6.7 MAIN STEAM ISOLATION VALVE LEAKAGE ISOLATED CONDENSER TREATMENT METHOD

The MSIV leakage Isolated Condenser Treatment Method (ICTM) controls and minimizes the release of fission products which could leak through the closed main steam isolation valves (MSIVs) after a LOCA. The treatment method provides this control by processing MSIV leakage prior to release to the atmosphere. This is accomplished by directing the leakage through the main steam drain line to the condenser.

The ICTM takes advantage of the large volume and surface area in the main steam lines and main condenser to provide hold-up and plate-out of fission products that may leak from the closed MSIVs. In this approach, the main steam piping, the bypass/drain piping, and the main condenser are used to mitigate the consequences of an accident which could result in potential offsite exposures comparable to 10CFR50.67 limits. Therefore, as required by Appendix A to Part 100, the components and piping systems used in the ICTM must be capable of performing their function during and following a safe shutdown earthquake (SSE). The technical justification for the seismic capability of the ICTM is based on plant specific analyses of a sample set of anchors, the main condensers, and the turbine buildings. In addition, a plant specific walkdown was completed to compare the plant with an experience data base developed for this application.

A plant specific dose calculation shows that the ICTM is effective to reduce dose consequences of MSIV leakage over an expanded operating range. The ICTM also resolves the safety concern (Generic Issue C-8) that the original MSIV Leakage Control System (LCS) would not function at MSIV leakage rates higher than the LCS design capacity. Except for the requirement to establish a proper flow path from the MSIVs to the condenser, the ICTM is passive and does not have any logic controls and interlocks. The method is consistent with the philosophy of protection by multiple leak-tight barriers used in containment design for limiting fission product release to the environment. The ICTM is reliable and effective for MSIV leakage treatment.

6.7.1 Design Bases

6.7.1.1 Safety Criteria

The following criteria represent the design, safety and performance requirements imposed upon the MSIV leakage ICTM:

1. The ICTM has sufficient capacity and capability to treat any leakage from the MSIVs consistent with the containment leakage limits imposed for the conditions associated with a postulated design-basis LOCA. Specifically, a complete severance of a recirculation line shall not permit an offsite dose to exceed the guidelines of 10CFR50.67.

2. The ICTM is capable of performing its function during the postulated accident conditions and following a coincident loss of offsite power (LOOP).

3. Post Accident containment atmosphere from the ICTM shall be directed such that it will not affect functioning of structures, systems, or components important to safety.

4. The ICTM is capable of manual initiation and is designed to permit actuation about 20 minutes following the postulated design-basis LOCA. This time period is considered to be consistent with loading requirements of the emergency electrical buses and with reasonable times for operator action.

5. The ICTM is designed to permit testing of the main steam drain line motor operated valve during power operation to the extent practical; and testing of the boundary motor operated valves during plant shutdowns.

6. The ICTM piping and condenser are designed and constructed to standard industrial practices (e.g., ANSI B31.1 and Heat Exchanger Institute (HEI) Standards, respectively). They are seismically rugged and not susceptible to a primary collapse mode of failure as a result of seismic vibratory motion.

6.7.1.2 Regulatory Acceptance Criteria

All piping and motor operated valves included in the ICTM comply with the applicable codes, addenda, code cases, and errata in effect at the time the equipment was procured. There is no change in quality classification of components used in the ICTM. The original design requirements are considered to be capable of mitigating the consequences of a LOCA. The technical justification for the seismic capability of the ICTM is based on plant specific analyses of a sample set of anchors, the main condensers, and the turbine buildings. In addition, a plant specific walkdown was completed to compare the plant with an experience data base developed for this application.

A plant specific dose calculation shows that the ICTM is effective to reduce dose consequences of MSIV leakage over an expanded operating range. The ICTM also resolves the safety concern (Generic Issue C-8) that the original MSIV Leakage Control System (LCS) would not function at MSIV leakage rates higher than the LCS design capacity.

6.7.1.3 Leakage Rate Requirements

The features of the ICTM are established to reduce the leakage rate of radioactive materials to the environment during the postulated LOCA. The leakage requirements are imposed upon the ICTM, in order to:

1. include all plant effluents in the filtered, elevated release dose calculations,

2. allow for realistically attainable MSIV leakage limits (limits which are operationally and statistically assured), and

3. assure reasonable leakage verification test frequencies.

