6.5 Fission Product Removal and Control

6.5.1 Fission Product Removal

The systems required to perform safety-related fission product removal functions following a design basis accident are:

(1) Standby Gas Treatment System (SGT)

(2) Control Room Habitability Area (CRHA) portion of the Control Building HVAC System (CBHV)

The CRHA portion of CBHV is discussed in Section 6.4 and Subsection 9.4.1. The SGT is discussed in this subsection (6.5.1).

6.5.1.1 Design Basis

6.5.1.1.1 Power Generation Design Basis

The SGT has the capability to filter the gaseous effluent from the primary containment vessel (PCV) or the secondary containment when required to limit the discharge of radioactivity to the environment to meet 10CFR100 requirements.

6.5.1.1.2 Safety Design Basis

The SGT is designed to filter radiological effluents from the secondary containment. This includes radiological effluents that leak into the secondary containment from the PCV during design basis accidents. These include:

(1) Major pipe breaks within the PCV.

(2) Reactor Building refueling operation radioactive releases.

(3) Major reactor core transients which may result in fuel failure.

The SGT is not required for pipe breaks outside the PCV.

The SGT is designed to accomplish the following:

(1) Maintain a negative pressure in the secondary containment, relative to the outdoor atmosphere, to control the release of fission products to the environment.

(2) Filter airborne radioactivity (halogens and particulates) in the effluent to reduce offsite doses to within the limits specified in 10CFR100.

(3) Ensure that failure of any active component, assuming loss of offsite power, cannot impair the ability of the system to perform its safety-related function.

(4) Remain intact and functional in the event of a safe shutdown earthquake (SSE).

(5) Meet environmental qualification requirements established for system operation.

(6) Filter airborne radioactivity (halogens and particulates) in the effluent to reduce offsite doses during normal and upset operations to within the limits of 10CFR20.

6.5.1.2 System Design

6.5.1.2.1 General

The SGT P&ID is provided as Figure 6.5-1.

6.5.1.2.2 Component Description

Table 6.5-1 provides a summary of the major SGT components. The SGT consists of two parallel and redundant filter trains. The two SGT trains are located in two adjacent rooms and are mechanically separated. Each train is protected from fire, flood, inside PCV pipe breaks and missiles. Electrical separation is provided by connecting the two trains to Electrical Divisions 2 and 3. Suction is taken from the secondary containment, including the Reactor Building refueling area, or from the PCV via the Atmospheric Control System (ACS). The treated discharge goes to the Plant Stack. Major SGT equipment is located within the secondary containment boundary.

The SGT consists of the following principal components:

Two filter trains, each consisting of a moisture separator, a main electric heater, a prefilter, a primary high efficiency particulate air (HEPA) filter, a charcoal adsorber, a secondary HEPA filter, standby adsorber heaters, a main fan, and an adsorber cooling fan for the removal of decay heat from the charcoal. The main fans are located downstream of each filter train.

6.5.1.2.3 SGT Operation

6.5.1.2.3.1 Automatic

Upon receipt of a high drywell pressure signal or a low reactor water level signal, or when high radioactivity is detected in the secondary containment or refueling floor ventilation exhaust, both SGT trains are automatically actuated. When the operation of both the trains is assured, one train can be manually placed in standby mode. In the event that a malfunction disables an operating train, the standby train is automatically initiated.

6.5.1.2.3.2 Manual

The SGT is on standby during normal plant operation. It may be manually initiated for PCV de-inerting in accordance with the Technical Specifications when required to limit the discharge of contaminants to the environment to within 10CFR20 limits. Normal operation of the SGT while the plant is in the startup, power, hot standby, and hot shutdown modes of operation is much less than 90 hours per year for both trains combined. However, if 90 hours of operation per year for either train (excluding tests) is to be exceeded, a demonstration that the SGT is capable of performing its intended function in the event of LOCA must be performed. A single train may be manually initiated for surveillance testing.

