). These analyses shall be completed and submitted by [one year after the effective date of the rule], or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later.

(B) For each light-water nuclear power reactor that does not rely upon an inerted atmosphere to control hydrogen inside the containment, analyses shall be performed to show that containment structural integrity as defined in § 50.44(c)(3)(iv) will be maintained, and systems and components necessary to establish and maintain safe cold shutdown and maintain containment integrity will be capable of performing their functions during and after being exposed to the environmental conditions created by the burning of hydrogen, including the effect of local detonations. These analyses shall be completed and submitted as follows: for each boiling light-water nuclear power reactor with a Mark III type containment and each pressurized light-water nuclear power reactor with an ice condenser type containment, by [one year after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later; for every other light-water nuclear power reactor for which these analyses are required, by [two years after the effective date of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later.

Dated at Washington, D.C., this 18th day of December 1981.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 81-36558 Filed 12-22-81; 8:45 am]

BILLING CODE 7590-01-M

CIVIL AERONAUTICS BOARD

14 CFR Part 250

[EDR-436; Economic Regulations Docket No. 39932]

Denied Boarding Compensation Rules; Comprehensive Review

December 9, 1981.

AGENCY: Civil Aeronautics Board.

ACTION: Notice of Proposed Rulemaking.

SUMMARY: The CAB is initiating a comprehensive review of its oversales and denied boarding compensation rules as part of its examination of consumer protection regulations prior to sunset. The Board is seeking comment on, first, eliminating all governmental oversight in this area and, second, retaining the present rules with modifications. This rulemaking is at the Board's initiative.

DATES: Comments by: February 22, 1982; Reply comments by: March 9, 1982.

Comments and other relevant information received after this date will be considered by the Board only to the extent practicable.

Requests to be put on the Service List: January 7, 1982.

Enclosure "C"

ENCLOSURE "D"

Proposed Rules

Federal Register
Vol. 47, No. 38
Thursday, February 25, 1982

This section of the FEDERAL REGISTER contains notices to the public of the proposed issuance of rules and regulations. The purpose of these notices is to give interested persons an opportunity to participate in the rule making prior to the adoption of the final rules.

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

Interim Requirements Related to Hydrogen Control; Extension of Comment Period and Editorial Corrections

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule: extension of comment period and editorial corrections.

SUMMARY: The Nuclear Regulatory Commission is extending the public comment period on its notice of proposed rulemaking, published on December 23, 1981 (46 FR 62281), for an additional 45-day period. This will provide additional time for interested members of the public to evaluate the issues raised and to develop comments on the proposed rule. The proposed rule would amend 10 CFR Part 50 to improve hydrogen control capability during and following an accident in light-water reactor facilities. The public comment period was scheduled to expire on February 22, 1982.

DATES: The new comment period expires April 8, 1982. Comments received after that date will be considered if it is practical to do so, but assurance of consideration cannot be given except as to comments received on or before that date.

ADDRESS: Written comments or suggestions for consideration in connection with the proposed amendments should be submitted to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Copies of comments received and a copy of NUREG/CR-2540, when available, may be examined in the Commission's Public Document Room at 1717 H Street NW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: Morton R. Fleishman, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, telephone (301) 443-5981.

SUPPLEMENTARY INFORMATION: This document also corrects errors that appeared in the notice of proposed rulemaking published in the Federal Register on December 23, 1981 (46 FR 62281) as follows:

1. Table II on page 62284 is corrected to read as follows:

Table II. Parametric Variations of a PWR Small-Break Scenario

Rate of H_2 Release[1] [lb/min]	Timing of H_2 Release	Rate of Steam (Enthalpy) Release [lb/min (millions of Btu/min)][2]	Concurrent Failures & Recoveries
2 10 30 100 1,000	- Starting at time of uncovering of top of core - Prior to major steam release - Concurrent with major steam release - Following major steam release	- 600(1) - 3,600(6) - 10,000(16)[3]	- Fans - Containment sprays - All AC power - Recirculation

1 These rates should be assumed to be constant during the period of release and represent release from the primary system to the containment building.

2 The conversion from mass rate to enthalpy rate is based on 1600 Btu/lb which is believed to be appropriate for steam which is superheated by excessively hot fuel.

3 This high rate of steam release may occur for about 10 min. during ECC recovery.

2. The third paragraph following the tables in the first column of page 62284 should read as follows:

1. BWRs with Mark I and II type containments are required to be inerted by the companion rule on inerted containments that appeared in the Federal Register on December 2, 1981 (46 FR 58484). There are no further analyses required of these plants.

On page 62283, it was indicated that the Commission would publish for comment hydrogen and steam generic source terms as part of the third approach it was considering for performing the hydrogen design analyses. A report on these source terms, NUREG/CR-2540 (BMI-2090), "A Method for the Analysis of Hydrogen and Steam Release to Containment During Degraded Core Cooling Accidents", is being issued and will be sent to those persons on the mailing list for the proposed rule. Comments on the report may be included with comments on the proposed rule.

Enclosure "D"

Dated at Washington, D.C., this 19th day of February 1982.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 82-5048 Filed 2-24-82; 8:45 am]

BILLING CODE 7590-01-M

FEDERAL HOME LOAN BANK BOARD

12 CFR Parts 531 and 563

[No. 82-105]

Transfer and Repurchase of Government Securities

February 18, 1982.

AGENCY: Federal Home Loan Bank Board.

ACTION: Proposed rule.

SUMMARY: The Board proposes to amend its regulations concerning retail repurchase agreements to confirm and expand significant consumer protections, including the prohibition against the sale of retail repurchase agreements by insured institutions which do not meet the Board's net-worth requirement, the requirements that retail repurchase agreement purchasers be given a perfected security interest in the security or securities underlying retail repurchase agreements, that the securities underlying retail repurchase agreements be marked-to-market on a monthly basis, and that prospective retail repurchase agreement purchasers be provided with offering documents which contain full and accurate disclosure of all material information regarding the retail repurchase agreement and the issuing institution. In addition, the Board proposes to delete the current regulatory prohibition against the automatic renewal of retail repurchase agreements.

DATE: Comments must be received by: March 29, 1982.

ADDRESS: Please send comments to Information Services, Office of General Counsel, Federal Home Loan Bank Board, 1700 G Street, NW., Washington, D.C., 20552. Comments will be available for public inspection at this address.

FOR FURTHER INFORMATION CONTACT: Donna K. Ralston (202-377-6417) Office of General Counsel, Federal Home Loan Bank Board, 1700 G Street, NW., Washington, D.C. 20552.

SUPPLEMENTARY INFORMATION:

Background

On August 2, 1979, the Board amended the Federal Home Loan Bank System Regulations to provide in § 531.12 (12 CFR 531.12; 44 FR 46445, August 8, 1979) that a member of a Federal Home Loan Bank may issue to the public "obligations * * * evidencing an indebtedness arising from the transfer of direct obligations of, or obligations that are fully guaranteed as to principal and interest by, the United States or any agency thereof that [the] member institution is obligated to repurchase", provided that the obligations, commonly referred to as retail repurchase agreements, are issued in denominations less than $100,000, have a maturity less than 90 days, are not subject to automatic renewal or extension, and have the following legend:

> This obligation is not a savings account or deposit and is not insured by the Federal Savings and Loan Insurance Corporation.

In order to permit member institutions to sell retail repurchase agreements at their offices, the Board on February 13, 1981, amended § 563.8(f) of the Insurance Regulations (12 CFR 563.8(f); 46 FR 13982, February 24, 1981) to exempt retail repurchase agreements from the minimum denomination rule applicable to outside borrowings.

To provide guidance to issuing member institutions, on September 9, 1981, the Board's staff issued R Memorandum No. 51a, which set forth the staff's views regarding the requirements imposed by § 531.12 and other regulations of the Board on retail repurchase agreements. The Board has found that the staff views expressed in R Memorandum No. 51a constitute a reasonable interpretation of the applicable regulations and now proposes to formally adopt several of those interpretations in regulatory form. Moreover, the Board believes that the confirmation and expansion in its regulations of certain consumer protections will ensure that insured institutions will be able to offer and sell to their customers superior consumer investments that will combine competitive market rates and significant investor security.

Because retail repurchase agreements are borrowings, the Board believes that it would be appropriate to redesignate § 531.12 as § 563.8-4 of the Board's Insurance Regulations, and to amend the regulation to expressly establish the requirements that insured institutions must meet in connection with the issuance of retail repurchase agreements. In addition, because the proposed regulations would establish significant consumer protections, the Board proposes to remove the prohibition against the automatic renewal of retail repurchase agreements. This will substantially lessen administrative costs to issuing institutions and, therefore, enable issuing institutions to offer and consumers to receive higher rates of return. Also, it will give issuing institutions greater flexibility in developing competitive retail repurchase agreement programs.

Proposed Regulation

Proposed § 563.8-4 provides the following:

1. The interest of the purchaser in the security or securities underlying a retail repurchase agreement shall constitute a perfected security interest under applicable state law.

2. The market value of the security or securities underlying a retail repurchase agreement shall be at least equal to the principal amount of the issuing institution's obligation as of the date of the original issuance of the retail repurchase agreement and as of a date certain in each succeeding month of the original or renewed term of the repurchase agreement.

3. An institution issuing retail repurchase agreements shall provide to each prospective purchaser an offering document which shall contain full and accurate disclosure of all material information regarding the retail repurchase agreement and the issuing institution. Any significant change in any of the material representations set forth in the offering document shall be reflected in a revised offering document which shall be provided to retail repurchase agreement purchasers before any renewal of a retail repurchase agreement may be effected.

4. An institution which does not meet the net worth required under § 563.13(b) of institutions that have reached the twentieth anniversary of insurance of accounts shall be prohibited from issuing retail repurchase agreements. An institution that fails to meet the net-worth requirement at a time when it has retail repurchase agreements outstanding shall be prohibited from renewing its outstanding retail repurchase agreements.

5. An institution issuing retail repurchase agreements shall not use in its advertisements or offering documents the terms "guaranteed", "no risk", "account" "deposit", "withdrawal" or any other terms that imply that the retail repurchase agreement is insured or guaranteed by the United States government or any agency of the United States government, or the term "fund", or any other terms that imply that a retail repurchase agreement constitutes an interest in an investment company. In addition, an institution issuing retail repurchase agreements shall state in its

Enclosure "D"

ENCLOSURE "E"

COMMENT LETTERS FOR HYDROGEN RULE

Letter No.	Date	Organization	Commenter	No. of Comments
1	1/25/82	Commonwealth Edison	L. O. DelGeorge	6
2	2/8/82		S. L. Hiatt	5
3	2/11/82	Westinghouse Electric	E. P. Rahe, Jr.	12
4	2/19/82	Stone & Webster	R. B. Bradbury	18
5	2/22/82	Power Authority of N.Y.	J. P. Bayne	7
6	2/16/82	Alabama Power	F. L. Clayton	4
7	2/23/82	C-E Power Systems	A. E. Scherer	6
8	2/18/82		J. D. Parkyn	5
9	2/23/82	Florida Power	D. G. Mardis	4
10	2/26/82	Bechtel Power Corporation	A. L. Cahn	10
11	3/1/82	Houston Lighting & Power	C. G. Robertson	5
12	3/25/82	Commonwealth Edison	L. O. DelGeorge	2
13	3/31/82	Industry Degraded Core Rulemaking (IDCOR) Program	C. Reed	8
14	3/31/82	Tennessee Valley Authority	L. M. Mills	10
15	4/6/82	Washington Public Power	F. D. Bouchey	7
16	4/6/82	General Electric	G. G. Sherwood	8
17	4/8/82	Northeast Utilities	W. G. Counsil	6
18	4/6/82	Wisconsin Electric	C. W. Fay	12
22		Missississpi Power & Light	J. P. McGaughy, Jr.	4
23	4/8/82	Hydrogen Control Owners Group	J. D. Richardson	16
24	4/8/82	Portland General Electric	B. D. Withers	5
25	4/8/82	Nuclear Utility Group on Equipment Qualification	N. S. Reynclds	4
26	4/9/82	Yankee Atomic Electric	D. W. Edwards	3
27	4/8/82	Gulf States Utilities	J. E. Booker	9
28	4/8/82	Duke Power	W. L. Porter	10
29	4/5/82	Texas Utilities Genera-ting Co.	R. J. Gary	2
30	4/6/82	GPU Nuclear	J. R. Thorpe	8
33	4/12/82	Louisiana Power & Light	L. V. Maurin	6
			Total	202

Enclosure "E-1"

TALLY OF COMMENT LETTERS

Twenty-eight applicable comments have been received with the sources distributed as follows:

Nuclear steam system suppliers	3
Utilities	18
Architect/engineer firms	2
Industrial associations	3
Individuals	2
	28

Note:

1. Comment 19 identical to Comment 16
2. Comment 20 applied to a different final rule (46 FR 58484)
3. Comment 21 identical to Comment 15
4. Comment 31 applied to a different final rule (46 FR 58484)
5. Comment 32 identical to Comment 17

LIST OF COMMENTS

1. Commonwealth Edison - Utility

   Comment 1: Improvements in hydrogen control for small non-inerted containments is warranted.

   Comment 2: Hydrogen survivability considerations for inerted BWRs and large, dry PWRs should be deferred to the long term degraded core rulemaking.

   Comment 3: The 75% metal-water reaction is reasonable but plants should be able to analyze accident sequences to see if a combustible mixture can be formed.

   Comment 4: The added conservatism associated with the Eq approach is not warranted for a low probability event and no need for the conservatism has been demonstrated.

   Comment 5: The survivability rule may be counterproductive to safety by causing replacement of reliable equipment with equipment of a new design with less operating history.

   Comment 6: The first approach, using recommended accident sequences for the analyses, is preferred. Flexibility in the selection of the accident sequences should be permitted.

2. Susan L. Hiatt - Individual

   Comment 1: It is unrealistic to require analyses without giving any criteria for their evaluation.

   Comment 2: The Commission appears to be soliciting suggestions from the licensees as to what the requirements should be. The licensees should not be consulted.

   Comment 3: The analysis is only intended to justify the hydrogen control system already installed; not to install the most effective one. Analyses should be required before the plant is constructed.

   Comment 4: Not requiring the analyses until the plant exceeds 5 percent of rated power removes the issue from the public hearing.

Comment 5: The combustible gas requirements should be as specific as the ECCS criteria. Until such regulations are promulgated, the existing § 50.44(c), requiring containment inerting, should be enforced.

3. Westinghouse Electric - Nuclear Steam System Supplier

Comment 1: The rule does not give credit for all the improvements made since the TMI accident.

Comment 2: The order of the rule should be changed with the analysis requirement coming first.

Comment 3: The 75 percent clad reaction is too large compared to what happened at TMI and based on analysis results for a recovered degraded core event.

Comment 4: The arbitrary assumption of a 75 percent clad reaction can lead to problems when combined with accident sequences. A more mechanistic approach should be used.

Comment 5: The first approach, by specifying sequences, is most appropriate since the hydrogen generation rules will be plant specific. Low probability sequences should not be considered.

Comment 6: Transients with failure of all containment safeguards should not be included.

Comment 7: In Table II the suggested upper limit on the hydrogen production rate during a small LOCA (1000 lb/min) is unrealistic. It would be less than 100 lb/min due to break flow being choked.

Comment 8: It is inappropriate to require consideration of local detonations in demonstrating equipment survivability since the probability of occurrence of a local detonation is extremely small.

Comment 9: The issue of equipment qualification for a hydrogen burn should be kept separate from equipment qualification for design basis events to avoid additional complexity and inconsistencies in implementation of the two.

Comment 10: A two-phased approach to equipment qualification criteria will only add to the financial impact. The survivability concept is logical and should be issued in final form.

Comment 11: The survivability criteria should apply only to systems necessary for "safe shutdown" rather than "safe cold shutdown." "Cold shutdown" would require a new design basis for many plants.

Comment 12: The proposed containment structural integrity limits when coupled with the suggested accident sequences will likely result in "calculated" containment failures. The criteria are much too restrictive and go beyond merely addressing hydrogen control for a "TMI-like accident." A realistic value of structural capability should be allowed along with the use of actual material properties (rather than minimums) and realistic analyses (i.e., no concurrent multiple failures).

4. Stone and Webster - Architect/Engineer Firm

Comment 1: The interim rule should only be temporary pending completion of the severe accident rulemaking and should only address basic concerns such as containment failure and fission product release from a postulated hydrogen burn.

Comment 2: Analysis should only be required for a realistic source. If ultimate strengths are not exceeded, no further analysis should be done. Implementation of new design changes should await the severe accident rulemaking.

Comment 3: Only a date for submitting design analyses schedules should be required. The actual date for analyses submitted should be left on a case-by-case basis.

Comment 4: The criteria for whether or not a hydrogen control system should be added, should include an analytical demonstration, such as a PRA, that there would be a net safety improvement by its addition.

Comment 5: Is the 75 percent limit reasonable for BWRs? What about other potential hydrogen generating reactions such as with iron and other metals? What about credit for ECCS performance?

Comment 6: What is the basis for saying that control methods not involving burning provide protection for a wider range of accidents than those that involve burning? Why are deliberate ignition systems deemed acceptable for interim approval?

Comment 7: Equipment qualification should not be part of the hydrogen control rulemaking but should be addressed separately.

Comment 8: A two-step approach to equipment qualification is not practical since it makes no sense to replace or requalify equipment based on a "survivability" standard if it would have to be requalified to a stricter standard in the near future.

Comment 9: Why have different implementation dates for Mark IIIs and ice condensers than for PWRs?

Comment 10: The accident scenarios referenced appear to relate to LOCA scenarios which may not be the same as the worst hydrogen scenarios.

Comment 11: Will a review be required to identify scenarios having a greater risk than those specified or need they be addressed only if already identified elsewhere?

Comment 12: If because of unique plant design features the likelihood of a given accident sequence is small, it should not need to be analyzed.

Comment 13: Table II is confusing regarding its implementation.

Comment 14: The third approach is the best as it would put all plants on an equal basis and provide a better comparison of containment responses.

Comment 15: If analyses show that containment integrity will not be maintained, plant modifications should not be required without an integrated evaluation considering PRA, safety goals and severe accident rulemaking.

Comment 16: Mark I/II reactors should be allowed some other form of hydrogen control besides preinerting.

Comment 17: "Maintaining containment structural integrity" is not as important a concern as "mitigating radiological releases which could jeopardize public health and safety." The rules should be revise to reflect this comment.

Comment 18: Comparative analyses of systems should not be required, only a demonstration that the chosen system works.

5. Power Authority of the State of New York - Utility

Comment 1: The CRGR should review the rule to ensure that an integrated assessment and a cost/benefit analysis is performed to determine the need for the rule.

Comment 2: The rule would impose significant analytical and equipment installation requirements with no assurance that safety will be improved.

Comment 3: No dates should be set until the supplementary guidance is available. Furthermore, the dates for completion of analyses and equipment installation should not coincide to ensure sufficient time for mechanical work. (Suggested new wording in letter.)

Comment 4: Finite element stress analysis of the containment shell and fracture mechanics analysis of the steel liner should be allowed to verify containment integrity.

Comment 5: Required analytical tools that are approved and checked out are not currently available.

Comment 6: Credit should be given for facility modifications that prevent a degraded core accident and thus avoids hydrogen production.

Comment 7: Hydrogen control questions should be deferred to the severe accident rulemaking since improvements may be made which prevent a DCA.

6. Alabama Power Company - Utility

Comment 1: The proposed rule should only address non-inerted, small-volume, low-pressure containments and not require analyses and backfitting for other containments that would provide only marginal, at best, improvements in safety.

Comment 2: The 75 percent metal-water reaction is not supported by research information. Furthermore, a DCA is significantly less likely now than it was at the time the 5 percent metal-water reaction criterion was established.

Comment 3: The requirement for equipment qualification for systems necessary for safe cold shutdown is a significant backfit. The current licensing criterion in many cases is for hot shutdown capability not cold shutdown capability. The issue of cold vs. hot shutdown should be deferred to a separate rulemaking since it involves a significant backfit and is only marginally related to hydrogen control.

Comment 4: Environmental qualification has recently been fully addressed in response to the Commission and to reevaluate equipment inside containment for a hydrogen deflagration environment is not justified since it has not been demonstrated that safety would be improved.

7. C-E Power Systems - Nuclear Steam System Supplier

Comment 1: Equipment survivability should not be required until a safety goal has been established and a determination made of the degree to which degraded cores should be considered in safety regulation. A cost/benefit analysis should be done.

Comment 2: There does not appear to be coordination with the proposed rule on qualification of electrical equipment and there will be overlapping of requirements.

Comment 3: It is premature to select 75 percent for the metal-water reaction since it neglects the improvements made since the TMI accident as well as the results of current research studies that indicate that there is a natural phenomena which tends to limit hydrogen generation.

Comment 4: The two-step procedure for equipment qualification is not justified in view of the lack of indication that the level of safey needs to be increased.

Comment 5: Imposing extra margins for equipment qualification to account for uncertainties in a low probability event will not increase safety and may even be counter-productive to safety by precluding the use of otherwise reliable equipment.

Comment 6: When and if supplementary guidance is provided, it whould be in the form of acceptance criteria related to an overall safety goal and should allow flexibility with regard to the approach used provided that a certain level of safety is achieved.

8. John Parkyn - Individual

Comment 1: In view of the fact that the TMI accident showed that the containment did not fail and that vital equipment continued to function after the detonation, it is not justified to expand the scope of an existing environmental qualification program that is already of questionable value.

Comment 2: The environmental qualification effort should be delayed until after the extent of core damage at TMI is ascertained.

Comment 3: The environmental qualification program is not needed because the DCA is such a low frequency event.

Comment 4: . If only a LOCA can be turned into a DCA by human error, then events which break containment directly are of greater concern than hydrogen generating events.

Comment 5: The rule should not apply to plants that have stainless steel clad fuel elements since they do not have a hydrogen production problem.

9. Florida Power Corporation - Utility

Comment 1: It is inappropriate to require qualification to environmental conditions that are yet to be determined.

Comment 2: The two years requirement on equipment survivability verification should account for prior analyses as well as analyses required by § 50.44(c)(3)(vi).

Comment 3: It is reasonable to require the determination of the survivability of installed equipment. It will allow a cost/benefit analysis for equipment replacement decisions.

Comment 4: Analyses should not be required to include a certain amount of hydrogen generated but should include a determination of the amount of hydrogen generated during a worst case accident thus producing a conservative answer to the question of equipment survivability.

10. Bechtel Power Corporation - Architect/engineer Firm

Comment 1: It is not indicated that the rule only includes interim requirements. When and how will it be rescinded?

Comment 2: The 75 percent metal-water reaction is not justified and may impose overly restrictive requirements. It should be used as a default value but licensees should be permitted to use other values if justified by research, scenario definition and detailed analysis.

Comment 3: The implementation schedules may be impossible to meet in view of the fact that the survivability criteria have not yet been determined and the available testing facilities are committed to NUREG-0588 qualification testing. Realistic implementation schedules should be established on a plant by plant basis.

Comment 4: The criteria for containment integrity should not be limited to the provisions of the ASME Boiler and Pressure Vessel Code but should permit licensees to demonstrate containment integrity using mutually agreed upon methods. The ASME Code can be cited as an example of an acceptable means for the demonstration.

Comment 5: The proposed limits for concrete containments are overly restrictive and should be increased by a factor of 1.5 since the containments are designed to withstand pressure that is 1.5 times the accident pressure.

Comment 6: Comparative analyses of different hydrogen control systems should not be required since it is not required for other systems. Satisfaction of specific criteria should be sufficient.

Comment 7: The concept of a two-step approach to equipment survivability and qualification sounds reasonable but it was not described in sufficient detail. The criteria for survivability should take into account TMI and other operating experience.

Comment 8: The third approach for supplemental guidance on analyses appears preferable since it would minimize the amount of repetitive analysis and review required. It is essential that sufficient industry and PRA type input be utilized in the scenario definition.

Comment 9: With regard to local detonations, provisions should be made to allow arguments as to why detonations could not occur, or alternatively, detonation parameters should be provided.

Comment 10: While plants must be brought to a safe cold shutdown, the rule should not impose the use of safety related equipment to accomplish it particularly for plants whose licensing basis only requires achieving a safe hot shutdown.

11. Houston Lighting & Power - Utility

Comment 1: The TMI accident probably had close to the maximum metal-water reaction that could occur in an accident in which the containment threat is limited to the combustion of hydrogen. Furthermore, the upgrades required by NRC make a DCA less likely. The 75 percent metal-water reaction is thus not justified.

Comment 2: The first approach for guidance on analyses appears most appropriate but a probability threshold should be established to ensure that significant scenarios are identified for each plant.

Comment 3: The requirement for consideration of local detonations for equipment survivability should be justified since it is not clear they can occur in nuclear plants.

Comment 4: Hydrogen burn should not be used as part of equipment qualification since it represents a significant extension of the types of events encompassed by equipment qualification. The "survivability" concept is much more appropriate but should not be limited to only an interim period.

Comment 5: A realistic value of containment structural integrity should be used rather than defining it in terms of service level C and the factored load category.

