6.5 Fission Products Removal and Control Systems

6.5.1 Engineered Safety Features Filter Systems

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

(1) Standby Gas Treatment System (SGTS)

(2) Control room portion of the HVAC System (HVAC)

The control room portion of the HVAC System is discussed in Section 6.4 and Subsection 9.4.1. The SGTS is discussed in this subsection (6.5.1).

6.5.1.1 Design Basis

6.5.1.1.1 Power Generation Design Basis

The SGTS has the capability to filter the gaseous effluent from the primary containment or from 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 SGTS is designed to filter radiological effluents from the primary containment that leak into the Secondary Containment during design basis accidents. These include:

(1) Major pipe breaks within primary containment.

(2) Refueling operation radioactive releases.

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

The SGTS is not required for pipe breaks outside primary containment.

The SGTS 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 (halogen and air 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 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 SGTS 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 SGTS components. The SGTS consists of two parallel and redundant filter trains. The two SGTS trains are located in two adjacent rooms. Each train is protected from fire, flood, inside containment pipe break and missiles. The electrical separation is provided by connecting the two trains to Divisions 2 and 3 electric power. The two trains are mechanically separated also. Suction is taken from the secondary containment, including above the refueling area, or from the primary containment via the Atmospheric Control System (ACS). The treated discharge goes to the main plant stack. Major SGTS equipment is located within the Secondary Containment boundary.

The SGTS consists of the following principal components:

Two filter trains, each consisting of a of a moisture separator, an electric process heater, a prefilter, a high efficiency particulate air (HEPA) filter, a charcoal adsorber, a second HEPA filter, a space heater unit with fan, a process fan, and a cooling fan for the removal of decay heat from the charcoal.The process fans are located downstream of each filter train.

6.5.1.2.3 SGTS 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 SGTS trains are automatically actuated and one train is manually placed in the Standby mode. When the operation of both the trains is assured, one train is placed in the 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 SGTS is on standby during normal plant operation. It may be manually initiated for primary containment de-inerting in accordance with the Technical Specifications when required to limit the discharge of contaminants to the environment within 10CFR20 limits. Normal operation of the SGTS 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, the COL applicant is required to demonstrate that the SGTS is capable of performing its intended function in the event of LOCA. See Subsection 6.5.5.2 for COL license information. A single train may be manually initiated for surveillance testing.

6.5.1.2.3.3 Decay Heat Removal

Cooling of the SGTS filters may be required to prevent the gradual accumulation of decay heat in the charcoal. This heat is generated by the decay of radioactive iodine adsorbed on the SGTS charcoal. The charcoal is typically cooled by the air from the process fan. If the process fan is tripped or the other SGTS train placed into operation, the 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 SGTS process and space electric heaters. This instrumentation may also be used by the operator to [re-]establish a cooling air flow post-accident, if required.

Water is supplied from the fire protection system and is connected to the SGTS via a spool piece.

6.5.1.3 Design Evaluation

6.5.1.3.1 General

(1) A negative pressure of 6.4 mm water gauge is normally maintained in the secondary containment by the Reactor Building/Secondary Containment HVAC System (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 SGTS initiation (Subsection 6.5.1.2.3.1), the Reactor Building/Secondary Containment HVAC is automatically isolated.

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

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

The SGTS has independent, redundant active trains. The two SGTS trains are mechanically and electrically separated. They are located in two side by side

compartments (separated by rated fire barriers) inside secondary containment and adjacent to the normal HVAC system exhaust. Should any active train fail, SGTS functions can be performed by the redundant train. Each redundant train is powered from separate Class 1E electrical buses.

(4) The SGTS is designed to Seismic Category I requirements as specified in Section 3.2. The SGTS 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 SGTS 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. See Subsection 6.5.5 for COL license information requirements.

(6) The SGTS is designed as an Engineered Safety Feature (ESF) to mitigate the consequences of postulated pipe breaks inside primary containment and the refueling operation fuel bundle drop accident. The SGTS is not required to operate during or after breaks outside primary containment 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 primary containment, assuming an SGTS fan capacity of 6800 m^3/h (21°C, 1 atmosphere) per fan. Credit for secondary containment as a fission product control system 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 ABWR 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 SGTS fan was sized to individually establish a continuously negative differential pressure (considering the effect of wind) within 10 minutes after SGTS initiation. The dose analysis therefore assumes direct leakage from the 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 primary containment.

