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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Gentlemen:

Subject: Oyster Creek Nuclear Generating Station
Docket No. 50-219
Combustible Gas Control

By letter dated November 6, 1990, the NRC Staff stated its position with respect to Oyster Creek's compliance with the hydrogen mitigation requirements of 10 CFR 50.44. The Staff's letter also requested that GPU Nuclear respond and indicate whether it agreed with the Staff's position, and if it disagreed, to specify the areas of disagreement.

In responding to the November 6, 1990 letter, GPU Nuclear has carefully reviewed the November 6, 1990 letter as well as the extensive prior correspondence between GPU Nuclear and the NRC on 10 CFR 50.44 compliance. We have also analyzed again the requirements of 10 CFR 50.44 and its regulatory history. Finally, we have reevaluated the technical issues which surround combustible gas control, including those presented in the Staff's Safety Evaluation Report.

Based on all these considerations, GPU Nuclear remains convinced that Oyster Creek fully complies with all applicable requirements of 10 CFR 50.44. We also remain convinced that Oyster Creek, as designed and operated with regard to combustible gas control, will protect the public health and safety even in the event of a postulated loss-of-coolant accident (LOCA) in which the performance of emergency systems is seriously degraded. Attachments A through F of this letter set forth Oyster Creek's detailed position on compliance with applicable provisions of 10 CFR 50.44 as requested by the Staff's November 6, 1990 letter. In addition, the plant specific technical evaluation of radiolytic oxygen generation rates in the event of a postulated LOCA, set forth in the enclosed Topical Report, demonstrates that a flammable concentration of oxygen will not be reached in the Oyster Creek containment following a postulated LOCA. Modifications of our existing systems for combustible gas control are not necessary from a regulatory compliance perspective or warranted to address a safety/technical concern.

GPU Nuclear is committed to the safe operation of Oyster Creek and has invested very substantially in modifications to upgrade its safety and reliability. One mechanism to evaluate priorities and allocate resources to modifications is the existing Long Range Planning Program which is required by the Operating License and Technical Specifications. It is our opinion that the completion of those projects/modifications currently listed are of more benefit than additional modifications to address combustible gas control.

We believe that this information presented will allow the issues to be expeditiously concluded to the mutual satisfaction of both parties. We hope that the Staff's careful review of the information presented with this letter will resolve the Staff's remaining concerns on combustible gas control at Oyster Creek. We would be happy to discuss these matters with you at any time. If you have any questions, please contact Mr. M. W. Laggart of my staff at (201) 316-7968.

Sincerely,

Robert L. Long

R. L. Long
Vice President and Director
Corporate Services/TMI-2

RLL/ST/plp
Enclosures

cc: Administrator, Region 1
NRC Resident Inspector
Oyster Creek NRC Project Manager
S. A. Varga, Director, Division of Reactor Projects - I/II

ATTACHMENT A

Oyst(Creek Nuclear Generating Station

Co liance with 10 CFR 50.44(b)(1)

NRC Staff Position (Paragraph 1)

"Oyster Creek must have capability to measure hydrogen concentration in the containment, (i.e., drywell and wetwell) as required by Section 50.44(b)(1)"

GPUN Position

Oyster Creek has the capability to measure hydrogen concentration in the containment, as required by 10 CFR 50.44(b)(1).

Section 50.44(b)(1) states that "Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy cladding shall be provided with the capability for.... measuring the hydrogen concentration in the containment. The Oyster Creek hydrogen/oxygen monitoring system is described in FSAR Section 6.2.5.2.2. The system is Class 1E. Operating status and surveillance requirements for the H_2 monitor are governed by Technical Specifications 3.13.F and 4.13.D, respectively. The NRC Staff has found that the Containment Hydrogen Monitoring System design is acceptable.[1]

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1 Letter from D. M. Crutchfield (NRC) to P. B. Fiedler (GPUN), "NUREG-0737 Item II.F.4 . . . ," September 1983.

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ATTACHMENT B
Oyster Creek Nuclear Generating Station
Compliance with 10 CFR 50.44(b)(2)

NRC Staff Position (Paragraph 2)

"Oyster Creek must be able to insure a mixed atmosphere in containment, as required by Section 50.44(b)(2)."

GPUN Position

The Oyster Creek design insures that there will be a mixed atmosphere in containment following a postulated loss-of-coolant accident (LOCA), as required by 10 CFR 50.44(b)(2).

Section 50.44(b)(2) states that "Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy cladding shall be provided with the capability for.... insuring a mixed atmosphere in the containment." As described in FSAR Section 6.2.5.3.7, complete mixing of the gases in containment dur ng the first few hundred seconds of a LOCA is assured by the steam blowdow and subsequent condensation. During subsequent phases of the LOCA, there are both natural mechanisms (i.e., natural dispersion phenomena) and positive means of mixing (local turbulence caused by water spilling from the end of the broken pipe, and operation of either or both of the Containment Spray System loops) which will assure uniform concentrations of combustible gases in the drywell containment atmosphere following a LOCA.

ATTACHMENT C
Oyster Creek Nuclear Generating Station
Compliance with 10 CFR 50.44(c)(3)

NRC Staff Position (Paragraph 3)

"Oyster Creek must have an initially-inerted containment, as required by Section 50.44(c)(3)."

GPUN Position

Oyster Creek has an inerted containment as required by 10 CFR 50.44(c)(3)(i).

Section 50.44(c)(3) states that "Notwithstanding paragraphs (c)(1) and (c)(2) of this section: (i) Effective May 4, 1982 or 6 months after initial criticality, whichever is later, an inerted atmosphere shall be provided for each boiling light-water reactor nuclear power reactor with a Mark I or Mark II type containment."

Oyster Creek's Technical Specification Section 3.5.A.6 requires that the primary containment atmosphere [illegible] reduced to less than 4% oxygen with nitrogen gas within 24 hours after the reactor mode selector switch is placed in the run mode. The Technical Specification Section 4.5.M provides for surveillance of the inerted containment by requiring the oxygen concentration in the primary containment be checked at least weekly when an inerted atmosphere is required.[2]

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2 FSAR Section 6.2.5.3.6 identifies that oxygen concentration is continuously recorded and a high oxygen concentration (3.5%) is annunciated in the control room.

Technical Specification Section 3.5.A.6 allows deinerting of the primary containment to begin 24 hours prior to a scheduled shutdown. FSAR Section 6.2.1.1.1.h states that the inerted containment at Oyster Creek is achieved by a containment gas inerting system which maintains a non-explosive atmosphere in the containment. The system is described in FSAR Section 6.2.5.2.1.

The NRC Staff has agreed that Oyster Creek complies with the inerted containment requirement of 10 CFR 50.44(c)(3)(i).[3]

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3 Letter from J. N. Donohew, Jr. (NRC) to P.B. Fiedler (GPUN), "Recombiner Capability Requirements . . . ," March 13, 1987.

ATTACHMENT D

Oyster Creek Nuclear Generating Station

Compliance with 10 CFR 50.44(b)(3) and 50.44(g)

NRC Staff Position (Paragraph 4)

Oyster Creek must be able to control combustible gas concentrations in the containment following a postulated LOCA, as required by Sections 50.44(b)(3) and 50.44(g).

(a) The above Sections of 10 CFR 50.44 do not directly require a purging/repressurization system. However, Section 50.44(b)(3) does call for the control of combustible concentrations following a LOCA and Section 50.44(g) specifies the added requirements a purging/repressurization system must meet if the supporting analysis shows that such a system is needed. Therefore, if the supporting analysis for Oyster Creek shows such a system is needed, the system should satisfy the requirements identified in 50.44(g).