6.5.1.2.3.3 Decay Heat Removal

Cooling of the SGT filter trains may be required to prevent the gradual accumulation of decay heat from radioactive iodine adsorbed on the charcoal. The charcoal is typically cooled by the air from the main fan. If the main fan is tripped or the other SGT train placed into operation, the adsorber cooling fan will maintain air flow through the charcoal. The system valving will remain open during this sequence.

A water deluge capability is also provided, but primarily for fire protection, since redundant fans are provided for air cooling. Since the deluge is available, it may also be used to remove decay heat for sequences outside the normal design basis. Temperature instrumentation is provided for control of the SGT main and standby adsorber electric heaters. This instrumentation may also be used by the operator to monitor the need for, or performance of, the cooling air flow.

Water is supplied from the Fire Protection System and is connected to the SGT via a hose.

6.5.1.3 Design Evaluation

6.5.1.3.1 General

(1) A negative pressure of 62 Pa is normally maintained in the secondary containment by the Reactor Building HVAC System (RBHV) (Subsection 9.4.5) relative to the outdoor atmosphere. All the surrounding clean areas are maintained at positive pressure with respect to secondary containment. On SGT initiation (Subsection 6.5.1.2.3.1), RBHV automatically isolates its secondary containment boundary dampers.

(2) The SGT filter particulate and charcoal efficiencies are outlined in Table 6.5-1. Dose analyses of events requiring SGT operation (Subsections 15.6.5 and 15.7.4) indicate that offsite doses are within the limits established by 10CFR100.

(3) The SGT is designated as an engineered safety feature (ESF) since it mitigates the consequences of postulated design basis accidents (DBAs) by controlling and reducing the release of radioactivity to the environment. The SGT, except for the deluge and standby adsorber electric heaters, is designed and built to the requirements for Safety Class 3 equipment as defined in Section 3.2, and 10CFR50, Appendix B.

The SGT has independent, redundant active trains. The two SGT trains are mechanically and electrically separated. They are located in two side by side compartments (separated by rated fire barriers) inside secondary containment. Should any active train fail, SGT functions can be performed by the redundant train. Each redundant train is powered from separate Class 1E electrical buses.

(4) The SGT is designed to Seismic Category I requirements as specified in Section 3.2. The SGT is housed in a Category I structure. All surrounding equipment, components, and supports are designed to appropriate safety class and seismic requirements.

(5) A secondary containment draw-down analysis will be performed to demonstrate the capability of the SGT to maintain the design negative pressure following a LOCA, including inleakage from the open, non-isolated penetration lines identified during construction engineering and in the event of the worst single failure of a secondary isolation valve to close.

(6) The SGT is designed as an ESF to mitigate the consequences of postulated pipe breaks inside the PCV and a fuel bundle drop accident in the Reactor Building refueling area. The SGT is not required to operate during or after breaks outside the PCV either in the secondary containment, the main steam tunnel or the Turbine Building.

6.5.1.3.2 Sizing Basis

Figure 6.5.2 provides an assessment of the secondary containment pressure after the design basis LOCA inside the PCV, assuming an SGT fan capacity of 6800 m^3/h (21°C, 1 atmosphere) per main fan. Credit for secondary containment fission product control is only taken if the secondary containment is actually at a negative pressure by considering the potential effect of wind on the ambient pressure in the vicinity of the Reactor Building. For the Lungmen NPS dose analysis, direct transport of containment leakage to the environment was assumed for the first 20 minutes after LOCA event initiation (in addition to the leakage through the MSIVs to the main turbine condenser). Each SGT main fan was sized to individually establish a continuously negative differential pressure (considering the effect of wind) within 10 minutes after SGT initiation. The dose analysis therefore assumes direct leakage from the secondary containment to the environs for twice the required period. In addition, it should be recognized that fission product release on the order of that specified in Regulatory Guide 1.3 and used in the LOCA dose analyses (Subsection 15.6.5) realistically requires significant core damage and most likely more than 10 or 20 minutes for transport to and leakage from the PCV.

