GE Nuclear Energy

General Electric Company
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April 2, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Review Schedule - **DFSER Confirmatory Item 6.2.5-1 and 6.2.5-2 and Open Item 20.3-10**

Dear Chet:

Enclosed are SSAR markups addressing DFSER Confirmatory Items 6.2.5-1 and 6.2.5-2 and Open Item 20.3-10.

Please provide a copy of this transmittal to Gene Gou.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Bill Fitzsimmons (GE)
Norman Fletcher (DOE)
Bernie Genetti (GE)

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(16) The primary containment purge system will aid in the long-term post-accident cleanup operation. The primary containment atmosphere will be purged through the SGTS to the outside environment. Nitrogen makeup will be available during the purging operation.

(17) The system is also designed to release containment pressure before uncontrolled containment failure could occur.

6.2.5.2 System Design

6.2.5.2.1 General

INSERT 6.2.5.2-1

The ACS provides control over hydrogen and oxygen generated following a LOCA. In an inerted containment, mixing of any hydrogen generated is not required. Any oxygen evolution from radiolysis is very slow such that natural convection and molecular diffusion is sufficient to provide mixing. Spray operation will provide further assurance that the drywell or wetwell is uniformly mixed. The system (FCS) consists of the following features:

INSERT 6.2.5.2-2

CNFM 6.2.5-1

(1) Atmospheric mixing is achieved by natural processes. Mixing will be enhanced by operation of the containment sprays, which are used to control pressure in the primary containment.

INSERT 6.2.5.2-3

(2) The primary containment nitrogen purge establishes and maintains an oxygen - deficient atmosphere ($\leq$3.5 volume percent) in the primary containment during normal operation.

(3) The redundant oxygen analyzer system (CAMS) measures oxygen in the drywell and suppression chamber. Oxygen concentration are displayed in the main control room. Description of safety-related display instrumentation for containment monitoring is provided in Chapter 7. Electrical requirements for equipment associated with the combustible gas control system are in accordance with the appropriate IEEE standards as referenced in Chapter 7.

In addition, the ACS provides overpressure protection to relieve containment pressure, as required, through a pathway from the wetwell airspace to the stack. The pathway is solated during normal operation with two ruptur disks.

The following modes of operation are provided:

(1) Startup - Inerting. Liquid nitrogen is vaporized with steam or electric heaters to a temperature greater than 20°F and is injected into the wetwell and the drywell. The nitrogen will be mixed with the primary containment atmosphere by the drywell coolers in the drywell and, if necessary, by the sprays in the wetwell.

(2) Normal - Maintenance of Inert Condition. A nitrogen makeup system automatically supplies nitrogen to the wetwell and upper drywell to maintain a slightly positive pressure in the drywell and wetwell to preclude air leakage from the secondary to the primary containment. An increase in containment pressure is controlled by venting through the drywell bleed line.

(3) Shutdown - Deinerting. Air is provided to the drywell and wetwell by the primary containment HVAC purge supply fan. Exhaust is through the drywell exhaust lines and wetwell to the plant vent, through the HVAC or SGTS, as required.

(4) Overpressure Protection. If the wetwell pressure increases to about 5.6 kg/cm^2g, the rupture disks will open. The overall containment pressure decreases as venting continues. Later, the operators can close the two 350A air-operated butterfly valves to re-establish containment isolation as required.

The following interfaces with other systems are provided:

(1) Residual Heat Removal System (RHR-E11). The RHR provides post-accident suppression pool cooling as necessary following heat dumps to the pool, including the exothermic heat of reaction released by the design basis metal-water reaction. This heat of reaction is very small and has no real affect on pool temperature or RHR heat exchanger sizing. The wetwell spray

INSERT 6.2.5.2-1

The FCS and ACS are systems designed to control the environment within the primary containment. The FCS provides control over hydrogen and oxygen generated following a LOCA.

INSERT 6.2.5.2-2

(1) The FCS has two recombiners installed in the secondary containment. The recombiners process the combustible gases drawn from the primary containment drywell.

(2) The FCS is activated when a LOCA occurs. The oxygen and hydrogen remaining in the recombiners after having been processed are transmitted to the suppression pool.