The design and operational requirements imposed upon the MSIV leakage ICTM relative to the foregoing criteria are established to:

1. allow MSIV leakage rates up to 100 scfh for each MSIV in each line, but not to exceed 300 scfh total combined leakage for the four main steam lines,

2. allow a MSIV leakage rate verification testing frequency compatible with the requirements of SSES Technical Specifications, and

3. assure and restrict total plant offsite dose impacts below 10CFR50.67.

6.7.2 System Description

6.7.2.1 General Description

The MSIV leakage ICTM shall minimize the release of fission products to the environment after the postulated LOCA. This is accomplished by directing the MSIV leakage through the main steam drain line to the condenser. In addition, there are alternate pathways that can direct leakage to the condenser. The ICTM takes advantage of the large volume and surface area in the condenser to provide hold-up and plate-out of fission products that may leak from the MSIVs. This method provides effective fission product attenuation in the condenser such that the consequences of MSIV leakage can be significantly reduced. The MSIV leakage that enters the condenser is subsequently released to the atmosphere from the low-pressure turbine seals.

6.7.2.1.1 Primary Pathway

The primary pathway to the condenser is the main steam drain line through the HV-1(2)41F020 and HV-1(2)41F021 motor operated valves. The HV-1(2)41F020 valve is normally open and will not need to be operated. The HV-1(2)41F021 valve is normally closed and will need to be opened by an operator. The handswitch for the HV-1(2)41F021 valve is in the control room. The following criteria represent the design, safety and performance requirements imposed upon the HV-1(2)41F021 valve:

1. The valve shall be capable of performing its function following a coincident loss of offsite power (LOOP).

2. The valve shall be capable of manual initiation and is designed to permit actuation about 20 minutes following the postulated design-basis LOCA. This time period is considered to be consistent with loading requirements of the emergency electrical buses and with reasonable times for operator action.

3. The valve shall be tested in accordance with the SSES In-Service Test program.

These criteria assure, with a high degree of certainty, that the primary flow path can be established.

In addition to the valves required to establish the primary flowpath, there are three normally open motor operated valves that shall be closed by an operator to prevent leakage to other areas of the turbine building. The boundary valves are: HV-1(2)0107, to Steam Jet Air Ejector; HV-1(2)0109, to Steam Seal Evaporator; and HV-1(2)0111, to Reactor Feed Pump Turbines. The handswitches for these valves are in the control room. The following criteria represent the design, safety and performance requirements imposed upon these valves:

1. The valve shall be capable of performing its function following a coincident loss of offsite power (LOOP).

2. The valve shall be capable of manual initiation and is designed to permit actuation about 20 minutes following the postulated design-basis LOCA. This time period is considered to be consistent with loading requirements of the emergency electrical buses and with reasonable times for operator action.

3. The valve shall be tested in accordance with the SSES In-Service Test program.

These criteria assure, with a high degree of certainty, that the boundary can be established.

6.7.2.1.2 Alternate Pathways

In addition to the primary pathway, alternate orificed pathways (which do not require the opening of any valves) exist as a backup to direct MSIV leakage to the condenser should the HV-1(2)41F021 valve not open as expected. These pathways include:

1. The orificed bypass line around the HV-1(2)41F021 valve.

2. The four (4) orificed drain lines from the main steam line eight (8) inch drip legs.

3. The one (1) orificed drain line from the main steam line twelve (12) inch drip leg.

These pathways enter the condenser at or below the same elevation of the primary pathway.

6.7.2.2 System Operation

The ICTM primary pathway is established manually by the operator after it has been ascertained that:

1. MSIV leakage rates warrant processing by ICTM.

The ICTM primary pathway is established manually by the operator from control room panels by performing the following activities:

1. confirm the HV-1(2)41F020 valve is open,

2. open the HV-1(2)41F021 valve, and

3. close the boundary valves (HV-1(2)0107, HV-1(2)0109, and HV-1(2)0111).

Except for establishing the flowpath to the condenser, the ICTM is passive and does not require additional operator action. The alternate pathways do not require any operator action.