The calculation accounted for all expected heat sources in secondary containment after a LOCA inside PCV. Where appropriately conservative, a realistic basis was used to determine the heat loads. For example, no single failure of a diesel was assumed, since it is likely that all divisions of power would be available. Failure of one SGT main fan to start was assumed as the single failure. Therefore, heat loads from all divisions of ECCS motors and piping were used in the calculation.

Per SRP 6.2.3, II.3(b) and SRP 6.5.3, II.2, secondary containment should be held below –6.4 mm w.g. (-62 Pa) under all wind conditions up to the wind speed at which diffusion becomes great enough to assure site boundary exposures less than those calculated for DBAs, even if ex-filtration occurs (i.e., no credit for SGT is taken). For the Lungmen NPS, dispersion factors will be calculated for each stability class over a range of wind speeds. Based on previous analysis performed by GE, for wind speeds above 8.0 m/s, stability class D predominates and conservatively bounds observed meteorological conditions. At 8.9 m/s, above the 8.0 m/s stability class D transition, the dispersion from the increased wind speed results in offsite doses equal to or lower than the design basis calculation, which assumes the most stable, F-class stability and a 1 m/s wind speed. Therefore, the SGT will be designed to establish and maintain a negative pressure in secondary containment within 10 minutes for any wind speed up to and including 8.9 m/s.

6.5.1.3.3 SGT Filter Train

The SGT filter train consists of a moisture separator, main electric heater, prefilter, two HEPA filters, standby adsorber heaters, and a charcoal adsorber. The SGT is considered active but in practice provides the reliability associated with a passive component. Furthermore, the SGT has incorporated design features to eliminate potential failures or improper operation. These features include:

(1) The advanced design of the filter housing and flow pattern virtually eliminates any untreated bypass of the filter. In addition, the all-welded design is such that degradation of filter housing integrity is not likely to occur during system standby or operation.

(2) A number of operating plant events (during normal plant operation) have occurred causing the inadvertent deluge wetting of the charcoal. These events have rendered the filter train unavailable for safety-related service. These events have been observed to warrant an improved deluge design concept. These unintended deluge operations have been caused by personnel error and by failures in mechanical or electrical components. In the Lungmen NPS design, the deluge piping is not connected permanently from the Fire Protection System to the filter housing nozzle. Instead, a normally disconnected hose from the Fire Protection System is provided to act as a “spool piece” for connection by operating personnel to the filter housing, as required.

(3) Decay heat is not sufficient to cause a fire in the charcoal adsorber or HEPA filter. Calculations indicate that air flow from the main fan is more than enough to remove the heat from decay of the radioactive iodine on the charcoal or filters. Heating does not occur sufficient to cause iodine desorption or ignition of the charcoal. With the

reduced source term expected for most sequences [Subsection 6.5.1.3.3(4)], any heating of the charcoal is even further reduced. Tripping or failure of the main fan will result in the auto operation of the adsorber cooling fan and the operation of the other SGT train. The adsorber cooling fan operation will preclude charcoal heatup. No other mechanism for starting a fire in the filter housing during an accident has been identified. Other possible sequences for starting a fire in the filter train could occur during normal plant operation or plant shutdown. These sequences would involve an unspecified maintenance or operating personnel activity or an incredible malfunction of the standby adsorber electric heaters. In this case, a fire in the SGT charcoal, like in the Offgas System, would be a matter of plant availability and not of plant safety. The standby adsorber electric heaters, located inside the SGT filter housing, are powered only during SGT standby and not during system operation. Therefore, the standby adsorber electric heaters are not a potential cause of fire (and SGT unavailability) when the SGT is required to meet the licensing-basis release limits (and presumably inaccessible for repair).

Note that the standby adsorber electric heaters each have a small fan which better distributes the heat and minimizes local warming by providing a more uniform temperature throughout the filter housing. This uniform heating further reduces the risk of fire by lowering local temperatures around the space heater and by improving the accuracy of the temperature measurements (used to detect high temperature) taken at necessarily discrete points within the filter housing.