12. Commonwealth Edison - Utility

Comment 1: Table II should be revised in light of the NRC sponsored analyses presented in NUREG/CR-2540. The peak hydrogen and steam release rates are too high.

Comment 2: The 75 percent metal-water reaction assumption is not realistic in light of the data presented in NUREG/CR-2540 since is would seem to imply that ECCS is restored within only a 10 minute window out of a time span of over 4 hours from onset of LOCA to failure.

13. Industry Degraded Core Rulemaking Program - Industrial Association

Comment 1: The Commission should state in a policy pronouncement that the Interim Hydrogen Rule in combination with the ongoing generic rulemaking on severe accidents precludes consideration of generic severe accident issues from individual plant dockets.

Comment 2: Implementation of the proposed rule should be delayed pending the outcome of the Severe Accident Rulemaking.

Comment 3: The proposed rule ignores the post TMI improvements that have been made and which reduce the likelihood of a DCA.

Comment 4: There is not sufficient safety urgency to warrant issuance of the proposed rule; the requirements go beyond the framework originally envisioned for an "interim rule."

Comment 5: Hydrogen generation is only one of several technical issues that need to be resolved for accidents beyond the DBA. It should be treated in the Severe Accident Rulemaking rather than a piecemeal approach.

Comment 6: Delay of the proposed rule will permit the completion of major research programs in the hydrogen area; which will reduce technical uncertainties and provide a better technical basis for the rule.

Comment 7: Delay will permit completion of development of a new accident analysis program (early 1983) which would be used to perform the required analyses.

Comment 8: The cost of the rule to industry has not been adequately considered. It is estimated that the survivability analysis would cost between $250K and $600K per unit for a total cost for 100 units of about $35M - $50M.

14. Tennessee Valley Authority - Utility

<u>Comment 1</u>: The issue of hydrogen control should be considered in the context of overall plant risk from DCA's.

<u>Comment 2</u>: The term "certain important safety systems" in the summary should be revised to read "certain systems important to safety," to be consistent with other NRC terminology.

<u>Comment 3</u>: A physically more reasonable maximum clad reaction fraction would be 30-40 percent rather than 75 percent. The parameter of greater importance, however, is the hydrogen release <u>rate</u> rather than the magnitude.

<u>Comment 4</u>: The requirement that the operation of the hydrogen control system not further aggravate an accident or endanger the plant during normal operations would seem to eliminate the post accident inerting systems.

<u>Comment 5</u>: It is not clear why the Commission believes that hydrogen control methods that do not involve burning would provide protection for a wider spectrum of accidents than those that involve burning particularly if all ramifications are considered.

<u>Comment 6</u>: Since the consideration of severe accidents goes beyond the design basis for existing plants, the only requirement for systems that must function during a hydrogen burn should be that they "survive" and continue to be able to perform. The two-step approach is unnecessary and proof of survivability is adequate for extensions beyond the design basis.

<u>Comment 7</u>: Since maintenance of core cooling is mainly dependent on active systems outside containment, a rigorous burn "qualification" program on essential equipment inside equipment would have little effect on reducing the likelihood of a DCA or recovering from such an event.

<u>Comment 8</u>: As an alternative to the consideration of local detonations, a demonstration should be permitted to show that they are unlikely.

<u>Comment 9</u>: The first analysis approach of specifying a small number of significant scenarios appears to be reasonable.

<u>Comment 10</u>: The second analysis approach may also be reasonable except that the range of parametric variation suggested in Table 2 is unrealistic. Thus, while the base scenario may be reasonable, the introduction of arbitrary additional equipment failures represents a different scenario with a much lower occurrence probability and thus having a lower risk contribution. Analysis of events beyond the design basis should be performed as realistically as possible.

15. Washington Public Power Supply System - Utility

Comment 1: The hydrogen rule should be delayed pending completion of the severe accident rulemaking since the priority technical issues related to hydrogen have already been addressed and the severe accident rulemaking will address this and other technical issues in a more comprehensive framework.

Comment 2: The rule represents premature judgment in requiring mitigation for degraded core scenarios and extends the design bases to include degraded cores without sufficient technical justification.

Comment 3: The rule should be modified so that if it is shown that a method for controlling hydrogen concentration so as to prevent a hydrogen burn is supplied, then the equipment survivability criteria does not have to be demonstrated.

Comment 4: The rule is tantamount to requiring utilities to have the capability to mitigate Class 9 accidents, an extreme shift in the design basis of current plants, without the benefit of formal rulemaking. The option for utilities to make cost effective choices between prevention and mitigation is lost and the IDCOR effort is subverted.

Comment 5: The requirement for equipment survivability represents an open-ended rachet for equipment qualification in view of the ambiguity involved. For example, the Es models have no experimental basis and hence, no criteria for judging their acceptability; for Es, the tests would have to be redone whenever new analyses were done and it is not clear that test facilities could be found to match the environments; no criterion is provided as to what constitutes acceptability in "perform its function"; since Es could be treated on a case-by-case basis everyone could be qualifying to separate performance standards.

Comment 6: The three suggested approaches still do not provide the "unambiguous event descriptions and acceptance criteria" that are needed. No acceptance criteria are proposed and the event descriptions are still arbitrary and ambiguous. A safety goal should be provided and the utilities permitted to use their perogatives to achieve it.

Comment 7: It is inappropriate to require design studies for large amounts of hydrogen until an appropriate level of release has been determined in the severe accident rulemaking.

16. General Electric - Nuclear Steam System Supplier

Comment 1: The requirement for hydrogen control systems for Mark III BWRs should be revised to permit a demonstration that additional hydrogen control systems are not necessary as a result of design capabilities that prevent hydrogen generation or limit its impact. The decision criteria should include consideration of the probability and consequences of hydrogen generation.

Comment 2: Because some nuclear plants employ a multi-building, multi-barrier design for the containment, the loss of containment structural integrity would not necessarily result in excessive radiation dose to the public. The rule should refer to loss of containment "function" rather than containment "integrity."

Comment 3: The 75% metal-water reaction is unrealistically high and is inconsistent with the desire to set a limit in which the threat to containment is limited to that of hydrogen combustion. The metal-water reaction should be defined by applicant performed analyses using realistic accident scenarios.

Comment 4: The requirement imposed on post-accident inerting systems, that in case of inadvertent full inerting the containment structural stresses not exceed Service Level A, is unnecessarily conservative. In view of the time required for full inerting and operator intervention inadvertent full inerting is a low probability event. The requirement should only be that containment function and assurance of safe plant shutdown be maintained in the event of inadvertent full inerting.

Comment 5: A statement should be added to the Supplementary Information indicating that the issues are sufficiently resolved to warrant interim approval of a deliberate ignition system for Mark III BWR plants.

Comment 6: Survivability criteria (Es) and qualification requirements (Eq) should be defined prior to implementation of the proposed amendments and issued for public comment before being made effective.

Comment 7: The scope of the required analysis should be expanded to permit analyses that demonstrate that additional hydrogen control systems are not needed.

Comment 8: An approach similar to the proposed first approach is recommended except that realistic accident scenarios should be defined using PRA techniques and they should be analyzed using best estimates.

17. Northwest Utilities - Utility

Comment 1: The proposed amendments on survivability of equipment and containment and the associated analyses should deferred until ongoing

research programs are completed so as to provide a technical basis for the amendments.

Comment 2: Hydrogen issues are only a portion of the concerns associated with degraded cores. The proposed amendments should be deferred to the severe accident rulemaking.

Comment 3: A Regulatory Impact Analysis should be prepared and issued for comment before implementation of the proposed amendments.

Comment 4: No basis is provided for changing the licensing basis of operating plants from hot shutdown to cold shutdown. The cold shutdown issue should be considered completely and independently of the hydrogen issue.

Comment 5: The implementation schedule should not require completion of the proposed survivability program prior to completion of the equipment qualification program for DBAs. It should also coincide with refueling outages and allow time for design and implementation. Finally, it should be scheduled to follow the completion of the analysis required by § 50.44 (c)(3)(vi)(B).

Comment 6: The proposed amendment makes no mention of a two-step approach for qualification of essential equipment and is ambiguous. A one-step approach would be preferable.

18. Wisconsin Electric - Utility

Comment 1: The proposed amendments are not needed because conservative analyses and experiments demonstrate that there is a low probability of significant hydrogen generation in DBAs and an even lower probability in accidents beyond the design basis. This was reduced further by safety upgrades following the TMI-2 accident.

Comment 2: Preliminary best-estimate analyses of TMI-2 show that a hydrogen burn following a 100 percent metal-water reaction will not result in a loss of containment structural integrity or in a detonation.

Comment 3: Preliminary testing for EPRI of typical safety-related electrical equipment under hydrogen burn conditions indicate that they can survive a hydrogen burn.

Comment 4: Since there is no immediate safety need for the proposed rules, a cost-benefit analyses would show that the substantial burden on licensees with large containments is not warranted. Estimates for doing the containment analyses are $1-2 million and for equipment survivability testing are $0.5 million.

Comment 5: The proposed rule should be deferred to the Severe Accident Rulemaking and its need should be demonstrated by PRA.

Comment 6: The proposed rule should be delayed until ongoing research programs on hydrogen burning and equipment survivability are sufficiently completed to provide a technical basis for the rule.

Comment 7: Since the licensing basis of most operating plants is to achieve and maintain hot safe shutdown conditions following accidents, the proposed requirement should be modified by deleting the word "cold."

Comment 8: The 75% metal-water reaction is not technically justified and a 50% value appears to be more reasonable.

Comment 9: The accident scenarios for the analyses are not sufficiently defined or justified. A mechanistic time rate of hydrogen release should not be required if the hydrogen is assumed to start at the maximum hydrogen concentration.

Comment 10: Equipment survivability analyses should not be required to include detonation considerations since studies indicate they will not occur in large dry containments.

Comment 11: The implementation schedules are unrealistic. The equipment survivability analyses should commence after the containment analyses are completed which should take 2 years at a minimum. An estimated 2 to 5 years would be needed to meet the provisions of the rule.

Comment 12: The part of the rule which states that "the accident scenarios to be used in the analyses must be acceptable to the NRC Staff" should be deleted since it gives the NRC authority to arbitrarily change the rule. General accident scenarios should be specified, based on severe accident rulemaking and PRA studies, that also allow flexibility for plant-specific designs.

22. Mississippi Power and Light - Utility

Comment 1: The substantial quantity of information provided by industry in support of the distributed ignition system has been largely ignored in development of the rule.

Comment 2: The probability of scenarios leading to significant hydrogen generation is so small that the interim requirements are not needed.

Comment 3: Interim rules should be delayed pending completion of the ongoing research program which may demonstrate that the interim rule would provide a negligible increase in plant safety.

Comment 4: The industry cannot respond to a plethora of interim requirements and also support the severe accident rulemaking.

23. Hydrogen Control Owners Group - Industrial Association

Comment 1: Issuance of the interim rules for extremely low probability events is not advisable and should be considered in the context of the severe accident rulemaking and the safety goals.

Comment 2: Action on the rule should be deferred pending completion of the ongoing major research program which will be completed in the near future.

Comment 3: The rule makes no mention of when the interim requirements will be replaced with final requirements.

Comment 4: The consideration of large scale hydrogen releases is contradicted by NRC sponsored PRA studies that showed that the risk of containment failure due to hydrogen combustion is small compared to other risk contributors.

Comment 5: The concern over large amounts of hydrogen ignores the plethora of improvements, mandated by NRC since the TMI-2 accident, that substantially reduce the probability of degraded core accidents.

Comment 6: The discussion of the rule should be revised to indicate that the acceptability of the hydrogen control system will be assessed based on generic, rather than acceptable programs of experiment and analysis, since plant specific experiments are not justified.

Comment 7: The analyses in support of the hydrogen control system should be limited to establishing the adequacy of the selected design and it should not be required to include comparative analyses of alternative systems that may be used in system selection.

Industry has already submitted evaluations of alternate concepts to the NRC and, in the IDCOR program, will be preparing additional comparative analyses. Alternate concept studies have never been previously required for rulemakings and would represent a wasteful and inefficient allocation of industry and NRC resources.

Comment 8: The text should be modified to indicate that the Mark III owners are seriously considering a distributed igniter system for Mark III containments.

Comment 9: Because of the BWR design, which operates normally with a large steam fraction in the core, serious fuel damage and large hydrogen releases are unlikely. Studies have indicated that the maximum metal-water reaction for a BWR/6 prior to core slump is less than 12.5%. A metal-water reaction of less than 75% should be permitted if justified by analysis of realistic, mechanistic accident scenarios.

Comment 10: There is no technical justification for the statement "that control methods that do not involve burning provide protection for a wider spectrum of accidents then do those that involve burning."

Comment 11: Sufficient information has been submitted for Mark III BWRs to give interim approval of deliberate ignition systems for Mark IIIs as well as for ice condensers.

Comment 12: A two-step equipment survivability and qualification program is not warranted in view of the low probability of a DCA. A conservative analysis demonstrating survivability, with no consideration of local detonations, is all that is needed.

Comment 13: None of the three suggested approachs on the guidance for the analyses are desirable. The language is too vague permitting the possible scope of the analyses to be of unmanageable magnitude. Furthermore, the scenarios suggested are grossly conservative and are not realistic enough to assess containment response or hydrogen control effectiveness. It should be left to the applicant or licensee to choose the most probable accident scenarios and hydrogen release rates rather than for the NRC to establish arbitrary and overly conservative criteria.

Comment 14: The issue of hydrogen control should be considered in the broader context of safety goals and risk reduction. If it can be shown that hydrogen combustion only causes a slight increase in risk then additional analyses and hydrogen control is not warranted.

Comment 15: The description of containment integrity should not include the detailed ASME criteria. Instead, a range of alternative means should be permitted to demonstrate compliance; with the ASME criteria used only for illustrative purposes.

Comment 16: The implementation schedule for the submission of the required analysis is unreaslitic and cannot be met. It should be modified to avoid the necessity for numerous schedule extensions.

24. Portland General Electric - Utility

Comment 1: Since the basis for most operating plants is safe shutdown, the word "cold" should be deleted from the phrase "safe cold shutdown."

Comment 2: The 75% clad reaction is unsubstantiated and does not allow credit for the post-TMI modifications that are intended to prevent a DCA. Analyses that consider preventive measures should be used to establish a realistic cladding reaction percentage.

Comment 3: The two-step approach for qualification of equipment is not clearly defined and may involve an undue financial burden due to repeated testing of equipment.

Comment 4: Either of the first two methods for proceeding with the analyses are acceptable if preventive measures are permitted to be considered.

Comment 5: The proposed rule should be clarified with regard to the sequence of performing the analyses and providing the necessary systems. The schedule should be adjusted so that the required equipment should be provided 2 years after the analyses are completed.

25. Nuclear Utility Group on Equipment Qualification - Industrial Association

Comment 1: The proposed rule is premature, is being promulgated with no supporting technical basis, and appears to lack the proper review of its need by senior management and the Commissioners.

Comment 2: No technical justification has been presented to support the position that the temperatures and pressures associated with hydrogen burning and local detonation can be more severe than the conditions for which the equipment has been previously qualified.

Comment 3: Based on analyses and experiments of technical experts and the NRC staff, developed in support of licensing hearings, the essential equipment can survive hydrogen burning.

Comment 4: Supporting justification is required since the proposed rule is (1) interim in nature, (2) is subject to ongoing research, and (3) addresses a very remote accident beyond the design basis.

26. Yankee Atomic Electric - Utility

Comment 1: The proposed rule should be delayed pending completion of the IDCOR program related to severe accidents.

Comment 2: In view of the significant risk reduction steps taken since the TMI-2 accident, there is no urgency for the proposed rule.

Comment 3: The metal-water reaction should be established based on the results and codes developed in the IDCOR program.

27. Gulf States Utilities - Utility

Comment 1: The proposed rule should be considered in light of the broader severe accident rulemaking and the need for a hydrogen control system evaluated in the context of the long-term safety goals.

Comment 2: The implementation of the TMI Action Plan requirements has substantially reduced the probability of a DCA and credit should be allowed for the modifications.

Comment 3: There should be no requirement for a comparative analysis of alternate hydrogen control systems. Criteria should be specified and as long as the system meets the criteria it should be acceptable.

Comment 4: The 75% metal-water reaction is excessive in light of recent studies that core slump would occur before 35-40%. A mechanistic approach should be permitted to establish a realistic maximum value.

Comment 5: The containment structural integrity limits are too restrictive and actual material properties should be permitted. A realistic criteria of functional capability should be used.

Comment 6: The implementation schedules are unrealistic and should be modified.

Comment 7: A distributed ignition system should be considered generally acceptable for BWR Mark IIIs as well as for ice condenser plants.

Comment 8: The two step approach to equipment qualification is not warranted. An equipment survivability requirement is appropriate but it should be permitted to be demonstrated by analysis and should be separated from qualification for DBAs. Local detonations should not have to be considered in view of the low probability for its occurrence.

Comment 9: The first approach is preferred for the analyses, however, sequences that have a lower probability then that defined by the safety goal should not have to be considered. ATWS should not be included since the ATWS rule will ensure that this is a low probability event.

28. Duke Power - Utility

Comment 1: A post accident hydrogen control rule should not be promulgated now but should only be considered after the Severe Accident Rulemaking is complete and a safety goal is established.

Comment 2: The degree of cladding oxidation should be consistent with the accident sequence analyzed and not for the most severe sequence. The 75% limit is not consistent with the existing data.

Comment 3: It is unclear whether the version of the ASME Code referenced is the Summer of 1980 Code or the Code of Record.

Comment 4: Code limitations should not be applied to beyond DBAs. A realistic limit load analysis should be allowed to assure containment structural integrity.

Comment 5: Recent EPRI tests and recent studies, reports, and analyses, strongly indicate that the proposed survivability

requirements are not needed. They cannot be justified from either a risk reduction or cost-benefit standpoint.

Comment 6: Since the design basis of most nuclear stations is safe hot shutdown under DBA conditions it is inappropriate to require safe cold shutdown.

Comment 7: Licensees should have the option of demonstrating that local detonations cannot occur in lieu of evaluating the effects of local detonations.

Comment 8: Licensees should nct have to justify the selection of a safety system. Only the adequacy of the system should be of concern.

Comment 9: The particular analysis method to be used should be left optional so that the approach can be selected by the licensee to fit his particular capabilities and specific plant design.

Comment 10: The proposed hydrogen release rate of 1000 lb/min is not supported by current data for recoverable cores and should not be specified for the final rule.

29. Texas Utilities Generating Co. - Utility

Comment 1: The requirement for equipment to achieve cold shutdown should be deleted. Cold shutdown should be addressed in the same manner as it has in the past with the added consideration of the proper hydrogen conditions.

Comment 2: There is no technical justification for requiring a demonstration of either survivability or qualification of equipment for a postulated hydrogen burn. It is anticipated that the implementation of the rule would impose a severe burden on the industry with no evidence of a significant safety problem.

30. GPU Nuclear - Utility

Comment 1: In view of the improvements that have been made since the TMI-2 accident that reduce the likelihood of a DCA, it is inappropriate to implement a requirement that addresses the hydrogen burn issue for PWR large dry containments.

Comment 2: The issue of equipment qualification for hydrogen burn conditions should be kept separate from the qualification of equipment for current DBAs.

Comment 3: The two phased approach for equipment survivability can result in an unwarranted considerable financial impact. Only one set of criteria should be implemented.

Comment 4: Since both accident sequences and hydrogen generation rates will be plant specific, the first approach is most appropriate and realistic. However, the sequences should be prioritized using PRA and only the most likely ones analyzed.

Comment 5: The 75% clad reaction rate is unrealistic based on the results of TMI-2 and analysis of recovered degraded core accidents.

Comment 6: In view of the extremely small probability of occurrence of local detonations in nuclear plants, due to uniform mixing, relatively open geometries and containment sprays, it is unreasonable to require survivability of essential equipment after being exposed to local detonations.

Comment 7: The differences in the definitions of "survivability" and "qualification standards are too vague. "Survivability" should include nc margins or conservatisms. "Survivability" criteria are all that is needed for a low prabability event as a DCA.

Comment 8: The design basis for all plants is safe shutdown. Depending on individual licensee commitments, this can be either hot or cold shutdown. Unless the word "cold" was deleted it would mandate a new design basis for many plants.

33. Louisiana Power and Light - Utility

Comment 1: Since ECCS degradation is the governing event in significant hydrogen release scenarios, it would be more appropriate for the rule to codify the extent of ECCS degradation required to be postulated rather than the percentage of fuel clad oxidation. The rule should require the control of that amount of hydrogen resulting from degradation of the ECCS for a period of time to be based on the reliability of the ECCS. Sensitivity analyses would be required to determine the accident scenario producing the worst case hydrogen generation.

Comment 2: The 75% metal-water reaction is not credible since conservative analyses indicate that the core would have to be uncovered for 16 hours. It is not reasonable to expect the core to be uncovered for such a length of time.

Comment 3: The 75% metal-water reaction should not be considered to include contributions from radiolysis and other sources since radiolysis does not provide a major hydrogen contribution until 2-3 days after the accident.

Comment 4: It is not clear what the intent is regarding the two-step equipment qualification plan. How will the environmental conditions differ between Es and Eq? How will criteria be established for deciding which equipment meets Es or Eq?

Comment 5: The 75% metal-water reaction is not consistent with an accident such as occurred at TMI-2. Such a large metal-water reaction would have consequences for exceeding that of TMI-2.

Comment 6: The first suggested approach appears the most reasonable, however, PRA techniques should be permitted for determining the magnitude of hydrogen generation as well as the release rate.

ENCLOSURE "F"

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

Hydrogen Control Requirements

AGENCY: Nuclear Regulatory Commission.

ACTION: Final Rule.

SUMMARY: The Commission is amending its regulations to improve hydrogen control capability for boiling water reactors with MARK III containments and for pressurized water reactors with ice condenser containments. The amendments require improved hydrogen control systems that can handle large amounts of hydrogen during and following an accident. For those of the above reactors not relying upon an inerted atmosphere for hydrogen control, the rule requires that certain systems and components be able to function during and following hydrogen burning. The rule also requires affected licensees to submit analyses to the Commission in support of the previous two requirements. The rule is needed to improve the capability of the indicated types of nuclear power reactors to withstand the effects of a large amount of hydrogen generation and release to containment from an accident, as occurred at Three Mile Island. The new requirements will result in greater assurance that nuclear power reactor containments and safety systems and components will continue to function properly so that the reactors can be safely shut down following a Three Mile Island-type of accident.

EFFECTIVE DATE:

FOR FURTHER INFORMATION CONTACT: Morton R. Fleishman, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone 301-443-7616.

Enclosure "F"

SUPPLEMENTARY INFORMATION:

Background

The Commission has taken numerous actions to correct the design and operational limitations that were revealed by the accident at Three Mile Island, Unit 2 (TMI-2), which resulted in a severely damaged or degraded reactor core, in a concomitant release of radioactive material to the primary coolant system, and in a fuel cladding-water reaction causing the generation of a large amount of hydrogen. Included in these actions are several rulemaking proceedings intended to improve the hydrogen control capability of light-water nuclear power reactors.

On December 23, 1981, the Commission published in the Federal Register (46 FR 62281) a notice of proposed rulemaking on "Interim Requirements Related to Hydrogen Control," inviting written comments or suggestions on the proposed rule by February 22, 1982. A notice extending the comment period for an extra 45 days to April 8, 1982, including editorial corrections, was published in the Federal Register on February 25, 1982 (47 FR 8203). The notice concerned proposed amendments to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," which would have required that:

a. Each boiling water reactor (BWR) with a Mark III type containment and each pressurized water reactor (PWR) with an ice condenser type containment be provided with a hydrogen control system capable of handling an amount of hydrogen equivalent to that which would be generated if there were at least a 75 percent fuel cladding-water reaction without loss of containment integrity;

b. Each boiling water reactor and each pressurized water reactor that does not rely on an inerted atmosphere for hydrogen control be provided with safety systems needed to establish and maintain safe cold shutdown and maintain containment integrity that can function after the burning of substantial amounts of hydrogen; and

c. Analyses be performed for the reactor categories mentioned above to justify the hydrogen control systems selected and to assure containment structural integrity and survivability of needed safety systems during a hydrogen burn.

It should be noted that the proposed rule was not part of the separate, long-term rulemaking on degraded or melted cores (the "severe accident rulemaking") for which an advance notice of proposed rulemaking was published on October 2, 1980 (45 FR 65474) and which was the subject of the "Proposed Commission Policy Statement on Severe Accidents and Related Views on Nuclear Reactor Regulation," published in the Federal Register on April 23, 1983 (48 FR 16014).

General Comments

Twenty-eight persons submitted comments regarding the proposed amendments. The comments and the SECY paper noted above are part of the public record and may be examined and copied, for a fee, in the Commission's Public Document Room at 1717 H Street NW., Washington, D.C. A summary of the comments and a comment analysis are also available for inspection and copying, for a fee, in the Public Document Room.

The comments received have been carefully reviewed and evaluated during preparation of this final rule. The final rule contains revisions to the proposed rule that reflect consideration of these comments. The commenters generally provided many specific comments on all aspects of the proposed amendments. The following discussion represents a distillation of the more significant comments.

