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AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

9.1.1 NEW FUEL STORAGE

9.1.1.1 Design Bases

9.1.1.1.1 Safety Design Bases

9.1.1.1.1.1 Safety Design Bases - Structural.

a. The new fuel storage racks containing a full complement of fuel assemblies are designed to withstand all credible static and dynamic loadings, to prevent damage to the structure of the racks and the contained fuel, and to minimize distortion of the rack arrangement [see Table 3.9-2(s)],

b. The racks are designed to protect the fuel assemblies from excessive physical damage so as to prevent the release of radioactive materials in excess of 10 CFR 20 limits under normal or abnormal conditions,

c. The racks are constructed in accordance with the Quality Assurance Requirements of 10 CFR Part 50, Appendix B,

d. The new fuel storage racks are categorized as Safety Class 2 and Seismic Category I, and

e. The new fuel storage vault is located within secondary containment in the reactor building and therefore complies with the objectives set forth in Regulatory Guide 1.13, and General Design Criteria (GDC) 2, 3, 4, 5, 61, 62 and 63 of 10 CFR Part 50, Appendix A.

9.1.1.1.1.2 Safety Design Bases - Nuclear.

a. The new fuel storage racks are designed and maintained with sufficient spacing between the new fuel assemblies to ensure that the array shall be subcritical by at least 5% Δk, including allowance for calculation biases and uncertainties.

Calculations were performed to ensure that $k_{eff} \leq 0.95$ for all water mist densities up to 1.0 gm/cm^3 in and around the fuel. The new fuel storage vault was modeled using the KENO computer code (Reference 9.1-1). GE14 and GNF2 fuel bundles were modeled using the MCNP01A (GEH's version of MCNP4A) computer code (Reference 9.1-10).

The biases between the calculated results and experimental results, as well as the uncertainty involved in the calculations, are taken into account as part of the calculation procedure to ensure that the specified K_{eff} limits are met.

b. Columbia has chosen to comply with 10 CFR 50.68, "Criticality Accident Requirements".

9.1.1.1.2 Power Generation Design Bases

a. New fuel storage racks provide for approximately 8% of the full core fuel load, and

b. New fuel storage racks are designed and arranged so that the fuel assemblies can be handled efficiently during refueling operations.

9.1.1.2 Facilities Description

The new fuel storage vault containing the new fuel storage racks is a concrete structure adjacent to the spent fuel pool at the refueling floor level of the reactor building (see Figure 1.2-10). The reactor building is built to Seismic Category I requirements and is further discussed in Section 3.2. The new fuel rack design features are as follows:

a. The new fuel storage vault contains 24 sets of castings, with each casting containing 10 possible storage locations. A maximum of 60 fuel storage positions will be used. The remaining storage locations will be blocked with a positive physical barrier, such that no fuel can be placed in the blocked positions. Figure 9.1-1 shows the locations where fuel will be stored;

b. There are three tiers of castings positioned by fixed box beams. The castings hold the fuel assemblies in a vertical position; the fuel assemblies are supported at the lower tie plate, with additional lateral support;

c. The lower casting is designed to support the weight of the fuel assembly and restrict lateral movement when used in the as-built configuration. To facilitate the assembly of ABB type fuel, a stub tube rests in the bottom casting to raise the fuel approximately 30 in. The center and top castings restrict only lateral movement of the fuel assembly;

d. The new fuel storage racks are made from aluminum. Materials used for construction are specified in accordance with the latest issue of applicable ASTM specifications. The material choice is based on a consideration of the susceptibility of various metal combinations to electrochemical reaction. When considering the susceptibility of metals to galvanic corrosion, aluminum and stainless steel are similar insofar as their coupled potential is concerned. The use of stainless steel fasteners in aluminum to avoid detrimental galvanic corrosion is a recommended practice and has been used successfully for many years by the aluminum industry. The stub tubes are used when assembling Westinghouse type fuel, are made of stainless steel and are not directly fastened to lower casting;

e. Lead-in and lead-out of the casting provide guidance of the fuel assembly during insertion or withdrawal; and

f. The nominal center-to-center spacing with rows is 7 in. and between rows is 12 in. However, as shown in Figure 9.1-1, face adjacent locations are not used. The fuel assembly center-to-center spacing is a multiple of the above dimensions.