(4) Degradation of the charcoal effectiveness between charcoal efficiency surveillance tests is not likely to occur. During normal operation, the filter train is isolated both upstream and downstream by closed valves. Therefore, during SGT standby, the potential for impurities entering the filter train and unacceptably reducing charcoal efficiency is small.

The SGT charcoal bed thickness has been increased 5 cm to 15 cm as compared to the GESSAR II design. The additional 5 cm of charcoal provides an effective measure of protection against weathering or aging effects when the SGT is placed into operation.

In addition to the increased charcoal bed depth, significantly more charcoal is provided than is required to meet the 2.5 mg iodine per gram carbon requirement. This added charcoal is used to meet the requirement specifying a residence time of 0.25 s per 5 cm of bed depth. Approximately 332 kg of charcoal is required based on iodine loading calculated per Regulatory Guide 1.3 requirements, a 100% efficient charcoal adsorber, and no MSIV leakage. The SGT charcoal adsorber is required to meet a 720 m/h face velocity, which results in a nominal 794 kg of charcoal assembly using a conservatively high 561kg/m^3 charcoal density with 6800 m^3/h fan size, meeting the 0.25 s per 5 cm of bed depth (720 m/h) requirement of Regulatory Guide

1.52 (Position C.3.i). The weight of charcoal will be adjusted to be consistent with the purchased charcoal density (usually less than 481 kg/m^3) and any dead space in the adsorber section itself.

The effect of suppression pool scrubbing (per SRP 6.5.5) also serves to reduce the actual source term, providing capacity margin over the design basis calculation. Reasonable scrubbing factors of just 10 for elemental and particulate iodine results in only 45 kg of charcoal being required versus the nominal 794 kg provided. This margin between the charcoal realistically required and that needed per the design basis provides additional protection against any aging or weathering that may occur. The retention of iodine in the suppression pool is discussed in NUREG-0772 and NUREG-1169, which established the basis for the design. (See Paragraph 8.9 of the ABWR Licensing Review Basis. Reference 6.5-1). IE Bulletin No. 80-03 (issued on February 6, 1980) concerns the potential loss of charcoal from adsorber cells due to wide spacing between the rivets which secure the screen to the casing. The Lungmen NPS design does not use rivets. Instead the design utilizes a welded design construction which would prevent the loss of charcoal.

(5) Because of the high availability of the Lungmen NPS, the potential use of the SGT during de-inerting will occur primarily at the end of the fuel cycle. In this way, HEPA filter and charcoal adsorber effectiveness will be tested, and the filter and/or charcoal replaced, if necessary, before the plant returns to power operation.

All active SGT components are redundant. Non-safety standby adsorber electric heaters are located both upstream and downstream of the charcoal bed.

6.5.1.3.4 Source Terms for SGT Design

The basis for calculating the iodine source term for the SGT filters is provided in Table 6.5-2. For the purposes of sizing the SGT charcoal adsorber, no additional credit for iodine retention or holdup above that specified in Regulatory Guide 1.3 is assumed. Charcoal sizing is discussed in Subsection 6.5.1.3.3(4).

6.5.1.3.5 Compliance with Regulatory Guide 1.52

An assessment of compliance with Section C of Regulatory Guide 1.52, including testing, is provided in Appendix 6A.

6.5.1.3.6 Primary Containment Purging

The SGT may be used either for DBAs identified in Chapter 15 or during de-inerting of the PCV prior to plant shutdown. The more likely, though still infrequent, potential use of SGT is during de-inerting. Depending on the radiation level in the PCV prior to de-inerting or the radiation level in the RBHV secondary containment exhaust during de-inerting, SGT may be placed into service.

If purging (i.e., de-inerting) through RBHV will [or does] result in high radiation in the RBHV secondary containment exhaust, then de-inerting will be [re-]initiated at a reduced rate through the SGT. Use of SGT during de-inerting is expected to be infrequent.

The design basis condition for the relevant dose analyses assumes that the Atmospheric Control System (ACS) PCV purge isolation valves are closed, because the probability of a LOCA occurring at the same time the valves are open is very small. The valves are, in fact, closed throughout normal plant operation except during inerting and de-inerting.