The calculation accounted for all expected heat sources in secondary containment after a LOCA inside primary containment. 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 SGTS 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. 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 SGTS is taken). For the ABWR, dispersion factors were calculated for each stability class over a range of 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 ABWR SGTS was 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 SGTS Filter Train

The SGTS filter train, consisting of a demister, process heater, pre-filter, two HEPA filters, and an iodine adsorber, is considered active, and in practice provides the reliability associated with a passive component. Furthermore, the ABWR SGTS 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 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 ABWR 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 process 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 process fan will result in the auto operation of the cooling

fan and the operation of the other SGTS train. The 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 space heaters. In this case, a fire in the SGTS charcoal, like in the Offgas System, would be a matter of plant availability and not of plant safety. The space heaters, located inside the SGTS filter housing, are powered only during SGTS standby and not during system operation. Therefore, the space heaters are not a potential cause of fire (and SGTS unavailability) when the SGTS is required to meet the licensing-basis release limits (and presumably inaccessible for repair).

Note that the space 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 is isolated, and dampers upstream and downstream of the filter train are closed. Therefore, during SGTS standby, the potential for impurities entering the filter train and unacceptably reducing charcoal efficiency is small.

The ABWR SGTS charcoal bed thickness has been increased 5 cm to 15 cm as compared to the GESSAR II design. The additional 5 cm of charcoal provide an effective measure of protection against weathering or aging effects when the SGTS 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 SGTS charcoal adsorber is required to meet a 732 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 (732 m/h) requirement of Regulatory Guide 1.52 (Position C.3.i), and using a conservatively high 561kg/m^3 charcoal density. 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 ABWR design under Paragraph 8.9 of the 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 ABWR 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 ABWR, de-inerting and the potential use of the SGTS 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 SGTS components are redundant. Non-safety space heaters are located both upstream and downstream of the charcoal bed. Divisional power is used for reliable space heater operation.

6.5.1.3.4 Source Terms for SGTS Design

The basis for calculating the iodine source term for the SGTS filters is provided in Table 6.5-2. For the purposes of sizing the SGTS 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 SGTS may be used either for DBAs identified in Chapter 15 or during de-inerting of the primary containment prior to plant shutdown. The more likely, though still infrequent, potential use of SGTS is during de-inerting. Depending on indications from Leak Detection and Isolation System (LDS) primary containment radiation monitoring before de-inerting is initiated or from

the process radiation monitoring (PRM) Reactor Building ventilation exhaust radiation monitors during de-inerting, SGTS may be placed into service.

If purging (i.e., de-inerting) through the HVAC will [or does] result in a trip from the ventilation exhaust radiation monitors, then de-inerting will be [re-]initiated at a reduced rate through the SGTS. Use of SGTS during de-inerting is expected to be infrequent.

The design basis condition for the relevant dose analyses assumes that the Primary Containment large ventilation butterfly valves are closed, because the probability of a LOCA occurring at the same time the ventilation valves are open is very small. The large ventilation valves are, in fact, closed throughout normal plant operation except during inerting and de-inerting. The LOCA dose analyses do not assume any release from open containment isolation dampers, either through the SGTS or through the normal ventilation system.

The operators will be sized with adequate thrust to demonstrate the acceptability of the damper design to provide isolation. Furthermore, the butterfly valves used in the vent and purge lines are specified to be hinged neutrally or slightly biased in the direction that will assist the damper in sealing when exposed to differential pressure. If the valves are open for containment 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 ventilation valves, if open, would be isolated before significant fission products are transported to the containment atmosphere. “Significant” means fission products above that normally present in the primary system. A period much longer than the closing time of the ventilation valves would be required to generate conditions leading to the release of TID 14844-like source terms. Therefore, should a LOCA occur when the ventilation valves are open (dampers 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 SGTS and its components are periodically tested during construction and 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 SGTS are provided in Technical Specification 3.6.4.3 (Chapter 16). Environmental qualification testing is discussed in Section 3.11 and is applicable to SGTS 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 SGTS. Control and instrumentation for the SGTS 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 SGTS are compatible with normal and accident environments postulated for the area in which the equipment is located. The construction materials used in the dryer and filter trains are consistent with the recommendations of Regulatory Guide 1.52 and its references.