(b) Section 50.44(a) identifies those sources to be evaluated with respect to hydrogen/oxygen generation following a LOCA. Section 50.44(d)(1) further defines the amount of hydrogen generated by metal-water reaction to be considered for the DBA LOCA. To this extent, the rule addresses the hydrogen/oxygen source terms. However, no specific models are identified within the rule for either radiolytic decomposition or metal corrosion. Regulatory Guide (RG) 1.7 has been used for this purpose. Alternative radiolytic models, as described in GE report NEDO-22155 are not acceptable for calculating the amounts of hydrogen/oxygen generated to show compliance with Sections 50.44(b)(3) and 50.44(g). The basis for this position is provided as a Safety Evaluation in Enclosure 2. NEDO-22155 was used by the Staff ONLY for determining whether additional hydrogen control capability in the form of recombiners had to be provided in accordance with Section 50.44(c)(ii).

GPUN Position

Oyster Creek has the capability to control combustible gas concentrations in the containment following a postulated LOCA, as required by 10 CFR 50.44(b)(3), by means of a combustible gas control system that is designed to conform to the General Design Criteria 41, 42 and 43, as required by 10 CFR 50.44(g).

Section 50.44(b)(3) states that "Each boiling or pressurized light-water power reactor fueled with oxide pellets within cylindrical zircaloy cladding shall be provided with the capability for . . . controlling combustible gas concentrations in the containment following a postulated LOCA."

Section 50.44(g) states:

> For facilities with respect to which the notice of hearing on the application for a construction permit was published on or before December 22, 1968, if the combined radiation dose at the low population zone outer boundary from purging (and repressurization if a repressurization system is provided) and the postulated LOCA calculated in accordance with Section 100.11(a)(2) of this chapter is less than 25 rem to the whole body and less than 300 rem to the thyroid, only a purging system is necessary, provided that the purging system and any filtration system associated with it are designed to conform with the general requirements of Criteria 41, 42 and 43 of Appendix A to this part. Otherwise, the facility shall be provided with another type of combustible gas control system (a repressurization system is acceptable) designed to conform with the general requirements of Criteria 41, 42, and 43 of Appendix A to this part. If a purge system is used as part of the repressurization system, it shall be designed to conform with the general requirements of Criteria 41, 42, and 43 of Appendix A to this part. The containment shall not be repressurized beyond 50 percent of the containment design pressure.

1. Oyster Creek's Combustible Gas Control System

It is GPUN's position that the Oyster Creek inerted containment system provides the capability for controlling combustible gas concentrations in the containment following a postulated LOCA, as required by Section 50.44(b)(3), and that the inerted containment system is the combustible gas control system which conforms to General Design Criteria 41, 42 and 43) for Oyster Creek, as required by Section 50.44(g).

The Oyster Creek inerted containment system meets the regulatory definition for a combustible gas control system. Section 50.44(h)(2) defines the term "combustible gas control system" as

> a system that operates after a LOCA to maintain the concentrations of combustible gases within the containment, such as hydrogen, below flammability limits. Combustible gas control systems are of two types: (i) systems that allow controlled release from containment, through filters if necessary, such as purging systems and repressurization systems, and (ii) systems that do not result in a significant release from containment such as recombiners.

The Oyster Creek inerted containment system maintains the concentrations of combustible gases such as hydrogen below flammability limits by ensuring the initial oxygen levels do not exceed 4% concentration and do not exceed 5% after the postulated LOCA. Because there can be no flammability, no releases from containment are necessary.

Oyster Creek does not have a purging/repressurization system. As the Staff noted in paragraph 4(a), such a system is not required by NRC regulations.[4] Section 50.44(g) establishes criteria for a purging system in the event that doses from purging and repressurization, in the event of the postulated LOCA, are less than 25 rem whole body and 300 rem thyroid. If doses for purging would exceed those levels, as in the case of Oyster Creek, Section 50.44(g) states that the facility "shall be provided with another type of combustible gas control system."

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4 This corrects prior statements by the Staff that such systems were required. See, e.g. Generic Letter No. 84-09, "Recombiner Capability Requirements of 10 CFR 50.44(c)(ii)," May 8, 1984 (characterizing Owners Group program aimed at demonstrating that "Mark I plants potentially affected by need to rely on use of the safety grade purge/repressurization system required by the original 10 CFR 50.44 rule as the primary means of hydrogen control." (emphasis added))

Although the regulation states that "a repressurization system is acceptable" as meeting the requirement to have "another type of combustible gas control system", the language of Section 50.44(g) makes it perfectly clear that other types of combustible gas control systems (such as the inerted containment system) also may be used. This interpretation was confirmed by NRC's Office of General Counsel,

> we have reviewed your analysis and are prepared to agree that, on balance, it is reasonable to interpret 10 CFR 50.44(g) and 50.44(c)(1) so as not to preclude an inerted containment system from satisfying those regulations, provided the inerted containment system is indeed found to be technically acceptable.

Letter from T. F. Dorian (NRC) to R. F. Janecek (BWROG), "BWROG-8737 Inerted Containment Systems", August 31, 1987.[5]

For Mark I containments, inerting has been found to be an acceptable method to guard against damage to the plant from hydrogen combustion. For example, the National Research Council has concluded that "the presence of an inert atmosphere in small volume containments is a satisfactory approach to prevent detonations."[6]

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5 The OGC opinion effectively overruled the NRC Staff's earlier statement that "a passive system, as the inerted containment, is not sufficient alone to meet 10 CFR 50.44(g) and that an active system, such as the containment inerting system, is required," letter from J. N. Donohew, Jr. (NRC) to P. B. Fiedler (GPUN), "Recombiner Capability Requirements . . . ," March 13, 1987.

6 Report of the Committee on Hydrogen Combustion, National Research Council, "Technical Aspects of Hydrogen Control and Combustion in Severe Light-Water Reactor Accident" (1987), p. xviii.

According to the Council's report, since Mark I containments "are made inert, their failure due to hydrogen burning is considered to have a negligibly small probability."[7] Similarly, the Staff's report on the resolution of Unresolved Safety Issue A-48 stated that for Mark I containments "inerting the containment atmosphere (by adding a combustibly inert gas, such as nitrogen) effectively precludes combustion of any hydrogen generated."[8] This conclusion was also summarized in SECY-89-122, which stated that the inerted containment for Mark I (and Mark II) plants "effectively precludes combustion of any hydrogen generated. USI A-48 with respect to BWR Mark I and II containments is not only resolved but fully implemented in the affected plants."[9]

2. Sources and Amounts of Combustible Gases

Section 50.44(b)(3) requires Oyster Creek to have the capability to control combustible gas concentrations following a postulated LOCA. The Oyster Creek combustible gas control system has this capability.

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7 Id., p. 21.

8 NUREG-1370, "Resolution of Unresolved Safety Issue A-48, 'Hydrogen Control Measures and Effects of Hydrogen Burns on Safety Equipment'" (September 1989), p. 3.

9 SECY-89-122, "Resolution of Unresolved Safety Issue (USI) A-48, 'Hydrogen Control Measures and Effects of Hydrogen Burns on Safety Equipment'" (April 19, 1989) p. 2.