The ACS PCV isolation valve operators will be sized with adequate thrust to demonstrate the acceptability of the valve design to provide isolation. Furthermore, the ACS PCV isolation valves used in the vent and purge lines are of the butterfly type and are specified to be hinged neutrally or slightly biased in the direction that will assist the valve in sealing when exposed to differential pressure. If the valves are open for the PCV purge, they will receive an isolation signal to close on low reactor water level (L3) or high drywell pressure. These isolation signals are not bypassed in this mode of operation.

A realistic assessment of plant capability in support of the exclusion indicates that the ACS PCV isolation valves, if open, would be isolated before significant fission products are transported to the secondary containment atmosphere. “Significant” means fission products above that normally present in the PCV. A period much longer than the closing time of the valves would be required to generate conditions leading to the release of TID 14844-like source terms. Therefore, should a LOCA occur when the valves are open (valves expected to be open only during inerting or de-inerting), little fission product release to the environment would actually occur. Therefore, the plant design and analysis in this regard is conservative and bounds releases actually expected in the event of a LOCA.

6.5.1.4 Tests and Inspection

The SGT and its components are tested during construction and periodically during operation. These tests fall in three categories:

(1) Environmental qualification tests

(2) Acceptance tests as defined in ASME N509 and N510

(3) Periodic surveillance tests

The above tests are performed in accordance with the objectives of Regulatory Guide 1.52 and its references. Acceptance tests (including pre-operational tests) and periodic surveillance tests are defined and extensively described in ASME N509 and ASME N510. Testing requirements in ASME N509 are generally located in Section 5, “Components.” ASME N510 provides details of each component functional test. These tests are summarized in Table 9-1 of ASME N509 and Table 1 of ASME N510. Specific surveillance testing requirements for SGT are provided in Technical Specification 3.6.4.3 (Chapter 16). Environmental qualification testing is discussed in Section 3.11 and is applicable to SGT components. Dynamic qualification is addressed in Sections 3.9 and 3.10 for Seismic Category I equipment.

6.5.1.5 Instrumentation

Appendix 6B provides a discussion of the instrumentation for the SGT. Control and instrumentation for the SGT is also discussed in Subsections 7.3.1.1.5 and 7.3.2.5.

6.5.1.6 Materials

The construction materials used for the SGT are compatible with normal and accident environments postulated for the area in which the equipment is located. The construction materials used in the filter train are consistent with the recommendations of Regulatory Guide 1.52 and its references.

6.5.1.7 Operability and Effectiveness

Adsorption is time dependent and therefore instantaneous containment-removal efficiency is meaningless. True efficiency tests are run on small, representative samples (test canisters) of the adsorbent using a radioactivity tagged tracer gas having similar properties and composition of those of the containment of interest (e.g., radioactive elemental iodine or methyl iodine). Because of the difficulty in handling radioactive materials, this type of test is generally not made in the field. The in-place field tests are leak tests only. The iodine removal efficiency tests are carried out in a laboratory duplicating the field conditions as closely as possible.

Each filter train design for the SGT depends on stationary components for normal (routine) and accident operation. The prefilter assembly is filled with glass fibers as are the primary and secondary HEPA filters. The charcoal iodine adsorber bed is located between the HEPA filters. All are located in a welded housing making up the filter train. The standby adsorber electric heaters operate only in the standby mode of the SGT to maintain a low charcoal adsorber relative humidity. Readiness for design operation is assured by effective surveillance tests.

The filter train availability depends on the stationary components replacement. The filter fiber glass sections are modularized for ease in handling. The charcoal is replaced by dumping old charcoal from below the bed and refilling with new charcoal from above. The integrity of the charcoal bed structure is maintained by limiting the moisture content of the charcoal in standby. The charcoal bed is oversized to reduce heating and weathering or aging effects. The bed has nominally 794 kg of charcoal and is 150% thick over the calculated 332 kg required for adequate adsorber saturation and combustion protection.

