BWR OWNERS' GROUP

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Subject: **BWR Owner's Group Position On Issues Identified In Generic Safety Issue-189 And The Benefits And Cost Of The Identified Alternatives To Resolving GSI-189 Concerns.**

Enclosure: Review of Cost/Benefit for Back-up Power for Mark III Containments under SBO Conditions

References:

1. NRC Presentation titled "Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion during a Severe Accident" dated June 18, 2003.
2. "Benefit Cost Analysis of Enhancing Combustible Gas Control Availability at Ice Condenser and Mark III Containment Plants" dated December 23, 2003.
3. "Backup Power for PWR's with Ice Condenser Containments and for Mark III Containments under SBO Conditions: Impact Assessment" dated September 24, 2002.

Attention: Johnny Eads, Project Manager, Section 1
Project Directorate 3
Division of Licensing Project Management

As a result of information provided in Reference # 1 at the June 18, 2003 Public Meeting concerning resolution of Generic Safety Issue (GSI)-189 (Reference 1), the Boiling Water Reactor Owners' Group (BWROG) has formed a committee of owners who have Mark III containments. The purpose of this committee is to develop a coordinated BWROG position on issues identified in GSI-189 and on the benefits and cost of the identified alternatives to resolving GSI-189 concerns.

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The scope of the committee's efforts to date, have concentrated on the information contained in the above references including relevant plant differences between the BWR Mark III and the Pressurized Water Reactor (PWR) ice condenser containment designs which impact both cost and benefit assumptions. Such plant differences were identified as issues requiring additional NRC analysis in a hand out provided by industry representatives at the referenced June 18, 2003 meeting as well as a list of issues which impact the design criteria and scope for an acceptable approach.

The findings of the committee are that there are significant plant differences in the Mark III containment designs which contribute to the conclusion that the identified pre-staged backup power modification will be of low benefit and high cost for BWR's.

Our review concluded that reference 2 (December 22, 2002 benefit cost analysis document) provides analysis which supports our conclusion that a backup power modification for hydrogen igniters to help mitigate station blackout (SBO) concerns is of low benefit for BWR's. Page 34 of reference 2 concludes that the lifetime averted cost for the mean BWR Mark III plant is $10k and is a factor of 30 less than an ice condenser plant for internal events. The report notes the reasons for such differences. Additional benefits can be postulated for external events for BWR's, but such benefits should be of the same order of magnitude as those calculated for internal events (see enclosure for additional information). Thus, we conclude the total benefits for internal and external events will not support the cost for what we conclude will be a complex and costly plant modification to add backup power for BWR's.

Our review of the cost information provided in reference 3 indicates agreement with the provided cost estimate for the identified scope of equipment. Such cost would approach $300k which would not justify proceeding with the identified benefits for BWR's but the scope of what may be required is expected to significantly increase the design complexity and resulting costs beyond $300k for MarkIII containment owners.

The principal area of concern identified with the cost estimate is the BWR need for powering the containment hydrogen analyzers prior to re-energizing the hydrogen igniters with the backup power source (i.e. emergency diesel or gasoline powered diesel) for emergency hydrogen control following an accident. These analyzers are needed to assure hydrogen concentrations are below specified limits to prevent inadvertent containment failure from re-energizing the igniters. While the BWR Mark III plants have design differences for their hydrogen analyzers, at least one plant will need cooling water and the associated cooling systems, thus adding to the design complexities. Other plants will need power for analyzer sample line heat tracing and power for opening necessary valving including containment isolation valves in the analyzer sample path.

The additional scope associated with powering a hydrogen analyzer and its support equipment would necessitate a larger backup power source. This larger backup power source would in turn require an enclosure for weather protection and a substantial fuel supply. While no detailed cost estimate has been completed, it is expected the cost will

far exceed the $300k estimate and could approach $1.0 million depending on location of the enclosure, complexities in routing of cables and design needs to meet environmental, fire, other regulations and requirements. The addition of requirements to meet external events such as seismic, tornado etc would likewise add to the design complexities and cost.