Sections 50.44(b)(3) and 50.44(g) were added to 10 CFR Part 50 in 1978, before the Three Mile Island accident. The accident scenario to be considered for Sections 50.44(b)(3) and 50.44(g), i.e., a postulated LOCA followed by degraded ECCS performance resulting in localized core overheating, remained unchanged when the Commission added additional combustible gas control requirements after TMI.[10]

The Three Mile Island accident resulted in "a severely damaged or degraded reactor core . . . with hydrogen generation well in excess of the amounts required to be considered for design purposes by 10 CFR Section 50.44, Standards for combustible gas control system in light water cooled reactors."[11] Post-TMI rulemakings added new provisions to Section 50.44 to deal with the TMI-type accident.[12] These provisions were added explicitly to deal with postulated accidents that resulted in much more severely degraded

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10 See 45 Fed. Reg. 65465, 65468 (1980) ("the remainder of Section 50.44, particularly in regard to the hydrogen generation assumptions, is not being considered for revision at this time"); 46 Fed. Reg. 58484 (1981) ("the Commission wishes to leave in place the existing provisions of Section 50.44 because of the requirements for dealing with design basis accidents. These include, for example, requiring . . . the capability to deal with hydrogen from radiolytic decomposition of the reactor coolant and the corrosion of metals.")

11 See 45 Fed. Reg. 65467 (1980).

12 See 45 Fed. Reg. 65466 (1980); 46 Fed. Reg. 26491 (1981); 46 Fed. Reg. 58484 (1981); 46 Fed. Reg. 62281 (1981); 50 Fed. Reg. 3498 (1985).

cores than the pre-TMI portions of Section 50.44. While the post-TMI rulemakings of Section 50.44(c)(3)(i)[13] did require that Mark I containments (such as Oyster Creek) be inerted, they did not change the separate requirements of Section 50.44(b)(3) and 50.44(g).[14]

To meet the requirements of these rules, the amount of combustible gases is therefore to be based on the accident scenario on which the pre-TMI portions of Section 50.44 were based. It is inappropriate to quantify the combustible gas generation based on post-TMI considerations.

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13 See 46 Fed. Reg. 58484 (1981)

14 The NRC Staff acknowledges that "those Sections [of Section 50.44] that existed prior to this latest revision [of Section 50.44, effective January 4, 1982, 46 Fed. Reg. 58484] are still based on DBA considerations." Encl. 1, p. 3, to letter from S. A. Varga (NRC) to R. L. Long (GPUN), "Clarification of NRC Staff Position on Hydrogen Mitigation Requirements . . . ," November 6, 1990.

The sources of the hydrogen gas to be controlled are (1) the metal-water reaction involving the fuel cladding and the reactor coolant, (2) radiolytic decomposition of the reactor coolant, and (3) corrosion of metals.[15] 10 CFR 50.44(a). The amount of hydrogen to be produced by metal-water reaction is defined with great precision by 10 CFR 50.44(d).[16] F.r facilities such as Oyster Creek that are in compliance with 10 CFR 50.46,[17] the amount of hydrogen is the greater of

1. Five times the amount of hydrogen calculated in demonstrating compliance with Section 50.46(b)(3); or

2. The amount that would result from reaction of all the metal in the outside of the fuel cladding to a depth of 0.00023 inches.

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15 The amount of hydrogen gas produced by the corrosion of metals "is so small that it is not important to reactor safety considerations." Report of the Committee on Hydrogen Combustion, National Research Council, "Technical Aspects of Hydrogen Control and Combustion in Severe Light-Water Reactor Accidents" (1987), p. 12. The Staff also indicates that corrosion-generated hydrogen need not be considered. See letter from J. N. Donohew, Jr. (NRC) to P. B. Fiedler (GPUN), "Recombiner Capability Requirements of 10 CFR 50.44(c)(3)(ii)," March 13, 1987 (safety-related combustible gas control systems required by Section 50.44(g) "are for the control of the hydrogen and oxygen (combustible gases) generated from the metal-water reaction and the radiolysis of water during the design loss-of-coolant accident (LOCA).") It is therefore not considered further.

16 Section 50.44(d) is cross-referenced by Section 50.44(a), further demonstrating that the amount of hydrogen generated by metal-water reaction is the amount defined by Section 50.44(d).

17 See Safety Evaluation Related to Amendment No. 129, October 31, 1988, para. 6.0.

The amount of combustible gases from the other significant source -- radiolytic decomposition of reactor coolant -- is not directly defined by the rule. However, it is indirectly defined by the rule and the rule's regulatory history. The amount of radiolytic combustible gases is clearly intended to be based on pre-TMI type accidents.

Section 50.44(b)(3) and 50.44(g) are pre-TMI regulations.[18] They were promulgated to address the types of accidents that NRC considered prior to the TMI accident. Section 50.44(h)(1), also adopted as a part of the original 1978 rule, provides a definition of the type of accident that the pre-TMI portions of the rule were intended to cover:

> Degradation, but not total failure, of emergency core cooling functioning means that the performance of the emergency core cooling system is postulated, for purposes of design of the combustible gas control system, not to meet the acceptance criteria in Section 50.46 and that there could be localized clad melting and metal-water reaction to the extent postulated in paragraph (d) of this Section. The degree of performance degradation is not postulated to be sufficient to cause core meltdown.

This definition was explained in the Supplementary Information accompanying both the 1976 proposed rule and the 1978 final rule. In 1976, the Commission explained the proposed rule as follows:

> The Commission has always separated the design bases for ECCS and for containment systems and has required containment systems such as the combustible gas control system to be designed to wi' tand a more locally degraded condition of the reactor than the EC 3 design basis permits.[19]

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18 Both Sections were added to the NRC's rules in 1978, 43 Fed. Reg. 50162 (1978), based on a 1976 proposed rule, 41 Fed. Reg. 46467 (1976).

19 See 41 Fed. Reg. at 46468, (emphasis added).

In issuing the 1978 final rule, the NRC described the conditions covered by the rule as follows:

> It is assumed for conservatism that the emergency core cooling does not fail completely but that its performance is degraded to such a extent that a small fraction of the core becomes overheated. This could be caused by conservatively assuming the existence of a hot-spot effect of assumed coolant flow starvation resulting from (1) delivery of less-than-planned cooling to a localized area and (2) local flow blockage that might be associated with excessive fuel deformation, partial core support failure, etc. While such conditions are not assumed to lead to core meltdown, they are assumed to result in additional hydrogen production above that calculated by Appendix K, "ECCS Evaluational Models."[20]

Thus, the amount of radiolytic oxygen to be considered under Sections 50.44 B(3) and 50.44(g) is the amount generated during a LOCA in which the ECCS performance is degraded so as to cause overheating of a small fraction of the core.

3. NRC Staff Position on Amounts of Radiolytic Gases

Because Oyster Creek's containment is inerted, the amount of hydrogen generated by radiolysis (or by metal-water reaction) does not control flammability. Absent a source of oxygen, the containment atmosphere can never

20 See 43 Fed. Reg. at 50163, (emphasis added).

reach flammability. Therefore, the only significant issue is the oxygen generation rate.[21]

The NRC Staff takes the position that Regulatory Guide 1.7 must be used to calculate the oxygen generation rates from radiolysis.[22] Aside from the fact that "compliance with [Regulatory Guides] is not required,"[23] the oxygen generation rate assumption in Regulatory Guide 1.7 is overly conservative and should not be used. So too are the more recent oxygen generation rates provided by the Staff in Enclosure 2 to the November 6, 1990 NRC letter.

Regulatory Guide 1.7 lists as an "acceptable assumption" for the oxygen yield rate $G(O_2)$ the value of 0.25 molecules/100 eV. The Staff has stated that "this value is not based on any specific mechanism of radiolysis but is chosen to bound all possible cases and consequently it tends to overpredict the rates of generation of radiolytic oxygen."[24]

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21 Indeed as more hydrogen is produced, recombination with the available oxygen reduces the amount that could support flammability.