Per Regulatory Guide 1.52 Section 4d, each filter train should be operated at least 10 hours per month, with the main electric heater on, in order to reduce the buildup of moisture on the adsorbers and HEPA filters. The flow element in the filter train flow path and related recorders supply the operating and standby time measurement to assure timely surveillance testing. Charcoal penetration tests are conducted after 720 hours of system operation. Penetration and bypass leakage test are run every 18 months for the systems maintained in a standby status and following painting, fire or chemical release in the service area and after adsorbent replacement. Surveillance includes functional operation and pressure drop measurements. A single failure for any stationary safety-related component is very remote.

The SGT may be used during de-inerting of the PCV prior to plant shutdown. Of all the routine operational use of the SGT, the more likely, though still infrequent, potential use of SGT is during de-inerting. Because of the high availability of the Lungmen NPS, the potential use of SGT during de-inerting will occur primary at the end of the fuel cycle. In this way, HEPA filter and charcoal adsorber effectiveness will be tested, and the filter and/or charcoal replaced, if necessary, before the plant returns to full power.

General Electric reviewed the data obtained from operating power plants. It is GE's opinion that an effective surveillance testing and prompt stationary parts replacement is an effective way to assure the availability of the SGT for the designed operation.

The data for the Perry Nuclear power plant which has five filter trains with activated charcoal; two in the M15 Annulus Exhaust Gas Treatment System (AEGTS) which operate continuously and three in the M40 Fuel Handling Building (FHB) ventilation system was requested. The surveillance testing results of the two systems one each from AEGTS-M15 and FHB-M40 were provided. The M15 data shows that the charcoal bed replacement was necessitated after nearly four years of continuous operation and bypass failure of the HEPA filters for train B occurred only once in six years of operation. The reviewed data shows that in five years time only one charcoal bed had to be replaced due to an inadvertent deluge. The Lungmen NPS SGT design does not have an automatic deluge and, therefore, an inadvertent operation of the deluge is unlikely.

The SGT data from 1971 to 1991 for the Quad cities Nuclear Power was reviewed. For train B, charcoal bed replacement was needed in 1979, 1983 and 1987. The bypass leakage occurred rarely and HEPA filter replacement was needed. Train A needed charcoal bed replacement in 1984 and 1990.

The availability and reliability of the SGT to perform the designed function depends on effective surveillance testing and prompt replacement of inefficient parts. SGT charcoal surveillance tests can indicate a need to replace the charcoal in a filter train. Therfore, it is poosible that the charcoal in one SGT filter train will need to be replaced based on its next upcoming surveillance test. It is also possible for a LOCA to occur prior to this upcoming surveillance test. To protect against this possible situation which could hypothetically impact the performance of one of the SGT filter trains, the Process Radiation Monitoring System alarms the Main Control Room upon high radiation in the SGT discharge. Upon receiving such an alarm, the operator can switch to the second (redundant) SGT filter train. Probability of both the SGT filters trains failing at the same time is very remote.

6.5.2 Containment Spray

Credit is not taken for any fission product removal provided by the drywell/wetwell spray portions of RHR.

6.5.3 Fission Product Control

Fission product control is provided in conjunction with other safety-related systems to limit the release of radioactive material from the secondary containment to the environment following postulated design basis breaks inside the primary containment vessel (PCV) and Reactor Building refueling operation accident events. Dose analyses are provided in Chapter 15. The fission product control is achieved via the PCV and the secondary containment.

6.5.3.1 Primary Containment Vessel (PCV)

The PCV is a cylindrical steel-lined reinforced concrete structure forming a limited leakage boundary for fission products released to the PCV atmosphere following a LOCA or other event. The PCV is divided into the upper and lower drywells and the suppression chamber (wetwell) by the reinforced concrete diaphragm floor and the reactor vessel pedestal. The diaphragm floor is rigidly attached to the reactor pedestal and the PCV wall. A liner is also provided as part of the diaphragm floor to prevent bypass of steam from the upper drywell to the wetwell air space during an accident. The PCV is totally within the secondary containment. A test program confirms the integrity of the leakage boundary. The assumed leak rate from PCV is 0.5% weight per day measured at the PCV design pressure.