6.5.1.7 Operability and Effectiveness

Efficiency in the usual sense, cannot be measured for adsorption systems. 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 of installed systems are leak tests only. The iodine removal efficiency tests are carried out in a laboratory duplicating the field conditions as closely as possible.

The double filter train design for the SGTS depends on stationary components for normal (Routine) and accident operation. The pre-filter assembly is filled with glass fibers as are the pre and after 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 redundant active space heaters and fans operate only in the standby mode of the SGTS to dry the charcoal and maintain low relative humidity in the sealed train. 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 heaters 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. Technical specifications are satisfied and a single failure for any stationary component is very remote.

The SGTS may be used during de-inerting of the primary containment prior to plant shutdown. Of all the routine operational use of the SGTS, the more likely, though still infrequent, potential use of SGTS is during de-inerting. Because of the high availability of the ABWR, de-inerting and the potential use of SGTS 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 SGTS 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 M26 data shows that in five years time only one charcoal bed had to be replaced due to an inadvertant deluge. Current ABWR SGTS does not have an automatic deluge system and an inadvertent operation of the deluge system is unlikely.

The SGTS 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 filters replacement was needed. Train A needed charcoal bed replacement in 1984 and 1990.

The availability and reliability of the SGTS to perform the designed function depend on effective surveillance testing and prompt replacement of inefficient parts. Should the LOCA occur when the SGTS is in between surveillance testing period with the probability that the next surveillance test may indicate the need of the charcoal bed replacement, the process radiation monitoring system will alarm if there is any radiation leaking out and the operator can switch to the second (redundant) SGTS filter train. Probability of both the SGTS filters trains failing at the same time is very remote.

6.5.2 Containment Spray Systems

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

6.5.3 Fission Product Control Systems

Fission product control systems are provided in conjunction with other ESF systems to limit the release of radioactive material from the containment to the environment following postulated design basis breaks inside containment and refueling operation accident events. Dose analyses are provided in Chapter 15. The fission product control systems consist of the primary containment and the secondary containment. The following is a discussion of each fission product control system.

6.5.3.1 Primary Containment

The primary containment is a cylindrical steel-lined reinforced concrete structure forming a limited leakage boundary for fission products released to the containment atmosphere following a LOCA or other event. The containment 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 containment wall. A liner is also provided as part of the diaphragm floor to prevent bypass of steam from the upper drywell to the suppression chamber air space during an accident. The primary containment is totally within the secondary containment. A test program confirms the integrity of the leakage boundary. The assumed leak rate from primary containment is 0.5% of the free containment volume per day measured at the containment design pressure.

Containment leak rate testing is described in Subsection 6.2.6. The primary containment 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 primary containment are discussed in Subsection 3.8.2. Primary containment isolation valves are discussed in Subsection 6.2.4. The conditions in the containment during and after the design basis events are given in Section 6.2.

Layouts of the primary containment structure are given in the building arrangement drawings in Section 1.2.

The primary containment atmosphere is inerted with nitrogen by the Atmospheric Control System (ACS). The ACS is described in Subsection 6.2.5.

On appropriate signals, containment isolation valves close as required. The primary containment 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 primary containment is collected, treated and monitored by the SGTS 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 SGTS.

6.5.4 Not Used

6.5.5 COL License Information

6.5.5.1 SGTS Performance

The COL applicant will perform a SGTS dose/functional damage and drawdown analysis in accordance with Subsections 6.5.1.2.3.2 and 6.5.1.3.1(5) respectively.

6.5.5.2 SGTS Exceeding 90 Hours of Operation Per Year

The COL applicant is required to demonstrate the SGTS system is capable of performing its intended function in the event of a LOCA, if more than 90 hours of operation per year (excluding test) for either train is anticipated.