22 "Safety Guide 7 requirements have been and continue to be the basis for acceptance for the DBA events." "It is felt that the supporting analyses must use Safety Guide 7 assumptions . . . " Encl. 1, p. 5, 7 to November 6, 1990 letter from S. A. Varga (NRC) to R. L. Long (GPUN) (emphasis added); "The Staff . . . continues to require that the generation rates in Regulatory Guide 1.7 be used to demonstrate compliance with the combustible gas control requirements of 10 CFR 50.44." Safety Evaluation Relating to Generic Letter 84-09 (March 13, 1987), encl. to letter from J. N. Donohew, Jr. (NRC) to P. B. Fiedler (GPUN), "Recombiner Capability Requirements . . . ," March 13, 1987 (emphasis added).

23 Introductory Note to Regulatory Guide 1.7.

24 See Encl. 2, p. 1, to letter from S. A. Varga (NRC) to R. L. Long (GPUN), November 6, 1990.

To support this non-mechanistic assumed rate, the Staff developed a mathematical radiolysis model which, based on experimental data from Oak Ridge National Laboratory, yielded oxygen generation rates ranging from $G(O_2) = 0$ to 0.19 for the nonboiling case (depending upon the dissolved hydrogen concentration) and $G(O_2) = 0.19$ to 0.22 for the boiling case.[25]

These values depend on the amount of iodine released from the fuel rods. The greater the iodine release, the higher the oxygen generation rate.[26] The Staff assumed "the maximum credible iodine concentration." Id. This concentration was based on the "maximum degradation of core allowed by 10 CFR 50.44(d)(1) and 10 CFR 50.46(b)(3)," which the Staff described as "a LOCA in which five percent of fuel cladding was oxidized by reaction with steam producing failure of all fuel rods and overheating of the core, but without initiation of fuel melting." Id. Based upon a Sandia study,[27] the Staff assumed that 30 percent of the total fuel iodine inventory would be released.

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25 See Encl. 2, p. 2, to letter from S. A. Varga (NRC) to R. L. Long (GPUN), November 6, 1990.

26 The Staff indicates that the lower oxygen generation rates used in NEDO-22155 were based on that document's assumption of zero or low dissolved iodine concentrations. Encl. 2, p. 3 to November 6, 1990 letter from Varga (NRC) to Long (GPUN).

27 D. D. Thayer, et al., "Updated Best Estimate LOCA Radiation Signature," NUREG/CR-2367, Sandia National Laboratories (August 1981).

These assumptions are incorrect for several reasons:

a. The Staff should not have assumed that five percent of the fuel cladding would be oxidized. While five percent is the maximum metal-water reaction allowed by 10 CFR Section 50.44(d) for any plant, it is more than twice the value allowed for Oyster Creek. Where "no evaluation of compliance in accordance with Section 50.46(b) has been submitted and evaluated," a five percent metal-water reaction must be assumed.[28] This provision does not apply here, since Oyster Creek's Section 50.46(b) evaluation has been submitted and evaluated.[29] For a facility such as Oyster Creek that is in compliance with Section 50.46(b), maximum metal-water reaction to be considered is the MWR that results in the maximum hydrogen generation allowed by Section 50.44(d)(1), i.e., "five times the total amount of hydrogen calculated in demonstrating compliance with Section 50.46(b)(3)".[30] While the amount of hydrogen calculated pursuant to Section 50.46(b)(3) "shall not exceed 0.01 times" the amount of hydrogen from metal-water reaction of all the cladding, it is the calculated amount of hydrogen (to a maximum of 1 percent) that is required to be used by Section

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28 *See* Section 50.44(d)(2).

29 Letter from A. W. Dromerick (NRC) to E. E. Fitzpatrick (GPUN), "Issuance of Amendment," Safety Evaluation Related to Amendment No. 129, October 31, 1988.

30 Section 50.44(d)(1) sets forth as an alternate to the "five times Section 50.46(b)(3)" standard, the amount of hydrogen resulting from the reaction of all the outside cladding to a depth of 0.00023 inches. The larger of the two values must be used. For Oyster Creek, the amount of hydrogen calculated under the "five times Section 50.46(b)(3)" standard is greater than the amount calculated under the 0.00023 inches standard. GPU Nuclear Topical Report 88, "Oyster Creek Plant Specific Oxygen Generation Following a LOCA."

50.46 (and, for Section 50.44(d)(1), five times the calculated amount). For Oyster Creek, the calculated amount of hydrogen for purposes of Section 50.46(b)(3) is the amount of hvdrogen resulting from a MWR of 0.448 percent.[31] Five times that value is 2.24 percent. This is the appropriate value to use for Oyster Creek for purposes of Section 50.44(d)(1), not five percent.[32] The Staff's statement in its March 13, 1991 meeting summary that "the DBA case for compliance with 10 CFR 50.44 was 5 percent metal water reaction" is therefore incorrect.

b. The Staff should not have assumed that all fuel rods would fail or that the entire core was overheated. These assumptions are inconsistent with Section 50.44(h)(2)'s definition of "degradation, but not total failure of emergency core cooling function," which refers to "localized clad melting." It is also inconsistent with the description of the accident provided in the Supplementary

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31 See. NEDC-31462-P, "Oyster Creek SAFER/CORECOOL/GESTR-LOCA Loss-of-Coolant-Accident Analysis" (August, 1987), Table 5.2, submitted by letter from R. F. Wilson (GPUN) to NRC, "Technical Specification Change Request," March 30, 1988.

32 The Commission made this clear in the Supplementary Information accompanying the 1978 rule, noting that "the amount of metal-water reaction assumed in the proposed rule is less conservative for certain plants when compared with the 5 percent previously assumed by the NRC." 43 Fed. Reg. at 50163.

Information accompanying the rulemaking which added Section 50.44(d) to the NRC rules. There, the Commission stated that under the conditions of Section 50.44(d)(1), only "a small fraction of the core becomes overheated."[33] If only a small fraction of the core becomes overheated, it is inappropriate to assume that all fuel rods would fail. The Staff assumes that all rods fail and are heated to 1600°C.[34] The Staff also makes the "highly conservative" assumption that all fuel rods in the core are at the same centerline temperatures with no radial temperature dependence assumed within the fuel rod.[35] These assumptions are inconsistent with an accident where core overheating is limited to a small fraction of the core.

c. The Staff should not have assumed that 30 percent of the total fuel iodine inventory is released. There is no basis for this assumption. The 30 percent value comes from NUREG/CR-2367, cited in Enclosure 2 (p. 2) to the Staff's November 6, 1990 letter. That report estimates that 30% of the total fuel iodine inventory would be released by the time that fuel melting begins. The 30 percent assumption is inappropriate for several reasons. First, it is based on experiments with reactor fuel with a burn-up of approximately 30,000 MWd/MT.[36] There is no indication that the Sandia report

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33 See 43 Fed. Reg. at 50163.

34 See Memorandum from V. Benaroya (NRC) to W. R. Butler (NRC), "Hydrogen Recombiner Capability in Millstone 1 Plant," November 26, 1982, p. 3 ("Assuming failure of all rods, iodine releases at high temperature are estimated as follows . . . At 1600°F (2912°F) 30% of total fuel inventory").

35 See NUREG/CR-2367, p. 5.

36 See NUREG/CR-2367, p. 5.

or the Staff adjusted for the fact that the Oyster Creek core would not have that high a burn-up level. The core average [illegible] for actual end-of-cycle 12 conditions at Oyster Creek is [illegible] MWd/MT.[37] This value is typical of previous end of cycle conditions. Second, the 30 percent assumption is described in NUREG/CR-2367 as the "gap release", which is the release phase immediately preceding meltdown release. NUREG/CR-2367, p. 3. Since Sections 50.44(b)(3), 50.44(d)(1) and 50.44(g) are only intended to involve an accident in which "a small fraction of the core becomes overheated," 43 Fed. Reg. at 50163, it is clearly inappropriate to consider all the iodine released up to the very point at which the meltdown release from the core begins. Third, the Staff has arbitrarily picked an iodine release fraction that is probably an order of magnitude too high. In a November 1982 internal NRC memorandum,[38] the Chief of the Chemical Engineering Branch, for the purpose of "calculating the amount of radiolytic oxygen generated during post-LOCA conditions," presented seven estimates of the amount of iodine released.