As noted, there are significant design differences for the Mark III plants which need to be addressed separately prior to proceeding with regulatory action for BWR's with Mark III containments. It should be noted that while each of the committee members has contributed to the contents of this letter and it's enclosure, it should not be interpreted as the position of any individual member or imply a commitment to any specific course of action. As for all BWROG activities, each BWROG member utility must formally endorse the BWROG position in order for that position to become the member's position.

Enclosed you will find additional information concerning our review of GSI-189 issues. We appreciate the opportunity the NRC has provide for Industry and Public input into this GSI and encourage additional dialogue before final determination is made on resulting regulatory actions including Rule Making

If you have any questions, please contact the undersigned.

Regards,

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BWR Owners' Group Chairman

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Enclosure

BWROG GSI-189 COMMITTEE

REVIEW OF COST/BENEFIT FOR BACKUP POWER FOR MARK III CONTAINMENT UNDER SBO CONDITIONS

The Boiling Water Reactors Owner's Group (BWROG) GSI-189 committee was formed to coordinate a review by BWR Owner's with Mark III containments of information concerning the need for regulatory action to resolve GSI-189. The principal documents which were reviewed are the cost and benefit analysis performed by the NRC as well as the presentation material provided by the NRC at the June 18, 2003 Public Meeting in Rockville, Maryland.

The results of this review is the conclusion that there are significant plant differences between the BWR Mark III containment designs and the Pressurized Water Reactor (PWR) ice condenser containment design which contribute to reduced benefits for BWR's and higher costs for identified backup power modifications.

What follows are the results of the committee's review of information on potential benefits, the scope and cost of identified modifications and a section on other considerations which addresses the expectations for the plant's emergency response to station blackout (SBO) events and additional capabilities Mark III plants have to mitigate SBO events.

POTENTIAL BENEFITS

The Brookhaven National Laboratory report, "Benefit Cost Analysis of Enhancing Combustible Gas Control Availability at Ice Condenser and Mark III Containment Plants" was reviewed. While some of the information concerning probability of failures does not reflect more recent Mark III BWR plant improvements to help mitigate SBO's, the results are in line with the committee's understandings of the risk and consequence of SBO events resulting in severe core damage. The section on "Discussion of Results" on page 34 of this report concludes that the lifetime averted cost for the mean BWR Mark III plant is estimated at $10k. The report notes that this is a factor of 30 times less than the results for PWR's for internal events. The reasons behind such large differences are explained in the report.

The Brookhaven report notes that there is no information available for external events that can be used for BWR's, but that such information is available for PWR's. On page 8 of the June 18, 2003 NRC Presentation, "Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion during a Severe Accident," potential benefits are identified for both internal and external events. It appears that the external event benefits for PWR's have been used as an estimate of the benefits for BWR's. The result is that external event benefits for BWR's from PWR data is assumed to be $350k which is then added to internal event calculation of $10k thus biasing the assumed benefits for BWR's to PWR data.

The committee believes that a more realistic approach for the assumption of external event benefits for BWR's is a ratio of the calculated internal to external events benefits for PWR's. Such an approach would result in the benefits for external events being close to the benefits calculated for internal events and consistent with the explanations provided in the Brookhaven report for why there are differences in internal events between the BWR and PWR plants. Such internal event plant differences should also be applicable to external events should actual data be generated for BWR's. Current practices used in the Significance Determination Process for BWR's are to double internal event risk calculations to account for external events. Using the ratio approach suggested would result in the external event benefits for BWR's to more closely align with the calculated internal events which we conclude is more representative.

The committee has concluded that the identified benefits do not support proceeding with plant modifications. It is recognized that there are potential benefits resulting from increased defense in depth which may result from an additional backup power source for the hydrogen igniters but the cost of such extra defense in depth must be justified.