Numerous commenters suggested that the implementation of the Hydrogen Control Rule should be deferred until the severe accident rulemaking (see above) when applicable research and probabilistic risk analyses (PRAs) will be completed. The Commission agrees with these comments relative to PWRs with large dry containments. Dry containment designs have a greater inherent capability to accommodate large quantities of hydrogen because of their high design pressure and large volume; therefore, for these designs the Commission believes that rulemaking with regard to hydrogen control can be safely deferred pending completion of NRC- and industry-sponsored research. Furthermore, with regard to systems and components that must be able to function during and following hydrogen burning, the fact that TMI-2 was shut down and maintained in a shutdown condition indicates that such systems and components did generally perform their functions following the burn event. In addition, design improvements that have been implemented as a result of NRC directives have served to reduce the likelihood of a degraded core accident.

With regard to BWRs with Mark III containments and PWRs with ice condenser containments, the Commission believes that these containments can safely accommodate the burning in a single event of the hydrogen from about a 25 percent metal-water reaction.[1] However, since the TMI-2 accident showed that a 45-50

percent metal-water reaction was possible, the Commission believes that it is necessary to enhance the hydrogen control capability for reactors with these types of containments and that new regulations are required to ensure that the proper design features are incorporated. Adoption of the final rule will also formalize Commission regulatory decisions currently being applied on a case-by-case basis in individual licensing proceedings and will provide the needed basis for regulatory actions that cover licensing and continued operation of the affected plants.

Several commenters stated that the 75 percent metal-water reaction required to be assumed for design and analysis is unreasonably high based on evaluation of the TMI-2 accident and analyses of recoverable degraded core accidents.[2] The 75 percent metal-water reaction chosen by the Commission is greater than that which occurred during the TMI-2 accident; however, the primary intent of

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[1]The basis for this belief is contained in SECY 80-107, "Proposed Interim Hydrogen Control Requirements for Small Containments," February 22, 1980, which is available for inspection and copying for a fee at the Commission's Public Document Room at 1717 H Street, N.W., Washington, D.C.

[2]See the following studies, available for inspection at the Commission's Public Document Room at 1717 H Street, NW, Washington, D. C. Also NUREG and NUREG/CR publications may be purchased from the NRC/GPO Sales Program by calling (301) 492-9530.

NUREG/CR-2540, "A Method for the Analysis of Hydrogen and Steam Releases to Containment During Degraded Core Cooling Accidents," February 1982

NUREG/CR-1219, "Analysis of the Three Mile Island Accident and Alternative Sequences," January 1980

"Report on Hydrogen Control Accident Scenarios, Hydrogen Generation Rates and Equipment Requirements," Rev. 1, July 1982 - Submitted by the BWR/6 MARK III Hydrogen Control Owners Group.

the rule is to require containment designs that can accommodate accident sequences in which hydrogen combustion poses a significant threat to containment integrity. Consequently, the Commission believes it is prudent to specify a value sufficiently greater than that which was estimated to have occurred at TMI-2 so that there will be an appropriate margin of safety. The Commission feels confident that the 75 percent value is representative of a limiting case degraded core accident (beyond which a core melt is likely to occur). Finally, the Commission sees no significant benefit in reducing the metal-water reaction to a level such as 50 percent for those plants having Mark III and ice condenser containments since the basic design of the heretofore chosen igniter system would not change.

A number of commenters recommended that the requirement for a hydrogen control system be revised to permit licensees the option of demonstrating analytically that additional hydrogen control systems are not necessary because of intrinsic design capabilities that reduce the likelihood of hydrogen generation. While it is true that design features to reduce hydrogen generation are necessary and desirable, the Commission still believes that, in order to cope with unexpected events, there should be a solution to the hydrogen issue that involves design features that ensure containment integrity, even if a large amount of hydrogen is generated. Thus, while measures to prevent the the generation of large amounts of hydrogen are necessary and desirable, the Commission believes that it is also necessary, depending upon containment design, to provide measures to mitigate the effects of large amounts of hydrogen.

Some commenters indicated that, since the primary function of the containment is to prevent excessive radiation dose to the public, the rule should be modified to preclude the loss of containment function rather than to preclude

the loss of containment integrity. The Commission appreciates the fact that some nuclear plants are designed with a multi-building, multi-barrier concept that is intended to prevent the leakage of radiation by diverse methods such as filtering and scrubbing mechanisms, plate-out mechanisms, and containment sprays. However, the Commission's safety philosophy remains the same; namely, the containment should be designed to remain intact following a recoverable degraded core accident in order to provide additional assurance that excessive radiation will not be released. In other words, the Commission reaffirms its policy that the prevention of excessive radiation dose to the public can best be assured by maintaining a leak tight containment and that this, in turn, can be provided by assuring that there is structural integrity with margin.

Some commenters stated that the criterion for containment structural integrity is unnecessarily restrictive. They stated that it should not be limited to the provisions of the ASME Boiler and Pressure Vessel Code, but should permit the use of other methods such as realistic analyses using actual material properties. The Commission agrees with this comment and has modified the rule in this regard. Section 50.44(c)(3)(iv) has been changed to indicate that "containment structural integrity must be demonstrated by use of an analytical technique that has been accepted by the NRC staff." The rule includes two alternative methods as examples but does not preclude other methods that may be shown to be acceptable to the Commission. Finite element analysis would be acceptable for use with the methods considered.

It was suggested by some commenters that the rule snould address only non-inerted, small-volume, low-pressure containments and should not impose requirements for the remaining containments since, for these containments, it would provide, at best, insignificant improvements in safety. The Commission agrees for the reasons indicated above; therefore, as indicated previously, it has revised the rule to apply only to Mark III BWRs and ice condenser PWRs.

A number of commenters stated that the rule ignores those post-TMI suggested improvements which have been implemented and which reduce the likelihood of a degraded core accident. In the case of PWRs with large dry containments, as discussed above, the Commission believes that the post-TMI improvements, along with the inherent strength of the containments, have indeed provided sufficient safety to permit the delay of any additional rulemaking until completion of ongoing research programs.

It has been recommended that in view of the small probability of occurrence of local detonations as a result of various design features, the rule should permit licensees the option of demonstrating that local detonations cannot occur in lieu of evaluating the effects of local detonations. The Commission agrees and has modified paragraphs 50.44(c)(3)(v) and (vi) of the rule appropriately.

Many commenters indicated that they believe the requirement that systems and components that can function after a hydrogen burn be provided for "safe cold shutdown" is unnecessary and is inconsistent with the licensing basis for most operating plants which requires only "safe shutdown". Those commenters felt that the safe shutdown criterion should not be an issue with regard to hydrogen control, but that it should be considered in another forum. Because of the fact that a degraded core accident is less likely than a design basis accident, the Commission agrees that the requirement for cold shutdown may be overly conservative. The licensing basis for most plants is, in fact, just safe shutdown. The reference to cold shutdown has been deleted from the rule; but the Commission notes that the issue of safe shutdown versus safe cold shutdown has not yet been resolved. The issue is expected to be addressed

within the context of the resolution of Unresolved Safety Issue (USI) A-45, "Shutdown Decay Heat Removal Requirements," which is the subject of current NRC staff effort.

Several commenters have suggested that the implementation schedules should be made more realistic so that design changes logically follow after the required analyses are completed. The Commission agrees. The greatest relief, of course, has come by deferring implementation of the rule for PWRs with large dry containments. However, the rule has also been revised to specify that each applicant and licensee subject to the rule shall propose a schedule, to the Commission, for meeting the requirements. A final schedule for implementing the requirements shall be mutually agreed upon by the applicant or licensee and the NRC staff. The Commission anticipates that most applicants and licensees will be able to implement these requirements within two years. (See §50.44(c)(3)(vii).)

Some commenters noted that in the Supplementary Information accompanying the proposed rule it was stated that the selection of the hydrogen control system should be supported by comparative analyses of alternative systems to show their relative advantages and disadvantages. They stated that this guidance is inconsistent with Commission practice and is unnecessary. They felt that the only requirement should be a demonstration that the selected system is suitable for its intended application.

The Commission agrees that this guidance was inconsistent with Commission practice in the case of operating reactors and reactors for which operating licenses are about to be issued in the near-term. In the final rule, § 50.44(c)(3)(vi) has been modified to delete the implication that comparative analyses are required and to indicate that the analysis is intended to support the design of the hydrogen control system that is selected. Comparative analyses of alternative systems are not required.

HYDROGEN CONTROL SYSTEMS [§ 50.44(c)(3)(iv)]

As originally proposed, applicants and licensees with boiling water reactor (BWR) facilities with Mark III type containments and pressurized water reactor (PWR) facilities with ice condenser type containments, for which construction permits were issued prior to March 28, 1979, are required to install hydrogen control systems capable of accommodating an amount of hydrogen equivalent to that generated from the reaction of 75 percent of the fuel cladding (surrounding the active fuel region) with water, without loss of containment integrity. The particular type of hydrogen control system to be selected is left to the discretion of the applicant or licensee; however, the NRC must find it acceptable based upon suitable programs of experiment and analysis. The design of the selected system must be supported by the analyses which are to be submittted as part of the analyses required under § 50.44(c)(3)(vi). The system that is proposed and approved must safely accommodate large amounts of hydrogen, and operation of the system, either intentionally or inadvertently, must not further aggravate the course of an accident or endanger the plant during normal operations. As discussed previously, the amount of hydrogen to be assumed in the design of the hydrogen control system is that amount generated when 75 percent of the fuel cladding surrounding the active fuel region reacts with water.

As discussed above, the limited method proposed to demonstrate containment structural integrity has been expanded. Containment structural integrity may now be demonstrated by use of an analytical technique that has been accepted by the NRC staff. For example, finite element analysis is one acceptable technique for use with the methods considered. One of the acceptable methods is the use of the applicable ASME Boiler and Pressure Vessel Code. However, the Commission will accept other methods, provided that convincing evidence is presented regarding their suitability.

Other changes from the proposed rule are the relaxation of the implementation schedule to one that has been mutually agreed upon by the licensee and the NRC staff, and the elimination of the word "cold" in the phrase "safe cold shutdown."

SYSTEMS AND COMPONENTS [§ 50.44(c)(3)(v)]

At the time the proposed rule was issued for comment, the Commission indicated that it was considering a two-step approach to address "qualification" (as defined below) of those systems and components that must be able to function during and after a hydrogen burn. For the reasons explained below, the Commission did not choose this two-step approach. As the proposed first step, there would have been a demonstration that these systems and components could "survive" the hydrogen burn and continue to be able to perform their safety function. This step would not have entailed that these systems and components actually be qualified pursuant to NRC's qualification program. The proposed second step would have entailed the actual "qualification" of these systems and components. The conceptual differences between systems and components demonstrated to be "survivable" and systems and components demonstrated to be "qualified" were also described.

The Commission specifically sought comments on the use of the two-step approach for defining standards, on the "survivability" and "qualification" approaches themselves, and on proposals for implementation schedules. There were numerous comments in response to this request. The overwhelming reaction was that the two-step approach to reaching a survivability determination is unwarranted and will unnecessarily escalate the costs to industry. Many commenters felt that a straightforward survivability approach would be appro-

priate provided reasonable guidelines are specified. In view of the smaller likelihood of a degraded core accident as compared to a design basis accident, which has been reduced further by post-TMI improvements, the Commission has decided to forego the two-step approach previously described. The Commission now believes, in view of the recent issuance of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety," that there is no significant difference between demonstrating survivability and demonstrating qualification. Paragraph (f) of § 50.49 describes several methods, one of which must be used, for qualifying electrical equipment important to safety. For example, for those licensees which have already demonstrated survivability, as described in the Supplementary Information of the notice of proposed rule-making for this rule on hydrogen control requirements (46 FR 62281, Dec. 23, 1981), the qualification methods described in paragraphs (f)(2) and (f)(4) of § 50.49 could be used to show that the systems and components have been qualified. In this regard, the margins considered adequate for a degraded core accident are less than those considered adequate for a design-basis accident due to the lower probability of occurrence of a degraded core accident.

The Commission now views "qualification" as the generation and maintenance of evidence using tests and analyses to assure that systems and components will operate on demand to meet system performance requirements. In the case of a hydrogen burn environment, this means that there must be adequate evidence that systems and components necessary to establish and maintain safe shutdown and to maintain containment integrity are capable of performing their functions during and after exposure to the environmental conditions created by the postulated accident, including the burning of hydrogen. Qualification may be demonstrated

in a manner acceptable to the Commission using a combined approach of analysis and testing. Thus, an acceptable thermal analysis would have to be performed for the containment in order to determine the thermal response of the components during a hydrogen burn. This thermal response should then be compared to the thermal response the components had during their qualification testing. The licensee should then demonstrate that the qualification thermal response envelops the thermal response during a hydrogen burn. Selected tests should also be performed at predicted hydrogen burn conditions (or, other tests previously performed may be referenced if demonstrated to be applicable) to reasonabl assure the Commission that the systems and components are qualified to perform their functions during and following a hydrogen burn.

Paragraph 50.44(c)(3)(v) applies to those Mark III BWRs and ice condenser PWRs that do not have an inerted containment atmosphere for hydrogen control. At present, this includes all Mark III BWRs and ice condenser PWRs, since no applicant or licensee has as yet elected to use the inerting option for these plants. The systems and components that must be qualified for a hydrogen burn are those needed (a) to shut down the reactor and bring it to and maintain it in a safe shutdown condition, and (b) to prevent loss of containment integrity. These systems and components can be further categorized as follows:

a. Systems and components mitigating the consequences of the accident;
b. Systems and components needed for maintaining integrity of the containment pressure boundary;
c. Systems and components needed for maintaining the core in a safe condition; and

d. Systems and components needed for monitoring the course of the accident.

As discussed previously, these systems and components are described as bringing the reactor to "safe shutdown" rather than "safe cold shutdown." Furthermore, the schedule for implementation has been changed to one that has been mutually agreed upon by the licensee and the NRC staff. Finally, the rule has been revised to indicate that the environmental conditions to be assumed for a hydrogen burn do not have to include the effect of local detonations if it is shown to the Commission's satisfaction that local detonations are unlikely to occur.

ANALYSES [§ 50.44(c)(3)(vi)]

In the proposed rule, the Commission included a description of three different approaches concerning the supplementary guidance to be provided for performing the required analyses for the design of the hydrogen control system. These were (a) analyses of different accident scenarios, (b) analyses of a single accident scenario with variation of key parameters, and (c) analyses using an "envelope of time histories of hydrogen and steam release rates" to be supplied by the Commission. The Commission requested comments concerning which of the approaches was preferred as well as suggestions regarding improvements or other alternatives.

There was no preponderance of comments leaning toward a particular approach; however, the first two approaches appeared to have greater support. Furthermore, many commenters felt that there should be flexibility in the approach to be used and in the selection of the accident scenarios. It was also suggested that the accident scenarios should be considered in order of importance using PRA techniques.

Based on the comments received and in consideration of the improved calculational data base now available, the Commission has decided to adopt the second approach; applicants and licensees need not use the first or third approaches.

In the selected approach, a base sequence will be identified by the licensee or applicant based on the hydrogen threat to containment integrity. Key aspects of this sequence should then be parametrically varied by the licensee or applicant in determining the acceptability of the containment response. This will provide a wider range of parameters than that of the selected base sequence alone. The acceptability of the analyses used in this approach depends on the selection and range of the parameters being varied. A range must be chosen which includes the effects of recovery from the degraded condition. It is expected that each applicant or licensee will review its analytical approach with the NRC staff and arrive at a mutually agreeable method for performing the analyses.

As an example, in the recent Sequoyah case[3], the applicant based its initial analysis on an accident sequence involving a small break LOCA followed by loss of ECCS (S_2D), with a typical average hydrogen release rate of about 20 pounds per minute, which the NRC staff considered to be representative of the accident. However, several concerns remained open. Among these were the possibilities that: (1) other scenarios might present schedules of steam and hydrogen release not covered by the analysis chosen; (2) steam inerting might occur at some time during the sequence allowing large concentrations of hydrogen to develop; (3) the recovery period might produce an exceptionally large burst of steam or hydrogen; and (4) hydrogen might be released after the loss of the ice heat sink.

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[3]NUREG-0011, Supplement No. 6, "Safety Evaluation Report Related to the Operation of Sequoyah Nuclear Plant, Units 1 and 2," November 1982. Available for inspection at the Commission's Public Document Room at 1717 H Street, N.W., Washington, D. C.

In the Sequoyah case, the applicant broadened the studies to include higher rates of steam and hydrogen release and releases after the ice melted. The broadened calculations included hydrogen release rates as high as 6 lb. per second under representative steam conditions, with and without ice. It was shown that a representative selection of scenarios would be bounded by the broadened release rates, including an intermediate break LOCA with loss of ECC (S_1D), a small break LOCA with loss of containment heat removal (S_2G), a transient loss of main feedwater and loss of all AC power (T_BB_2), and a transient loss of main feedwater, loss of auxiliary feedwater and loss of the ECC (T_BLD). The staff concluded that the coverage of these additional scenarios was sufficient to assure that the hydrogen associated with a representative group of degraded core situations could be managed acceptably using the ignition systems.

As another example, in the McGuire case[4], hydrogen release rates up to 4.3 lb. per second under representative steam conditions were considered and the S_2D releases were analyzed with and without ice. The results were considered acceptable by the staff.

The staff has accepted ac-powered igniters without requiring a backup power supply in the two examples cited above. This judgment was based upon the staff's perception that the incremental risk reduction associated with provision of the igniter system backup power supply did not warrant the additional cost at these particular facilities. Provision of a backup power supply is not required by this rule.

It is apparent that applicants and licensees with conceptually different reactors may have to address other scenarios. The appropriate details for MARK III BWRs, for example, are currently being worked out through interaction between the NRC staff and applicants.

[4]NUREG-0422, Supplement No. 7, "Safety Evaluation Report Related to Operation of McGuire Nuclear Station Units 1 and 2," May 1983. Available for inspection at the Commission's Public Document Room at 1717 H Street, NW, Washington D.C.

Previously approved generic or reference analyses may be employed in lieu of plant specific analyses where the generic analyses can be shown to be applicable. It is believed that the adoption of the above approach will eliminate the need for repetitive calculation of accident scenarios.

REGULATORY ANALYSIS

The Commission has prepared a regulatory analysis for this regulation. The analysis examines the costs and benefits of the rule as considered by the Commission. A copy of the regulatory analysis is available for inspection and copying for a fee at the NRC Public Document Room, 1717 H Street, N.W., Washington, D.C. Single copies of the analysis may be obtained from Morton R. Fleishman, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone (301) 443-7616.

PAPERWORK REDUCTION ACT

This final rule imposes information collection requirements that are subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501, et seq.) These requirements were approved by the Office of Management and Budget. Approval Number 3150-0011.

REGULATORY FLEXIBILITY ACT

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission hereby certifies that this rule will not, if promulgated, have a significant economic impact on a substantial number of small entities. This rule affects only the licensing and operation of nuclear power plants. The companies that own these plants do not fall within the scope of the definition of "Small entities" set forth in the Regulatory Flexibility Act or the Small Business Size Standards set out in regulations issued by the Small Business Administration at 13 CFR Part 121. Since these companies are dominant in their service areas, this rule does not fall within the purview of the act.

LIST OF SUBJECTS IN 10 CFR PART 50

Antitrust, Classified information, Fire prevention, Incorporation by Reference, Intergovernmental relations, Nuclear power plants and reactors, Penalty, Radiation protection, Reactor siting criteria, and Reporting requirements.

Accordingly, notice is hereby given that, pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and section 553 of Title 5 of the United States Code, the following amendments to 10 CFR Part 50 are published as a document subject to codification.

PART 50--DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

1. The authority citation for Part 50 continues to read as follows:

AUTHORITY: Secs. 103, 104, 161, 182, 183, 186, 189, 68 Stat. 936, 937, 948, 953, 954, 955, 956, as amended, sec. 234, 83 Stat. 1244, as amended (42 U.S.C. 2133, 2134, 2201, 2232, 2233, 2236, 2239, 2282); secs. 201, 202, 206, 88 Stat. 1242, 1244, 1246, as amended (42 U.S.C. 5841, 5842, 5846), unless otherwise noted.

Section 50.7 also issued under Pub. L. 95-601, sec. 10, 92 Stat. 2951 (42 U.S.C. 5851). Sections 50.58, 50.91 and 50.92 also issued under Pub. L. 97-415, 96 Stat. 2073 (42 U.S.C. 2239). Section 50.78 also issued under sec. 122, 68 Stat. 939 (42 U.S.C. 2152). Sections 50.80-50.81 also issued under sec. 184, 68 Stat. 954, as amended (42 U.S.C. 2234). Sections 50.100-50.102 also issued under sec. 186, 68 Stat. 955 (42 U.S.C. 2236).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 50.10(a), (b), and (c) 50.44, 50.46, 50.48, 50.54, and 50.80(a) are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)); §§ 50.10(b) and

(c) and 50.54 are issued under sec. 161i, 68 Stat. 949, as amended (42 U.S.C. 2201(i)); and §§ 50.55(e), 50.59(b), 50.70, 50.71, 50.72, and 50.78 are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

2. In § 50.44, paragraph (c)(3) is revised by adding new paragraphs (iv), (v), (vi) and (vii) to read as follows:

§ 50.44 Standards for combustible gas control system in light water cooled power reactors.

* * * * *

(c)(3) ***

(iv)(A) [~~*Effective one year after the effective date of the rule, or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later,*~~] Each licensee with a boiling light-water nuclear power reactor with a Mark III type of containment and each licensee with a pressurized light-water nuclear power reactor with an ice condenser type of containment [~~for which~~] issued a construction permit [~~was issued prior to~~] before March 28, 1979, shall [~~be~~] provide[~~s~~] its nuclear power reactor with a[~~n acceptable~~] hydrogen control system justified by a suitable program[~~s~~] of experiment and analysis. The hydrogen control system must be capable of handling without loss of containment structural integrity an amount of hydrogen equivalent to that generated from a metal-water [~~the~~] reaction [~~of~~] involving 75% of the fuel cladding surrounding the active fuel region (excluding the cladding surrounding the plenum volume). [~~with water~~]

(B) Containment structural integrity must be demonstrated by use of an analytical technique that is accepted by the NRC staff. This demonstration must include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved. This method could include the use of actual material

properties with suitable margins to account for uncertainties in modeling, in material properties, in construction tolerances, and so on. Another method could include a showing that the following specific criteria of the ASME Boiler and Pressure Vessel Code are met:

(1) That steel containments [must] meet the requirements of the ASME Boiler and Pressure Vessel Code (Edition and Addenda as incorporated by reference in paragraph 50.55a(b)(1) of this part), specifically in Section III, Division 1, Subsubarticle NE-3220, Service Level C Limits, [except that] considering pressure and dead load alone (evaluation of instability is not required); and

(2) That concrete containments [must] meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division 2, Subsubarticle CC-3720, Factored Load Category, considering pressure and dead load alone.

(C) Subsubarticle NE-3220, Division 1, and subsubarticle CC-3720, Division 2, of Section III of the ASME Boiler and Pressure Vessel Code, referenced in paragraphs(c)(3)(iv)(B)(1) and (c)(3)(iv)(B)(2) of this section, [These subsubarticles] have been approved for incorporation by reference by the Director of the Office of the Federal Register. A notice of any changes made to the material incorporated by reference will be published in the Federal Register. Copies of the ASME Boiler and Pressure Vessel Code may be purchased from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017. It is also available for inspection at the Nuclear Regulatory Commission's Public Document Room, 1717 H Street N.W., Washington, D.C.

(D) If the hydrogen control system relies on post-accident inerting, the containment structure must be capable of withstanding the increased pressure:

(1) During the accident, where it [must] is acceptable to show that it does not exceed Service Level C Limits or the Factored Load Category (as [previously specified] described in paragraph (c)(3)(iv)(B) of this section [paragraph]); and

(2) Following inadvertent full inerting [that may occur] during normal plant operations, where it [must] is acceptable to show that it does not exceed either the Service Level A Limits of Subsubarticle NE-3220 (for a steel containment) or the Service Load Category of Subsubarticle CC-3720 (for a concrete containment).

(3) Modest deviations from the criteria in paragraph (c)(3)(iv)(D) of this section will be considered by the Commission if good cause is shown.

(E) If the hydrogen control system relies on post-accident inerting, the systems and components [equipment] required to establish and maintain safe [cold] shutdown and containment integrity must be designed and qualified for the environment caused by such [post-accident] inerting. Furthermore, inadvertent full inerting during normal plant operations must not adversely affect systems and components needed for safe operation of the plant.

(v) (A) Each licensee with a boiling light-water nuclear power reactor with a Mark III type of containment and each licensee with a pressurized light-water nuclear power reactor with an ice condenser type of containment [for which] issued a construction permit [was issued prior to] before March 28, 1979, for a reactor that does not rely upon an inerted atmosphere to control

hydrogen inside the containment shall [be] provide[d] its nuclear power reactor with systems and components necessary to establish and maintain safe [cold] shutdown and to maintain containment integrity. These systems and components must be [that-are] capable of performing their functions during and after [being-exposed] exposure to the environmental conditions created by the burning [(or-local-detonation)] of hydrogen. Environmental conditions caused by local detonations of hydrogen must also be included, unless such detonations can be shown unlikely to occur.