PCV leak rate testing is described in Subsection 6.2.6. The PCV walls, liner plate, mechanical penetrations, isolation valves, hatches, and locks function to limit release of radioactive materials, subsequent to postulated accidents, such that the resulting offsite doses are less than the guideline values of 10CFR100.

The structural design details of the PCV are discussed in Subsection 3.8.2. PCV isolation valves are discussed in Subsection 6.2.4. The conditions in the PCV during and after the design basis events are given in Section 6.2.

Layouts of the PCV are given in the building arrangement drawings in Section 1.2.

The PCV atmosphere is inerted with nitrogen by the Atmospheric Control System (ACS). The ACS is described in Subsection 6.2.5. Following the design basis LOCA, the Flammability Control System (FCS) controls the concentration of oxygen in containment. Oxygen is generated by the radiolytic decomposition of water.

On appropriate signals, PCV isolation valves close as required. The PCV provides a passive barrier to limit the leakage of airborne radioactive material. Systems required to accomplish ECCS or other ESF functions are not isolated. See Subsection 6.2.4 for further details of isolation valve closure signals.

6.5.3.2 Secondary Containment

The secondary containment is provided so that leakage from the PCV is collected, treated and monitored by the SGT prior to release to the environment. Refer to Subsection 6.2.3 for a description of the secondary containment boundary and Subsection 6.5.1 for a description of the SGT.

6.5.4 References

6.5-1 Thomas E. Murley (NRC) letter to Ricardo Artigas (GE), August 7, 1987, *Advanced Boiling Water Reactor Licensing Review Bases*.

Table 6.5-1 Summary of Major Standby Gas Treatment System Components

Filter Train	
	Consists of a moisture separator, a main electric heater, prefilter, primary HEPA filter, charcoal adsorber, and secondary HEPA filter and standby adsorber electric heaters
Quantity	2
Capacity	6800 m^3/h(@21°C &1 atmosphere pressure absolute)
Moisture Separator	
General	Woven wire, stainless steel mesh pads
Quantity	1 bank of standard size moisture separators per filter train
Efficiency	Per ASME N509, Section 5.4
Main Electric Heater	
General	Electric, finned tubular
Quantity	1 per filter train
Rating	5.3 kW minimum, 26.2 kW maximum
Relative humidity	
Inlet	*100% @ 66°C
Outlet	70% @ 75°C
Prefilter	
General	Cartridge type
Quantity	1 bank of standard size filters per filter train
Media	Glass fiber
Efficiency	Per ASME N509, Section 5.3
HEPA Filters	
General	Vertically oriented
Quantity	Banks of standard size HEPA filters both upstream and downstream of charcoal adsorber per filter train
Media	Glass fiber
Charcoal Adsorbers	
General	Vertically oriented deep beds
Quantity	1 per filter train
Charcoal weight	794 kg
Depth of Bed	15 cm

Table 6.5-1 Summary of Major Standby Gas Treatment System Components

	Maximum Face velocity	720 m/h
Main Fan		
	General	Centrifugal
	Quantity	2
	Capacity	6800 m^3/h(@ 21°C & 1 atmosphere pressure absolute)
Adsorber Cooling Fan		
	General	Centrifugal
	Quantity	2
	Capacity	700 m^3/h(@ 21°C & 1 atmosphere pressure absolute)

* Capacity of the heater is sufficient to reduce the relative humidity to ≤ 70% at any temperature ≤ 66°C