Unfortunately, such defense in depth will come at a significant cost which would not support the marginal benefits. As noted in the section on cost, the backup power option will need to consider features unique to the BWR which will drive costs upward of $1.0 million. Such expenditures should rightfully compete with other plant and NRC identified initiatives which improve plant safety and also provide defense in depth.

COST OF BACKUP POWER MODIFICATION

The Information Systems Laboratories, Inc., report, "Backup Power for PWR's with Ice Condenser Containments and for BWR's with Mark III Containments under SBO Conditions: Impact Statement," was reviewed. The base case involving a pre-staged generator with costs of $312,700 was compared to actual results by a utility which installed a similar modification for backup power for a Year 2000 (Y2K) issue. The results showed similar costs for the limited scope of supply.

Further review by the committee identified significant issues with the required scope of supply for BWR's beyond the backup generator to satisfy requirements for igniter operation. "Facts Related to Hydrogen Igniter Operation Emergency Plant Guidelines (EPG) Basis Document" (Attachment 1), is a summary relevant to the issues with hydrogen igniter power contained in existing emergency procedure requirements which would apply to action under accident conditions including SBO. Such procedures restrict use of igniters to assure operation does not inadvertently create containment failure. Operation of the igniters requires that the Hydrogen Deflagration Overpressure Limit maintain operation within specified limits based on containment hydrogen concentration (%) and containment pressure. To meet this requirement the percentage of hydrogen must be known prior to igniter operation. Such hydrogen percentage is determined by sampling of the containment atmosphere by using the hydrogen analyzers. Under the

postulated SBO conditions, the hydrogen analyzers would also need backup power as would certain support systems needed for hydrogen analyzer operation.

There are plant differences among the BWR Mark III plants as to support needs for hydrogen analyzers. At least one Mark III plant needs cooling water for the analyzers so they function properly in a steam environment. Other plants have power requirements for analyzer heat tracing and power to open valves including containment isolation valves to obtain samples. While there are differences among the Mark III plants as to scope, all have procedure restriction on igniter use and will need support equipment and instrumentation which may be physically located in different locations.

Included in Attachment 1 is a list of required support for hydrogen igniter operation for one of the plants which can be considered as conservative. It shows that while the igniter loads are 15 KVA the total loads would be 1235 KVA when the hydrogen analyzers and support systems are included. This will result in larger diesel generators but more importantly in a complex modification which involves cable routing, use of containment penetrations and electrical connections which are physically located in different parts of the plant/containment. This will add to the cost of the modification.

The extra power needs and scope will also add design challenges to the enclosure for the generator and probably necessitate a separate fuel storage tank. Such a tank and enclosure will need to meet environmental (EPA) standards including provision for a berm to retain potential spillage and fire protection considerations for the combustible loads. The enclosure will also need to address weather concerns especially for the plants located in cold weather climates which will need provisions to assure the fuel oil viscosity meets specifications.

While no detailed cost estimate has been done for BWR Mark III plants, the committee believes the extra scope needed will result in costs that far exceed the original estimated of $300k and may approach $1.0 million. This estimate may prove to be low if the issues identified in the June 18, 2003 meeting results in imposing additional requirements to meet such as seismic.

As noted, there are conservatisms in our estimates of what will be required to provide a backup power supply because of the uncertainties in the definition of what SBO events resulting in core damage need to be covered in the design. The key assumption is the postulation of when during an SBO core damage is assumed to occur. Under certain assumptions (e.g., SBO coping is effective), core cooling would be available and there would be sufficient time to use a backup power supply for the igniters without needing hydrogen analyzers. If the design was limited to SBO events that maintained the reactor core water level above top of active fuel (TAF) then no core damage would have occurred, no resulting hydrogen deflagration would be of concern and thus no need for analyzers. This approach would restrict the benefit of the backup power provision to slow moving SBO events which assumes the Plant is maintaining core cooling for an extended time and that the risk of inadvertent operation without analyzer confirmation of

hydrogen concentrations is warranted. With such assumptions, the cost which would be the $300k option would still far exceed the identified benefits.