The fuel assemblies are loaded into the rack through the top. Each hole for a fuel assembly has adequate clearance for inserting or withdrawing the assembly channeled or unchanneled. Sufficient guidance is provided to preclude damage to the fuel assemblies. The design of the racks and the blocking devices prevent accidental insertion of the fuel assembly into a position not intended for the fuel. The only spaces in the racks are those into which it is intended to insert fuel. The weight of the fuel assembly is supported by the lower tie plate which is seated in a chamfered hole or stub tube in the base casting.

The floor of the new fuel storage vault is sloped towards a drain located at the low point. This removes any water that may be accidentally and unknowingly introduced into the vault. The drain is part of the floor drain subsystem of the liquid radwaste system.

The radiation monitoring equipment for the new fuel storage area is described in Section 12.3.4.

9.1.1.3 Safety Evaluation

9.1.1.3.1 Criticality Control

The calculations of k_{eff} are based on the geometrical arrangements of the fuel array, and that subcriticality does not depend on the presence of neutron absorbing materials. To meet the requirements of GDC 62, geometrically safe configurations of fuel stored in the new fuel array are used to ensure that k_{eff} will not exceed 0.95 if fuel is stored in the dry condition or in an abnormal mist condition with water densities up to 1.0 g/cm^3.

The new fuel storage vault has concrete covers with rubber seals.

The fuel storage rack is designed using noncombustible materials. New fuel storage vault covers prevent optimum moderation in the new fuel vault (water density between 0 and 1 g/cc).

The GE14 fuel assembly is a 10 x 10 fuel rod array with 2 internal water channels offset in the center of the assembly (displacing 8 fuel rod locations). The GE14 nominal design parameters are listed in Reference 9.1-14, Table 2-1. The GE14 analysis new fuel storage vault model assumes several key assumptions:

a. New fuel assemblies are assumed to contain the highest enriched unexposed lattice for the entire length of the assembly and are associated with a beginning-of-life reactivity of 1.31 with benchmark uncertainties included.

b. The GE14 analysis assumes infinite fuel in the axial direction (no axial reflector) for normal dry storage conditions and fully flooded abnormal conditions. Neutron absorption in fuel structural components is neglected.

c. The GE14 analysis assumes a finite geometry for a single new fuel vault loaded in accordance with the loading pattern shown in Figure 9.1-1. Neutron leakage is assumed on all sides, top, and bottom for optimally moderated abnormal conditions. Neutron absorption in fuel structural components is neglected with the exception of the concrete walls of the new fuel storage vault.

d. Up to 3 GE14 bundles can be safely handled in the spent fuel pool, outside of the spent fuel rack, in any configuration.

e. The results of the analysis include a statistical rollup of all significant manufacturing and calculational uncertainties and abnormal storage condition biases.

f. An infinitely long fuel bundle is modeled to lie horizontally at 1 cm above the active fuel region of the rack.

g. An abnormal condition that evaluates a misplaced fuel bundle that is loaded in addition to the fully loaded fuel loading pattern, shown in Figure 9.1-1, in a position that yields the optimum reactivity for the scenario.

The GNF2 fuel assembly is a 10 x 10 fuel rod array with 2 internal water channels offset in the center of the assembly. The GNF2 nominal parameters are listed in Reference 9.1-14, Table 2-1. The GNF2 new fuel storage vault model is consistent with the model described for GE14 (Reference 9.1-13).

9.1.1.3.2 New Fuel Rack Structural Design

The new fuel storage racks are designed to meet Seismic Category I requirements.

The maximum stress in the fully load rack in a faulted condition is 16.5 kips. This is significantly lower than the allowable stress.

The storage rack is designed to withstand horizontal combined loads up to 222,000 lb, well in excess of expected loads.

The storage rack is designed to withstand the pull-up force of 4000 lb and a horizontal force of 1000 lb. There are no readily available forces in excess of 1000 lb. The racks are designed with lead outs to prevent sticking. However, in the event of a stuck fuel bundle, the upward force on the racks is limited to the 1000 lb load limit of the jib crane (MT-CRA-9A or 9B) used to handle new fuel.