1. 1.3% of total fuel inventory (Chemical Engineering Branch, NRR)
2. 1.8% of total fuel inventory (Core Performance Branch, NRR)

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37 See GPUN TR-049, "Reload Information and Safety Analysis Report for Oyster Creek Cycle 12 Reload" (March 1988) (reference 2 in Safety Evaluation Related to Amendment No. 129, October 31, 1988).

38 See Memorandum from V. Benaroya (NRC) to W. R. Butler (NRC), "Hydrogen Recombiner Capability in Millstone 1 Plant," November 26, 1982.

3. 0.6% of total fuel inventory (License of Millstone 1)

4a. 0.035% of total fuel inventory at 1200°C

4b. 30% of total fuel inventory at 1600°C

5. Negligible (based on DBA best estimate by Staff)

6. 50% of total fuel inventory (Regulatory Guide 1.7)

The Staff has not apparently sought to rely on the 50% assumption in Regulatory Guide 1.7. The 30% estimate should also have been disregarded. Indeed the November 26, 1982 Memorandum states that both the 30% and 50% cases "are not applicable." The 50 percent Regulatory Guide 1.7 estimate, according to the Memorandum "does not have a mechanistic basis." The 30 percent, 1600°C estimate is similarly inapplicable since the scenarios under which fuel could reach that temperature, according to the Memorandum, "are not considered in our licensing reviews" and, in any event, even in those scenarios, the fuel would only reach that temperature "for a short period of time."

For all of these reasons, the oxygen generation rates presented in Regulatory Guide 1.7 and in the Staff's November 6, 1990 letter are inappropriate.

4. GPUN Position on Amounts of Radiolytic Gases

Following the NRC's adoption of the post-TMI additions to 10 CFR 50.44 applicable to Mark I containments, the BWR Owners' Group developed and submitted to the NRC a study predicting the amount of oxygen which would be produced following a LOCA.[39] As discussed in Attachment E, Section 4, Oyster Creek is bounded by the analysis of NEDO-22155, and because of the Oyster Creek design, NEDO-22155 substantially overpredicts the amounts of combustible gas mixtures that will be generated at Oyster Creek.

The NRC Staff has accepted the NEDO-22155 analysis with respect to the recombiner requirements of 10 CFR 50.44(c)(3)(ii) and Generic Letter 84-09.[40] The Staff has, however, not been willing to accept NEDO-22155 for other purposes. In its November 6, 1990 letter,[41] the Staff for the first time spelled out in detail its objections to NEDO-22155. Enclosure 2 to the November 6, 1990 letter[42] argues that NEDO-22155 underpredicted the generation of radiolytic oxygen because it failed to adequately account for the effects on radiolysis of iodine dissolved in the reactor coolant following

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39 See NEDO-22155, "Generation and Mitigation of Combustible Gas Mixtures in Inerted BWR Mark I Containments," June 1982, submitted by letter from T. J. Dente (BWROG) to D. G. Eisenhut (NRC), "NEDO-22155 . . . ," August 12, 1982.

40 See Attachment E.

41 Letter from S. A. Varga (NRC) to R. L. Long (GPUN), "Clarification of NRC Staff Position . . . ," November 6, 1990.

42 "Safety Evaluation by the Office of Nuclear Reactor Regulation, General Electric Company's Methodology for Determining Rates of Generations [sic] of Oxygen by Radiolytic Decomposition (NEDO-22155)," July 6, 1989.

the LOCA. As discussed in more detail in the preceding Section of this Attachment, the Staff provided various oxygen generation rates which it believed would require Oyster Creek to install a purge/repressurization system in order to avoid combustible levels of hydrogen and oxygen in the post-LOCA environment. The discussion in that Section demonstrates why it is inappropriate to use the oxygen generation rates put forward by the Staff.

In order to address the concerns expressed in Enclosure 2, GPUN has prepared Topical Report 81, "Oyster Creek Plant Specific Oxygen Generation Following a LOCA," a copy of which is attached. The Topical Report calculates the oxygen concentration in the Oyster Creek containment as a function of time following the postulated LOCA and specifically accounts for the concentration of hydrogen and iodine in the containment water on the generation of radiolytic oxygen

Levels of iodine released into containment water are determined from calculated fuel centerline temperature, using the values presented in NUREG/CR-2367.[43] Fuel rod temperatures, percent metal-water reaction and numbers of failed fuel rods are determined by a plant specific fuel heat-up calculation using the HUXY code approved for 10 CFR 50 Appendix K calculations at Oyster Creek.

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43 D. D. Tha'er, et. al., "Updated Best-Estimate LOCA Radiation Signature," NUREG/CR-2367, Sandia National Laboratory (August 1981).

Using the Oyster Creek plant specific iodine and hydrogen concentrations, the oxygen concentration was calculated using the methodology described in Appendix A to Section 6.2.5 of NUREG-0800, "Combustible Gas Control in Containment." The only modification to this methodology is that the non-boiling oxygen generation rate is calculated as a function of dissolved iodine and hydrogen. The effect of dissolved iodine and hydrogen is added to the NUREG-0800 methodology by the equation presented in a June 23, 1982 memo from K. I. Parczewski (NRC) to V. Benaroya (NRC) "Radiolysis of Coolant Water in Millstone I."

The Topical Report shows that the effect of dissolved iodine in the containment water on the oxygen generation rate is offset by the effect of dissolved hydrogen resulting from the metal-water reaction and from radiolysis. Because of this effect, oxygen concentration in the Oyster Creek containment in the event of a LOCA, with severely degraded ECCS performance, is not likely to reach 5 percent. Even using the assumed release of 30 percent of the total core iodine relied upon by the Staff,[44] and a conservatively estimated 40% metal-water reaction would take over 12 months following the LOCA for the oxygen concentration in the Oyster Creek containment to reach 5 percent.

Based upon the Topical Report, the Oyster Creek inerted containment system will adequately protect against the combustible gases generated by a postulated LOCA, even if it is assumed that the performance of the ECCS is severely degraded.

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44 See Encl. 2, p. 3, to November 6, 1990 letter.

ATTACHMENT E

Oyster Creek Nuclear Generating Station
Compliance with 10 CFR 50.44

NRC Staff Position (Paragraph 5)

At the present time, the Staff is unable to determine if Oyster Creek must rely on a purge/repressurization system as the primary means for combustible gas control following a LOCA as discussed in Sections 50.44(b)(3) and 50.44(g). Without an Oyster Creek plant unique analysis using RG 1.7, models and accompanying assumptions, such a determination is impossible. However, the Staff believes it is highly probable that a purge/repressurization system will be shown to be needed.

(a) If Oyster Creek relies upon a purge/repressurization system as the primary means for combustible gas control following a LOCA, then the plant must have either an internal recombiner or the capability to install an external recombiner following the start of an accident, as required by Section 50.44(c)(3)(ii).

(i) NEDO-22155 may be used for the purposes of determining whether recombiner capability must be provided. Within this limited context, purge/repressurization may be shown as not the primary means of hydrogen control. However, the consequences of use of the purge/repressurization system considering RG 1.7 assumptions must be considered when evaluating potential oxygen sources.

(ii) The following prerequisites must be met if elimination of the need for recombiner capability is to be considered as contained in Section 50.44(c)(3)(ii). These prerequisites were first set forth in Generic Letter (GL) 84-09 (May 8, 1984).