6.5.6 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, an electric process heater, prefilter, pre-HEPA filter, charcoal adsorber, post-HEPA filter and space 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
Electric Process 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
Air ΔT	9°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
Efficiency	≥99.97% with 0.3 micrometer DOP (shop test) ≥99.9% with 0.5 micrometer DOP (surveillance test)

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

Charcoal Adsorbers	
General	Vertically oriented deep beds
Quantity	1 per filter train
Efficiency	≥99.825% (laboratory) ≥99.95% (in-place bypass test)
Charcoal weight	794 kg
Depth of Bed	15 cm
Maximum Face velocity	732 m/h
Process Fan	
General	Centrifugal
Quantity	2
Capacity	6800 m^3/h(@ 21°C & 1 atmosphere pressure absolute)
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 SGTS 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:

- 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
- 50%/day for secondary containment
- $0 m^3/s$ @ Standard Condition through MSIVs

The following figure is located in Chapter 21:

Figure 6.5-1 Standby Gas Treatment System P&ID (Sheets 1–3)

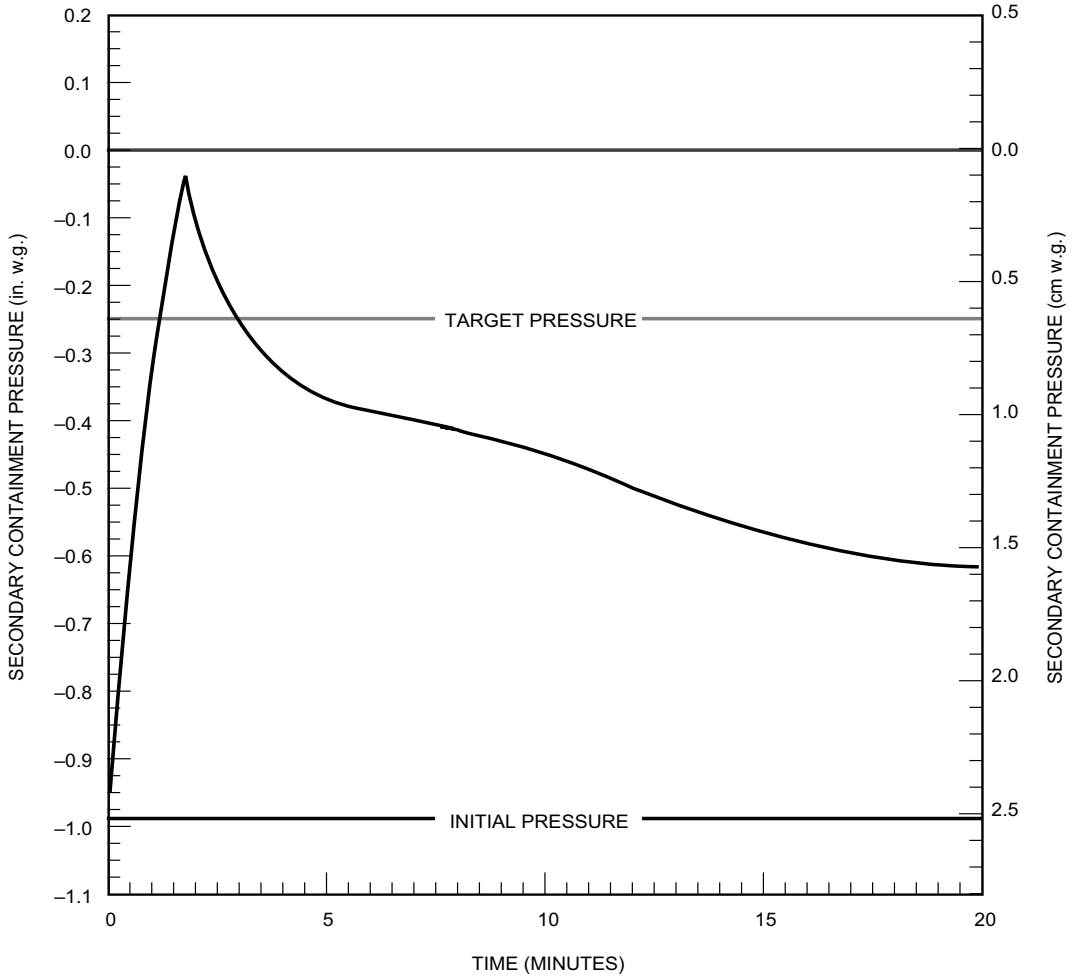

Figure 6.5-2 Secondary Containment Pressure Transient After Design Basis LOCA