The storage rack structure (Figure 9.1-2) is designed to withstand the impact resulting from a falling weight. Tests using a simulated fuel bundle have been conducted to verify that the rack casting can withstand the impact from a bundle dropped from above the array. During testing the lowest drop to cause the rack casting to exceed ultimate stress was a drop of 6.17 ft (4314 ft/lb) made at mid span.

Therefore, procedural requirements dictate that no more than one bundle at a time can be handled over the storage array. These requirements ensure that the racks cannot be displaced in a manner causing critical spacing as a result of impact from a dropped fuel assembly. Since the 125-ton reactor building crane can traverse the full length of the refueling floor, administrative controls will prohibit carrying loads over the new fuel.

9.1.1.3.3 New Fuel Handling

New fuel is carried to the new fuel vault and placed in the storage rack with jib crane MT-CRA-9A or 9B or the reactor building crane auxiliary hoist. To handle the new fuel, rigging controlled by plant procedures is used, which interfaces with the lifting device at the upper end and the fuel bundle bail at the lower end.

During the positioning of a new fuel assembly into the new fuel rack, the rigging is always above the upper fuel rack casting. The rigging interfaces only with the fuel bundle bail, thus precluding engagement of the fuel rack. The transfer devices used for new fuel handling to the new fuel vault, therefore, cannot impose uplift loads on the rack castings. See Section 9.1.4.2.10.1 for further discussion of new fuel handling.

9.1.1.3.4 Other New Fuel Storage Design Factors

The new fuel racks are designed to be restrained by holddown bolts to ensure that rack spacing does not vary during the safe shutdown earthquake (SSE).

The storage rack structure is so designed that the height of the rack is less than the length of the fuel bundle. Therefore, the upper tie plate of the bundle cannot pass below the top cross member of the rack. Also, the fuel bundle insertion spaces in the top casting of the rack have a lead in chamfer on the upper and lower surfaces. These design features prevent any tendency of the fuel bundle to jam during insertion into or removal from the rack.

The new fuel storage rack castings are made from aluminum and are secured by stainless steel fasteners. Materials used for construction are specified in accordance with ASTM Specifications B108, B179, B209, B211, and B221 dated January 1971.

The new fuel storage racks do not require any periodic special testing or inspection for nuclear safety purposes.

9.1.2 SPENT FUEL STORAGE

9.1.2.1 Design Bases

9.1.2.1.1 Safety Design Bases

9.1.2.1.1.1 Safety Design Bases - Structural.

a. The spent fuel storage racks are designed to withstand the affects of the SSE and remain functional and maintain subcriticality. The racks are also designed to withstand the impact of a dropped fuel assembly or the upward force of a stuck assembly without loss of function. The racks are designed and fabricated to meet seismic and quality class requirements per 10 CFR 50, Appendix B;

b. The spent fuel storage facility is located so that no missiles can enter the fuel pool with the necessary energy to cause any damage to the fuel; and

c. The reactor building containing the spent fuel storage facility provides the capability for limiting the potential offsite exposures in accordance with 10 CFR Part 100 in the event of significant release of radioactivity from the stored fuel.

9.1.2.1.1.2 Safety Design Bases - Nuclear.

a. The center-to-center spacing between stored fuel assemblies in a fully loaded rack is sufficient to maintain a k_{eff} less than 0.95 at a conservative water temperature.

b. The spent fuel storage rack design precludes storage of a fuel assembly other than where intended at a nominal 6.5 in. center to center distance between fuel assembly placed in the storage rack.

c. The spent fuel storage racks are designed to allow adequate cooling of the stored spent fuel assemblies; and

d. Shielding for the spent fuel storage arrangement is sufficient to protect plant personnel from exposure to radiation in excess of 10 CFR Part 20 limits.

e. Columbia has chosen to comply with 10 CFR 50.68, "Criticality Accident Requirements".

9.1.2.1.2 Power Generation Design Bases

a. Spent fuel storage space in the fuel storage pool is for 2658 fuel assemblies, and

b. Spent fuel storage racks are designed and arranged so that fuel assemblies can be handled efficiently during refueling operations.