(B) The amount of hydrogen to be considered is equivalent to that generated from [the] a metal-water reaction [of] involving 75% of the fuel cladding surrounding the active fuel region (excluding the cladding surrounding the plenum volume). [with-water-This-requirement-shall-be-effective-as-follows: for-each-boiling-light-water-nuclear-power-reactor-with-a-Mark-III-type-containment-and-each-pressurized-light-water-nuclear-power-reactor-with-an-ice-condenser type-containment,-on-[one-year-after-the-effective-date-of-the-rule]-or-the date-of-issuance-of-a-license-authorizing-operation-above-5-percent-of-full power,-whichever-is-later;-for-every-other-light-water-nuclear-power-reactor that-must-meet-this-requirement,-on-[two-years-after-the-effective-date-of the-rule]-or-the-date-of-issuance-of-a-license-authorizing-operation-above 5-percent-of-full-power,-whichever-is-later.]

(vi) (A) Each applicant for or holder of an operating license for a boiling light-water nuclear power reactor with a Mark III type of containment or for a pressurized light-water nuclear power reactor with an

Enclosure "F"

ice condenser type of containment issued a construction permit before March 28, 1979, shall [analyses-shall-be-performed-and] submit[ted] an analysis to the Director of the Office of Nuclear Reactor Regulation. [for-each-light-water nuclear-power-reactor,-for-which-a-construction-permit-was-issued-prior-to March-28,-1979,-to-evaluate]

(B) The analysis required by paragraph (c)(3)(vi)(A) of this section must:

(1) Provide an evaluation of the consequences of large amounts of hydrogen generated after the start of an accident (hydrogen resulting from the metal-water reaction of up to and including 75% [percent] of the fuel cladding surrounding the active fuel region, excluding the cladding surrounding the plenum volume) and include [with-water-including] consideration of hydrogen control measures as appropriate; [Each-analysis-must]

(2) Include the period of recovery from the degraded condition;

(3) Use [the] accident scenarios [to-be-used-in-the-analyses-must-be] [acceptable-to] that are accepted by the NRC staff. These scenarios must be accompanied by sufficient supporting justification to show that they describe the behavior of the reactor system during and following an accident resulting in a degraded core. [The-scope-and-implementation requirements-for-The-analyses-for-the-various-types-of-light-water-nuclear power-reactors-are-as-follows:

(A)--For-each-boiling-light-water-nuclear-power-reactor-with-a-Mark-III type-containment-and-each-pressurized-light-water-nuclear-power-reactor-with an-ice-condenser-type-containment,-analyses-shall-be-performed-that-justify the-selection]

(4) Support the design of the hydrogen control system selected [required-by-§-50.44] under paragraph (c)(3)(iv) of this section; and, [These analyses-shall-be-completed-and-submitted-by-[one-year-after-the-effective-date

of the rule] or the date of issuance of a license authorizing operation above 5 percent of full power, whichever is later.]

(5) Show that, for those reactors described in paragraph (c)(3)(iv) of this section that do [for each light-water nuclear power reactor that does] not rely upon an inerted atmosphere to control hydrogen inside the containment: [analyses shall be performed to show that]

(i) The containment structural integrity as [defined] described in [§ 50.44] paragraph (c)(3)(iv) of this section will be maintained; and

(ii) Systems and components necessary to establish and maintain safe [cold] shutdown and to maintain containment integrity will be capable of performing their functions during and after [being exposed] exposure to the environmental conditions created by the burning of hydrogen, including the effect of local detonations, unless such detonations can be shown unlikely to occur. [These-analyses-shall-be-completed-and-submitted-as-follows:-for-each-boiling-light-water-nuclear-power-reactor-with-a-Mark-III-type-containment-and-each-pressurized-light-water-nuclear-power-reactor-with-an-ice-condenser-type-containment;-by-[one-year-after-the-effective-date-of-the-rule]-or-the-date-of-issuance-of-a-license-authorizing-operation-above-5-percent-of-full-power;-whichever-is-later;-for-every-other-light-water-nuclear-power-reactor-for-which-these-analyses-are-required;-by-[two-years-after-the-effective-date-of-the-rule]-or-the-date-of-issuance-of-a-license-authorizing-operation-above-5-percent-of-full-power;-whichever-is-later.]

(vii) Implementation. By [insert a date 180 days after the effective date of the amendment], each applicant for or holder of an operating license subject to the requirements of paragraphs (c)(3)(iv), (v) and(vi) of this section shall develop and submit to the Director of the Office of Nuclear Reactor Regulation a schedule for meeting those requirements. A final schedule for meeting the requirements of paragraphs (c)(3)(iv), (v) and (vi) of this section shall then be mutually agreed upon by the applicant for or holder of the operating license and the NRC staff.

Dated at Washington, D.C. this _________ day of _____________, 1983.

For the Nuclear Regulatory Commission,

____
Samuel J. Chilk
Secretary of the Commission

ENCLOSURE "G"

REGULATORY ANALYSIS
FOR
AMENDMENTS RELATED TO HYDROGEN CONTROL

1. STATEMENT OF THE PROBLEM

1.1 Background

The accident at Three Mile Island, Unit 2 (TMI-2) resulted in a severely damaged or degraded reactor core, a concomitant release of radioactive material to the primary coolant system, and a fuel cladding-water reaction which resulted in the generation of a large amount of hydrogen. The Commission has taken numerous actions to correct the design and operational limitations revealed by the accident. Included in these actions are several rulemaking proceedings intended to improve the hydrogen control capability of light-water nuclear power reactors. On October 2, 1980, the Commission published in the Federal Register (45 FR 65466) a notice of proposed rulemaking on "Interim Requirements Related to Hydrogen Control and Certain Degraded Core Considerations" (Interim Rule). The notice concerned proposed amendments to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," to improve hydrogen management in light-water reactor facilities and to provide specific design and other requirements to mitigate the consequences of accidents resulting in a degraded reactor core.

On March 23, 1981, the Commission published in the Federal Register (46 FR 18045) a notice of proposed rulemaking on "Licensing

Requirements for Pending Construction Permit and Manufacturing License Applications." The notice proposed a set of licensing requirements applicable to construction permit applications that stemmed from lessons learned from the TMI-2 accident. On May 13, 1981, the Commission published in the Federal Register (46 FR 26491) a notice of proposed rulemaking on "Licensing Requirements for Pending Operating License Applications" (OL Rule).

As a follow-up to the October 2, 1980 notice of proposed rule-making, the Commission published a notice of final rulemaking on December 2, 1981 (46 FR 58484) on hydrogen control require-ments related to inerting of Mark I and II boiling water reactors, hydrogen recombiner capability and high point vents.

The Commission has also been considering the ability of all light-water nuclear power reactors, particularly pressurized light-water reactor facilities with ice condenser-type contain-ments and boiling light-water reactor facilities with Mark III-type containments, to withstand an accident with the concomitant generation of large amounts of hydrogen, such as the type which occurred at Three Mile Island, Unit 2 (TMI-2). As a result, three new amendments to the regulations were proposed for public comment via a notice of proposed rulemaking on December 23, 1981 (46 FR 62281). The amendments would require: (a) improved hydrogen control systems for boiling water reactors with Mark III type containments and for pressurized water reactors with ice

condenser type containments; (b) that all light-water nuclear power reactors not relying upon an inerted atmosphere for hydrogen control show that certain important safety systems must be able to function during and following hydrogen burning; and finally (c) analyses to be submitted to justify the hydrogen control systems selected and to provide assurance that containment structural integrity will be maintained and important safety systems will continue to function following a hydrogen burn.

The Commission has required hydrogen control measures for ice condenser PWRs and for Mark III BWRs (for those that are operating and those that have pending operating license applications). The licensing actions taken are in basic agreement with the proposed amendments.

1.2 Description of Rulemaking

Section 50.44 of 10 CFR Part 50 is being amended to improve hydrogen control capability during and following an accident for BWRs with Mark III type containments and PWRs with ice condenser type containments. The amendments apply to those of the above reactors whose construction permit was issued prior to March 28, 1979 and would require:

a. hydrogen control systems that can handle large amounts of hydrogen,

b. certain systems and components and containment that are able to perform their functions during and following hydrogen burning, and

c. analyses to be performed and submitted that supports the design of the hydrogen control system selected and the demonstration of system and component survivability/ qualification.

As noted, the rulemaking requires submittal of the analyses to the Commission. The information contained in the analyses is necessary to permit the NRC staff to perform an evaluation to determine if the requirements for hydrogen control and system and component functioning during a hydrogen burn are met. Without this information the NRC staff could not evaluate the design of the hydrogen control systems or determine whether or not needed safety equipment could indeed function during a hydrogen burn.

2. <u>OBJECTIVES</u>

The objective of the rulemaking action is to provide specific requirements which, when implemented, will improve the capability of Mark III BWRs and ice condenser PWRs to withstand the consequences of a degraded core accident that generates a large amount of hydrogen.

The action will also formalize regulatory positions that have already been taken by the Commission in individual licensing cases (e.g., Sequoyah, McGuire, and D.C. Cook.)

3. ALTERNATIVES

The specific amendments are consistent with recent Commission licensing decisions. These decisions have been based on engineering evaluation and qualitative professional judgment that have evolved during the regulatory process. The technical decisions have been reviewed by the Advisory Committee on Reactor Safeguards (ACRS).

The rule is an outgrowth of recommendations made by the Lessons Learned Task Force (LLTF) in NUREG-0578, "TMI-2 LLTF Status Report and Short-Term Recommendations," and by the Commission in NUREG-0660, "TMI-2 Action Plan." It was recommended that short-term actions be implemented, in the form of rulemaking, to improve the capability of reactors to mitigate the consequences of degraded core accidents.

An alternative to rulemaking could be maintenance of the status quo with licensing decisions being treated on a case-by-case basis. However, this alternative would not result in any savings to NRC or industry since the requirements of the rule would still be implemented. In fact it would result in additional costs since it would leave the question of hydrogen control as an unresolved issue that would be subject to time-consuming and costly litigation for each case. For example, it has been estimated that the manpower cost in litigating the hydrogen control issue in the Perry hearing involves at least one man-year (my) from NRC and one my from the licensee, not including ASLB and intervenor costs. Hence, it was decided that the rulemaking route was the most reasonable alternative.

The rule does not require that any particular type of hydrogen control system be selected. However, as indicated in Section 4.2, the distributed igniter system is expected to be the system chosen to meet the requirements of the rule. Numerous other technical alternatives were considered during the development of the rule. These are:

a. Double-walled containments
b. Water fog sprays
c. Halon suppressants
d. Post-accident inerting
e. Inerting
f. Large capacity hydrogen recombiners
g. Purge systems
h. Filtered-vent systems.

While some of these systems are still under consideration, the distributed igniter system has advantages from the cost, operations, and reliability standpoint. For example, in the case of inerting, it is estimated that the initial capital costs alone for the 24 plants covered by the rule would be about $48,000,000 and the maintenance costs over the lifetime of the plants would be approximately $230,000,000. Furthermore, because of the frequency of containment entry for maintenance functions, especially for the ice chests in ice condenser types of contain-

ments, inerting is impractical and relatively costly. Air changes associated with each inert/de-inert cycle could cause excessive ice loss. While BWRs with Mark III types of containments do not have the concerns with the ice chests, much more equipment is located inside containment than for Mark I and II containments and thus the equipment maintenance could be impeded by inerting and prove to be costly.

Double-walled containments have been mentioned but not seriously considered because of the extremely high costs. It would involve essentially the construction of an additional large containment to surround the smaller containment so as to provide an increased volume to contain the generated hydrogen. In effect, adding a large dry containment. The cost of such an addition would be on the order of $400 million dollars per plant or $10 billion dollars for the 24 plants affected by the rule.

The Commission also considered pressurized water reactors with large dry containments for inclusion under the rule. However, because of the greater inherent capability of these plants to withstand the effects of hydrogen build-up as a result of their high pressure capacity, large volume, and the post-TMI improvements, it was decided to defer action on them until the completion of the long-term rulemaking on severe accidents.

4. CONSEQUENCES

4.1 Plants Affected

There are currently 14 Mark III BWRs and 5 ice condenser PWRs in various stages of the licensing process and 5 operating ice condenser PWRs that are covered by the rule (i.e., whose construction permit was issued prior to March 28, 1979).

4.2 Costs of Hydrogen Control System

The cost of the hydrogen control system will clearly depend on the type of system selected, be it a distributed igniter system, a post-accident inerting system, or some other system. However, for the purpose of this analysis, it will be assumed that a distributed igniter system is selected since this is apparently the system of choice of licensees for both Mark III BWRs and ice condenser PWRs.

The cost of the equipment has been variously estimated as $25,000 to $140,000, with the lowest estimate supplied by a licensee who actually installed the equipment. The cost of installing the equipment, including QA costs, has been estimated by some to be $50,000 and by others to be 5 my (~$500,000). There was one combined estimate of $500,000 for equipment plus installation. The estimates for the design and analysis of the hydrogen control system have varied from 1.5 my (~$150,000) to $750,000 (this included the survivability/qualification analyses and design work associated with the testing). For the purpose of this analysis, the

equipment cost per plant will be assumed to be $100,000, the installation cost will be $300,000, and the design and analysis costs will be $300,000. The installation costs are estimated for the forward fit of plants and would approximately double for backfits. However, the backfit would only be applicable to the five operating plants and they have already had the required modifications made.

Some of the plants have already begun or have completed installation of hydrogen control systems as a result of Commission decisions. For the purposes of the cost estimate, it will be assumed that 14 plants would be required to implement the hardware requirements of the rule. Because of similarities between plants and sites it is estimated that only 6 design and analysis studies will have to be performed. The resulting costs are as follows:

equipment = $1,400,000 (14 x $100,000)

installation = $4,200,000 (14 x $300,000)

design and analysis = $1,800,000 (6 x $300,000)

Total = $7,400,000

It should be noted that the above estimates include the fact that some applicants have already taken steps for implementation based on interaction with the NRC staff.

4.3 Costs for Demonstration of Survivability/Qualification

The cost of implementing the survivability/qualification requirement will involve both analysis costs and costs of system and component testing. Much of the analysis performed in support of the hydrogen

control system design is applicable to the demonstration of equipment survivability/qualification as well. It is estimated that the additional analyses required to meet the survivability/qualification requirement is 0.5 my (~$50,000) per plant.

The major systems and components tests needed will have been accomplished during the qualification program designed to qualify equipment for a LOCA environment. Some additional testing will be required for a hydrogen burn environment for certain items such as thermocouples and cables. The additional testing required for survivability/qualification is judged to be about $200,000 per plant study.

The costs for the 6 plant studies are then:

testing = $1,200,000 (6 x $200,000)

analysis = $300,000 (6 x $50,000)

Total = $1,500,000

4.4 Costs of Analyses

The specific costs of this requirement are the analysis costs discussed under 4.2 and 4.3 and repeated here:

hydrogen control system	=	$1,800,000
survivability/ qualification	=	$300,000
Total	=	$2,100,000

The cost of the reporting requirement for documenting and submitting the analyses to the Commission is included in the above figures and is estimated to represent about 10 percent of the total cost or $210,000.

4.5 Sources of Cost Estimates

The above costs have been estimated based on preliminary data supplied by Pacific Northwest Laboratories (PNL) in support of Unresolved Safety Issue A-48, "Hydrogen Control Measures and Effect of Hydrogen Burns on Safety Equipment." Comments supplied by the Industry Degraded Core Rulemaking (IDCOR) Program and by Wisconsin Electric were also considered in arriving at the estimates. Finally, actual costs were solicited with regard to the Sequoyah, the McGuire and the Perry plants, since they have already had significant expenditures related to the design and installation of a distributed igniter system and the demonstration of survivability/qualification. These costs were tempered when arriving at the final estimated costs for the rule by the belief that the Sequoyah costs are expected to be higher than for future forward fitting of plants.

4.6 NRC Costs

The additional cost to the NRC is expected to result from the required evaluation of the submitted reports. It is estimated that it will involve about 24 man-weeks (mw) for the evaluation of each of the 6 reports for a total of 144 mw (2.8 my) or $280,000.

5. DECISION RATIONALE

Following the accident at TMI, the staff undertook a reassessment of plant capabilities to tolerate the consequences of a severe accident. One concern was that a hydrogen burn resulting from an accident similar to TMI-2 could result in a breach of containment. The staff concluded that ice condenser and Mark III type containments could safely accommodate the burning of hydrogen produced from a 25 percent fuel cladding-water reaction. However, since the accident at TMI-2 resulted in an estimated 45-50% reaction, it was felt prudent to require enhanced hydrogen control capability for reactors with these types of containments.

In 1981 the Commission began implementing the requirements, now being incorporated into this rule, for ice condenser PWRs and for Mark III BWRs. Though the effect of these requirements on the calculated risk is small, they were intended to provide additional assurance, pending generic resolution of severe accident issues, that these types of plants could be safely shut down following degraded core accidents. Thus far the Commission has imposed these requirements on 5 plants in individual licensing cases following detailed plant reviews. The Commission requested the NRC staff to prepare a rule that codifies the regulatory position already being applied for plants on a case-by-case basis.

Although the requirement in this rule will result in substantial costs to the industry (~ $9,000,000) and the NRC (~ $300,000), the Commission has already determined in individual licensing cases that

these requirements are necessary. The net result of codifying these requirements into the NRC regulations will be to eliminate the need for redundant litigation of this particular hydrogen control issue in future licensing cases.

6. IMPLEMENTATION

6.1 Schedule

No implementation problems are now anticipated. As a result of comments received on the proposed rule, the rule has been revised to require a schedule that has been mutually agreed upon by the applicant or licensee and the NRC staff.

6.2 Relationship to Other Schedules

In view of the implementation schedule recommended, it is not anticipated that other required actions will be affected since needed personnel can be acquired or reassigned to perform the tasks.

ENCLOSURE "H"

NRC ADOPTS ADDITIONAL HYDROGEN CONTROL REQUIREMENTS

FOR NUCLEAR POWER PLANTS

The Nuclear Regulatory Commission is amending its regulations to improve they hydrogen control capability in nuclear power plants which have Mark III or ice condenser-type containments.

In the event of a loss-of-coolant accident, the cladding of the nuclear fuel could be damaged or melted and react with the reactor cooling water to form hydrogen. If sufficient quantities of hydrogen were released to a reactor containment and combine with oxygen, an explosion or fire could result in the loss of containment leakage integrity and the subsequent release of radioactivity to the environment.

The new amendments to Part 50 of the Commission's regulations require that owners of boiling water reactors with Mark III containments or pressurized water reactors with ice condenser containments assure that:

--each reactor is provided with a system capable of handling--without loss of containment integrity--an amount of hydrogen equivalent to that which would be generated if at least 75 percent of the fuel cladding melted and reacted with cooling water;

Enclosure "H"

--each reactor that does not rely on an inerted atmosphere (the oxygen in the atmosphere is replaced by a gas such as nitrogen) for hydrogen control, have safety systems--those systems necessary to establish and maintain a safe shutdown condition and maintain containment integrity--that can function after the burning of substantial amounts of hydrogen;

--analyses be performed for each reactor to support the design of the hydrogen control system and to assure the structural integrity of the containment and the survivability of needed safety systems during a hydrogen burn.

The new amendments are among a number of actions taken by the Commission since the March 1979 accident at Three Mile Island. That accident resulted in the generation of hydrogen--from the fuel cladding-water reaction--well in excess of the amounts assumed when the reactor containment was designed.

As a result of the accident, the NRC has initiated a long-term effort to determine to what extent nuclear power plants should be designed to deal effectively with accidents which result in damage to or melting of the nuclear fuel.

In the interim, however, the Commission determined that certain hydrogen control requirements are of significance to safety and that they should be implemented pending completion of the long-term effort. The initial measure requiring, among other things, inerted containments for boiling water reactors having Mark I and Mark II containments, was published in the Federal Register in December 1981.

The new amendments governing Mark III and ice condenser-type containments will become effective 30 days after publication in the Federal Register on ________________.

Implementation of the safety systems will be required based on a schedule that has been mutually agreed upon by the applicant or licensee and the NRC staff. Operating reactor licensees have already implemented these requirements and it is expected that for prospective licensees, the requirements can be met prior to or soon after receipt of the operating license.

ENCLOSURE "I"

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

April 29, 1983

Mr. William J. Dircks
Executive Director for Operations
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Dircks:

SUBJECT: SURVIVABILITY OF SAFETY-RELATED EQUIPMENT

During its 276th meeting, April 14-16, 1983, the ACRS discussed with the NRC Staff and the Seabrook OL Applicant the question of the survivability of equipment important to safety in the event of the burning of large quantities of hydrogen in a large, dry PWR containment. Current requirements for large, dry PWR containments do not include such events involving quantities of hydrogen beyond those calculated to be generated in a "well-behaved" LOCA. However, NRC Staff members present stated their belief that current environmental qualification requirements would, if met, enable the equipment of interest to survive such an event. The Applicant's representatives noted, however, that the matter had not been explicitly examined.

The Committee believes that the Staff should consider the need for equipment to be qualified to survive a large hydrogen burn in large, dry PWR containments. In particular, attention should be directed toward equipment necessary to shut a plant down, to continue to remove decay heat, and to maintain the integrity of containment for long periods. If, on reflection, the NRC Staff is of the opinion that current environmental qualification requirements lead automatically to equipment qualified to withstand such an event, please inform the Committee.

Sincerely,

Jesse C. Ebersole
Acting Chairman

001105

Enclosure "I"

JUN 7 1983

MEMORANDUM FOR: Jesse C. Ebersole, Acting Chairman
Advisory Committee on Reactor Safeguards

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: SURVIVABILITY OF SAFETY-RELATED EQUIPMENT

This is in response to your letter of April 29, 1983 regarding survivability of safety-related equipment in the event of the burning of large amounts of hydrogen in large, dry PWR containments.

The staff has recently completed evaluation of equipment survivability in the event of hydrogen burning in both ice condenser and Mark III case reviews. Based on these evaluations it is the staff's conclusion that current equipment qualification requirements for MSLB/LOCA accident environments provide high assurance of survivability in the event of hydrogen burning. A staff survey of equipment performance in the TMI-2 containment supports this conclusion.

Ongoing NRC sponsored research programs at Sandia National Laboratories and research sponsored by the nuclear industry will provide a substantially improved understanding of the conditions likely to result from the combustion of hydrogen in large, dry containments, as well as additional test data to address survivability of equipment in a hydrogen combustion atmosphere. At the present time these programs are scheduled for completion by the end of Fiscal Year 1984. In light of the protection provided by current qualification requirements, as noted above, we believe it appropriate to defer consideration of further equipment survivability requirements, if any prove necessary, pending completion of these research programs.

A recently issued EPRI report, RP 2168-3, is enclosed for your information.

(Signed) William J. Dircks

William J. Dircks
Executive Director for Operations

Enclosure:
As stated

CONTACT:
M. Garg, NRR
Ext. 27206

Enclosure "I"

ENCLOSURE "J"

MANUAL VS AUTOMATIC ACTUATION OF HYDROGEN IGNITER SYSTEMS

The following is a discussion of the advantages and disadvantages of automatic versus manual actuation of hydrogen igniter systems. Our evaluation of igniter actuation strategies has considered the following factors:

- Reliability
- Cost
- Systems Design Considerations

Reliability

Our assessment of the reliability of automatic vs manual actuation modes has principally focused on the time interval available for effective hydrogen igniter actuation. Analyses of the more probable degraded core accident sequences for ice condenser plants indicate that at least 1 hour elapses from the start of the accident until hydrogen release to the containment commences. This includes consideration of small break LOCA's as well as transients with loss of feedwater. Furthermore, numerous calculations have shown that significant hydrogen burning would not occur until about 75 minutes after onset of the accident. An evaluation of the less probable, intermediate size LOCA (6" break) indicates that hydrogen release does not begin until 25-50 minutes following onset of the accident, with an additional 15 minutes available before hydrogen burning could occur.

Degraded core accident analyses of small break LOCAs and transient sequences at BWR Mark III plants also indicate that hydrogen release to the containment begins no sooner than 1 hour after the onset of the accident. Likewise, significant hydrogen burning does not begin for another 10 to 15 minutes: Calculations for an intermediate size LOCA produce results quite similar to those for the PWR analyses.

In summary, for the more probable degraded core events (transients and small pipe breaks) there are approximately 60-75 minutes available for hydrogen igniter system

Enclosure "J"

actuation. For the more limiting and less probable case of an intermediate size LOCA, which has not been used as a design basis sequence in evaluating igniter systems, there are approximately 40 to 60 minutes available for actuation of the igniter system.

Staff evaluations of the acceptability of manual operator actions are based on the guidance provided in draft Standard ANS 58.8/ANSI N660, Revision 2, March 1981, "Time Response Design Criteria for Safety Related Operator Actions." This draft standard, which accepts operator action after 20 minutes, has not been completed by the standards organization but has been used by the staff for guidance in making licensing decisions. For example, the NRC credits manual isolation of auxiliary feedwater 30 minutes after a steam line break accident.