The ACS provides for inerting the primary containment during normal or on-line operation. This system is not designed as an on-line containment purging system. The ACS exhaust line isolation valves are closed when ABWR is on-line. The nitrogen supply lines, compensating for leakage, provide a continuous flow of nitrogen to the containment. If a LOCA signal is received by the ACS the nitrogen supply valves close. Nitrogen purge from the containment occurs at shutdown. ~~Nitrogen~~ purging is accomplished as the containment exhaust isolation valves are opened and the nitrogen supply valves are closed. Nitrogen is replaced by air in the containment (See Item (3) Shutdown - Deinerting below in this Subsection). The system has the following features:

INSERT 6.2.5.2-3

(2) The ACS primary containment nitrogen makeup maintains an oxygen-deficient atmosphere (≤3.5 volume percent) in the primary containment during normal operation.

9.4.5 Reactor Building Ventilation System

The reactor building HVAC system is composed of the following subsystems:

(1) Secondary Containment HVAC System

(2) Essential Equipment HVAC System (14)

(3) Non-Essential Equipment HVAC System (8)

(4) Essential Electrical Equipment HVAC System (3)

(5) Essential Diesel Generator HVAC System (3)

(6) ~~Drywell Purge~~ containment deinerting Supply/Exhaust System

(7) Mainsteam/Feedwater Tunnel HVAC System

(8) Reactor Internal Pump Control Panel Room

9.4.5.1 Secondary Containment HVAC System

9.4.5.1.1 Design Bases

9.4.5.1.1.1 Safety Design Bases

The secondary containment HVAC system has no safety-related function as defined in Section 3.2. Failure of the system does not compromise any safety-related equipment or component and does not prevent safe reactor shutdown. Provisions are incorporated to minimize release of radioactive substances to atmosphere and to prevent operator exposure.

9.4.5.1.1.2 Power Generation Design Bases

The secondary containment HVAC system is designed to provide an environment with controlled temperature and airflow patterns to insure both the comfort and safety of plant personnel and the integrity of equipment and components.

The secondary containment is maintained at a negative pressure with respect to atmosphere.

The system design is based on outdoor summer conditions of 115^{O}F, outdoor winter conditions of -40^{O}F. Space temperature is maintained as specified in Appendix 3I.

9.4.5.1.2 System Description

The reactor building secondary containment HVAC system P&ID is shown in Figure 9.4-3. The system flow rates are given in Table 9.4-3, and the system component descriptions are given in Figure 9.4-3. The HVAC system is a once-through type. Outdoor air if filtered, tempered and delivered to the secondary containment. The supply air system consists of a medium grade filter, a heating coil, a cooling coil, and three 50% supply fans located in the turbine building. Two are normally operating and the other is on standby. The supply fan furnished conditioned air through ductwork and registers to the equipment rooms and passages. The exhaust air system pulls the air from the rooms through ductwork, filters and monitors the air for radioactivity and exhausts out the plant stack. INSERT 9.4.5.1.1.2

9.4.5.1.3 Safety Evaluation

Operation of the secondary containment HVAC system is not a prerequisite to assurance of either of the following:

(1) integrity of the reactor coolant pressure boundary, or

(2) capability to safely shut down the reactor and to maintain a safe shutdown condition.

However, the system does incorporate features that provide reliability over the full range of normal plant operation. The following signals automatically isolate the secondary containment HVAC system:

(1) secondary containment high radiation signal,

(2) refueling floor high radiation signal,

(3) drywell pressure high signal,

(4) reactor water level low signal, and

(5) secondary containment HVAC supply/exhaust fans stop.

On a smoke alarm in a division of the secondary containment HVAC system, the HVAC system shall be put into smoke removal mode. To remove smoke from the secondary containment, the standby exhaust and supply fans are started to provide an increase in air flow through the secondary containment. The

INSERT 9.4.5.1.1.2

HVAC air supply and exhaust used by the ACS for primary containment deinerting is discussed in Subsection 6.2.5.2.1 (14) and the shutdown mode of operation in Subsection 6.2.5.2 (3).

elevation which would be covered by post-LOCA flooding for unloading the fuel.

6.2.5.2.5 Pressure Control

(1) In general, during startup, normal, and abnormal operation, the wetwell and drywell pressures is maintained greater than 0 psig to prevent leakage of air (oxygen) into the primary containment from secondary containment but less than the nominal 2 psig scram set point. Sufficient margin is provided such that normal containment temperature and pressure fluctuations do not cause either of the two limits to be reached considering variations in initial containment conditions, instrumentation errors, operator and equipment response time, and equipment performance.