9.1.2.2 Facilities Description

9.1.2.2.1 Spent Fuel Storage Racks

Spent fuel storage racks provide a place in the fuel pool for storing the spent fuel discharged from the reactor vessel. They are top entry racks, designed to maintain the spent fuel in a space geometry that precludes the possibility of criticality under both normal and abnormal conditions. This is accomplished with the aid of neutron absorbing plates. The location of the spent fuel pool within the plant is shown in Figures 1.2-10 and 1.2-11.

The spent fuel storage rack design, shown in Figure 9.1-3, consists of fuel storage cells which are square stainless steel tubes with neutron absorbing B_4C plates between them. A stainless steel plate grid at the top and the bottom of the tubes, to which the tubes are welded, form the tubes into racks and maintain center-to-center spacing between the tubes at 6.5 in. The racks are welded together into modules which are held firmly in place by seismic restraints attached between the rack modules and the pool wall. The storage racks are made of stainless steel. The square tube storage cells are 1/8 in. thick.

The neutron absorber plates have nominal dimensions of 19 in. long, 5.88 in. wide, and 0.2 in. thick. They are composed of B_4C granular material bonded together to form a plate of uniform properties. They have a nominal B-10 loading of 0.0959 g/cm^2 of plate and a plate density of 0.05 lb/in^3. The plate has been shown by tests to have negligible corrosion in water and thermally stable over the range of pool water temperatures that can occur. The plates are seal welded in a stainless steel cavity to prevent water intrusion and are vented at the pool curb through sampling valves.

There are no load bearing requirements for the plates. Based on the results of the Modulus of Rupture tests, the plates will withstand approximately two times the calculated stresses caused by a postulated seismic event. Plate integrity and mechanical properties have been verified by comprehensive tests. These tests included Modulus of Rupture and Modulus of Elasticity tests.The Modulus of Rupture testing was performed using a three point support method and was done on specimens at temperatures varying from ambient to 300°F, specimens soaked in water, and irradiated specimens. The modulus of elasticity was performed using a resonance procedure and was done at varying temperatures and after the plate had been immersed in water. The tests showed no swelling, cracking, or dimensional changes and provided verification of the plate mechanical properties required for the rack design.

To prevent distortion of the spent fuel rack cavities and binding of spent fuel assemblies due to pressure buildup, the enclosures are vented through an arrangement of tubing and sampling valves to above the storage pool water surface at the pool curb. Monitoring for offgas pressure, sampling of offgas, and venting to relieve pressure are provided for.

Different rack sizes are used (12 x 16, 12 x 13, 8 x 13, 7 x 18, and 11 x 16 arrays) to take full advantage of the fuel storage space in the pool (see Figure 9.1-4). The upper rack structures are welded to an elevated base plate which, in turn, is supported by a system of welded beams and stiffeners. The base serves to support the weight of the fuel assemblies and to distribute the load to the pool floor. The base plate contains an opening at each fuel assembly storage location which accommodates the fuel assembly lower nozzle. Natural circulation of pool water flows upward through the lower nozzle and the fuel assembly to remove decay heat. The storage cells are designed to provide lateral support for the storage assemblies

The minimum edge-to-edge distance of the assembly array from adjacent concrete walls is 16.75 in. between the edge of the C-14 storage rack and the shipping cask storage area wall.

The seismic restraints are stainless steel turnbuckles located between the pool walls and the racks around the periphery of the pool (Figure 9.1-4). They are located at both the top and bottom of the rack and will transmit the seismic forces of the operating basis earthquake (OBE) and the SSE between the racks and the walls and remain functional. The turnbuckles are connected at the wall to stainless steel bands which are embedded in the concrete wall and seal welded to the pool liner.

9.1.2.2.2 Spent Fuel Storage Pool

The spent fuel storage pool is designed to withstand earthquake loadings as a Seismic Category I structure. It is a reinforced-concrete structure completely lined with stainless steel, which provides a leakproof membrane that is resistant to abrasion and damage during normal and refueling operations. The stainless steel liner plates are seamwelded together and are anchored to the surrounding concrete by concrete anchors in the walls and structural members in the floor welded to the liner plates. Each liner weld seam is backed up by a drainage monitoring channel. These channels form a series of interconnecting systems designed to provide the following:

a. Detection, measurement, and location of any liner leakage,

b. Prevention of pressure buildup behind the liner plates due to leakage, and

c. Prevention of uncontrolled loss of contaminated pool water to other relatively clean locations within the secondary containment.