OTHER CONSIDERATIONS

The addition of a pre-staged backup power supply will add some defense in depth for containment integrity during SBO events but it also will add to the demands on the operating staff and the emergency response organization. During SBO events which potentially challenge core cooling the operations staff and emergency response organization need to be focused on the key tasks of on-site and off site power restoration and on maintaining core cooling pending power restoration. Plant SBO coping strategies and emergency response procedures provide such focus as well as providing planning for contingencies such as failures which result in loss of core cooling including the need to protect the containment.

The need for the hydrogen igniters to assure containment integrity is well established in the emergency procedures including the emergency operating procedures (EOP's), severe accident management guidelines (SAMG's) and other emergency procedures directed at mitigating beyond design basis events. Should power not be available for the hydrogen igniters the plant emergency staff will consider options for power restoration and use all the resources available within their utility to have the power available if needed for containment protection.

Should the pre-staged backup power for the igniters be required by regulatory action for SBO events and resulting fuel damage contingencies, it will be assumed to be needed at the initiation of SBO events. This will result in procedural requirements which result in the diversion of operations emergency personnel at a critical time to manning the pre-staged igniter backup power system rather than to be available for other potential duties which may result in the avoidance of ever needing the igniters by power restoration or avoidance of core damage by providing long term core cooling.

Other considerations which need to be factored into the decisions for BWR Mark III plants are the existing capabilities including the separate high pressure cooling system (HPCS) diesel generator which is the division 3 diesel. This diesel is of high reliability, is of a different design and manufacturer than the other two emergency diesels and thus not subject to emergency diesel common mode failure concerns. The diesel generator driven pump is expected to provide the necessary core cooling during SBO events as well as other means available for core cooling for Mark III plants including RCIC and the diesel driven fire pump.

Should the HPCS pump fail for some reason, use of the pumps diesel generator would be available and would be considered by the emergency organization as a means of providing alternative power including powering the igniters if needed.

CONCLUSION

Based on the committee's review of existing information on GSI-189 concerning the cost/benefit of a backup power system for Mark III containments under SBO conditions, we have concluded that the benefits identified do not support the cost required. We have also concluded that the significant design differences resulting in negligible benefits necessitate separate decisions by the NRC as to the appropriateness of regulatory actions involving Rulemaking for BWR's. Such a separate review should provide additional clarity as to the need for BWR's to consider appropriate actions to resolve identified concerns.

We also conclude that additional reviews are needed for the PWR ice condenser plants before Rulemaking decisions are made to help clarify the criteria and scope for modifications as documented in the industry provided "Discussion Points" provided at the June 18, 2003 Public Meeting.

Facts Related to Hydrogen Igniter Operation
Emergency Plant Guidelines (EPG) Bases Document

Key Points

- Hydrogen igniters mitigate hydrogen generation in the containment and drywell.
- The hydrogen igniters were modified such that they would not automatically re-energize after losing electrical power.
- Hydrogen analyzers provide assurance that containment and drywell hydrogen is less than their respective Hydrogen Deflagration Overpressure Limit (HDOL). The hydrogen analyzers are started upon entry into the Reactor Pressure Vessel Control EPGs to allow adequate time to obtain a valid sample. This analyzer is capable of taking a sample from a steam laden environment in the drywell or containment.
- Upon entering the Hydrogen Control EPG due to reactor water level at Level 1 (16.5") above top of active fuel or hydrogen concentration > 0.5 %, the igniters are energized provided containment and drywell hydrogen are less than HDOL.
- Hydrogen igniters may not be energized or re-energized unless containment hydrogen concentration is less than the HDOL and drywell hydrogen concentration is less than 9% (DW HDOL).
- Current EPG Bases state that "a minimum of ten minutes would be available between the time when RPV water level reaches the top of active fuel and the time when significant hydrogen production begins." It is acceptable to energize the hydrogen igniters during this period of time without having a hydrogen analyzer available.
- Hydrogen sampling by chemistry personnel is an alternative should the analyzers be unavailable. This method of hydrogen concentration determination has several limitations during a loss of diesel generators concurrent with a loss of off-site power.
    - A sample is normally drawn from the Post Accident Sampling Panel. This sample path would not be available due to a loss of power to the solenoid actuated sample valves.
    - The gas chromatograph requires a 24 hour warm-up period. It is a semi-portable unit that could be moved to a power source, but a large gas bottle must be moved with it and it cannot be allowed to cool excessively before use.
    - A sample is provided by using a standard gas sample vial. The radioactivity level of the sample may prohibit handling by a chemistry technician.

