6.7 CONTAINMENT IODINE REMOVAL SYSTEM

6.7.1 DESIGN BASIS

The containment iodine removal system is designed to collect, within the containment, the iodine released following a LOCA.

6.7.2 SYSTEM DESCRIPTION

Following a LOCA, SIAS automatically starts three 20,000 cfm recirculation filter units. Each unit has the capacity of 50% of the design air flow. These units consist of activated charcoal filters preceded by HEPA filters. A moisture separator is provided upstream of the particulate air filters to remove water droplets. An electric-driven induced-draft fan located at the end of the banks of filters pulls the containment atmosphere through these components and discharges vertically back into the containment (Figure 6-6).

The three containment charcoal filter units contain a total of approximately 7300 lbs. of Barnebey-Cheney #727 coconut shell charcoal (or equivalent) impregnated with 5 wt% iodine compounds. The flow velocity through each bed is 40 fpm and the corresponding residence time is .25 seconds. Filter testing is explained in Sections 6.6.7 and 6.7.7. Testing is performed to demonstrate that the installed charcoal adsorbers will perform satisfactorily in removing both elemental and organic iodides for design conditions or flow, temperature, and relative humidity.

Each of the recirculation filter units is provided with an emergency dousing system for the charcoal beds to dissipate the decay heat load in the event there is a significant rise in the charcoal bed temperature. During Modes 1, 2, 3, and 4, the dousing system is isolated by manual valves. An analysis (Reference 1) shows that maximum post-LOCA charcoal bed temperature will not cause iodine desorption or charcoal bed ignition. During Modes 5 and 6, the manual valves may be opened to allow the dousing system to be functional during iodine removal unit maintenance to provide fire protection if required.

This system is shown in diagram form on Figures 6-7 (Unit 1) and 6-11 (Unit 2).

6.7.3 SYSTEM COMPONENTS

a. Unit Housing

The unit housing is made of carbon steel and is capable of operating under the LOCA conditions of pressure and temperature. It is provided with service access doors, explosion-proof lights, a charcoal filter emergency dousing system, a monorail suitable for supporting an electric hoist to handle charcoal cells, test connections, connections for pressure gauges and floor drains. The housing is designed to be light-tight.

b. Moisture Separators

The moisture separators consist of a steel casing, two-and-one-half-pass vertical louvers, and filter element frames. The bottom of the unit is a sump equipped with drain connections. Elements are constructed of stainless steel wire mesh. In addition to acting as moisture separators, the filter elements also act as a prefilter for the HEPA filters and remove large particles and any fibrous material present in the air steam.

c. High Efficiency Particulate Air (HEPA) Filter

Each element of the HEPA filter measures 24"x24"x11 1/2" and is constructed by pleating a continuous sheet of waterproof fire retardant fiberglass mat into closely spaced pleats separated by aluminum inserts. The filter medium is treated with a

silicone-base water repellent to achieve wet strength characteristics. The filter medium and separators are encased in cadmium-plated carbon steel. The filter bank frame is galvanized steel.

d. Charcoal Filters

The material used in these filters is activated charcoal containing 5 wt% impregnation of iodine compounds and having an ignition temperature of ≥ 680°F. It is encased in perforated stainless steel beds. Each element is a standard manufactured size, has a frontal face size of approximately 8"x24", and contains two horizontal charcoal beds, each approximately 24"x24"x2" deep. The filter bank frame is galvanized steel.

As shown on Figures 6-7 (Unit 1) and 6-11 (Unit 2), each charcoal filter bank is equipped with an emergency cooling water dousing system. Provisions are made to collect the cooling water after it flows through the charcoal beds and onto the floor of the filter unit, and to drain it through a check valve into the Containment Structure. Each filter bank may contain a test tray which will be used to verify the efficiency of the charcoal bed periodically (Section 6.6.3).

e. Fan-Motor Unit

The fan is an internally-direct-driven, vane-axial type, equipped with an inlet and discharge adapter. The motor is a totally enclosed, air-over type and is provided with an insulation system capable of operating under LOCA conditions.

6.7.4 SYSTEM OPERATION

The containment iodine removal filter units are not in operation during normal reactor operation. However, following a LOCA, receipt of SIAS will automatically start all three filter unit fans. These units may also be started manually by the operator from the Control Room at any time.

During Modes 5 and 6, the charcoal bed emergency dousing system in each unit may be initiated manually, as needed.

6.7.5 DESIGN EVALUATION

a. The system consists of three recirculating filter units with a total capacity of 150% of design flow requirements. Each unit is protected from all expected missile sources by concrete structures.
b. The design life of the filter units is 40 years, the same as the design life of the plant. The units are not in operation during normal reactor operation.
c. The filter units are designed to operate under the maximum temperature and pressure conditions resulting from a LOCA (original calculations show an atmosphere composed of steam-air mixture at a pressure of 47.45 psig and a temperature of 274°F). The filter units have been evaluated for the revised maximum pressure and vapor temperature contained in Section 14.20. In addition to this, the units are designed to withstand conditions of ambient temperature and 57.5 psig for 24 hours during testing of the containment.
d. The units are designed to assure no loss of function when subjected to a pressure differential of 2 psi.
e. The filter units are classified as Seismic Category I equipment and are designed accordingly.

f. Filter unit components are designed to withstand a radiation level of 1 r/hr of principally gamma radiation with a 40 year cumulative dosage of 3.5×10^5 r under normal environmental conditions.

g. The components are also designed to be capable of operation in an atmosphere of borated water spray and a maximum cumulative radiation dose of 10^8 r, occurring as a result of a LOCA.

h. Each element of the moisture separators is designed to have a nominal flow of 1500 cfm and a clean pressure drop of less than 1" of water.

i. Each element of the HEPA filters is designed to have a nominal flow rate of 1000 cfm and a clean pressure drop of less than 1" of water.

j. Each element of the charcoal filter units is designed for a nominal flow rate of 333.3 cfm and a clean pressure drop of less than 1" of water.

6.7.6 AVAILABILITY AND RELIABILITY

The Containment Iodine Removal System incorporates three filter units, each with a capability to handle 50% of the required air flow. The units are designed to operate without loss of function under the maximum temperature and pressure conditions resulting from a LOCA, as well as in the accompanying containment atmosphere environment, i.e., a steam-air mixture with borated water spray and radiation.

Because the system is not in use during normal reactor operation, special routine tests and inspections are incorporated into plant operating procedures. These periodic tests will be performed during plant operation to assure the availability of power to each of the electrical components (both visual and audible indicators are provided in the control panel for this test). During plant shutdown the condition of each filter bank will be determined by visual inspection and pressure differential gauge indication while the fans are in operation. In addition, the water line solenoid valves will be visually checked for proper operation during periods of plant shutdown.

Failure of the normal electrical power supply will automatically place the three fans on emergency electric power.

6.7.7 TESTS AND INSPECTIONS

See Section 6.6.7 for a current description of the tests and inspections performed for both systems.

6.7.8 REFERENCES

1. Nuclear Consulting Services, Inc. Report NUCON-6BG021/01, A Computer Analysis of the Iodine Decay Heat Generated in a Carbon Bed Following a Loss of Coolant Accident, January 19, 1990, and Supplement 1 July 25, 1990