This network of drainage monitoring channels is embedded in the concrete behind the liners and is designed to permit free gravity drainage to the radioactive drain system, the flow of which is monitored.

The refueling canal connecting the spent fuel storage pool to the reactor well is provided with two gates in series, with a monitor drain between them. This arrangement permits monitoring for any leaks and facilitates repair of a gate or seal, if required.

A gamma scan collimator port is located 15 ft 11 in. from the bottom of the fuel pool and extends through the side of the pool. Through this port, gamma scanning of radioactive reactor components and spent fuel assemblies can be performed. This nondestructive method of analysis by the measurement of the gamma radiation being emitted by a material can indicate fuel enrichment, reactor power distribution, or fission product content of the component being analyzed.

The water supply to the spent fuel pool is provided and level maintained as described in Section 9.1.3.

9.1.2.3 Safety Evaluation

9.1.2.3.1 Criticality Control

9.1.2.3.1.1 8 x 8 Fuel. The design of the spent fuel storage racks provides for a subcritical multiplication factor (k_{eff}) of $\leq$0.95 for both normal and abnormal storage conditions. Normal conditions exist when the fuel storage racks are covered with a normal depth of water (about 23 ft above the active fuel) for radiation shielding, and with the maximum number of fuel assemblies or bundles in their design storage position. An abnormal condition may result from damage caused by accidental drop of a fuel assembly or stuck fuel assembly during attempted withdrawal.

The criticality analyses of the normal condition included several conservative assumptions as well as the effect of uncertainties in calculation method and geometric and material variations of the fuel storage rack. The following conservative assumptions were used in the calculation:

a. Fresh fuel of 3.25 wt % ^{235}U enrichment.

Initially the maximum enrichment will be much lower than this, but could approach this value if an 18-month fuel cycle is used. The enrichment selected is higher than the average enrichment of any fuel expected to be stored in the spent fuel pool. It was chosen because the fully loaded rack of fuel with this enrichment gives a more reactive condition than any presently foreseen;

b. Uniform planar array of 3.25 wt % enrichment fuel. Calculations have shown that this is conservative compared to the realistic, planar distributed enrichments within an assembly;

c. Spent fuel pool bulk water temperature 68°F. This is considerably lower than expected. Nevertheless, a calculation was done to determine the increase in reactivity due to a decrease in pool temperature to 32°F. The results showed the effect to be negligible;

d. Fuel racks are infinite in three dimensions; and

e. Fixed neutron poisons in the fuel assembly are neglected.

The majority of the calculations were performed with methods commonly used in light water reactor design; i.e., four-group diffusion theory cell calculations using PDQ-7 (Reference 9.1-2). Cross sections for these calculations are generated with NUMICE-2 (Reference 9.1-3), the NUS Corporation version of the Westinghouse LEOPARD code. This code uses the same cross section library tape and calculational techniques as LEOPARD. Selected cases were checked and the final design multiplication factors were verified with Monte Carlo calculations using KENO-IV (Reference 9.1-4), with a 123-group cross section library generated from a basic GAM-THERMOS library using two subroutines, NITAWL and XSDRNPM, in the AMPX1 (Reference 9.1-5) code package. Both the PDQ-7 and the KENO-IV calculation methods, as described above, have been benchmarked. These calculation methods, as described, were used for the Columbia Generating Station (CGS) calculation and do not contain any significant modifications.

Under normal conditions, for a center-to-center spacing of 6.5 in. between fuel assemblies with B_4C plates surrounding each stored fuel assembly, the k_{eff}, as determined using KENO, is 0.851. With the void space between the B_4C plates and the stainless steel box flooded with water, the KENO calculation yielded a lower k_{eff}. Calculation uncertainties were determined from comparison between calculation and experiments using KENO and a statistical evaluation of Monte Carlo runs. The results indicated a calculational uncertainty for the former of 0.013 Δk and for the latter 0.010 Δk at a 95% confidence level; this represents a total calculation uncertainty of 0.023 Δk. Mechanical spacing and tolerances acting in a direction close to the water gaps between adjacent racks result in a slight reactivity increase of 0.002 Δk. Production tolerances of B_4C plates result in a reactivity increase of 0.003 Δk.

