

B 3.6 CONTAINMENT SYSTEMS

B 3.6.8 Hydrogen Skimmer System (HSS)

BASES

BACKGROUND The HSS reduces the potential for breach of containment due to a hydrogen oxygen reaction by providing a uniformly mixed post accident containment atmosphere, thereby minimizing the potential for local hydrogen burns due to a pocket of hydrogen above the flammable concentration. Maintaining a uniformly mixed containment atmosphere also ensures that the hydrogen monitors will give an accurate measure of the bulk hydrogen concentration and give the operator the capability of preventing the occurrence of a bulk hydrogen burn inside containment per 10 CFR 50.44, "Standards for Combustible Gas Control Systems in Light-Water-Cooled Reactors" (Ref. 1), and 10 CFR 50, GDC 41, "Containment Atmosphere Cleanup" (Ref. 2).

The post accident HSS is an Engineered Safety Feature (ESF) and is designed to withstand a loss of coolant accident (LOCA) without loss of function. The System has two independent trains, each consisting of two fans with their own motors and controls. Each train is sized for 3000 cfm. There is a normally closed, motor-operated valve on the hydrogen skimmer suction line to reduce ice condenser bypass during initial blowdown. The two trains are initiated automatically on a containment pressure high-high signal. The automatic action is to open the motor operated valve on the hydrogen skimmer suction line after a 9 ± 1 minute delay. Once the valve has fully opened, the hydrogen skimmer fan will start. Each train is powered from a separate emergency power supply. Since each train fan can provide 100% of the mixing requirements, the System will provide its design function with a limiting single active failure.

Air is drawn from the dead ended compartments by the mixing fans and is discharged toward the upper regions of the containment. This complements the air patterns established by the containment air return fans, which take suction from the operating floor level and discharge to the lower regions of the containment, and the containment spray, which cools the air and causes it to drop to lower elevations. The systems work together such that potentially stagnant areas where hydrogen pockets could develop are eliminated.

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APPLICABLE SAFETY ANALYSES The HSS provides the capability for reducing the local hydrogen concentration to approximately the bulk average concentration. The limiting DBA relative to hydrogen concentration is a LOCA.

Hydrogen may accumulate in containment following a LOCA as a result of:

- a. A metal steam reaction between the zirconium fuel rod cladding and the reactor coolant;
- b. Radiolytic decomposition of water in the Reactor Coolant System (RCS) and the containment sump;
- c. Hydrogen in the RCS at the time of the LOCA (i.e., hydrogen dissolved in the reactor coolant and hydrogen gas in the pressurizer vapor space); or
- d. Corrosion of metals exposed to containment spray and Emergency Core Cooling System solutions.

To evaluate the potential for hydrogen accumulation in containment following a LOCA, the hydrogen generation as a function of time following the initiation of the accident is calculated. Conservative assumptions recommended by Reference 3 are used to maximize the amount of hydrogen calculated.

The HSS satisfies Criterion 3 of 10 CFR 50.36 (Ref. 4).

LCO Two HSS trains must be OPERABLE, with power to each from an independent, safety related power supply. Each train consists of one fan with its own motor and controls and is automatically initiated by a containment pressure high-high signal.

Operation with at least one HSS train provides the mixing necessary to ensure uniform hydrogen concentration throughout containment.

APPLICABILITY In MODES 1 and 2, the two HSS trains ensure the capability to prevent localized hydrogen concentrations above the flammability limit of 4.0 volume percent in containment assuming a worst case single active failure.

In MODE 3 or 4, both the hydrogen production rate and the total hydrogen produced after a LOCA would be less than that calculated for

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APPLICABILITY (continued)

the DBA LOCA. Also, because of the limited time in these MODES, the probability of an accident requiring the HSS is low. Therefore, the HSS is not required in MODE 3 or 4.

In MODES 5 and 6, the probability and consequences of a LOCA or steam line break (SLB) are reduced due to the pressure and temperature limitations in these MODES. Therefore, the HSS is not required in these MODES.

ACTIONSA.1

With one HSS train inoperable, the inoperable train must be restored to OPERABLE status within 30 days. In this Condition, the remaining OPERABLE HSS train is adequate to perform the hydrogen mixing function. However, the overall reliability is reduced because a single failure in the OPERABLE train could result in reduced hydrogen mixing capability. The 30 day Completion Time is based on the availability of the other HSS train, the small probability of a LOCA or SLB occurring (that would generate an amount of hydrogen that exceeds the flammability limit), the amount of time available after a LOCA or SLB (should one occur) for operator action to prevent hydrogen accumulation from exceeding the flammability limit, and the availability of the Hydrogen Mitigation System.

B.1

If an inoperable HSS train cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours. The allowed Completion Time of 6 hours is reasonable, based on operating experience, to reach MODE 3 from full power conditions in an orderly manner and without challenging plant systems.

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SURVEILLANCE
REQUIREMENTSSR 3.6.8.1

Operating each HSS train for ≥ 15 minutes ensures that each train is OPERABLE and that all associated controls are functioning properly. It also ensures that blockage, fan and/or motor failure, or excessive vibration can be detected for corrective action. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.8.2

Verifying HSS fan motor current at rated speed with the motor operated suction valves closed is indicative of overall fan motor performance and system flow. Such inservice tests confirm component OPERABILITY, trend performance, and detect incipient failures by indicating abnormal performance. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.8.3

This SR verifies the operation of the motor operated suction valves and HSS fans in response to a start permissive from the Containment Pressure Control System (CPCS). The CPCS is described in the Bases for LCO 3.3.2, "ESFAS." The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

SR 3.6.8.4

This SR ensures that each HSS train responds properly to a containment pressure high-high actuation signal. The Surveillance verifies that each fan starts after a delay of ≥ 8 minutes and ≤ 10 minutes. The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

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- REFERENCES
1. 10 CFR 50.44.
 2. 10 CFR 50, Appendix A, GDC 41.
 3. Regulatory Guide 1.7, Revision 0.
 4. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).