(A) Oyster Creek technical specifications and [illegible] conditions for operation (LCOs) must requ[illegible] the containment atmosphere be less than four [illegible] oxygen when the containment is required to be i[illegible]

(B) Oyster Creek uses only nitrogen or recycled containment air in all pneumatic control systems within containment; and

(C) There are NO potential sources of oxygen in containment other than those resulting from reactor coolant radiolysis. Reliance on a system which uses air to repressurize the containment to comply with other requirements of 10 CFR 50.44, such as an ACAD system, is inconsistent with this prerequisite.

If Oyster Creek uses an ACAD system, it does not fulfill the third prerequisite of GL 84-09, and recombiner capability must be provided for in accordance with 10 CFR 50.44(c)(3)(ii). However, use of an NCAD system, which meets the requirements of GDC 41, 42 and 43, will not be inconsistent with the third prerequisite of GL 84-09.

(b) If recombiners are required at Oyster Creek such recombiners must meet the requirements of Section 50.44(d). See Section 50.44(c)(3)(ii).

(c) If external recombiners are relied upon at Oyster Creek, the penetrations used for the external recombiners must meet the criteria in Section 50.44(c)(3)(ii)(A) and (B).

GPUN Position

As set forth in Attachment D, Oyster Creek does not have a purge/repressurization system and does comply with the requirements of 10 CFR 50.44(b)(3) and 50.44(g) without the need to install such a system. Oyster Creek is not required by 10 CFR 50.44(c)(3)(ii) to install either an internal recombiner or the capability to install an external recombiner following the start of an accident.

Section 50.44(c)(3)(ii) provides that notwithstanding the requirements of sections 50.44(c)(1) and (2),

> By the end of the first scheduled refueling outage beginning after July 5, 1982 and of sufficient duration to permit required modifications, each light-water nuclear power reactor that relies upon a purge/repressurization system as the primary means of controlling combustible gases following a LOCA shall be provided with either an internal or external recombiner following the start of an accident. The internal or external recombiners must meet the combustible gas control requirements in paragraph (d) of this section. The containment penetrations used for external recombiners must either be:
>
> (A) Dedicated to that service only, conform to the requirements of Criteria 54 and 56 of Appendix A of this part, be designed against postulated single failures for containment isolation purposes, and be sized to satisfy the flow requirements of the external recombiners, or

(B) Of a combined design for use by either external recombiners or purge/repressurization systems and other systems, conform to the requirements of criteria 54 and 56 of Appendix A of this part, be designed against postulated single failures both for containment isolation purposes and for operation of the external recombiners or purge/repressurization systems, and be sized to satisfy the flow requirements of the external recombiners or purge repressurization systems.

Since Oyster Creek does not "rel[y] on a purge/repressurization system as the primary means of controlling combustible gases following a LOCA," section 50.44(c)(3)(ii) does not require Oyster Creek to install recombiners or the capability to install recombiners. As set forth in Attachments C and D, the Oyster Creek inerted containment system provides the means for adequately controlling combustible gas in the event of a postulated LOCA. Therefore, the basis for Oyster Creek's compliance with 10 CFR 50.44(c)(3)(ii) is that Oyster Creek does not rely on a purge/repressurization system as the primary means of controlling combustible gases following a LOCA. Nor does Oyster Creek need to rely on such a system.

1. Generic Letter 84-09

Notwithstanding the absence of a purge/repressurization system at Oyster Creek, the Staff requested that GPUN (and all other Mark I BWR owners who concluded that recombiners were not required for their facilities) submit a response to the May 8, 1984 Generic Letter No. 84-09. That letter set out the Staff's determination "that a Mark I BWR plant will be found to not rely on purge/repressurization systems as the primary means of hydrogen control, if certain technical criteria are satisfied." The Generic Letter stated the three criteria as follows:

(1) The plant has technical specifications (limiting conditions for operation) requiring that, when the containment is required to be inerted, the containment atmosphere be less than four percent oxygen, and

(2) The plant has only nitrogen or recycled containment atmosphere for use in all pneumatic control systems within containment, and

(3) There are no potential sources of oxygen in containment other than that resulting from radiolysis of the reactor coolant. Consideration of potential sources of inleakage of air and oxygen into containment should include consideration of not only normal plant operating conditions but also postulated loss-of-coolant-accident conditions. These potential sources of inleakage should include instrument air systems, service air systems, MSIV leakage control systems, purge lines, penetrations pressurized with air and inflatable door seals.

Even though Oyster Creek does not need to show compliance with these criteria to be in compliance with 10 CFR 50.44(c)(3)(ii), compliance with the three technical criteria has been shown by GPUN.[45]

<u>Criterion 1</u> (Oxygen Technical Specification): Oyster Creek Technical Specification 3.5.A.6. provides that primary containment atmosphere shall be reduced to less than 4.0% oxygen with nitrogen gas within 24 hours after the reactor mode selector switch is placed in the run mode and that deinerting may commence 24 hours prior to a scheduled shutdown.[46]

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45 Letter from P. B. Fiedler (GPUN) to NRC, "Recombiner Capability Requirements of 10 CFR 50.44(c)(3)(ii) - Response to Generic Letter 84-90," July 13, 1984; letter from P. B. Fiedler (GPUN) to J. A. Zwolinski (NRC), "NRC Request for Additional Information Regarding Licensee Response to Generic Letter 84-09," August 14, 1985; letter from R. F. Wilson (GPUN) to J. A. Zwolinski (GPUN) to J. A. Zwolinski (NRC), "Combustible Gas Control and Suppression Pool Temperature Limits," June 16, 1986; letter from R. F. Wilson (GPUN) to NRC, "Combustible Gas Control," May 31, 1988, encl. B.

46 Oxygen concentration is continuously recorded and a high oxygen concentration (3.5%) is annunciated in the control room. FSAR Section 6.2.5.3.6.

Criterion 2 (pneumatic control systems): All pneumatic functions in containment during normal operation are performed by the Drywell Instrument Air/Nitrogen system. [FSAR Sections 9.3.1.2 and 6.2.5.3.6.b and Operational Plant Manual pages 28.16 and 28.23]. During normal operation, that system is supplied with nitrogen. Two nitrogen compressors supply compressed nitrogen to perform all pneumatic functions. In the event of a loss of nitrogen pressure or loss of power to the nitrogen compressors, the system automatically transfers to an air supply.[47] The failure/loss of the nitrogen system annuciates a control room alarm. However, in the event of a LOCA, the containment is automatically isolated. Thus, any containment isolation would automatically terminate all sources of flow (whether nitrogen or air) to the containment instrument system since the nitrogen/air supply to containment uses the same penetration and containment isolation valves.[48] Isolation of the containment instrument system continues as long as the containment isolation signal is present.

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47 See letter from R. F. Wilson (GPUN) to J. A. Zwolinski (NRC), "Combustible Gas Control and Suppression Pool Temperature Limits," June 16, 1986; letter from R. F. Wilson (GPUN) to NRC, "Combustible Gas Control," May 31, 1988, encl. B. Although the Staff's March 13, 1987 Safety Evaluation (p. 2) states the Staff's understanding that air is supplied to the containment instrument system during normal operation, this only occurs if the nitrogen supply fails.

48 The total volume of instrument air (corrected to atmospheric pressure) represents about 0.16% of the volume of the Oyster Creek drywell. The oxygen represented by this potential addition of air wou'd represent less that 0.08% of the drywell volume. See letter fror . B. Fiedler (GPUN) to J. A. Zwolinski (NRC), "NRC Request for Additional Information Regarding Licensee Response to Generic Letter 84-09," August 14, 1985.