Even though some time following an accident will be absorbed in initiating set-points and signals, we conclude that if they have reasonable procedures to follow the operators have abundant time to manually actuate hydrogen igniters for the accidents of concern, and that even for the more remote accidents there is sufficient time for operator action. We note, however, that emergency procedures should not over burden or challenge operators with diagnostic tasks as a prerequisite to actuating igniter systems.

It would appear that automatic actuation of hydrogen igniters could be readily accomplished in the required time assuming system actuation occurs upon receipt of signals generated early in the accident (e.g., Safety Injection Signal). Without actuation system design information, it is not possible at this time to assess the reliability of automatic actuation. Single failure criterion, testability, quality assurance, maintenance, etc. would likely be required to assume high reliability of actuation.

For the Grand Gulf Mark III plant MP&L has proposed and the staff has approved the initiation of containment sprays and the drywell purge compressors, if they are not already operating, when the igniters are energized. Thus, the modification of igniter actuation modes would likewise need to recognize the other elements of hydrogen control.

Effective manual operation depends heavily upon the operator having sufficient time to initiate action. For all but the most remote accident (large break LOCAs), the operator has ample time. Nevertheless, we note that for large pipe breaks without ECCS, hydrogen release may begin in a time frame of 1-10 minutes. However, because this event proceeds so rapidly, it is not likely to be a recoverable accident; i.e., one which can be successfully terminated short of core melt. Lower probability accidents which proceed to full core melt and vessel failure are not included among the design bases for hydrogen control systems.

An additional accident sequence which poses questions for igniter strategies involves a station blackout scenario for which A. C. power is reinstated. The concern over this sequence is that loss of A. C. power leads to significant hydrogen release, and to the failure of the igniters which are A. C. powered. When power is restored dangerous amounts of hydrogen could have already accumulated in the containment. If an igniter system is manually actuated, emergency procedures may have to be written to prevent the operator from turning on the igniters following onset of a station blackout with subsequent power recovery, unless it can be ascertained that such an action would not have adverse consequences. It is not clear what is entailed in designing similar cautionary aspects into an automatic system.

On balance we believe the above discussion supports the staff's prior conclusion that manual actuation of igniter systems is acceptable. Aside from the available evidence which supports the adequacy of manual actuation, there is the underlying precept that while hydrogen control systems for degraded core accidents are required, these systems need not meet the full complement of regulatory criteria normally applicable to safety systems. We believe the approach of manual actuation properly recognizes the remote likelihood of accidents for which the hydrogen control systems are needed to provide protection. However, this should not be construed to mean that, if a utility were to propose an automatic actuation system, the staff would find it unacceptable.

Cost

Since present hydrogen igniter systems are not automatically actuated, the matter of cost has been evaluated from the standpoint of the additional cost to enhance the actuation capability of an existing system. In this regard, a utility estimate for upgrading the system to automatic status is that the additional cost would be modest. As a point of reference, the cost of current igniter systems is estimated at $100,000. Therefore, the cost involved in upgrading manual systems to automatic status is not a factor to dissuade us from further consideration of this course of action.

It is important to note, however, that current igniter systems are not required to be designed to Class IE standards and that NRC criteria require electrical isolation of non-IE systems from IE systems. The usual means of isolating non-IE loads from IE power sources is to disconnect these loads upon receipt of an accident signal (safety injection signal). McGuire has adopted this approach, thus in their design igniter actuation cannot occur until the safety injection signal is manually reset. However, for important non-Class IE systems another alternative means of isolation is the use of redundant Class IE series overcurrent devices. This alternative, which should be modest in cost, precludes the need for separation of important non-Class IE loads from the Class IE power supply by an SI signal.

Systems Design Considerations

Although igniter systems are simple in design and operation, there are systems design matters related to their actuation. The igniter devices themselves have finite lifetimes; currently, igniters installed in plants have been endurance tested for 1 to 2 weeks (168 hours). Although glow plug igniters appear to have substantially longer lifetimes as demonstrated by their use in diesel engines, their use in this application is based on 14 volts versus the 12 volts in diesel engine

application. Thus, any actuation strategy which results in the early actuation of igniters will ultimately reduce the useful life of the system since the igniters will undoubtedly be turned on in response to events for which they are not in fact required. However, this is not a significant disincentive to require automatic actuation because appropriate replacement schedules can be established for the igniter devices. This problem applies to either manual or automatic actuation, depending upon the emergency procedure (manual) or the initiating signals (automatic). One obvious means of avoiding this problem would be to use more discriminating procedures or signals (e.g., reactor vessel inventory) which more clearly indicate a potential for inadequate core cooling.

Another systems design aspect of igniter actuation is the required simultaneous actuation or shutdown of other equipment. The staff requires ice condenser plants to turn off the ice condenser air handling units when igniters are energized. Thus, conversion of an igniter system from manual to automatic would need to consider this aspect as well.

We have considered the question of linking automatic operation of the non-IE electrical system to the vital busses. NRC requirements such as those of Regulatory Guide 1.75, "Physical Independence of Electric Systems" provide for electrical isolation of non-IE and IE systems. These provisions generally require that for accident conditions non IE systems be separated from their Class IE power supplies by a safety injection signal. For non IE systems which have important functions, however, the NRC has accepted alternative isolation means such as use of Class IE series connected overcurrent devices, which preclude the need for tripping the non-Class IE loads from their Class IE supplies by an SI signal.

ORIGINAL

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

DISCUSSION OF HYDROGEN IGNITION
SYSTEM AND FINAL RULE

Docket No.

Open Meeting

Location: Washington, D.C. Pages: 1 - 98

Date: Wednesday, November 9, 1983

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Court Reporters
1625 I Street, N.W. Suite 1004
Washington, D.C. 20006
(202) 293-3950

RILEY, Riley

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DISCUSSION OF HYDROGEN IGNITION SYSTEM
AND FINAL RULE

- - - -

Public Meeting

- - - -

Room 1130
1717 H Street Northwest
Washington, D.C.

Wednesday, November 9, 1983

The NRC Commissioners met in public session, convening at 2:00 p.m., pursuant to notice, Nunzio Palladino, Chairman of the Commission, presiding.

NRC COMMISSIONERS PRESENT:

NUNZIO PALLADINO, Chairman

VICTOR GILINSKY, Commissioner

THOMAS ROBERTS, Commissioner

FREDERICK BERNTHAL, Commissioner

JAMES ASSELSTINE, Commissioner

NRC STAFF PRESENT AND SEATED AT TABLE:

R. BERNERO

W. OLMSTEAD

W. BUTLER

J. ROE

J. ZERBE

M. MALSCH

J. HOYLE

NRC STAFF IN THE AUDIENCE:

R. MATTSON

M. FLEISHMAN

V. NOONAN

DISCLAIMER

This is an unoffical transcript of a meeting of the United States Nuclear Regulatory Commission held on Nov. 9, 1983 in the Commission's office at 1717 H Street, N. W. Washington, D. C. The meeting was open to public attendance and observation. This transcript has not been reviewed, corrected, or edited, and it may contain inaccuracies.

The transcript is intended solely for general informational purposes. As provided by 10 CFR 9.103, it is not part of the formal or informal record of decision of the matters decussed. Expressions of opinion in this transcript do not necessarily reflect final determinations or beliefs. No pleading or other paper may be filed with the commission in any proceeding as the result of or addressed to any statement or argument contained herein, except as the Commission may authorize.

P R O C E E D I N G S

CHAIRMAN PALLADINO: Good afternoon.

Our meeting this afternoon concerns changes to 10 CFR Part 50 relative to hydrogen control issues inside containments of particular types of power reactors.

Since the TMI-2 accident, various changes have been made to regulations dealing with potential hydrogen generation following accidents.

The final rule before the Commission today is contained in SECY 83-357 and was initially published as a proposed rule for comment in December 1981.

Changes in the rule in response to comments received have resulted in the final rule being applicable only to Mark III BWRs and ice condenser PWRs.

It is my understanding that both the Research and NRR intend to address the Commission today. Research will discuss the final rule itself, and NRR will speak on the subject of hydrogen released from the Mark III BWRs.

Unless any of my fellow Commissioners have any opening remarks, I will turn the meeting over to Mr. Bernero.

MR. BERNERO: Thank you.

Good afternoon, Mr. Chairman. I am here sponsoring this final rule on hydrogen control for the two types of plants you mentioned, and here from the Staff as

well today we have Roger Mattson, who is the principal division director relating to this topic in the Office of Nuclear Reactor Regulation.

I will give you a presentation -- may I have the first slide, please?

(Slide.)

I will give you a presentation that follows this outline.

Slide No. 1, please, Debbie.

First I'd like to give you some background on the rather complex history of this rulemaking and a summary of the types of plants which are affected by it, by this particular rulemaking.

Then I will go into the rule status, the features of the rule, how we got there, the decision rationale, and the residual questions that remain in this rulemaking, and then Dr. Walter Butler of NRR Containment Systems will speak to the question of hydrogen release rates, and how we model them and calculate them today.

In addition, if time remains and the Commission is interested, Dr. Butler is prepared to speak on manual vs. automatic actuation of hydrogen igniters. There is an appendix dedicated to this subject in the Commission paper, Appendix J, and he can also give you the status of hydrogen control for ice condenser containments and also for Mark III

containments as we go along in licensing work.

He is prepared to speak to all those three subjects.

In addition, there is one other important subject in this rulemaking, and that is the issue of qualification or survivability of equipment. You know, the resistance to the effects or environment of hydrogen combustion. And Vince Noonan from NRR Equipment Qualification who is the Staff leading technical expert on this is here to speak to that issue in any depth that you would like.

Also --

CHAIRMAN PALLADINO: I should point out that at least one Commissioner has expressed interest in the automatic vs. manual, and I would be interested also.

MR. BERNERO: Well, we will have that capability.

CHAIRMAN PALLADINO: I would like some amplification of what requirement is associated with survivability as opposed to qualification.

MR. BERNERO: Okay, I'm sure Mr. Noonan is prepared to fill in the general remarks that I will make in the basic presentation.

And lastly, for your information, I have appended to the viewgraph list to the charts, the last two charts are a table of ongoing research that is either directly or indirectly related to hydrogen control work, and it is

there for your information. I don't intend to go into any briefing on that subject.

May I have Slide No. 2, please.

(Slide.)

If we go into the background of this issue, I think the best way to start is to recall that the big surprise, or a big surprise at TMI was that containment was challenged not by the less than 5 percent hydrogen -- less than 5 percent metal/water reaction that one would calculate from our then-existing regulations, but rather in that accident there was about 50 percent metal/water reaction, a large amount of hydrogen was free in the containment, and somehow ignited shortly after noon on the first day, and caused a pressure pulse in the containment. And that surprise, that fact that our regulations didn't recognize that sort of an accident, gave us, gave the Commission the aegis to go forward with rulemaking considerations related to hydrogen control and other severe accident issues, issues related to what were then called degraded core conditions.

There was in the fall of 1980, late in calendar year 1980, a pair of advance notices or Federal Register notices that went out. One was an advance notice of rulemaking that I indicate here first. It had 18 questions related to degraded core conditions, and it addressed the

full spectrum of accidents; that is arrested degraded core accidents, as well as ones that went to full scale coremelt.

Accompanying it, back to back in a separate but associated Federal Register notice, was a proposed rule called the Interim Rule for Degraded Core Cooling Accidents, and that rule proposed inerting Mark I and Mark II containments, the boiling water reactor Mark I and Mark II containments, and it had other things that were mostly hardware-related within it; high point vents for plants, in order to vent gases, including hydrogen, from the reactor coolant system, to avoid binding the cooling -- the coolant circulation.

And the logic that was taken at the time was a rather crude approximation. It said if TMI had about 50 percent cladding reaction -- metal/water reaction with the clad, it would probably be a good idea to have a little more margin and let's say 75 percent ought to be the right assumption for existing plants that were going to do something on hydrogen control.

(At 2:09, Commissioner Gilinsky entered the meeting.)

Another rule that was coming up at that time related to the construction permit manufacturing license, the possibility that other plants might still get construct permit or manufacturing license.

That rule, which was published in proposed form in March of 1981, included hydrogen control but there because of the future character of the plants, there was a relatively arbitrary selection of 100 percent metal/water reaction.

Keep in mind that the context of all these percent selections, whether 50 percent or 75 or 100, was entirely in the context of TMI-like accidents; that is, where the accident goes to a certain extent and then is turned around, is arrested. It does not go to full-scale coremelt, and one is trying to deal with the hydrogen threat as in TMI, rather than a full scale coremelt threat.

That is an important point because when people debate hydrogen generation rates and systems to control it, many analyses indicate that when you get out to the regime of 20 or 30 or 40 percent metal/water reaction, it is very likely that you will melt the whole core.

The TMI accident was peculiar in that the cooling water was turned off, turned back on, turned off, turned back on repeatedly, almost to maximize the amount of metal/water reaction you could get before you melted the core. It was a peculiar scenario.

So, remember that the entire context of hydrogen control is for arrested core accidents.

The last rule listed on this slide here, the

proposed rule for pending operating licenses, came to the Commission with hydrogen control features and hardware features still in the same rulemaking package. And at this point the Commission chose to separate --

COMMISSIONER GILINSKY: Let's see, why is it for arrested -- what did you say, coremelt accidents?

MR. BERNERO: Oh, because in the -- arrested sequences. Those sequences that have stopped short of full coremelt.

COMMISSIONER GILINSKY: Why is that?

MR. BERNERO: In the context after TMI, in the way these rules were put together and considered by the Commission, the intent was for the interim rulemaking, which was hydrogen control, to address arrested sequences and for the long-range consideration addressed by the advance notice listed first, to deal with the full coremelt sequences as well as the resident sequences.

COMMISSIONER GILINSKY: Now it's true that the effectiveness of these measures is much greater if you don't go to coremelt, but it seems to me it would help even there.

MR. BERNERO: Oh, this is not to say it wouldn't help. However, you must recognize that when you go to a full-scale coremelt, you have many other sources of hydrogen You have metal/water reaction with other metals in the

reactor coolant system; you can generate appreciable amounts of hydrogen from reactions with concrete, you know, molten core reaction with concrete; you can get many other factors that get into it.

The hydrogen control systems in these regulatory packages, starting with the first interim rule, are addressed to arrested sequences. They are addressed to hydrogen as the dominant threat.

COMMISSIONER GILINSKY: Well, that's right, but I think it's worth making the point that they could well be helpful in more serious circumstances, too.

MR. BERNERO: Oh, yes. Definitely so. But their regulatory context is the arrested sequence.

CHAIRMAN PALLADINO: Or their design basis.

MR. BERNERO: Well, not quite that -- it's in the gray area. It's not really design basis.

COMMISSIONER GILINSKY: But at any rate, that is what they addressed specifically to deal with. But it seems to me, given all the uncertainties of what might happen -- and we hope of course we'll never have to face such circumstances, but it might well be very useful then, too, because after all you'd like the containment to stay together as long as possible, and perhaps stay together altogether.

MR. BERNERO: Yes, certainly.

CHAIRMAN PALLADINO: That is the basis on which you design your hydrogen control, or do I misunderstand?

MR. BERNERO: The hydrogen control systems are designed on the basis of the steam and hydrogen mixtures associated with accident scenarios that go up to a point and stop.

CHAIRMAN PALLADINO: I just wanted to clarify it, that I understood.

MR. BERNERO: May I have the next slide, No. 3, please.

(Slide.)

In December 1981, then, after having separated the hardware matters -- those were associated with NUREG 0737 -- they went into separate administrative action by the Commission and Staff -- the final hydrogen rule which inerted Mark I and Mark II containments dealt with recombiner capability and added high point vents for all plants.

That action was taken December 2nd, 1981, and shortly thereafter on December 23rd, 1981, there was put out the proposed rule for the Mark III and ice condenser containments, essentially the matter before you today.

CHAIRMAN PALLADINO: But the December 2nd one required of all reactors recombiner capability in a high

point vent?

MR. BERNERO: Well, on certain reactors it involved recombiner systems, yes. It had some specific requirements there --

CHAIRMAN PALLADINO: Unless they were inerted.

MR. BERNERO: All reactors had to have high point vents, that was the -- the one general requirement in there, high point vents for all reactors. And then, of course, inerting, using nitrogen gas for Mark I and Mark II containment reactors.

Now, this proposed rule that went out in December 1981 covers Mark III containments and ice condenser containments and deals with the question of equipment qualification or survivability, and that is a tough issue because of the terminology and meaning thereof, and at that time there was a dialogue with the Commission on how could we get a source term, that is the steam and the hydrogen as a function of time, that could be used to design hydrogen control systems? Would we be going out and having every reactor owner dream up his own scenarios and his own source terms, and we would have all sorts of calculations and it would be chaos.

And what we did in that rule is we proposed three methods and we engaged the Staff in contractor service to put out a NUREG document which is part of the background

of this rulemaking, it's NUREG/CR-2540. We developed three different approaches for estimating the hydrogen challenge to the containment; that is, the rate at which hydrogen and steam would come out and appear in the containment and threaten, of course, ignition or detonation.

Those three methods were put out for comment along with that supporting technical document I mentioned as part of the rule.

COMMISSIONER GILINSKY: Now what did the equipment qualification cover?

MR. BERNERO: Well, at that time I was going to go into it, that it covered the -- it used the term "survivability" as different from "qualification," and it spoke of a two-step process.

We are going to get into that, and Vince Noonan is here to speak to that specifically.

COMMISSIONER GILINSKY: Well, what categories of plants did it cover?

MR. BERNERO: Oh, this covered these plants. And it covered the issue of survivability in the face of and subsequent to hydrogen burning.

COMMISSIONER GILINSKY: It only covered the Mark III and the ice condenser plants?

MR. BERNERO: Yes. And it was specific to this issue of hydrogen control. It wasn't the overall

equipment qualification rulemaking.

MR. MATTSON: Bob, it covers all plants.

CHAIRMAN PALLADINO: Get up and --

MR. MATTSON: I think maybe Bob misspoke. Hydrogen problem for environmental qualification is meant to apply to all reactors, not just the Mark IIs and Mark IIIs.

COMMISSIONER GILINSKY: The reason I asked is the rule that you have proposed to us restricts that to Mark IIIs and ice condensers.

MR. MATTSON: Well, somebody's got to straighten it out, because they're saying I've got it wrong.

COMMISSIONER GILINSKY: Well, in any case, I didn't follow the logic in restricting that to this category of plants.

CHAIRMAN PALLADINO: Well, why don't we see if --

MR. BERNERO: Could we ask Mort? Mort Fleishman is the architect of the rule.

COMMISSIONER GILINSKY: I'm glad he's here.

MR. FLEISHMAN: In the proposed rule, the equipment qualification survivability was supposed to apply to all plants, Mark IIIs and ice condensers, essentially to all plants that were not inerted. It was supposed to include the large drys as well.

In this final rule, as a result of many comments from the public and as a result of ongoing research, we have

restricted the rule to only the Mark IIIs and ice condensers. It does not cover the large drys.

COMMISSIONER GILINSKY: That's precisely the way I understood it.

MR. BERNERO: The whole issue of the hydrogen threat and the associated equipment qualification or survivability requirement in large dry containments is deferred, since the beginning --

COMMISSIONER GILINSKY: On the basis of what?

MR. BERNERO: Because of the --

COMMISSIONER GILINSKY: Not since the beginning, because it was in the proposed rule.

MR. BERNERO: No, no. The hydrogen threat for large dry containment was not included in the original rules --

COMMISSIONER GILINSKY: I thought you said it was.

MR. BERNERO: Please. The hydrogen threat -- not the question -- I'm not addressing the question of equipment qualification or survivability. I'm talking about hydrogen control. The idea of having hydrogen control for large drys, the logic at the beginning was for large dry containments we will deal with that later in the long range consideration because large drys have inherently more capacity, we've got the data from TMI.

COMMISSIONER GILINSKY: It's not a big problem in

the --

MR. BERNERO: Not a big problem.

Then the rule had equipment qualification and survivability for large drys as just one facet of it, whereas here in this rule -- and the logic was, well, why deal with one facet of the large dry problem here, why not defer that --

COMMISSIONER GILINSKY: You're dividing problems into large drys and small drys or small wets, or whatever. The problem is hydrogen. Now it affects the small containments --

MR. BERNERO: More.

COMMISSIONER GILINSKY: -- in two ways:

It affects them because the integrity of the containment is threatened, and also the equipment -- survivability of the equipment, whatever the word you want to use, is also threatened. It affects the large dry containments in another way by threatening the survivability of the equipment.

Now I just cannot understand why you would not include all of these in one rule.

MR. BERNERO: It threatens large dry containments in both ways. It's just judged that -- and there was a great deal of comment to this effect, that it is logical to deal with both challenges, both the question of containme challenge and the question of survivability together.

COMMISSIONER GILINSKY: We're not going to deal with the threat of containment challenge, because there is not a big threat to the large dry containments.

MR. BERNERO: And the argument is that there is not a big threat to survivability, either.

COMMISSIONER GILINSKY: So what are you talking about doing -- well, is it different in the small containment?

MR. BERNERO: Yes. It is widely believed to be different than -- less of a threat to small containments.

COMMISSIONER GILINSKY: Well, I guess I'd like to hear about that. That would be something you could --

MR. BERNERO: And the principal experience --

COMMISSIONER GILINSKY: Incidentally, what is your relationship to this paper? We had a little discussion earlier today about who is responsible for these papers.

MR. BUTLER: We addressed that.

MR. BERNERO: Yes, at the beginning.

COMMISSIONER GILINSKY: I wasn't here. I apologize.

MR. BERNERO: I am the sponsor of it. My Division of Risk Analysis is the sponsor of this paper, and Mort Fleishman, who just spoke, works for me.

COMMISSIONER GILINSKY: Has Bob Minogue signed off on this paper?

MR. BERNERO: Yes, Bob Minogue is the --

COMMISSIONER GILINSKY: Have the relevant other offices of the Staff dealt with it?

MR. BERNERO: NRR is intimately involved in it, and one of the principal speakers.

COMMISSIONER GILINSKY: It would be nice if it was reflected at least on the title page of this paper.

MR. BERNERO: Well, what we usually do is put -- Mort Fleishman's name is there.

COMMISSIONER GILINSKY: Well, Mort -- you never know whether a man is a telephone operator or --

(Laughter.)

MR. BERNERO: He is a senior professional.

COMMISSIONER GILINSKY: I appreciate that, but I think his role ought to be a little more enhanced, as should yours, and those of the other technical offices.

MR. BERNERO: Well, okay.

The logic, once again, getting back to large dry containments, is that both the threat to containment and the threat to the further functionability of equipment after a hydrogen burn, are lesser in the large dry containment than they are in the smaller containments like these and therefore it is logical to do them all together.

COMMISSIONER GILINSKY: I did not see that in the paper. Is that covered in the paper?

MR. BERNERO: I thought it is there.

COMMISSIONER GILINSKY: If you can direct me to that, I'd appreciate it.

CHAIRMAN PALLADINO: I think you say it, but you don't explain why you drew that conclusion.

COMMISSIONER ASSELSTINE: That's right. That's right.

MR. BERNERO: There was mention of the TMI experience as the --

CHAIRMAN PALLADINO: The basis for your conclusion was not in there. That's one of my questions. I'm not saying your statement may not be right, I just don't have a basis for it.

(At 2:25 p.m., Commissioner Bernthal entered the meeting.)

MR. BERNERO: I just remember the citation of TMI experience as the only thing that I recall in the paper.

COMMISSIONER ASSELSTINE: I gather you pin some of it on 50.49, as well.

CHAIRMAN PALLADINO: That's right.

MR. BERNERO: Well, yes, because -- you know, there is a good deal of experience growing to say that if you are qualified for main steamline break and LOCA and things like that --

COMMISSIONER GILINSKY: But isn't that true of the others, too?

MR. BERNERO: Yes, except that when you get to the smaller containments, all of these temperature effects are exacerbated because of the small containment. It's not --

COMMISSIONER GILINSKY: You're going to keep these things down with all this -- you know, by controlled ignition and periodic cooling?

I'm not persuaded at all, I must say.

CHAIRMAN PALLADINO: Mort has something to say.

MR. BERNERO: Mort, do you have a reference?

MR. FLEISHMAN: Well, the ACRS did raise this question. We covered this in Enclosure I, and it was a Staff response in Enclosure I from Dircks to Ebersole on that subject.

COMMISSIONER GILINSKY: Let's see. Okay.

MR. BERNERO: Way near the end.

COMMISSIONER GILINSKY: Well, I see it was the subject of -- well, the ACRS, at any rate, thought that -- the Committee believes that the Staff should consider the need for equipment to be qualified to survival in large hydrogen burn in large dry PWR containments. So I guess they were not persuaded.

MR. BERNERO: And the comment letter is in the second paragraph.

COMMISSIONER GILINSKY: Let's see what it has to

say about this subject. Second paragraph.

MR. BERNERO: His technical credentials, he's the EDO.

COMMISSIONER GILINSKY: No, I appreciate that.