6.7.2.3 Equipment Required

The following equipment components are required for the ICTM:

1. Piping - the main steam drain piping or erosion resistant alloy. The piping provides the flowpath from the main steam lines, down stream of the outboard MSIVs, to the main condenser.

2. Valves - motor operated. One of the valves is normally closed and will be opened to establish an unrestricted flowpath to the condenser. Three of the valves are normally opened and will be closed to prevent MSIV leakage from flowing to other areas in the plant.

3. Condenser - anchored to prevent excessive movement during a SSE. The condenser volume and surface area provide hold-up and plate-out of fission products

6.7.3 System Evaluation

An evaluation of the capability of the ICTM to prevent or control the release of the radioactivity from the main steamlines following a design-basis LOCA has been conducted. The results of this evaluation are presented in the following subsections.

6.7.3.1 Functional Protection Features

The ICTM is designed to operate under the expected conditions following a design-basis LOCA. The main steam piping and main condenser designs are seismically rugged, and the design requirements applied to SSES main steam piping and main condenser contain adequate margin, based on the original design requirements. The valves' operating conditions (pressure drop across the valve) will be less severe following a LOCA than the valves' normal operating conditions. The valves will be capable of performing their function following a coincident loss of offsite power (LOOP).

6.7.3.2 Effects of Single Active Failures

The ICTM will function following an active component failure of the HV-1(2)41F021 to open by virtue of the alternate pathways to the condenser. The alternate pathways are passive and do not require any equipment to be operated.

6.7.3.3 Effects of Seismic Induced Failures

The ICTM is capable of its function based on the plant specific analyses of a sample set of anchors, the main condensers, and the turbine buildings. In addition, a plant specific walkdown was completed to compare the plant with an experience data base developed for this application. The walkdown and analyses confirmed that other plant systems would not adversely affect the ICTM. The main steam piping and main condenser designs are seismically rugged, and the design requirements applied to SSES main steam piping and main condenser contain adequate margin, based on the original design requirements.

6.7.3.4 Isolation Provisions

The ICTM does not contain any valves required to maintain containment integrity.

6.7.3.5 Leakage Protection Evaluation

The ICTM will limit the release of radioactive materials to the environment during a postulated LOCA. The ICTM will accomplish this function through the use of components described in Subsection 6.7.2. The ICTM could be manual initiated following the LOCA. The dose contribution from activity processed by the ICTM is evaluated in Subsection 6.7.3.8.

6.7.3.6 Failure Mode and Effects Analysis

The ICTM is considered to be reliable based on the few components needed to implement the method. Except for the requirement to establish a proper flow path from the MSIVs to the condenser, the ICTM is passive and does not have any logic controls and interlocks.

6.7.3.7 Influence on Other Safety Features

The ICTM motor operated valves are powered from the engineered safeguard power sources. The load is estimated to be about 4 kw per unit. These non-class 1E loads are connected through an approved isolation system to Diesel Generator backed Class 1E sources.

The ICTM does not introduce or expose the steam piping or valves to thermal or mass loadings different from that experienced in normal isolation valve service; therefore cannot affect or degrade the sealing ability of the MSIVs.

6.7.3.8 Radiological Evaluation

A plant specific radiological analysis has been performed to assess the effects of the ICTM on the Control Room and off-site doses following a postulated design basis LOCA. The analysis used standard conservative assumptions for the radiological source term consistent with Regulatory Guide (RG) 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” (dated July 2000). The analysis results show that the ICTM is effective. The off-site doses and Control Room doses will not exceed the regulatory limits contained in 10CFR50.67.

The off-site and Control Room doses resulting from a LOCA are discussed in Subsection 15.6.5 of the FSAR. The off-site and Control Room doses associated with the ICTM are the sum of containment leakage LOCA doses evaluated in the power uprate revision to the design-basis LOCA calculation and the additional doses calculated for the ICTM.

6.7.4 Instrumentation Requirements

Except for the requirement to establish a proper flow path from the MSIVs to the condenser, the ICTM is passive and does not have any logic controls and interlocks.

6.7.5 Inspection and Testing

The ICTM valves (HV-1(2)41F021, HV-1(2)0107, HV-1(2)109, and HV-1(2)0111) shall be tested in accordance with the SSES In-Service Test program. The valves will be stroke tested at least every refueling outage.