Note: Quotes from the EPG Bases are indented and marked with a bar in the right margin.

Hydrogen Igniters

The Emergency Plant Guideline (EPG) Bases explain the basic strategy:

> The Igniter system is actuated as early as possible in situations which could lead to significant hydrogen production. This action assures that combustion of hydrogen will occur at the lowest possible hydrogen concentration to limit any pressure increase.
>
> If the Hydrogen Igniters and Hydrogen Recombiners do not effectively control containment hydrogen, then this procedure subsequently directs the operator to initiate venting of the containment. If deflagrations could threaten containment integrity, containment venting is conducted regardless of the resulting Site Radioactivity Release Rates.
>
> The entry conditions give the operators sufficient time to prevent hydrogen combustion and containment failure resulting from a hydrogen generation event. Calculations show that a minimum of ten minutes would be available between the time when RPV water level reaches the top of active fuel and the time when significant hydrogen production begins. Ten minutes provides the operators with sufficient time to mitigate the consequences of hydrogen generation.
>
> The term significant hydrogen as it is used above corresponds to the minimum detectable hydrogen concentration, or 0.5%.

Elsewhere the EPG Bases state that the severity of hydrogen generation is related to the time RPV water level drops below the top of active fuel:

> The further the level drops and the longer it remains there, the greater the potential that hydrogen production will occur.

The EPG Bases also identify the conditions that are required to be met prior to igniter operation:

Operation of the Igniters is conditional upon two parameters:

(1) Containment hydrogen concentration being below the containment HDOL, Figure 7, and
(2) Drywell hydrogen concentration below the Drywell HDOL of 9%.

Operation of the Igniters with containment hydrogen concentrations above the containment HDOL is prohibited, since a deflagration and the resulting pressure increase under these conditions could overpressurize the containment. Similarly, a deflagration in the drywell, with the drywell HDOL exceeded, could threaten drywell or containment integrity.

When either of the entry conditions are met, the Hydrogen Igniters should be started to limit hydrogen accumulation in the drywell and containment. Starting the Hydrogen Igniters is desired to prevent hydrogen accumulation by ignition of hydrogen at the lowest concentrations. Although not explicitly stated in this step, Hydrogen Igniter startup is dependent on the existence of the following:

- Starting the Hydrogen Igniters with containment hydrogen concentration above the HDOL (Figure 7) is prohibited since a deflagration and the resulting containment pressure increase under these conditions could overpressurize the containment.

- Starting the Hydrogen Igniters with drywell concentration = 9% [or containment hydrogen concentration > HDOL] is prohibited (if the Igniters were not operating), since a drywell pressure [or containment pressure] increase under these conditions could threaten the integrity of the drywell and containment.

