Results of Initial Review of the Seven Screening Criteria

If any of these screening criteria are **not** met, then the issue would **not** continue in the Generic Issue (GI) process.

1. The issue affects public health and safety, the common defense and security, or the environment. For issues that are not amenable to quantification using risk assessment, qualitative factors may be developed and applied as necessary to assess safety/risk significance.

   The Nuclear Regulatory Commission (NRC) staff recognizes that the production of hydrogen occurs as a consequence of severe core damage, and can be subsequently released into the containment where it has the potential to collect into a combustible concentration. Consequently, the NRC established requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.44, "Combustible Gas Control for Nuclear Power Reactors," for licensees to analyze their plants for this phenomena and ensure that their plants can prevent and mitigate the consequence of hydrogen production. The analyses ensure that ignition sources, regardless of their cause, would not result in unacceptable consequences. Therefore, Dr. Leishear's postulated ignition source (water hammer in the reactor coolant system) for the hydrogen in the containment is bounded by these plant analyses. Therefore, the staff finds that this proposed GI does not present a risk to public health and safety significant enough for it to continue in the GI process.

   - Therefore, the proposed issue would **not** meet screening criterion #1.

2. The issue applies to two or more facilities and/or licensees/certificate holders, or holders of other regulatory approvals.

   The two elements required to have a hydrogen explosion in the reactor coolant system are (1) the production of hydrogen and oxygen, typically from radiolysis of water, and (2) a sudden compression, resulting from events such as a water hammer. All operating U.S. nuclear power plants have primary reactor coolant piping containing water; hence, that water is exposed to radiolysis while inside the reactor core. Hydrogen and oxygen are produced during this radiolysis. Both pressurized water reactors (PWRs) and boiling water reactors (BWRs) operate with the primary system under pressure. Therefore, theoretically, both conditions for hydrogen generation and denotation may exist in all U.S. nuclear power plants. There have been no hydrogen combustion events reported at any PWR plants, but there were two international facilities reporting combustion events at BWR plants that may be attributable to combustible gas accumulation. Therefore, the proposed issue has the potential to apply to two or more nuclear power facilities.

   - Therefore, the proposed issue would meet screening criterion #2.

3. The issue is not being addressed using other regulatory programs and processes; existing regulations, policies, or guidance.

   The NRC staff has already addressed the potential hazard from combustible gases through the GI program. However, the NRC staff is evaluating the potential of explosions in buildings and containment following an accident within the scope of Recommendation #6 to the report from the Near-Term Task Force, "Recommendations for Enhancing Reactor Safety in the 21st Century." Once the staff concludes its evaluations, it will recommend whether to impose any additional regulatory requirements on nuclear power facilities. The

staff has an existing mandate under the Near-Term Task Force to examine any corrective measures required as a result of the review of the accident in Japan, and so the issue raised by Dr. Leishear is being addressed by another regulatory program.

- Therefore, the proposed issue would **not** meet screening criteria #3.

4. The issue can be resolved by new or revised regulation, policy, or guidance.

   The NRC staff had already addressed the potential hazard from combustible gases. For control of combustible gases during severe accidents, the NRC established requirements in 10 CFR 50.44, "Combustible Gas Control for Nuclear Power Reactors," for licensees to analyze their plants for this phenomena and ensure that their plants can prevent and mitigate the consequence of hydrogen production. For control of gases during normal operation, the NRC issued Generic Letter 93-06 to inform U.S. licensees of the technical findings from the resolution of Generic Safety Issue 106. In addition, the NRC issued Information Notice (IN) 2002-15 and IE Bulletin No. 78-03, and evaluated the issue in GI-195 for BWRs and GI-198 for PWRs. Industry experts at General Electric Nuclear Energy (GE-NE) issued Rapid Information Communication Service Information Letter No. 85 to advised BWR owners of the Hamaoka-1 event. The service letter identified piping systems susceptible to the accumulation of noncondensable gas and made recommendations for the prevention of hazardous accumulations. GE-NE also issued Service Information Letter No. 643 to advise BWR owners of the event at Brunsbuttel. The issuance of previous guidance related to this potential hazard illustrates that this issue can be resolved using regulation, policy, or guidance, if deemed necessary.

   If any additional regulatory requirements arise from the evaluation of the nuclear accident in Japan, the staff will issue regulatory requirements as part of efforts under its Near-Term Task Force mandate.

   - Therefore, the proposed issue would meet screening criterion #4.

5. The issue's risk or safety significance can be adequately determined in a timely manner (i.e., it does not involve phenomena or other uncertainties that would require long-term study and/or experimental research to establish the risk or safety significance).

   The NRC staff previously evaluated GIs on the potential hazard of hydrogen gas explosions in PWRs and BWRs. The results of these evaluations included a quantitative risk assessment. The core damage frequency (CDF) and the large early release frequency (LERF) values calculated for BWRs and PWRs were found to be less than the threshold values required for an issue to continue in the GI process. Since the staff demonstrated its ability to quantify the risk on previous similar GIs, the current risk can also be determined; hence, this criterion would be satisfied if a reevaluation were warranted.

   - Therefore, the proposed issue would meet screening criterion #5.

6. The issue is well defined, discrete, and technical.

   The submitter, Dr. Leishear, provided his theory on how a combustible mixture of hydrogen and oxygen gases can form and be pressurized to the point of ignition in the reactor coolant system (RCS). His theory is technical and based upon basic scientific principles.

The physical design of the RCS piping system (e.g. exhausts from all pressurizer safety valves and power operated relief valves) is that it is hard piped to the primary relief tank. This configuration would create a long torturous pathway, making it unlikely that an ignition source inside the RCS could migrate through the relief valves, down the exhaust piping, and up through a tank mostly filled with water. If a flame were to exit through the pressurizer relief valves, the flame would likely be extinguished by the sudden pressure drop when the valve opened, or extinguished when passing through the body of water in the relief tank.

Nonetheless, a scenario could possibly exist where there were a path for a flame to reach the containment atmosphere from the RCS. One scenario includes a rupture of the RCS piping, providing a direct path to the containment. Another scenario is where a flame could propagate out of the RCS through a relief valve into the primary relief tank; if the tank was not filled with water or steam, then the flame could propagate into the containment and possibly ignite the hydrogen.

- Therefore, the proposed issue would meet screening criterion #6.

7. Resolution of the issue may involve review, analysis, or action by the affected licensees, certificate holders, or holders of other regulatory approvals.

   A significant number of reviews, analyses, and actions have already been taken by the nuclear plant operators, owner groups, and NRC staff on the potential hazards of combustible gas accumulations. The NRC has previously taken regulatory action to address the control of hydrogen during severe accidents, such that ignition sources, regardless of their cause, would not result in unacceptable consequences. The submitter did not provide any new information that would change the results of these reviews, analyses, and actions. Therefore, the NRC does not find any additional concerns that would warrant additional review or actions to be taken by its licensees.

   - Therefore, the proposed issue would **not** meet screening criterion #7.