Table 6.5-2 Source Terms Used for SGT Charcoal Adsorber Design

Source term assumed available for leakage from containment (Regulatory Guide 1.3):
■ 100% of noble gases from fuel inventory
■ 25% of iodine from fuel inventory
Chemical form of iodine assumed available for leakage from primary containment vessel:
■ 4% organics
■ 91% elemental
■ 5% particulates
Suppression pool iodine decontamination factor used in calculation:
■ 1 for organics
■ 1 for elemental
■ 1 for particulates
Containment spray iodine decontamination factor used in calculation:
■ 1 for organics
■ 1 for elemental
■ 1 for particulates
Leakage rates assumed for calculation:
■ 0.50%/day for primary containment vessel
■ 50%/day for secondary containment
■ $0 m^3/s$ @ Standard Condition through MSIVs

Figure 6.5-1 Standby Gas Treatment System P&IDs (Sheets 1–2)

(Proprietary information provided in a separate proprietary volume.)

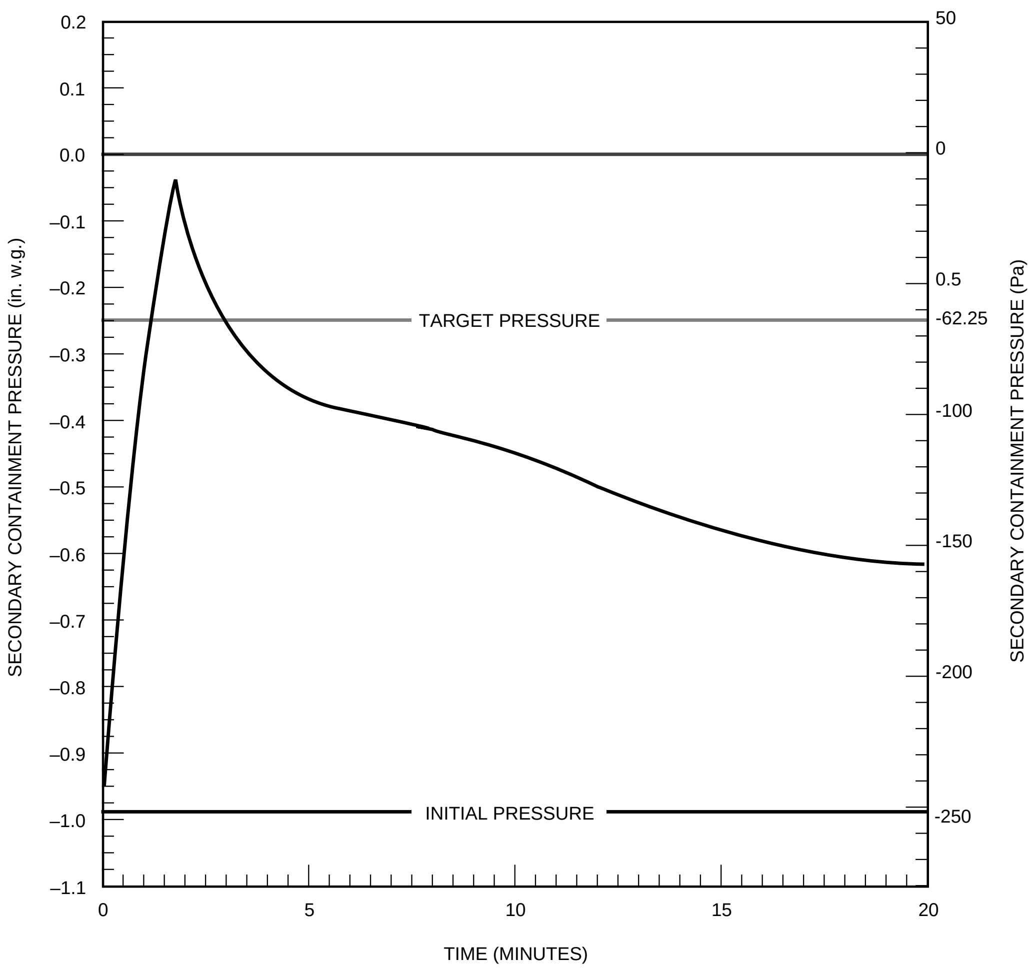

Figure 6.5-2 Secondary Containment Pressure Transient After Design Basis LOCA