Right here, it says the Staff agreed to a complete evaluation of equipment survivability in the event of hydrogen burning in both ice condenser-Mark III case reviews. Based on these evaluations it is the Staff's conclusion that current equipment qualification requirements for NSLD/LOCA accident environments provide high assurance of survivability in the event of hydrogen burning. The Staff survey of equipment performance in the TMI-2 containment supports this conclusion.

You seem to be saying it applies to all the plants.

MR. ROE: No.

COMMISSIONER GILINSKY: Oh, I see. Ongoing --

MR. BERNERO: No, the only argument here is this deferral of the issue for large dry containment.

COMMISSIONER GILINSKY: That's not an argument. That's a deferral.

MR. BUTLER: But the decision to defer is based on a consideration of the fact that when you have a very large volume to burn the same amount of hydrogen, the energy density is lower and therefore the impact on any piece of equipment is less than in a smaller containment.

It's pretty much a judgment call and the proposed rule required that all large drys perform analyses that we felt were rather expensive and need not, in our judgment, be done now.

COMMISSIONER GILINSKY: You may, since you don't have any control, any burning control in the large containments, you may burn at a higher percentage of hydrogen.

MR. BUTLER: That is true, you would get one big burn instead of a series of small burns, given an igniter system, yes.

COMMISSIONER GILINSKY: I think it is just unclear. I must say logic suggests to me that that aspect of the problem ought to be dealt with uniformly.

COMMISSIONER BERNTHAL: Well, I'm sorry, this must be a -- not totally an exact science. I mean the amount of the energy released is something certainly that you can calculate for the volume that you have and the conditions under which you can achieve a burn. Isn't that true?

MR. BUTLER: Yes, but nevertheless some measure of judgment here is needed. If you have one large burn, presumably you could achieve higher temperatures locally, but the time at high temperature is less when you have the combustion of the same total amount of hydrogen in a large volume vs. combustion of that amount of hydrogen in a smaller

volume. And it is on that kind of argument that we judge it appropriate to defer all these detailed analyses for the large drys.

COMMISSIONER GILINSKY: Well, what sort of details are there to analyze? I mean, at most it is a factor of two.

MR. BUTLER: Well, there have been substantial --

COMMISSIONER GILINSKY: Because you don't have a set of igniters in there, you may be burning, as I said, at higher levels of hydrogen. I guess I just don't know what the consequences of that are, but I must say that one or two passing references to TMI don't persuade me, particularly -- and apparently the ACRS was not persuaded. I don't want to tie up the meeting --

COMMISSIONER ASSELSTINE: Or if they're that persuasive, they ought to apply to the others as well.

COMMISSIONER GILINSKY: I don't want to tie up the meeting on this point.

CHAIRMAN PALLADINO: No, but it is an important point. This one I stumbled on and didn't have a real good basis to understand why you made this statement.

COMMISSIONER GILINSKY: We seem to be sort of sheltering the others. Is there some big problem?

MR. BERNERO: No. No. The judgment that was made was principally to deal with the entire universe of the hydrogen problem in large drys all at once, and the

argument was persuasive to the Staff.

COMMISSIONER GILINSKY: But there's not much to deal with. There's not a structural problem, from what I can tell. So it's just this survivability question, and we ought to deal with it here. And we either think there is a problem or we don't think there's a problem.

MR. BERNERO: We believe that it's less of a problem for the large dry, just as hydrogen control itself is less of a problem, and that's why it was deferred.

MR. MATTSON: There's one other factor besides the technical factor that I think has been well described. You've got the essence of the choice that you have to make.

The resource factor is another one that entered our minds. If there are 50 or 40 large dry containments in operation, if you went with the rule as it was posed, then each of them would take 75 percent metal/water reaction over some period of time. They would analyze potential ignition sources within the containment. They'd make some judgments about when the ignition occurred and what the consequences of it were. They'd look at equipment, look at survivability, they'd write all that down, they'd send it in for us to look at.

One of the comments -- and I don't remember, I think it was made by several people, but the flavor of some of the comments was that there was a lot of ongoing work in

the NRC research program with the big hydrogen doer at Nevada; that there was a lot of analysis underway in connection with the severe accident program, some of it inside NRC in Bernero's research program, and some of it in industry, in IDCOR's reference plants, several of which are large dry containments. And that that analysis would likely be able to show us ways to make conclusions about critical equipment survivability in large dry containments that were much easier to judge, much more efficient to judge, generically than plant-specific. And that since there was such a burden of calculations out there in the industry already with things like emergency procedure guidelines still under development, and what-have-you, we'd be zapping the same people.

So the deferral was, can it be justified, given that benefit that you'd get from it, how long does it take to get these other things finished. The tests at Nevada are well underway and probably most of --

COMMISSIONER GILINSKY: Well, what are the tests in Nevada doing?

MR. MATTSON: The large space with hydrogen injected with burns conducted at various concentrations, with typical safety equipment located in there.

COMMISSIONER GILINSKY: These are survivability tests/

MR. MATTSON: Yes. Yes, it's primarily compartmentalization, stratification, survivability of equipment. It covers a number of bases within the experimental program.

And remember, we shared some of this with you --

CHAIRMAN PALLADINO: In the big sphere?

MR. MATTSON: Yes, the --

MR. BERNERO: It's an EPRI program with which we participate.

MR. MATTSON: I think more than a year ago we shared with the Commission the view that these generic ways to approach the large dry, especially in light of the survivability of equipment that was demonstrated at TMI, plus the fact that you are able to show the equipment isn't more challenged by hydrogen than by main steamline break, for example, in the small containment -- and I bet you've talked about that isn't exact proof -- but those kinds of things, coupled with these other programs coming along about to conclude, the IDCOR results becoming available now, the Nevada tests are being finished now, that we could make a decision generically this year and why put all of those plants through that exercise of doing all those plant-specific calculations?

It's a judgment call, as Dr. Butler said, but it's a choice you have to make. In the proposed rule you

said make them do the analysis, and we thought that was the way to do it. In view of the comments and in light of these other things ongoing, we thought it made more sense to wait, since the risk for large drys isn't as large as it is for the ice condenser and smaller containment.

COMMISSIONER GILINSKY: Well, wait a minute. When you say the risk, the risk to the survivability of equipment is -- it depends on how you come out on the difference -- is roughly comparable, within a factor of two, at most.

But --

MR. MATTSON: And that's why we didn't say don't do it at all; we said you can wait.

MR. BERNERO: Those arguments Roger just made were in the third paragraph of that response to the ACRS. We made that same point there.

COMMISSIONER GILINSKY: Well, I'd be interested to know whether you persuaded them.

MR. BERNERO: They did not come back afterward.

COMMISSIONER GILINSKY: What do you draw from that? Like Roger once said, they were all nodding.

(Laughter.)

MR. BERNERO: Tacit consent.

CHAIRMAN PALLADINI: I thought there was also a point that the qualifications test, or if the components

pass the qualification test, that they would certainly survive a hydrogen burn because your temperatures are lower.

MR. BERNERO: Likely to. Very likely to.

CHAIRMAN PALLADINO: Is this what we are talking about?

MR. BERNERO: That's part of it. That's part of the reason that one can feel reasonably comfortable deferring something like this. The larger --

CHAIRMAN PALLADINO: That's the part I didn't understand.

COMMISSIONER GILINSKY: I guess I'm just not persuaded there's a difference between those and the other plants.

CHAIRMAN PALLADINO: Well, you did provide a basis for that statement.

MR. BERNERO: May I have Slide No. 4, please.

(Slide.)

I think it might be useful here to look at a summary slide for hydrogen control. We are dealing here with five different types of containment. We have lumped subatmospheric containments with large dry containments under the last column there, dry. And then coming from the right to the left, the ice condenser containment, IC, and then the Mark I, Mark II and Mark III boiling water reactors.

The construction permit manufacturing license rule of 1982, that called for hydrogen control based on 100 percent cladding reaction with a control system to keep hydrogen concentration below 10 percent, and the assumption of uniform distribution. That's the way that rule went out. And therefore, no local concentration.

It also called for a minimum containment design pressure of 45 psig.

Now if you note the plant population there, five Mark IIIs, two ice condensers, and five dry containments, those are the plants most affected by later deferrals and calculations, so that, you know, this list of all plants is 172 plants. It does not reflect the deferrals and calculations since we started this rulemaking effort.

The hydrogen control rule of December '81 affected by the inerting requirement approximately two dozen Mark I containments and two dozen Mark II containments, which is the full population there, and the recombiner capability requirements go across the board, as well as the high point vents.

CHAIRMAN PALLADINO: The recombiner capability also applies to large dry containment?

MR. BERNERO: Yes. Now by the way there is a typo there. The footnote is 50.44, not 50.54.

CHAIRMAN PALLADINO: There's more that's not

clear in the footnote. It says required either recombiners--

MR. BERNERO: Or purge represurization systems.

CHAIRMAN PALLADINO: I thought that we wanted recombiner capability for those that use purge systems. Didn't we?

VOICE: No. I thought it was either/or.

MR. BUTLER: The original version of 50.44 required these plants to have recombiners installed. Unless they are a very old series of plants, these are grandfathered plants, inwhich case purge repressurization systems would have been acceptable.

We subsequently amended the rule to require a recombiner capability for those plants that relied on the purge repressurization system as their primary means of hydrogen control.

CHAIRMAN PALLADINO: That's what I meant.

COMMISSIONER GILINSKY: Why do we want recombiners?

CHAIRMAN PALLADINO: Let me just finish here, because the footnote is not clear. It says see to the one or the other and we required recombiners for those plants where purging was a primary method of control.

MR. BUTLER: Yes. I guess one would have to say here that the original version of 50.44 required either the recombiners or the purge repressurization. It was subsequently amended to say that those plants that relied

primarily on purge repressurization system would be required to provide the recombiner capability.

COMMISSIONER GILINSKY: Why do we require recombiners?

CHAIRMAN PALLADINO: Recombiner capability.

COMMISSIONER GILINSKY: Capability. Recombiner capability. What is that designed to do?

MR. BUTLER: There is a SECY discussion paper on that of a few months ago and its primary thrust was to provide the operator of the plant with the option of not venting the containment to deal with hydrogen generation.

COMMISSIONER GILINSKY: Now, let's see. Why is he worried about hydrogen generation in a large dry containment?

MR. BUTLER: Because for design basis accidents, you do not want to have any combustion of hydrogen in the containment.

COMMISSIONER GILINSKY: Why?

MR. BUTLER: Because design basis accidents tend to be more frequent in nature. You do not wish to challenge the essential equipment with the temperatures associated with hydrogen burns.

We are willing to accept that challenge --

COMMISSIONER GILINSKY: When you say design basis, you're talking about a LOCA but with ECCS functioning?

MR. BUTLER: To some measurable --

COMMISSIONER GILINSKY: To sort of 1 percent of

the cladding or something like that?

MR. BUTLER: Yes.

COMMISSIONER GILINSKY: Or a few percent of the cladding?

MR. BUTLER: 1 to 5 percent metal/water reaction.

COMMISSIONER GILINSKY: Combining with steam?

MR. BUTLER: Yes.

COMMISSIONER GILINSKY: And that is what we are dealing with here?

MR. BUTLER: Yes. The recombiner capability is primarily directed at design basis accidents or something slightly more severe, but not the degraded core accidents that we have been talking about today.

COMMISSIONER GILINSKY: And how much hydrogen can you get? What's the percentage, what concentration, in a design basis accident?

MR. BUTLER: Well, you can go slightly above 4 percent, 4 to 6 percent.

COMMISSIONER GILINSKY: Do you get a burn at 6 percent?

MR. BUTLER: Yes. However, you go above 4 percent at a very slow rate.

COMMISSIONER GILINSKY: So you could hardly get a burn. I mean I know our rule doesn't say 4 percent. I thought that you sort of switched over in terms of thinking

of 8 percent.

MR. BUTLER: 4 percent is the lower flammability limit that we have been working with, and to prevent any combustion of hydrogen we have required the use of recombiners which is a very slow technique of cleaning up the containment of the hydrogen.

COMMISSIONER GILINSKY: Well, I think it's really a relict from the time when we never thought you were going to get much hydrogen at all. At that time we used to worry about 4 percent. Now that we know you can get a lot of hydrogen, we --

CHAIRMAN PALLADINO: But this is where we stand now.

COMMISSIONER GILINSKY: And I'm worried about larger amounts somehow, and that's dealing with the equipment problem. In that case I guess I --

CHAIRMAN PALLADINO: This still leaves your question about the hydrogen large dry containments, justifying the basis for eliminating it. But this is where we stand on that rule.

MR. BUTLER: The rule does require hydrogen control for small amounts of hydrogen. It just does not require specific pieces of equipment to deal with large amounts of hydrogen.

COMMISSIONER GILINSKY: Well, I guess I'm surprised

that we worry about small amounts and not large amounts.

MR. BUTLER: The argument for that is that we think that the design basis accidents have greater probability of occurring than degraded core accidents.

COMMISSIONER GILINSKY: Well, I realize that, but it doesn't sound to me like the small amounts are remotely as serious as the large amounts.

MR. BUTLER: It might help to say that the small amounts of hydrogen cover not only the sources from metal/water reaction, but also radiolysis, corrosion, et cetera.

COMMISSIONER GILINSKY: How can you say that those are more likely, but we haven't experienced one of those, and we have experienced one of the others?

CHAIRMAN PALLADINO: We have had LOCAs, but they --

COMMISSIONER GILINSKY: Not LOCAs with hydrogen forming.

CHAIRMAN PALLADINO: No, we haven't had --

COMMISSIONER GILINSKY: So it makes you wonder which is more likely.

CHAIRMAN PALLADINO: I thought we were talking in terms of survivability. I believe the equipment survived that.

COMMISSIONER GILINSKY: You're telling me the one we haven't had is more likely? I mean that's not to say

that it's logically wrong, but experience suggests that we ought to take pretty seriously the possibility of being faced with --

COMMISSIONER BERNTHAL: I must say I wonder, too, because isn't the time between the small event and the large event very short, basically? I mean is that a factor? If you reach the threshold of the smallevent, then I would assume with very little extra effort you reach the the threshold for a large event.

MR. BERNERO: It's really a different scenario. What you are talking about with the -- with scenarios in which a recombiner can be effective to deal with hydrogen, for example, you are talking about things like a LOCA wherein the ECCS worked. It was a mitigated LOCA and there is a slow generation of hydrogen and a slow device like a recombiner can cope with it.

end 1

It's a way of insuring that you don't reach flammability or, if you come close, getting you away from it -- cleaning it out.

In the degraded core accidents, the recombiners are -- are just nowhere near capable of coping with that. It's much too rapid, much too rapid. They're really different scenarios.

COMMISSIONER BERNTHAL: I understand they're different scenarics, but I'm really getting to Victor's point of wondering whether the probabiltiy is really accurately reflected in what you've said, whether it really is --

MR. MATTSON: Let me try. I don't think it's really a probabilistic argument, Walt. Maybe I can try something a little different.

When you talk to the Licensing Staff and you say "design basis accidents," then you mean something very special to us. You mean the conservatism and the margin that's in a stylized set of unreal events that we analyze in the licensing process to make sure that that plant has a margin of capability to deal with the broad spectrum of events that's impossible to forecast.

Real events are from a wide array of permutations and combinations of operator and plant response.

So, there's this stylized set -- classical set -- of design basis accidents, Chapter 15 of the FSAR. And the

theory behind that stylized set is that there's margin, there's conservatism -- in picking the events, in failing equipment, in modeling the events, in analyzing the results -- to provide a capability to deal with other events we can't foresee.

MR. BERNERO: And it says nothing about frequency; is that what you're saying?

MR. MATTSON: They were developed with some thought about frequences, but no specification of frequencies. They grew up over the years, over 30 years of regulations. And they didn't get done in any systematic probabilistic way.

The people, down through the years, suggest we ought to go back and do that. But it's never been done.

So, what you have is a need to deal with hydrogen that's generated by an accident that's beyond that envelope that's thought to present a particular challenge to the containment, namely hydrogen, that we all felt was important to deal with because it happened at TMI.

And what's the construct of features or characteristics that you attach to that accident?

One of the things that we thought we had talked over with you several years ago at the proposed stage of this rule was that as we made this journey into beyond-design-basis accidents, in the licensing process with our regulations, we were going to try something new, which was realism and

best-estimate. That's why we invented terms like "survivability." And that's why there's a difference between what we're willing to tolerate in a degraded core accident, something with 75 percent metal-water reaction that doesn't result in a core meltdown, and, on the other hand, what we're willing to tolerate for a design-basis accident.

Our code of the hills, our standard review plan -- and we don't know any other way to think in those design-basis accidents, other than conservative.

In order to manage your licensing process, there isn't any other way that you want us to think, other than that way that people can know and understand. That's regulatory stability.

Now, what do you want in this hydrogen control rule? It's going to be a tad bit different. And it's that difference that we're having difficulty explaining and you grappling with again.

We've lived with it for the two years between proposed rule and final rule, trying to carve out some logic to describe that difference. And we think we have that logic and people can understand it.

And you're just having a little difficulty either understanding it or accepting it -- I can't tell which yet --

COMMISSIONER GILINSKY: But I think you're talking about --

MR. MATTSON: -- and Vic seems to want us to go back to the large drys and do these analyses and demonstrate survivability. And that's a good point for this rule. That is something we have proposed and have taken out.

COMMISSIONER GILINSKY: But I think you're addressing the question of survivability versus full qualification, you know, as you would in dealing with design-basis accidents. I don't think that really goes to the question of whether we ought to require survivability -- you know, that realistic standard, so to speak, in the large dry containments.

MR. MATTSON: Well, I don't want to repeat the arguments I --

CHAIRMAN PALLADINO: Let me make an observation.

MR. MATTSON: Your point was well taken -- it was a good point.

CHAIRMAN PALLADINO: I think the proposed rule does not contain provision for large amounts of hydrogen in large dry containments.

MR. MATTSON: No.

CHAIRMAN PALLADINO: I think that's correct.

Nor, in my mind, does it contain justification for not including potential large amounts of hydrogen.

Now, what we want to do about it is a question we'll have to deal with. But I don't think you have either,

either the provision for handling the large amounts of hydrogen or a justification that satisifies for not doing so.

And maybe we can leave that for the moment and then pick it up later, or we might want to reflect it in our vote sheets.

MR. BERNERO: The only other point I would make on this chart here is to show you that the two types of containment covered by this rule, Mark III and ice condenser, are the subject of this new rule, this final rule. And they are listed here, respectively, as 14 Mark IIIs and 10 ice condensers.

Deferrals in calculations substantially reduce the 14 Mark III containments -- have little impact on the ice condenser. So that that population is a little on the high side.

And the entire rule analysis, including costs, is going on the presumption of the 14.

COMMISSIONER GILINSKY: I don't understand. When you have 19 at the bottom, that includes -- what?

MR. BERNERO: The five CMPLs, which are --

COMMISSIONER GILINSKY: Which have gone.

MR. BERNERO: Yes, which have gone. Yes.

COMMISSIONER GILINSKY: Well, why --

MR. BERNERO: And even some of the --

COMMISSIONER GILIBSKY: Why are they up there?

MR. BERNERO: Well, the -- this rulemaking has spanned this whole era.

COMMISSIONER GILINSKY: I see.

MR. BERNERO: Yes. And it's just that it's all -- it's more historical than anything.

That's the very reason I'm making these --

COMMISSIONER GILINSKY: But the right number is more like 14?

MR. BERNERO: No, no. The 14 is the existing, already received CP.

But as you know, many of those ahve been deferred or canceled.

COMMISSIONER GILINSKY: And do you have any idea how many?

MR. BERNERO: I was trying to figure that out, and I think we're down to about six --

COMMISSIONER GILINSKY: I see.

MR. BERNERO: -- Mark IIIs.

CHAIRMAN PALLADINO: Are you saying the 14 is 6?

MR. BERNERO: Yes, I think -- 6.

CHAIRMAN PALLADINO: The 19 is 6?

MR. BERNERO: Yes. The 19 is actually down to 6.

CHAIRMAN PALLADINO: And what's the 14 --

MR. BERNERO: And the 14 -- down to 6.

Grand Gulf --

CHAIRMAN PALLADINO: And Perry.

MR. BERNERO: Yes. I think that there's a handy list in the OPE memo. And it --

COMMISSIONER GILINSKY: When you say Grand Gulf, was that 1 and 2 -- or 1?

MR. BERNERO: Well, 2 was -- 2 was deferred.

See, you get into questions.

COMMISSIONER GILINSKY: Well, it's obviously an imprecise --

MR. BERNERO: Perry Unit I and 2 -- then, River Bend -- there's a question of about Unit 2 at River Bend.

And Clinton -- there's a question about Unit 2.

And then the Hanford Skagit, et cetera. Those are all --

COMMISSIONER GILINSKY: Those are all filled?

MR. BERNERO: Yes.

COMMISSIONER GILINSKY: It's sort of 6 plus or minus 2?

MR. BERNERO: Yes, it's of that order.

That's why I said -- I tried to figure out whether I should say it's down to a certain number, and it's -- it's too arguable from day to day.

Now, may I have slide 5, please.

(Slide 5.)

If you look at the status of this rule, then, the comment period was extended, it expired in April 1982. The major comments are characterized here. One was to defer the entire matter to some sort of severe accident, long-range consideration, rulemaking or otherwise.

The 75 percent metal-water reaction is argued to be too high, principally for the reason that whenever you go to analyze core melt accidents that are marching along to core melt, you can't get close to 75 percent without melting the core first. And that takes it out of the jurisdiction, if you will, that's intended.

Arguments were made that the --

COMMISSIONER GILINSKY: That's 75 percent cladding --

MR. BERNERO: Cladding reaction, yes.

The arguments were also made that the requirement for containment integrity that was rather strictly ASME Code 1 method was too restrictive.

There were arguments made that tradeoffs of alternative hydrogen control systems are onerous and should not be required.

And then, in the proposed rule, there was a two-stage or two-step process for equipment qualification. It spoke of a two-step, where you would first establish something called survivability and then later revisit the subject and somehow convert to equipment qualification.

And many commenters argued that this two-step approach is impractical.

Lastly, there was an argument that the cold shutdown was inconsistent with the licensing basis for many of the plants -- these are the later generation plants -- that the cold shutdown is consistent perhaps with the newer plant -- older plants are just safe shutdown.

COMMISSIONER GILINSKY: But aren't these all newer plants?

MR. BERNERO: They're all newer plants to a degree.

COMMISSIONER GILINSKY: To a degree --

MR. BERNARO: Their argument -- that argument, that if you -- well, remember as plants are canceled, the newer plants that are deferred or canceled can include large drives.

And the large drive containments --

COMMISSIONER GILINSKY: Let me, for the moment here, make that separation between the large drives and the others -- at least within the context of your rule, it seems to me --

MR. BERNERO: Most of these are newer plants --

COMMISSIONER GILINSKY: And that cold shutdown requirement would not, I think, be inconsistent with the basis on which we --

MR. BERNERO: It's the next day, yes.

COMMISSIONER GILINSKY: Is that right or wrong?

MR. MATTSON: I would guess that D. C. Cook probably didn't have -- the first ice condensers -- but Sequoya and McGuire and Grand Gulf would all have been --

COMMISSIONER GILINSKY: So, with all but a very small number.

MR. BERNERO: Now, as far as hydrogen generation rates are concerned, there were meetings with the Mark III Hydrogen Control Owners Group on the dates indicated, and Dr. Butler is going to speak to that subject after I stop. And so I'll just defer to his remarks for that.

May I have slide 6, please.

(Slide 6.)

The principal features of this rule, then, are that it applies only to the two type containments, Mark IIIs, ice condensers; that it does require hydrogen control systems based on 75 percent fuel cladding water reaction.

There must be shown that there is no loss of containment integrity. However, two methods are permitted -- two analytical methods -- to demonstrate that. They're referred to here -- the ASME Service Level C or factored load category limits. Either way can be used.

The functioning of systems and components during hydrogen burn -- and, of course afterward -- that are needed to establish and maintain safe shutdown and containment

integrity has to be assured.

This gets you into this question of equipment qualification. And the rule speaks of it as equipment qualification, distinguishing, only in the Statement of Considerations, that the equipment qualification associated with accidents such as this, which is beyond the design basis, need not be showing as much margin perhaps as a design basis qualification should show -- in other words, a degree of margin.

CHAIRMAN PALLADINO: Does that lead to confusion if you use the same word to mean two different things?

MR. BERNERO: Well --

CHAIRMAN PALLADINO: "Qualification" means qualification, and --

MR. BERNERO: -- it can, indeed, do so.

Until you have established protocols for tests and demonstrations, you know, and what need to be -- what tests need to be done -- and that's something that develops with time and experience.

CHAIRMAN PALLADINO: I think we've had some letters that raise this question.

MR. BERNERO: Yes. Time and again in the discussion, people want to be sure. That's one of the reasons we got away from --

CHAIRMAN PALLADINO: Well, I don't understand

what survivability is.

COMMISSIONER GILINSKY: Well, it's obviously a less rigorous test.

CHAIRMAN PALLADINO: It's a less rigorous test.

MR. BERNERO: Yes.

CHAIRMAN PALLADINO: Well, how much less?

MR. BERNERO: Perhaps it would be opportune at this time for Vince Noonan to speak to the subject.