Other air systems (such as the Service Air and Breathing Air systems) use separate hoses and are not connected into the drywell during power operation. All penetrations are sealed by separate nitrogen bottles. There are no inflatable seals using air. The TIP purge system, which may use nitrogen or air, by procedure only uses nitrogen during power operation.

<u>Criterion 3</u> (potential sources of inleakage): During normal operation, there are no potential sources of oxygen in the Oyster Creek containment other than radiolysis of the reactor coolant. The drywell is maintained at a positive pressure of about 1.1 psig to 1.3 psig, with makeup drawn from a liquid nitrogen tank (minimum purity 99.7%). The positive pressure makes oxygen inleakage through penetrations unlikely. Oyster Creek does not rely on repressurization of the containment with air to comply with the requirements of 10 CFR 50.44 and does not have an Air Containment Atmospheric Dilution (ACAD) system.[49] Oyster Creek's Containment Inerting System has been referred to by the Staff as a Nitrogen Containment Atmospheric Dilution (NCAD) system. The Containment Inerting System is used to inert the containment as required by Technical Specifications and to provide nitrogen makeup to the drywell and torus.

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49 Even if Oyster Creek had a ACAD system, which it does not, the requirement of 10 CFR 50.44 (c)(3)(ii) to install recombiners or recombiner capability, as noted above only applies if the facility relies on a purge/repressurization system as the primary means of combustible gas control. The Staff statement that Generic Letter 84-09 grants relief from the hydrogen recombiner capability for those inerted Mark I containments that do not rely on safety grade purge/repressurization systems as the primary means of hydrogen control is inconsistent with the clear language of section 50.44(c)(3)(ii) which requires recombiner capability only for those Mark I containments that rely on purge/repressurization as the primary means of hydrogen control.

A. W. Dromerick (NRC), "Summary of the June 27, 1989 Meeting with GPU Nuclear . . . ," July 10, 1989, encl. 3. The Containment Inerting System is non-safety grade and is not relied upon to satisfy the criteria of Generic Letter 84-09 or to prevent combustible gas concentrations after a LOCA.

2. Recombiner Requirements

Paragraphs 5(b) and 5(c) of the Staff's November 6, 1990 letter set forth requirements which recombiners and recombiner capability must meet if recombiners or recombiner capability is either required or relied upon at Oyster Creek. Since neither recombiners nor recombiner capability is required or relied upon at Oyster Creek, the requirements set forth in these paragraphs are inapplicable.

3. Vent and Purge Procedures

Oyster Creek has adopted procedures to vent and purge the containment. These do not constitute an additional source of oxygen with respect to Generic Letter 84-09. The Staff's November 6, 1990 letter urged that Oyster Creek "develop procedures for post-accident combustible gas control compatible with the guidelines of Revision 4 to the BWR Owners' Group Emergency Procedure Guidelines."[50]

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50 Letter from S. A. Varga (NRC) to R. L. Long (GPUN), "Clarification of NRC Staff Position . . . ," November 6, 1990, encl. 1, p. 8.

Revision 4 to the guidelines specifically contemplates the venting and purging of the primary containment when hydrogen concentration reaches 6 percent and oxygen concentration reaches 5 percent.[51] The Staff has found Revision 4 of the guidelines to be "acceptable for implementation."[52] The Staff's Safety Evaluation for Revision 4 of the guidelines expressly approved the vent/purge instruction.

> This operator action is acceptable since the occurrence of a hydrogen or oxygen detonation in the drywell or suppression chamber when the RPV is pressurized could result in either severe core damage or in loss of primary containment integrity and an uncontrolled release of radioactivity much greater than might occur from a controlled purging and venting of the primary containment.[53]

Oyster Creek has developed Emergency Operating Procedures (EOPs)[54] that are based on Revision 4 to the BWR Owners' Group Guidelines. The Oyster Creek EOPs allow for venting and purging of the containment with air or nitrogen, but only under narrowly defined scenarios that are beyond the scope of 10 CFR 50.44.[55]

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51 NEDO-31331, BWR Owners' Group - Emergency Procedures Guidelines," Rev. 4 (March 1987).

52 Letter from A. Thadani (NRC) to D. Grace (BWROG), "Safety Evaluation of 'BWR Owners' Group-Emergency Procedure Guidelines, Revision 4,' NEDO-31331, March 1987," September 12, 1988.

53 Safety Evaluation by the Office of Nuclear Reactor Regulation - BWR Emergency Procedure Guidelines, Revision 4, BWR 1 through 6," September 1988, p. 36 (encl. 2 to letter from A. Thadani to D. Grace, September 12, 1988).

54 Procedure 2000.EMG-3200.02, "Primary Containment Control Hydrogen." Emergency Operating Procedure for Oyster Creek.

55 See letter from R. L. Long (GPUN) to S. A. Varga (NRC) "Compliance with 10 CFR 50.44," July 17, 1989; A. W. Dromerick (NRC), "Summary of the June 27, 1989 Meeting with GPU Nuclear . . . ," July 10, 1989.

Since these circumstances (hydrogen concentration above 6.0 percent, oxygen concentration above 5.0 percent) are beyond the scope of 10 CR 50.44, it would be inappropriate to consider the vent/purge system an additional source of oxygen within the meaning of the Generic Letter 84-09 criteria. Instead, the EOPs are consistent with the Commission's general philosophy of dealing with severe accidents, i.e., the licensee should have emergency procedures that take advantage of all available equipment, whether safety-related or not, to deal with beyond-licensing basis conditions.

4. NEDO-22155

In reaching the determination that a Mark I BWR plant will be found not to rely on purge/repressurization systems as the primary means of hydrogen control if it meets the three technical criteria, the Staff in Generic Letter 84-09 accepted the BWR Owners' Group's study, NEDO-22155, "Generation and Mitigation of Combustible Gas Mixtures in Inerted BWR Mark I Containments", June 1982, submitted by letter from T. J. Dente (BWROG) to D. G. Eisenhut (NRC), "NEDO-22155 . . . ," August 12, 1982.[56]

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56 See, e.g., letter from J. A. Zwolinski (NRC) to P. B. Fiedler (GPUN), "Meeting on April 10, 1986 ...", May 5, 1986; memorandum from J. N. Donohew, Jr. (NRC), "April 10, 1986 Meeting with GPU Nuclear ...," September 15, 1986, p. 4; letter from S. A. Varga (NRC) to R. L. Long (GPUN), "Clarification of NRC Staff Position ...," November 6, 1990, encl. 1, p. 5.

Oyster Creek has been shown to be bounded by the analyses of NEDO-22155.[57] Because of the Oyster Creek design, NEDO-22155 substantially over-predicts the amounts of combustible gas mixtures that will be generated at Oyster Creek. These include significantly lower core power at Oyster Creek than in the reference plant used in NEDO-22155 (1971 MWt vs. 3359 MWt), significantly greater drywell volume for Oyster Creek (180,000 $ft.^3$ vs. 159,000 $ft.^3$), shorter equivalent boiling time for limiting LOCA (100% for 8 hours vs. 100% for 12 hours), and measured containment leakage greater than maximum value used in analysis (0.204%/day v. 0.1%/day).[58]

The Staff stated that "relative to the need for recombiner capability, the NEDO report provided a basis to accept the BWR Mark I Owner's Group position that Mark I plants do not rely on the use of safety grade purge/repressurization as the primary means of combustible gas control."[59] Notwithstanding this acceptance of NEDO-22155, the Staff has stated that NEDO-22155 was not acceptable for other purposes. For example, in the meeting minutes of the April 10, 1986 meeting with GPUN, the Staff stated that it has

57 See letter from P. B. Fiedler (GPUN) to NRC, "Final Rule on Interim Requirements Related to Hydrogen Control . . . .", December 15, 1982.