(2) Nitrogen makeup automatically maintains a 530 kg/m^2 (0.75 psig) positive pressure to avoid leakage of air from the secondary into the primary containment.

(3) The drywell bleed sizing is capable of maintaining the primary containment pressure less than 880 kg/m^2 (1.25 psig) during the maximum containment atmospheric heating which could occur during plant startup.

6.2.5.2.6 Overpressure Protection

(1) The system is designed to passively relieve the wetwell vapor space pressure at 5.6 kg/cm^2g. The system valves are capable of being closed from the main control room using AC power and pneumatic air.

(2) The vent system is sized so that residual core thermal power in the form of steam can be passed through the relief piping to the stack.

(3) The initial driving force for pressure relief is assumed to be the expected pressure setpoint of the rupture disks.

(4) The rupture disks are constructed of stainless steel or a material of similar corrision resistance.

(5) A number of rupture disks are procured at the same time and made from the same sheet to provide uniformity of relief pressure.

(6) The rupture disks are capable of withstanding full vacuum in the wetwell vapor space without leakage.

(7) The piping material is carbon steel. The design pressure is 10.5 kg/cm^2g (150 psi), and the design temperature is 171°C.

6.2.5.2.7 Recombiner

INSERT 6.2.5.2.7

(1) Two permanently installed safety-related recombiners are located in secondary containment. Each recombiner, as shown in Figure 6.2-40, takes suction from the drywell, passes the process flow through a heating section, a reactor chamber, and a spray cooler. The gas is returned to the wetwell.

(2) The recombiners are normally initiated on high levels as determined by CAMS (if hydrogen is not present, oxygen concentrations are controlled by nitrogen makeup).

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6.2.5.3 Design Evaluation

The ACS is designed to maintain the containment in an inert condition except for nitrogen makeup needed to maintain a positive containment pressure and prevent air (0_2) leakage from the secondary into the primary containment.

The primary containment atmosphere will be inerted with nitrogen during normal operation of the plant. Oxygen concentration in the primary containment will be maintained below 3.5 volume percent measured on a dry basis.

Following an accident, hydrogen concentration will increase due to the addition of hydrogen from the specified design-basis metal-water reaction. Hydrogen concentration will also increase due to radiolysis. Any increase in hydrogen concentration is of lesser concern because the containment is inerted. Due to dilution, additional hydrogen moves the operating point of the containment atmosphere farther from the envelope of flammability.

6.2.5.2.7 Recombiners

(1) The FCS consists of two permanently installed, ~~identical~~ safety-related thermal hydrogen recombiners, with associated piping, valves, controls and instrumentation. The recombiner units are located in the secondary containment and controlled from the main control room. Each recombiner, as shown in Figure 6.2-40, removes gas from the drywell, recombines the oxygen with hydrogen, and returns the gas mixture, along with the condensate to the suppression chamber.Each recombiner unit is an integral package consisting of a blower, electic heater, reaction chamber, water spray cooler, a water separator, piping, valves, controls and instrumentation.

(2) During operation of the system, gas is drawn from the drywell by the blower, and heated. Hydrogen and oxygen in the gas will be recombined into steam in the reaction chamber and condensed in the spray cooler. The condensate and spray water, along with some of the gas, are returned to the wetwell. The rest of the gas is recycled through the blower. Cooling water required for operation of the system after a LOCA is taken from the RHR system. The cooling water is used to cool the water vapor and the residual gases leaving the recombiner prior to returning them to the containment.

(3) All pressure containing equipment, including piping between components is considered an extension of the containment, and therefore is designed to ASME Section III, Safety Class 2 requirements. Independent drywell and supression chamber penetrations are provided for the two recombiners. Each penetration has two normally closed isolation valves; one pneumatically operated and one motor operated. The system is designed to meet Seismic Category I requirements. The recombiners are in separate rooms in the secondary containment and are protected from damage by flood, fire, tornadoes and pipe whip.

(4) After a LOCA, the system is manually actuated from the control room when high oxygen levels are indicated by the containment atmospheric monitoring system (CAMS). (If hydrogen is not present, oxygen concentrations are controlled by nitrogen makeup). Operation of either recombiner will provide effective control over the buildup of oxygen generated by radiolysis after a design-basis LOCA. Once placed in operation the system continues to operate until it is manually shut down when an adequate margin below the oxygen concentration design limit is reached.