MR. NOONAN: Yes, sir. Vince Noonan, from the Staff.

In our parallel effort that we have been working on, the EQ area, where we're dealing with the main steam line breaks and the LOCA break, we have looked at the ice condenser in some detail, completing our reviews on the McGuire and Sequoyah dockets.

At the same time, back in -- when we addressed the hydrogen question, we looked at the equipment survivability question a lot of those people answered at that time.

Subsequent to that and after completing these reviews for the -- the LOCA main steam line break, we would find that today, had we done that same review on the hydroge question, the work done -- the qualifications for the LOCA and main steam line would envelope all of the requirements for the hydrogen area.

COMMISSIONER GILINSKY: What are the temperatures

involved?

MR. NOONAN: Sir, I don't know -- I have my staff here we could talk to -- but the temperatures are much higher, but they're a very short time duration. And we looked at the --

COMMISSIONER GILINSKY: What's the relevant measure, energy or what?

MR. NOONAN: Well, the question -- the way to go is on a thermal response to the equipment in question, sir. The thermal response is slow enough that it does not react to these temperatures, only at a slower rate. So, it never reaches -- it never reaches the full peak of the LOCA.

CHAIRMAN PALLADINO: Suppose you were a utility trying to implement this rule, would you know what to do with regard to survivability?

MR. NOONAN: Would I know what to do with regard to survivability?

CHAIRMAN PALLADINO: Yes. I'm trying to draw out of you what your intent is. And then once I understand it, ask you to write it down.

COMMISSIONER ASSELSTINE: Let me ask -- just ask it just a little differently.

CHAIRMAN PALLADINO: All right. Go ahead.

COMMISSIONER ASSELSTINE: You seem to be saying that equipment qualification for design basis accidents under

50.49 would do everything that would have to be done to establish survivability; is that correct?

MR. NOONAN: That's correct, sir.

COMMISSIONER ASSELSTINE: So, if you're using a survivability standard, is it fair to say that you're not imposing anything beyond what's required by 50.49.

MR. NOONAN: We're not imposing anything under 50.49.

CHAIRMAN PALLADINO: I think they said that the 50.49 is okay for large dry containments. I'm sorry, I didn't mean to bring it up again. But they didn't say that for the others.

COMMISSIONER ASSELSTINE: I know. But he seems to be saying it now. That's -- I guess that's --

MR. NOONAN: We just saying that, to date, we have looked at these -- at these reviews under equipment qualification -- and agree we have looked at the -- at the large drys.

We just haven't taken the time yet, at this point in time, to look at the particular hydrogen environments we'll authorize in detail.

But the supporting factor is right now and that we are enveloped, the 50.49 environment -- the qualification does envelope all the environments we have seen today -- not the enviroments, the thermal response of the same equipment.

CHAIRMAN PALLADINO: So, you're saying that if they meet the basic qualifications test, they have no problem?

MR. NOONAN: That is our finding today, sir.

COMMISSIONER GILINSKY: This is for the large dry containment?

CHAIRMAN PALLADINO: No, we're saying, all of a sudden, for all of them.

COMMISSIONER GILINSKY: So, there's no problem with equipment qualification?

MR. NOONAN: We would anticipate there will probably be -- we're always going to find some piece of quipment that doesn't quite meet this, and we're ready to address that on a case-by-case basis.

But I think, in general, we would support that. Our qualification program does -- does show that it survives.

CHAIRMAN PALLADINO: Are you saying a utility -- all you have to do is meet your qualification tests and you're home like --

MR. NOONAN: Not quite that, sir, no. No.

COMMISSIONER ROBERTS: Well, how would the Staff respond to a letter from the Nuclear Utility Group on Equipment Qualifications addresed to the Chairman on October 26th?

MR. NOONAN: I read that -- that particular document. I would say that the officer -- doesn't quite

understand what we're doing on the rule. He talks in terms of high concern, et cetera.

But we find that the margins -- the margins for the equipment, for the -- question -- are comfortable.

There are no --

MR. BERNERO: You'll find on page 13 of enclosure F, pages 12 12 to 13, this is spelled out -- this is in the rulemaking -- the rule package, enclosure F, the bottom of page 12 and top of page 13.

And I think it is clear. And, of course, now we've got a lot more data --

COMMISSIONER GILINSKY: Well, let me ask you this --

MR. BERNERO: -- Appendix F.

COMMISSIONER GILINSKY: -- if it is, in fact, true that current requirements already envelope what we might require under this rule?

What is it that we're investigating in that big sphere out there?

Whether that's true or --

CHAIRMAN PALLADINO: He sure asks hard questions.

(Laughter.)

MR. BERNERO: Well, I don't think anyone is proposing a regulatory finding that the EQ for main steam line break and LOCA is, by definition, sufficient. No.

This passage in the rulemaking describes how to use that data.

So, it appear to be a reasonable basis to say that it is a high likelihood, you've qualified for main steam line break, it's probably good equipment for the higher temperature, but shorter temperature pulse of --

CHAIRMAN PALLADINO: You're not sure?

MR. BERNERO: But -- but, no, there's a residual uncertainty, a residual doubt. You have to look at it.

COMMISSIONER GILINSKY: But suppose you swept the large dry containments into this rule, from what I gather they wouldn't have to do anything until these results came out and they raised some questions. I suppose you'd have to do something about it.

MR. BERNERO: No, if you -- they'd have to start work on the problem, with analysis, et cetera, right now if you swept them back into the rule.

COMMISSIONER GILINSKY: What is there to analyze?

MR. BERNERO: They would have to --

COMMISSIONER GILINSKY: Do you want them to demonstrate that --

MR. BERNERO: They would be doing hydrogen scenarios and the works, you know. This --

MR. BUTLER: Let me amplify on that. I think we're right about that.

You see, you do the hydrogen burn analysis and you get temperature responses of the atmosphere.

You then do equipment heat-up computations as a result of the burn. You determine the peak equipment temperature and compare that with the temperature to which that piece of equipment was previously qualified.

COMMISSIONER GILINSKY: I see.

So, that was his guess as to how it was all going to come out.

COMMISSIONER ASSELSTINE: So, the requirement really is an analysis.

CHAIRMAN PALLADINO: But, frankly, you are requiring those analyses for --

MR. BERNERO: For these, the Mark IIIs -- for the weaker containments, yes. But for all those people with large drives to be turning that crank --

CHAIRMAN PALLADINO: Well, let me just finish.

Then, you're saying, for those Mark IIIs and ice condensers, make the calculations. And if you happen to come up a little bit higher than the equipment qualification and thereby reduce your margin, it's okay.

MR. BERNARO: Case by case.

COMMISSIONER GILINSKY: Well, he seems to think they're all going to make it.

MR. NOONAN: Well, you know, really, it's the

Licensee submittal that we looked at on McGuire -- support that.

COMMISSIONER GILINSKY: Okay.

MR. BERNERO: So, we think the -- we think when the -- because they would have to do the calculations.

COMMISSIONER ROBERTS: What was the reason for the proposal that talked about equipment survivability?

Now you've changed that to "qualification."

Explain to me what -- what's the basis?

MR. BERNERO: Oh, the original concept was less known, and it was thought that there was a lot more logic to having what you might call Class 9 qualification. It's not equipment qualification in the formal sense, but some lesser degree of confidence, some lesser degree of assurance, because it wasn't realized at that time that we might be in better shape than people thought at the time.

And the concept was it was -- it was sort of a lesser degree of reliability of equipment, that survivability was less confidence, but just sufficient confidence that it would work.

And now that scene is a fiction, it's a misuse of terms, it's a confusion. And so that the concept of qualification, the nomenclature of qualification is adopted, and none of this two-step escalation of quality. It was just qualification.

COMMISSIONER GILINSKY: Oh, I didn't realize you were dropping that entirely.

MR. BERNERO: Now, there is no -- the term "survivability" is gone. It's "qualification." Because it was terribly confusing, people just --

COMMISSIONER ROBERTS: Well, obviously, these people are confused.

MR. BERNERO: Oh, yes, yes.

In fact, that letter -- if you look, there's a footnote that's alleged now if you meant they're the same thing, it s a whole .ot simpler.

And, of course, once they have the advantage of studying this document, they will find it clear.

COMMISSIONER ROBERTS: I'd be more reassured to hear them say that.

MR. BERNERO: I don't dispute what you said.

COMMISSIONER ROBERTS: Vote the rule.

MR. BERNERO: What's that?

Vote the rule, please.

(Laughter.)

MR. MATTSON: I hope you understand that we're giving up on the use of the word "survivable," as opposed to EQ, but we're not giving up on the concept of realism beyond the design basis -- and our conservatism within the design basis. We're going to hang in there with that, even though

this didn't turn out to be a very good example.

COMMISSIONER ASSELSTINE: And that's the difference between the meaning of "qualification" in the two contexts?

MR. MATTSON: It was, in the old context.

MR. BERNERO: Yes, that's a broader principle than merely this.

The only other features of the rule that I want to note here -- the supporting analyses --

CHAIRMAN PALLADINO: We skipped the one that gives me a problem -- that local detonations are included unless unlikely to occur.

MR. BERNERO: Yes, the rule has that thing, that local detonations are included unless unlikely to occur.

This is not a quantitative standard. There is no 10^{-7} buried in the woodwork somewhere. This is a -- in the course of review, case-by-case work, the analyst has to do the hydrogen combustion work on his containment. And if the local detonations -- if a case can be made, a persuasive case, that can be accepted. But there is no attempt here for the rule to spell out exactly what is unlikelihood. You know, it's too hard to define.

CHAIRMAN PALLADINO: It's only got a 50-50 chance. You probably wouldn't buy it.

MR. BERNERO: No. I bet you they wouldn't.

(Laughter.)

CHAIRMAN PALLADINO: All right. Suppose they say, "Well, there's only one chance in three that this could happen." That's unlikely.

MR. BERNERNO: Yes. But it's not going to be such a simple odds.

CHAIRMAN PALLADINO: I know. I'm trying to be --

MR. BERNERO: It depends what you mean by "unlikely."

MR. BUTLER: It might help just to describe the review process for relying on that provision.

CHAIRMAN PALLADINO: You see, somewhere along the line, the designer has to make a statement. You have to accept it or deny it.

And I'm --

MR. BUTLER: Well, we would expect that once this rule gets put in place that we would amend our standard review plans to relfect how we would pursue these review criteria.

And now with respect to local detonations and whether they are likely or not, we would have the reviewer examine the configuration of the containment at likely points of hydrogen release. And if there are configurations that tend to promote the production of detonations, we would require consideration of local detonations.

If, on the other hand, it is a moderately clean configuration of large volumes, very few reflective surfaces, we would then accept an argument that local detonations are not likely to develop.

CHAIRMAN PALLADINO: So, it could be a qualitative use.

MR. BERNERO: Yes. That's why it doesn't lend itself to 90-10, 50-50, or quantitative guidelines.

COMMISSIONER GILINSKY: See, this brings up a point that, in a large dry containment, you may have various areas --

MR. BERNERO: Compartments.

COMMISSIONER GILINSKY: -- volumes and subvolumes within the containment. And they may be more or less like the smaller containments.

I think the situation isn't all that clear, in terms of drawing a line between them.

That's another -- I don't know.

CHAIRMAN PALLADINO: Yes. I just want to follow up --

COMMISSIONER GILINSKY: Sure.

CHAIRMAN PALLADINO: -- one more sentence on this -- unlikely.

Again, what does a utility do or a designer do, i.. coming to you? He has to -- he has to go through that

qualitative thinking and convince you -- it's a hard way for an engineer to work, yes. And I'm thinking, what if I were trying to meet the rule, I wouldn't know how to do it.

MR. BUTLER: Yes. I think what we would do here is --

CHAIRMAN PALLADINO: You've helped me by explaining it this afternoon, but -- but it's going to have the benefit of an explanation.

MR. BUTLER: Standard review plans generally tend to be made available rather widely, and I believe --

CHAIRMAN PALLADINO: Yes. When will that be acommodated in the Standard Review Plan? Is it now?

MR. BUTLER: With respect to these descriptions, they are not in there. But I guess given a reasonable period of time, we could amend the Standard Review Plans to reflect what we intend by these provisions.

MR. FLEISHMAN: I just want to say one thing. This particular change was made as a result of comments that we received from industry. In fact, the wording is very much like they suggested.

So, they apparently feel that they understand what the words mean.

My impression is we would essentially interpret it, similar as to what was done for Seqouyah, where they show that there were no high-energy sources or that there

mixing or that there were no areas of containment where you had a geometric confinement.

That sort of qualitative discussion would convince us that thing were -- it was unlikely to occur.

MR. BERNERO: All right, Mr. Chairman?

COMMISSIONER GILINSKY: He's going to let you go --

MR. BERNERO: Go ahead.

COMMISSIONER GILINSKY: There's a question on how you initiate these control systems.

MR. BERNERO: Yes, the --

COMMISSIONER GILINSKY: We discussed it earlier -- should they be automatic, should they be manual. I gather they are manual.

MR. BERNERO: When I opened the briefing, I indicated that Walt Butler will speak to hydrogen generation rates after I stop. And he's prepared to address manual versus automatic, as Appendix J, and the status of hydrogen control in Mark IIIs and ice condensers as well if the Commission desires.

COMMISSIONER GILINSKY: I'd like to hear that.

MR. BERNERO: Yes, he'll be prepared to do that.

The only other two points I wanted to make, the supporting analyses in the present rule call for analysis to support the design of the chosen hydrogen control system without a mandate to go look at every other possible way and

do competing analyses.

CHAIRMAN PALLADINO: Could you start over again? I'm sorry.

MR. BERNERO: I'm referring to the second last bullet, the principle features of the rule.

The supporting analyses required by this rule just call for the owner to provide analyses supporting design of the chosen hydrogen control system and not some competing system analysis to show why others are not as good, and so forth.

And as far as implementation, this schedule -- implementation schedule has to be submitted within six months and agreed upon by the Staff. This is getting into the living schedule concept. The rule has been adjusted to reflect that.

CHAIRMAN PALLADINO: Speaking of analyses, I gather the Staff has not made a cost-benefit analysis regarding this final rule.

MR. BERNERO: Oh, I have a slide on that subject. I'll speak to it.

Two more slides -- yes.

COMMISSIONER ASSELSTINE: I've got one other question on the analyses.

I gather from the paper, particularly on page 8, you're giving the individual licensees a good deal of

flexibility in terms of the sequences.

MR. BERNERO: Well, basically, we recommend -- you know, before we had a sort of a shopping cart, with three different methods.

And here, what we're recommending is that they -- the use of a single scenario with variations on it -- really sensitivities for accident analysis. It appears to be a much better way to do it.

COMMISSIONER ASSELSTINE: But you are allowing them to chose the base sequence that they want?

MR. BERNERO: Oh, yes. Well, yes, but we now have fairly ample literature to test whether they've chosen the right sequence.

COMMISSIONER ASSELSTINE: I see.

Do you think the guidance is clear enough to assure that you're going to get uniformity and consistency among the different analyses?

MR. BERNERO: In the proper selection of sequence, yes, I think that's fair to assume.

COMMISSIONER ASSELSTINE: Okay.

MR. BERNERO: Yes, if you'd go to slide 7, please.

(Slide 7.)

So, the principle differences from the proposed rule -- I would just emphasize, the first one we've discusse at some length -- I even could have said defer all

requirements on dry containments, you know, both the hydrogen control and equipment qual -- revising implementation schedule. And most of these I have discussed already, so there's no need to dwell on them further.

And the very last one we just discussed from the last slide, the use of a single scenario with variations.

And as I say, in the past two years, the literature for analysis of this threat and this type of an accident has grown immensely, and it's a much better situation.

May I have slide 8, please.

(Slide 8.)

We come to cost-benefit analysis. And this is a rather interesting thing, because in a sense the entire regime of interim degraded core cooling rulemaking -- hydrogen control rulemaking, if you want to call it that -- was a Commission choice based on the TMI experience and not based on a cost-benefit analysis.

Any attempt to develop a cost-benefit analysis is likely to come up with a marginal result. TMI is an experience point, of course, you know -- this kind of accident, where the hydrogen was the threat, not the core melt.

And one should be on guard here. Whenever you go to generate a cost-benefit analysis on a severe accident like this, you're obviously going to go into the hopper of

the PRAs.

And probabilistic risk analysis is at its weakest perhaps in distinguishing what they called, back in WASH-740, hazard state number 1 and hazard state number 2 -- that is, distinguishing between the frequency or probability of severe core damage and the frequency or probability of large-scale fuel melt. Those were defined years ago, in WASH-740, as hazard state 1 and hazard state 2. And the ACRS safety goal used the same terminology.

But nobody knows how to calculate it. You can have night-long arguments about whether the sequences are most likely to be arrested or most likely to go on to a large-scale fuel melt.

Whenever you read a PRA or hear people report the results of PRA, all they are calculating is the probability of getting into a situation where severe core damage may begin. They don't really have the ability to distinguish the elegant modeling of degraded cooling and intermediate failure states and so forth to calculate that.

So, any attempt to do a cost-benefit analysis on this is likely to be doomed by that weakness.

CHAIRMAN PALLADINO: Are you saying you can't do it?

MR. BERNERO: You can --

CHAIRMAN PALLADINO: Hard to do?

MR. BERNERO: Yes, very hard to do.

You can go around the Staff, you can go around the industry, and you can get such a varied range of opinions that you can make it look great or make it look terrible. And it's all in what do you think is the probability of proceeding to large-scale fuel melt once you have entered severe core damage, what is the likelihood of proceeding.

CHAIRMAN PALLADINO: In the PPG, we're saying that a cost-benefit analysis should be made.

MR. BERNERO: Oh, yes, and we do that wherever possible.

COMMISSIONER ASSELSTINE: Yes, where it's possible to do, I think it's a good qualification.

CHAIRMAN PALLADINO: But I think that needs to be said here.

COMMISSIONER GILINSKY: Well, it's a comment on both these analyses in the PPG.

MR. BERNERO: No, I think it's a -- the Staff use it --

CHAIRMAN PALLADINO: I wasn't knocking what you qualified --

MR. BERNERO: No, the Staff use it as a good thing to do. And as you well know, we do try to do a cost-benefit analysis and carefully use risk analysis to help them out where possible.

But in a case like this, it's very difficult to do.

COMMISSIONER GILINSKY: Well, I have a question, how you evaluate your experience here --

MR. BERNERO: Yes.

COMMISSIONER GILINSKY: -- you know, where you're going to go with your calculations -- somebody straight out of school? Or are you going to listen to --

MR. BERNERO: Yes.

COMMISSIONER GILINSKY: -- what Mother Nature is telling you?

CHAIRMAN PALLADINO: If the method doesn't listen to Mother Nature, then the method is wrong.

MR. BERNERO: No, if the method doesn't have the data -- you know, if you recall a very interesting experience involving the two of us, when I first got into the Probabilistic Analysis Staff, there was an extant analysis that said it's not worth inerting Mark Is and Mark IIs -- then it's not worth doing. Because if they are proceding to core melt and not being arrested, the over-pressure failure swamps the hydrogen-induced failure, and therefore you're not working on the problem by inerting the containment.

And at that time, I think it was a sound regulatory judgment that that limited PRA analysis is not a good adviser, that arrested sequence does have a

substantial likelihood -- we've got one data point certainly -- and therefore the Commission chose to inert Mark I and Mark II containments, and that's more costly than what we're talking about here.

COMMISSIONER GILINSKY: Well, what you're saying is if we do get into trouble, it may well be this kind of trouble.

CHAIRMAN PALLADINO: Well, that's one of the troubles with cost-benefit.

But this is a requirement --

MR. BERNERO: Yes. We try to do it. We try to honor that. And I think it's a good --

CHAIRMAN PALLADINO: And I qualitatively feel the same way you do it happened.

COMMISSIONER GILINSKY: Well, I think cost-benefit analyses should not necessarily be driven to use of numbers. You know, often it's a matter of writing down the pros and cons.

There's a tendency, when you say "cost-benefit" and you require -- for people to put down numbers and particularly to stress those aspects of the analysis that are more --

CHAIRMAN PALLADINO: But I want to understand, you know. I like cost-benefit analysis, and I intuitively feel we need some hydrogen control.

And now I'm trying to see what can I do to get the best out of all the --

MR. BERNERO: Well, basically, what we've said is this. A monetized risk-reduction benefit analysis -- in other words, if I were to calculate risk very carefully before taking hydrogen control measures and calculate it afterward, that sort of cost-benefit analysis we don't think is justified.

What we have done is we have addressed cost-benfit in a much general sense and said the costs of $9 million to the industry and $300,000 to the NRC -- and of that $9 million, about 60 percent of it is actual hydrogen control equipment and installation -- that's the estimate. And for that rule, we say, okay, that's the obvious cost of the rule for going forward with these hydrogen control systems.

And the benefits? You avoid litigation in licensing cases -- some ill-defined resource saving. And the second bullet is the important one. You know that you can't get to core melt without first getting to core damage. And this, in some poorly quantified way, gives you additional aasurance of maintaining containment integrity.

It's unquantified -- my judgment, probably substantial. But I just can't give you some fancy risk number to prove it.

CHAIRMAN PALLADINO: So, you're saying --

MR. BERNERO: So, that's the cost-benefit.

CHAIRMAN PALLADINO: But a true cost-benefit analysis is difficult to do.

MR. BERNERO: Very difficult.

CHAIRMAN PALLADINO: It's not something you could do in a month or two months.

MR. BERNERO: And it's controlled, it's dominated by the fraction of severe core damage sequences that proceed to large-scale core melt. And there's a great deal of debate about that.

CHAIRMAN PALLADINO: Well, let me drop it for now. If I have any other qualms --

MR. BERNERO: Okay.

May I have slide No. 9.

(Slide.)

Let me just wind up with what is given here as questions. It's really an essential question.

end 2

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When you approach a severe accident scenario -- and here for the Mark III the question arises in particular -- you can find or postulate sequences that can give you more hydrogen or different kinds of burns or different circumstances that could lead to damage of equipment. And this goes back to the fundamental philosophy that we interpret the Commission was looking for, that the Commission wanted to address the hydrogen threat and then Chairman Hendrie, I think, in one of the meetings said to me that he wanted to take a bite out of the risk, or some words like that. Take the bulk of it. Go after the bulk of it and not try to get every single little piece of a scenario.

In fact, that's what led to this NUREG document that we published, was looking for hydrogen challenges that substantially represent the hydrogen threat in severe accidents. Now we think we have that. We think we have a rule that provides substantial protection. But there is that residual concern that you could still conjure up sequences -- and I take you back to the TMI experience, where an almost perverse turning on, turning off, turning on, turning off --

COMMISSIONER GILINSKY: How does this compare with the rate of TMI?

MR. BUTLER: The rule itself is silent on the question of rate of hydrogen release. It gives only the total amount, prescribing 75 percent of the active clad. It is up

to us, the Staff, to work out an acceptable rate.

COMMISSIONER GILINSKY: But we're talking about several hundred kilograms of hydrogen, aren't we?

MR. BUTLER: Oh, yes. The total amount, 75 percent of the active clad, in a PWR amounts to about 1500 pounds of hydrogen. In a BWR, it amounts to about 2500 pounds.

COMMISSIONER GILINSKY: So you're going to have this happen over 3000 seconds?

MR. BUTLER: Approximately, released over about an hour period, yes.

CHAIRMAN PALLADINO: TMI-2 came out over a longer period of time, didn't it?

MR. BUTLER: I don't believe we have any data on how or what the rate of release was. We believe it occurred on several occasions.

MR. BERNERO: Well, I just wanted to make the point that this is a residual question and I think it is a logical point at which to ask Walt to pick up the subject of hydrogen rates and any other subjects you wish to pursue after that.

CHAIRMAN PALLADINO: Well, we want to pursue the automatic versus manual.

MR. BERNERO: Yes. I'd like him to first take hydrogen generation rates and then go right into that. He's prepared for both.

CHAIRMAN PALLADINO: So you're saying that this rule is a little bit like putting on a helmet or work shoes when you go out in a construction area?

MR. BERNERO: Yes. I think it's substantial protection. It's not 100 percent protection against all conceivable hydrogen threats.

MR. BUTLER: Okay, Debra if we can start with the title page on hydrogen release rates.

(Slide.)

We have about five view graphs, title page, Hydrogen Release Rates.

MR. BERNERO: They were a separate package. It probably is in here. Go ahead, I'll catch up.

MR. BUTLER: At the outset, I wish to reemphasize that we're limiting our consideration here to degraded core accidents and excluding consideration of core melt accidents. In the course of defining or developing design conditions for the ignition systems, we have been working with a total reaction fraction of 75 percent of the active clad.

COMMISSIONER GILINSKY: Why not say that you are dealing with degraded core phase of any accident, or an extended degraded core phase of an accident, and -- this doesn't cope with later stages, if there are any, but it may well be useful.

MR. BUTLER: But as we try to develop the design

basis or the design conditions for the ignition system, we need a specific set of scenarios to look at. Now a specification of the release rates was --

COMMISSIONER GILINSKY: I just didn't want you to write off all these other accidents because this may be useful during the early part of those.

MR. BERNERO: We're not writing them off.