58 See J. N. Donohew, Jr. (NRC), "April 10, 1986, Meeting with GPU Nuclear Corporation ...," September 15, 1986, encl. 2.; letter from R. F. Wilson (GPUN) to NRC, "Combustible Gas Control", May 31, 1988, encl. A, p. 2.; A. W. Dromerick, "Summary of the June 27, 1989 Meeting with GPU Nuclear ...," July 10, 1989, encl. 3.

59 See Letter from J. A. Zwolinski (NRC) to P. B. Fiedler (GPUN), "Meeting of April 10, 1986 . . . ," May 5, 1986, p. 2.

previously reviewed the G value data in NEDO-22155. It concluded that this data could be used as a basis for the Staff to issue GL 84-09 but was not acceptable for use in combustible gas calculations for the design basis LOCA.[60]

In its November 6, 1990 letter the Staff states that NEDO-22155 was acceptable for analyses called for by 10 CFR 50.44(c)(3)(ii) because "the staff believed that the models could be a more 'best estimate' approach than those required for the supporting analysis of 50.44(g)." However, the Staff continued to insist on the use of the assumptions in Regulatory Guide 1.7 as "the basis of acceptance for the DBA events."[61]

The Staff's position accepting NEDO-22155 for one combustible gas control purpose but not for another is not supportable. There is nothing in the regulatory history to 10 CFR 50.44 which supports the requirements for more conservative assumptions to satisfy 10 CFR 50.44(g) than are needed to satisfy 10 CFR 50.44(c)(3)(ii). If NEDO-22155 is sufficiently reasonable to satisfy section 50.44(c)(3)(ii), it should also be reasonable enough to satisfy section 50.44(g). Indeed, since 10 CFR 50.44(c)(3) is intended for conditions that go beyond the design basis accident scenarios of section 50.44(g), the Staff's position is counterintuitive.

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60 Memorandum from J. N. Donohew, Jr. (NRC), "April 10, 1986 Meeting with GPU Nuclear . . . ," September 15, 1986, p. 4.

61 Letter from S. A. Varga (NRC) to R. L. Long (GPUN), "Clarification of NRC Staff Position . . . ," November 6, 1990, encl. 1, p. 5.

The Staff has also stated that NEDO-22155 was "initially presented only to support the exemption from the recombiner capability requirement."[62] Presumably this limitation is suggested to justify the Staff's limited acceptance of NEDO-22155. In fact, however, the NEDO report was submitted for a broader purpose. As stated in its transmittal letter, NEDO-22155 "was prepared by the BWR Owners' Group in response to Reference 1." The report itself states that its purpose

> is to determine if the existing inerted containment design adequately controls combustible gas concentrations to below combustible gas limits without requiring the use of hydrogen recombiners <u>or containment purging</u>.[63]

The Staff's primary criticism of NEDO-22155 seems to be with the report's oxygen generation rates. The Staff believes that radioactive iodine in the primary coolant, which can significantly influence the production of radiolytic oxygen, will be substantially greater than assumed in NEDO-22155. The Staff's analysis used an assumed release of 30% of the total fuel iodine inventory.[64] However, the Staff subsequently retreated from its reliance on the 30% value.

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62 See November 6, 1990 letter, encl. 1, p. 5.

63 See NEDO-22155, Summary, (emphasis added).

64 See November 6, 1990 NRC letter, encl. 2, p. 2.

> One could argue whether the amount be 30 percent, as assumed by the staff, or some other number. However, we do not believe that such a detailed discussion is necessary nor prudent. Since the staff has always acknowledged that the events covered by 50.44 are significantly more severe than those described by 50.46, the presence of large amounts of iodine should not be under question.[65]

Whatever the number, there is no logic in accepting the iodine releases for the purposes of section 50.44(c)(3)(ii) analyses while rejecting them for section 50.44(g).

The amount of iodine assumed to be released must have some basis. If the Staff is going to disregard the 30% value it previously proposed (which in any event is shown in Attachment D to be substantially overconservative), it must provide support for some other value. The analysis presented by GPUN in Attachment D presents such an evaluation specific to Oyster Creek. GPUN believes that the values set forth in that evaluation conservatively estimate the iodine releases, as well as the oxygen and hydrogen generation rates, and demonstrate that combustible levels of oxygen will not be reached at Oyster Creek following either a DBA loss of coolant accident or a degraded ECCS loss of coolant accident.

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65 Memorandum from A. W. Dromerick (NRC), "Summary of Meeting to Discuss the Technical Evaluation Published by the Staff . . . ," March 13, 1991, p. 3.

ATTACHMENT F
Oyster Creek Nuclear Generating Station
Compliance with 10 CFR 50.44(c)(3)(iii)

NRC Staff Position (Paragraph 6)

"Oyster Creek must have high point vents for the reactor coolant system, the reactor vessel head, and any other systems required to maintain adequate cooling if the accumulation of noncondensible gases would cause loss of these systems, as required by 50.44(c)(3(iii)."

GPUN Position

Oyster Creek complies with the high point vent requirements of 10 C.F.R. 50.44 (c)(3)(iii).

Section 50.44(c)(3)(iii) states:

To provide improved operational capability to maintain adequate core cooling following an accident, by the end of the first scheduled outage beginning after July 1, 1982 and of sufficient duration to permit required modifications, each light-water nuclear power reactor shall be provided with high point vents for the reactor coolant system, for the reactor vessel head, and for other systems required to maintain adequate core cooling if the accumulation of noncondensible gases would cause the loss of function of these systems. (High point vents are not required, however, for the tubes in U-tube steam generators.) The high point vents must be remotely operated from the control room. Since these vents form a part of the reactor coolant pressure boundary, the design of vents and associated controls, instruments and power sources conform to the requirements of Appendix A and Appendix B of this part. In particular, the vent system shall be designed to ensure a low probability that (A) the vents will not perform their safety functions and (B) there would be inadvertent or irreversible actuation of a vent. Furthermore, the use of these vents during and following an accident must not aggravate the challenge to the containment or the course of the accident.

For Oyster Creek, the requirements for high point vents for the reactor coolant system and the reactor vessel head are met by the five safety-grade power operated relief valves that are part of the automatic depressurization system.[66] The NRC Staff found this to be acceptable.[67] High point vents also exist on the isolation condenser. (Refer to FSAR Sections 1.9.15 and 6.3.1.1.2). The NRC Staff has also found these to be in compliance with 10 CFR 50.44(c)(3)(iii).[68]

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66 See letter from T. D. Keenan (BWROG) to D. G. Eisenhut (NRC), "BWR Owners' Group Position on NUREG-0578," October 17, 1979; letter from I. R. Finfrock, Jr. (JCPL) to D. G. Eisenhut, "Follow-up to Reviews Regarding the Three Mile Island Unit 2 Accident," October 19, 1979; letter from I. R. Finfrock, Jr. to D. G. Eisenhut, "NUREG-0578 Implementation - Oyster Creek Nuclear Generating Station," January 4, 1980; letter from D. B. Waters (BWROG) to D. G. Eisenhut, "Preliminary Clarification of TMI Action Plan Requirements . . . ," October 8, 1980; letter from D. B. Waters to D. G. Eisenhut, "NUREG-0660/0737 Requirement II.B.1: Reactor Coolant System Vents," April 24, 1981.

67 See letter from D. M. Crutchfield (NRC) to P. B. Fiedler (GPUN), "NUREG-0737 Item II.B.1, Reactor Coolant System Vents," September 2, 1983, and enclosed safety evaluation.

68 See Letter from J. A. Zwolinski to P. B. Fiedler, "Schedular Exemption - Compliance with 10 CFR 50.44(c)(3)(iii) - Isolation Condenser High Points Vents," April 24, 1986.