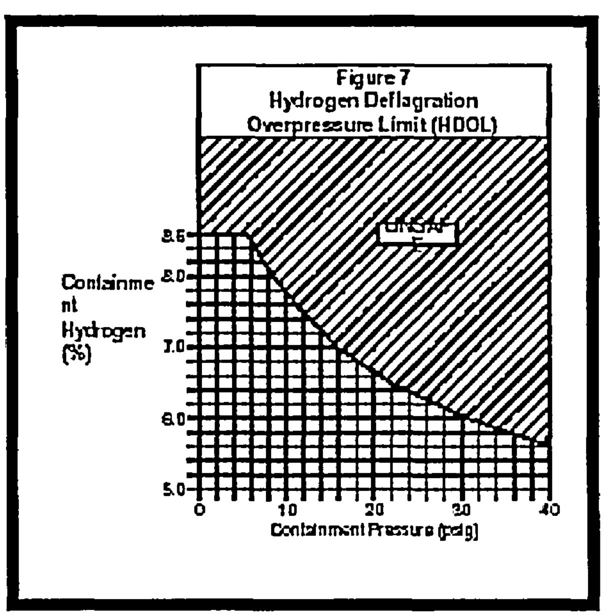

Figure 7
Hydrogen Deflagration Overpressure Limit (HDOL)

Hydrogen Igniters have a drop out feature. If they lose power, they will not automatically come back on when power is restored. Hence the Bases state,

> If the Hydrogen Igniters could not be initially started or they were started but dropped out the flowchart conditions must be such that the operator is directed to start/restart the igniters upon override implementation or if hydrogen concentration can be determined to be below the HDOL.

Hydrogen Analyzer Operation

The first step in the EPG for Reactor Pressure Vessel (RPV) Control is to scram the reactor if it has not already scrammed. The second step is to start the hydrogen analyzers.

The EPG Bases Document states,

> Per NUREG 0737, monitoring of Hydrogen is required after "safety injection" (i.e. ECCS injection). However, no safety injection can be required without meeting an entry condition for the RPV Control Guideline. Since "safety injection" is possible during the use of the RPV Control Guideline and, once it is required, the operators would have little or no time available to perform additional actions; therefore, it is appropriate to manually initiate the Hydrogen Analyzers as one of the first operator actions after entering RPV Control.

The hydrogen analyzers are started from standby early in the Plant Emergency Instructions to allow the sample pumps to obtain a representative sample as they recirculate air from the containment or drywell.

The hydrogen analyzer system operating instruction notes that, "At least 15 minutes should be allowed after each Sample Point Channel change before channel readings can be considered valid."

During plant emergencies, the hydrogen analyzers are started from the standby mode with the analyzer cabinet heaters on. (Once the hydrogen analyzer cabinet space heaters are energized, it takes about 5 hours to reach the appropriate analyzer cabinet temperature.)

This ensures that the unit is up to operating temperature and capable of analyzing a containment or drywell atmosphere in a timely fashion.

Required Support For Hydrogen Igniter Operation shows the support equipment need for hydrogen igniter operation. The sizing of the loads was determined using electrical prints based on the amp rating of electrical breakers and fuses. This information is indicative of the types of loads involved and has not been verified as to accuracy. The transformers for the hydrogen igniters are rated at 15 KVA. Conversion from HP to KW/KVA is based on the formula:
KW = HP x 0.7457. For these purposes KW and KVA were used interchangeably.

Attachment 2

H2 IGNITERS
- Remote Control
- Remote Indication

15 KVA

H2 ANALYZER
- Cabinet Heater
- Isolation Valves
- Sample Pump

4 KVA

EMERGENCY CLOSED COOLING
- Circulating Water Pump
- HVAC Unit
- Chiller and Circulating Water Pump

596 KVA

EMERGENCY SERVICE WATER
- ESW Pump
- Valves
- Area Cooling

620 KVA

REQUIRED SIZE OF BACKUP GENERATOR
for
Hydrogen Igniters and Support Equipment

1235 KVA Total Required Load

Igniters

15 KVA

Analyzer
- 0.8 KVA
- 2.4 KVA
- 0.7 KVA

4 KVA

ECC
- 74.6 KVA
- 14.9 KVA
- 507 KVA

596 KVA

ESW
- 74.6 KVA
- 14.9 KVA
- 507 KVA

596 KVA

Generator

TOTAL
1235 KVA

Required Support For Hydrogen Igniter Operation