MR. BUTLER: Now modestly conservative specifications of these release rates were quite well accomodated by the ignition system in ice condenser containments. Efforts to use similar release rates in Mark I analyses uncovered a potential problem that has occupied our a ttention over the past couple of months.

Let me have the next view graph, please.

(Slide.)

Our preliminary analyses in the Grand Gulf Safety Evaluation Report, dated July '82, of the ignition system found the system to be acceptable for the first fuel cycle, pending completion of certain additional research work, by Grand Gulf and the Mark III owner's group. This preliminary analysis relied on some conservatively high prescriptions of hydrogen release rates, pretty much influenced by the prior work on ice condenser containments.

CHAIRMAN PALLADINO: Are you reading from this slide?

MR. BUTLER: These are just my notes. They do follow the view graph.

Now recent testing, by the Mark III owners, using a relatively crude, 1/20 scale model of the Mark III containment, has shown that certain essential equipment had temperatures that exceeded the qualification temperature principally because there developed some diffusion flames directly above the suppression pool. These diffusion flames developed when the hydrogen release rates exceeded some .4 pounds per second.

With this information, the Mark III owners pursued a program to determine what are the real realistic rates of hydrogen release by taking a look at real scenarios to determine whether they can back off of the more conservative specifications that they just adopted from the ice condenser work.

On the next view graph, I'll try to review what was done by the owner's group --

(Slide.)

-- using the BWR HEAT-UP code in analyzing the Mark III containment. This is a proprietary code developed by IDCOR -- work done for IDCOR by EPRI.

COMMISSIONER GILINSKY: Why is this proprietary?

MR. BUTLER: This was co-developed using funds furnished by the IDCOR group. At some time in the near

future we hope to have detailed information on the code filed with the Staff. But up to this point, we do not have detailed information on the code.

MR. BERNERO: I might add that right now IDCOR considers all of its data proprietary but we expect that there is some mechanic by which we can get it into the public domain very shortly. Not 100 percent of the owners supported IDCOR and it gets into some sticky questions with them.

MR. BUTLER: Using this HEAT-UP code to analyze different sets of realistic scenarios, the Mark III owner's group determined that the only way you can get 75 percent of the active clad oxidized, without involving a core melt sequence, is to have the hydrogen release rates be very slow, something like .2 pounds per second or less. And basically, they determined that if the reaction is slow, a lot of hydrogen can be generated, up to 75 percent of the clad.

If, on the other hand, the reaction goes very fast then only a small amount of the clad will be oxidized before you proceed into the core melt sequence. So they are trying to work with us to develop a reasonable release rate that would still fall in the arena of degraded core sequences.

Because they are relying on the BWR HEAT-UP code, a proprietary code -- let me have the next view graph, please.

(Slide.)

The Staff took a crew to the Palo Alto offices of

EPRI to have a detailed review of the BWR HEAT-UP code, admittedly brief. The Staff brought its consultants along, people who have been doing similar work at their own home. And based on this cursory review, the Staff has found that the BWR HEAT-UP code is a more sophisticated code than the latest available MARCH code that the Staff has been using, that the BWR HEAT-UP code represents current state of the art and that the results that you obtain by use of this code should be reliable.

COMMISSIONER GILINSKY: This doesn't really deal with the rule. It deals with how the rule might be implemented.

MR. BUTLER: Yes, right.

MR. BERNERO: Technical calculation.

MR. BUTLER: Because we do have to prescribe the release rate of hydrogen into the containment. It turns out --

COMMISSIONER GILINSKY: In the rule or --

MR. BUTLER: No, no. We might make it part of our standard review plan, for example.

MR. MATTSON: The reason for dwelling on it is fairly simple. Between the proposed rule and the final rule, we took out a lot of details on how to do this. We're going to come down to you, on the Grand Gulf full power OL, and show this to you. We had planned to do that before you got this briefing. You know Grand Gulf has slipped and so we didn't get to do it. We wanted to show you how we're going to go

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about implementing this rule, so it doesn't come as a surprise to you later, when we remove those specifications.

We think this is what you intended, and we wanted to spend some time going through it just to make sure because we're inferring some things from what you said at the time of the proposed rule and your makeup has changed slightly since the proposed rule.

COMMISSIONER GILINSKY: I didn't know my makeup had changed.

(Laughter.)

MR. BUTLER: The last view graph on this summarizes a statement of residual Staff concern that we thought we would discuss with you.

(Slide.)

Basically, we find that the Mark III igniter system provides protection for most, but not all, of the degraded core sequences. We believe that one can theoretically prescribe some degraded core sequences for which the ignition system would not work very effectively.

We intend to explore this matter more during the upcoming year, as the Mark III owner's group develops more information, as they complete their testing on quarter-scale tests. This quarter-scale test is to provide more reliable information than what was obtained from the 1/20th scale test recently completed.

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CHAIRMAN PALLADINO: Could you give me a clue as to what you mean? Give me an example of the sequence that might not be accomodated by your control system?

MR. BUTLER: It would have to be a very contrived sequence, where you allow the water level in the core to recede down to possible 20 percent of core height and then just maintained at that point, with some degraded CRD pump delivering around 50 gallons per minute, just dribbling in water just at the right rate so that the energy delivered into the water by the lower portion of the core produces just enough steam. And as that steam comes up to cool the rest of the fuel, that steam reacts with the clad in a rate that produces hydrogen higher than .4 pounds per second. And if that then is released into the pool, you could produce standing diffusion flames on the pool, just on top of the pool.

CHAIRMAN PALLADINO: You're talking about suppression?

MR. BUTLER: Of the suppression pool, I'm sorry, yes. Of the suppression pool of the containment, to produce flames that could harm essential equipment located in that area.

CHAIRMAN PALLADINO: I understood that was one of your concerns on that, the local detonation, unlikely to occur or likely to occur?

MR. BUTLER: I'm not sure I understand that one.

CHAIRMAN PALLADINO: I was told that one of the reasons you had put into your rule that you would be willing to -- not consider local detonation, if you can show that it's unlikely to occur and that that was one of the -- the flaming above the pool was one that led you to that.

MR. BUTLER: Yes. Yes, indeed because you are able to combust all the hydrogen before it's able to develop high concentrations elsewhere in the containment.

COMMISSIONER BERNTHAL: I'm sorry. I certainly haven't been at this very many years. Detonation and flaming, to me, mean two different things. Are you using local detonation to mean flaming?

MR. BUTLER: No. There is a very sharp distinction.

COMMISSIONER GILINSKY: Well, you can develop higher concentrations in parts of the containment and then support a detonation.

COMMISSIONER BERNTHAL: Yes. I wonder how that can happen. And I guess -- I had a question earlier, in fact, realistically whether that can happen easily? You've got -- hydrogen is pretty -- stuff that escapes pretty rapidly and diffuses pretty rapidly. But maybe that can happen. But now we're talking about flaming above the pool and it sounded to me like you were calling that a local detonation.

MR. BUTLER: No, not at all.

CHAIRMAN PALLADINO: Remembering that that was one case where local detonation might have been considered a problem, and you may be talking about some other aspect of it.

MR. BUTLER: But a point that should be made here I think, is that even though you might have high concentrations of hydrogen, it would be rather difficult to set off a detonation, absent a real strong detonator. The use of thermal igniters tend to minimize the likelihood of setting off any detonation. That's all I have to say on the matter of hydrogen release rates. It's primarily to apprise the Commission of our work in this area.

COMMISSIONER BERNTHAL: Let me just pick up for a moment. That also applies -- and especially applies, I suppose -- to the concept of a local detonation. Is that true, or are there ways that I don't see and don't understand that you can confine hydrogen to a small area?

COMMISSIONER GILINSKY: You can get large concentrations -- you know, if you're feeding it into some part of the containment, you can get larger concentrations in one part of another for a time.

MR. MATTSON: Let me see if I can give you a theoretical example. If the PORV, on a PWR discharges down to a quench tank, and if the quench tank -- for some reason were located in a confined space in the bottom of the building

so that the hydrogen, as it goes through the PORV down to the quench tank, through a ruptured disk and into that confined space, or captured near the roof of that confined space. And then there were a motor in that room. Then you could have a local detonation. And so when Walt says we look at the layout, we look at the forced air circulation patterns. We look at the likely release points for hydrogen, it's that kind of thing we're looking for, the combination of release, confinement and ignition. And you can just go through a plant layout and look for situations like that. Usually, they don't exist. If they do, you might carve a hole in the room or something to allow the circulation that does go on to affect diffusion or mixing in that room.

COMMISSIONER GILINSKY: Tell us about manual versus automatic.

MR. BUTLER: All right. Debbie, if we may have view graph 2-1 through 2-4.

(Slide.)

(Pause.)

COMMISSIONER GILINSKY: Let me ask you this. What are the requirements on plants, right now? In other words, short of this rule?

MR. BUTLER: On the subject of automatic versus manual?

COMMISSIONER GILINSKY: Well, I know that they're

manual. But what is the requirement for the type of a vendor condition that triggers turning on these igniters? Do we have a specific requirement?

MR. BUTLER: We request that the Applicant describe, think through his process and describe and propose for us what his signal would be to manually turn on the igniters. And we have found pretty much consistency. Primarily, you would have a safety injection signal plus, generally some indication of inadequate core cooling.

In some cases, a straight safety injection signal would be sufficient. In others, there would be a need for the operator to go into their emergency procedures manual -- emergency procedures package. And there will be, at that point, an instruction to turn on the igniters.

COMMISSIONER GILINSKY: Now why would you want to burden the operator with all these evaluations? Incidentally, at Grand Gulf it's on low water level?

MR. BUTLER: Yes, at Grand Gulf, if the water level falls to the top of the active core, at that point they are required or instructed to turn on the igniters.

COMMISSIONER GILINSKY: Now at the beginning of an accident it may not be down there, later it may be down there. It means the man has got to come back. He's got to keep in mind that he's got some items to pick up. And I bring this up because I just don't see any disadvantages to

making it automatic.

MR. BUTLER: There are modest disadvantages. We agree that it is no big deal one way or the other. However, our practice, in other areas, has been that if there is sufficient time, i.e. more than 20 minutes, there should be a sufficient opportunity for the operator here to reliably perform that function. And in this case --

COMMISSIONER GILINSKY: Oh, I think there's enough time but accidents are pretty exciting events and you're just adding one more thing that the person has to deal with to evaluate. You could take it off his mind and I must say I don't see any disadvantage, whatsoever, to doing that.

MR. BUTLER: Well, the disadvantage we see is a minor one. For example, in ice condenser plants it is not a simple matter of turning on the igniters. The operator must also turn off the air handling units.

COMMISSIONER BERNTHAL: But so the same question applies, and it's really a basic philosophy question and I absolutely agree. I don't understand the reason to burden the operator with one more thing.

MR. MATTSON: Just to try to cut through this. This is a longstanding discussion that's been going on. We don't mean to argue with you. We've written down, in this appendix, all we know about the subject. And it's a close call. If

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you'd like them to be automatic, vote and require them to be automatic. If you agree with us that they can be manual, vote and let them be manual. Our only point has been there are many activities in a plant following a scram. We have a policy of allowing people to demonstrate to us time and opportunity for the actions that can be taken manually after a scram. We used that same policy here and they passed the test. They had the instrumentation. They had the opportunity to get to the place to do it and they had the time to do it.

COMMISSIONER BERNTHAL: But why would you ever give preference to doing things manually that you don't have to do manually.

MR. MATTSON: There are operations that will occur in these plants for hours and days afterwards, most of them not automatic. Only those very quickly after an accident a re automated.

COMMISSIONER GILINSKY: Roger, a lot of these other items that you're referring to have certain disadvantages attached to them, you know, if you turn the systems on. You may want to reflect on whether you want to turn them on or not if they have enough to time to do it. We often say sure it would be up to the operator. But here, I really don't see any disadvantage. The only disadvantage that was brought up at various times was that these plugs may burn out.

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MR. MATTSON: There's no disadvantage to safety but the plugs have only been qualified for a time -- a life of hours, around 160 --

MR. BUTLER: Yes. 168 hours is the endurance test.

MR. MATTSON: If you go to automatic, you'll probably have to use a signal like trip or some conservative signal -- not uncovering the core, which has a lot of judgment involved in it. When you do that, then you're going to be turning them on several times a year.

COMMISSIONER GILINSKY: Are there several safety injections a year? I wouldn't think it's that high.

MR. MATTSON: Okay. If safety injection is the signal,then they might be one every year or two, that's true.

COMMISSIONER GILINSKY: But you'll turn it off once you realize it's an unnecessary injection.

MR. MATTSON: I just want to say that the one thing that would change is the amount of time that they're qualified for. Somebody will have to go turn them on and run them for however many days they want to run them, in those situations, without replacing them -- and I'm sure they can do that. They may have to redesign some if they burn out too easily. It's only money. It can be done.

COMMISSIONER GILINSKY: Well, you're talking about years of qualification, by any measure. Isn't that right? Suppose you talk about hours per safety injection -- and I

can't imagine that it's more than that -- and you're talking about 160 hours. It sounds like the lifetime of the plant.

MR. MATTSON: Are you going to turn them off when you get to cold shutdown, or are you going to turn them off when you're at hot standby, or are you going to turn them off when the site emergency is over? When are you going to turn t hem off? You get into a discussion of that, and that again is going to be manual, not automatic.

COMMISSIONER GILINSKY: That's all right. I think we can cope with that one.

CHAIRMAN PALLADINO: Let me ask you a question, what sort of technical problems are involved in making them automatic? Does it mean interfacing safety circuits and non-safety circuits?

MR. BUTLER: There are some modest interfacing of those circuits.

CHAIRMAN PALLADINO: Does that, in any way, bring about other problems. That's what I'd like to hear more about.

MR. BUTLER: The igniter system has not been required to be a Class 1E electrical system. And there has been a Staff criterion that when you hook up Class non-1E to a Class 1E bus, there has to be some kind of a isolation device, such as breaker devices. That's not a complicated thing. It can be provided. There will be needs for --

CHAIRMAN PALLADINO: Since it's in breakers, it puts a little more (inaudible) --

(Laughter.)

-- it may or may not work but go ahead.

(Laughter.)

MR. BUTLER: Well, there are redundancy requirements that need to be met and appropriate surveillances. When you automate them you have to check out the automatic system periodically. There are these little nits that --

CHAIRMAN PALLADINO: Well, are they little or are they significant? I don't know. I'm asking you.

MR. BUTLER: I think probably the biggest effect might be the placement of a capability to frequently change out the igniters. Right now, the igniters are set in as fixed systems.

COMMISSIONER GILINSKY: Why do you say frequently change out?

MR. BUTLER: Well, frequently might not be the right word. If you prescribe a service life for these things and you might have to change them out every five years or so.

COMMISSIONER GILINSKY: Well, the numbers -- that doesn't sound so dreadful but from the numbers you gave us, it sounded like it would be quite a bit longer than that.

MR. BUTLER: Well, if you were to have a degraded

core accident, I think you would like to have the igniters available for service for at least three or four days following onset of the event. So you do want to have a cushion of at least three of four days left in the igniters. And once you burn up a couple of days, you are just about prepared -- that is about 48 hours of life. Once you burn that much up, you want to be prepared to replace them unless you do endurance testing and demonstrate that they have longer life.

COMMISSIONER GILINSKY: Well, (a) you may well demonstrate that because glow plugs run in diesel engines for an awfully long time.

MR. BUTLER: That is also possible. However, these glow plugs are run at a slightly higher voltage, 14 versus 12. Whether that, in any way, affects the lifetime, I don't know.

COMMISSIONER BERNTHAL: What's the cost of installing a set of these glow plugs?

MR. BUTLER: It's estimated to be about $100,000 dollars per unit.

COMMISSIONER BERNTHAL: So put in two sets and you've got twice the life.

COMMISSIONER PALLADINO: No, putting in two sets is not twice replacing it.

COMMISSIONER BERNTHAL: No, I don't mean running in parallel.

MR. BUTLER: We're not talking large dollars here.

CHAIRMAN PALLADINO: Well, how about the cost of putting in an automated system. Is that a significant number?

MR. BUTLER: We haven't heard from the Licensees and getting reliable numbers is somewhat difficult.

COMMISSIONER GILINSKY: It sounds to me like it's a question of philosophy, that you felt that the manual system was more in mind with the way a lot of other systems were handled and other types of equipment. My feeling is, in this case at least, the advantages and disadvantages argue the other way.

MR. BUTLER: That's what I'm to determine.

CHAIRMAN PALLADINO: I don't have a preconceived notion on whether it ought to be automatic or manual. I have an intuition that if I don't have to do it I -- during an accident I don't have to worry about it, that that's an advantage. But I'd like to make sure that tying these systems in together doesn't produce some unforeseen fault that we never discover.

COMMISSIONER GILINSKY: When I asked the shift superintendent what the condition was, he had to refer to his procedures. So it means it's one more thing that you've got to go down the list and check and pick up if the condition change. And it seems to me we want to relieve people of those

burdens as much as we can.

MR. OLMSTEAD: I would like to point out that there were a significant number of comments from industry commenters saying that they ought to have the option of choosing. In order for the Staff to require automatic, they would have to have a basis for saying we think automatic is required. Now they've chosen to leave th e option with industry. If the Commission chooses otherwise, it's something we shouldn't neglect to go back and put in the statement of considerations because it's not there now.

COMMISSIONER GILINSKY: I agree. I think we certainly ought to give a reason.

COMMISSIONER BERNTHAL: But I'd like to get back -- to the Chairman's question. I've not yet heard a real downside for not making them automatic.

CHAIRMAN PALLADINO: Well, let me put it another way. I wonder, have you really analyzed the downside? I'm not looking for an downside, I just want to make sure that when the glow plugs come on that you somehow shunt it out the control rod scram. Crazy things happen.

MR. BUTLER: Our perception is that clearly an automated

(Laughter.)

MR. BUTLER: We would have to include that as part of our review. We would have to have the Licensee propose

a design that we would look at to assure that there are no bad interactions. It would have to be an additional review effort.

MR. MATTSON: That's on a plant specific basis. Generically, we have thought through the downside. And as I thought I tried to summarize, there aren't many negative aspects of making it automatic.

COMMISSIONER GILINSKY: Also, you know releases might come all of a sudden, some piece of equipment failing, or a valve failing or a seal failing or whatever. Operators don't have to come back and reconsider the state of affairs. I think it's best just to have these things on.

I would say just as a general matter, not just here, that the more you can take off people's minds -- procedural books are awfully thick -- the better so that people are concentrating on those things that really do require judgment, which you can't deal with in any other way.

CHAIRMAN PALLADINO: Automatic systems are great when they work but there's nothing more frustrating than to have an automatic system that doesn't work and you don't have any way of interacting with it.

COMMISSIONER BERNTHAL: Well, but you've clearly -- in any case -- put in a manual override at some place. You can throw a switch if you want to, but that's pretty simple.

COMMISSIONER GILINSKY: If we're not going to have confidence in automatic systems, to a degree, we've got big problems.

CHAIRMAN PALLADINO: I was getting at -- I hadn't thought about it on this particular moment. Maybe some manual override is the right answer.

MR. BUTLER: Yes, and we think if you went automatic you would want to have the manual override capability, yes.

COMMISSIONER ASSELSTINE: On the manual systems, you mentioned that the parameters that would be used to turn them on or off -- or turn them on in any event -- would tend to vary. Different plants use different sets of parameters.

MR. BUTLER: Just slight variations. Whatever is convenient for that particular operator.

COMMISSIONER ASSELSTINE: I take it the Staff reviews each set of parameters that are proposed for turning t he systems on and makes sure that the equipment that would provide those parameters are available under conditions where hydrogen is being produced?

MR. BUTLER: Yes, we do. We do have a Human Factors specialist take a look at their proposed procedures.

COMMISSIONER GILINSKY: This is not like the case, say an ATWS where injecting boron and all kinds of other problems associated with it and doing that automatically.

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CHAIRMAN PALLADINO: Well, I can see if you have a manual override, though, then you've got to decide under what conditions can you override. But I agree you can design a good automatic system to tell me whether you have any problems.

COMMISSIONER GILINSKY: Well, you're coming out the other way on an ATWS system where there really are problems with automatic injection.

COMMISSIONER ASSELSTINE: Of course, then again, there are also strong incentives not to use the automatic injection -- for the operators -- at the ATWS point.

We can talk about that tomorrow.

(Laughter.)

CHAIRMAN PALLADINO: I've made a judgment on automatic versus manual on this case, or automatic with manual override. Okay.

COMMISSIONER ASSELSTINE: I have just a couple of other questions. One was on page 9 of the paper, where you talk about you've provided some additional flexibility in terms of the options for the methods for demonstrating containment structural integrity. And I notice that you mention the ASME code as one option and then you say the code is included as an example of one of the acceptable methods. Are there other methods that are proposed? Are you going to basically insist that they be equivalent to the

code? Are you considering possible relaxations from the ASME code?

MR. BERNERO: I'm looking for the right place in the rule for that, the coverage of that - the analytical methods that are referred to. They give analytical flexibility but my understanding is that it is not --

MR. FLEISHMAN: Page 19.

MR. BERNERO: It is not a compromise of --

MR. BUTLER: I believe identifying that provision of the code primarily is a neat way of pointing your finger at some margins and if someone were to use a different approach that tended to shave a little away from that margin, we would tend to look favorably on it.

MR. BERNERO: The key passage in the rule is on page 19 of Enclosure F and I'll just quote that passage for simplicity here.

"Containment structural integrity must be demonstrated by use of an analytical technique that is accepted by the NRC Staff. This demonstration must include sufficient supporting justification to show that the technique describes the containment response to the structural loads involved. This method could include the use of actual material properties with suitable margins to account for uncertainties in modeling in material properties, in construction tolerances, and so on.

Another method could include a showing that the following specific criteria of the ASME boiler and pressure vessel code are met: --"

And then it goes on with that so that it really opens it making an optional showing. But it's a case by case review. You know, it's not some blanket.

COMMISSIONER ASSELSTINE: One other question I had had to do with one of the comments. It's on Enclosure E, looks like page 3. It was the fourth comment from Susan Hyatt. And the comment was "Not requiring the analyses until the plant exceeds 5 percent of rated power removes the issue from the public hearing."

I guess I was wondering, first, is it right that the analyses aren't required until the plant exceeds 5 percent of rated power? Second, if that's the case, why that's the case -- why the analyses can't be done before that? And third, is the practical effect to remove that issue as an issue that can be raised in the hearing?

MR. BERNERO: Let me ask Mort if he can help me on that one. I don't --

COMMISSONER ASSELSTINE: I didn't see a response to that comment.

MR. BERNERO: I don't think it's true any longer, but --

MR. FLEISHMAN: We've changed the schedule. We've

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eliminated the implementation. Before there was an implementation where they had to do certain things before they get to 5 percent of full power. We've eliminated that now. Now what they do is they submit a schedule to us about what they're going to do and then we discuss it. We mutually agree upon a schedule about when they should implement the rule.

COMMISSIONER ASSELSTINE: When would that occur? I take it you're leaving it up them to propose --

MR. FLEISHMAN: In other words, they have six months to propose a schedule for meeting the rule.

MR. ASSELSTINE: For any one of these plants?

MR. FLEISHMAN: For any one of these plants, no specific schedule.

MR. BERNERO: That schedule is what's going to set that pace.

COMMISSIONER ASSELSTINE: Is there any reason, assuming you got out beyond the next six months, why for new plants that shouldn't be done before their license then? I understand the need for the six month transition.

MR. BERNERO: I don't see any reason.

MR. FLEISHMAN: Originally we had some words to the affect that the analyses would be done within one year after the effective date of the rule or the date of issuance of a license authorizing operation above 5 percent of full

power, whichever way -- that was what you were referring to.

We've eliminated that now and we don't tie them to a schedule like that.

COMMISSIONER ASSELSTINE: Now it's case by case.

MR. FLEISHMAN: It's a case by case basis. They submit a schedule to us. We agree with them whatever feels reasonable and that's the schedule that they would meet.

So the question really didn't apply any longer.

COMMISSIONER ASSELSTINE: But I assume once you got over some initial transitional period that the objective would be to get the analyses done as early as possible.

MR. FLEISHMAN: Yes.

MR. MATTSON: Just a small point. It would be open for litigation in individual cases. If someone wanted to raise the issue of what the schedule ought to be since the rule doesn't resolve it.

CHAIRMAN PALLADINO: Any other questions?

COMMISSIONER ROBERTS: I have some but I'll submit them in writing.

CHAIRMAN PALLADINO: Will we get copies of the questions and the answers?

COMMISSIONER ROBERTS: Well, I don't know about the answers --

(Laughter.)

-- and the reactions.

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CHAIRMAN PALLADINO: Okay. Anything more?

(No response.)

Well thank you very much.

(Whereupon, at 4:02 p.m. the meeting was adjourned.)

CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the NRC COMMISSION

In the matter of: NRC Commission Meeting on Hydrogen Igniters

Date of Proceeding: Wednesday, November 9, 1983

Place of Proceeding: Washington, D.C.

were held as herein appears, and that this is the original transcript for the file of the Commission.

Ann Riley
Official Reporter - Typed

Ann Riley
Official Reporter - Signature