To determine the effect of reduced or missing neutron absorbing material, it was assumed that one out of every 25 neutron absorber plates was missing. This case is extremely unlikely but shows poison variation sensitivity. The results of the calculation was an increase in reactivity of 0.015 Δk. A temperature decrease in pool water temperature of 32°F was included, i.e., 0.004 Δk. Adding the total calculational uncertainties of 0.023 Δk and the total geometric and material uncertainties of 0.024 Δk to the nominal k_{eff} results in a k_{eff} of 0.897 with a confidence level of 95%. This is well below the design basis of $\leq$0.95% for the normal wet condition.

Two abnormal conditions were also considered. They are (a) a dropped assembly assumed to lay across the top of a fuel rack and (b) a fuel assembly in transport in a vertical position, accidentally dropped into the water channels between racks. Of these two, the second condition is more severe. For the first condition, the end fittings on the top of the BWR assembly prohibits a spacing between the dropped assembly and the active fuel in the storage racks of less than 11.6 in. Using the same techniques, assumptions, and uncertainties previously discussed, the second case resulted in a k_{eff} of 0.903. This is only slightly different from the conservative normal condition and within the design basis k_{eff} of $\leq$0.95.

9.1.2.3.1.2 9 x 9 and 10 x 10 Fuel. The criticality safety of the spent fuel storage rack with 9 x 9-9X, SVEA-96 (10 x 10), ATRIUM-10 (10 x 10), GE14 (10 x 10) and GNF2 (10 x 10) fuel is assessed in accordance with NUREG 0800 and ANSI/ANS 57.2 (References 9.1-7, 9.1-8, 9.1-9, 9.1-11 and 9.1-13). The spent fuel storage rack meets the applicable criticality safety criteria subject to the conditions given below:

a. Fuel design - As specified below with a maximum enrichment of 4.0 wt % ^{235}U for 9 x 9-9X fuel.

b. For SVEA-96 fuel - Enrichment above 3.77 wt % ^{235}U is allowed in the spent fuel pool by determining the reactivity equivalency. Reactivity equivalency is predicated on the reduction in reactivity associated with the combination of fuel depletion and gadolinia burnable absorbers (Reference 9.1-8). The reactivity equivalency is checked for each SVEA assembly design for each reload. Any significant deviation from the fuel assembly geometry specified by this design will require additional analysis as specified in Westinghouse methodology (CE NPSD-786-P, Revision 1).

c. For ATRIUM-10 fuel, the maximum enriched lattice zone is ≤4.6 wt % ^{235}U with ≥10 gadolinia rods at ≥2.0 wt % Gd_2O_3. Any significant deviation from the fuel assembly geometry specified by this design will require additional analysis as specified in AREVA NP methodology (Reference 9.1-9).

d. The CGS spent fuel fuel storage racks were analyzed for the storage of GE14 fuel bundles. The analyses were performed with the MCNP01A (GEH's version of MCNP4A) Monte Carlo neutron transport program (Reference 9.1-

10). The GE14 spent fuel design basis bundle was analyzed in rack with an infinite lattice geometry and uniform 4.9w% U-235 enrichment, using both full and part length fuel rods with initial distributed fissile inventories, burnable absorber, and evaluated at its respective cold, uncontrolled, exposure-dependent reactivity statepoints. Representative placement and numbers of Gadolinium rods were used to model a peak in-core eigenvalue (k_∞) of 1.33 using the TGBLA06A production lattice physics code with benchmark uncertainties included. Any fuel meeting a k_∞ of 1.33 and the established in-core calculated benchmark uncertainties of the GE14 analysis are also bounded by the results of the GE14 analysis. No further evaluation is required.

e. The CGS spent fuel storage racks were analyzed for the storage of GNF2 fuel bundles. The GNF2 spent fuel storage rack model is consistent with the model described for GE14. Reference 9.1-13 provides additional details about the GNF2 fuel storage analysis.

f. When stored, the fuel assemblies must be inserted into the fuel storage boxes such that no fully enriched fuel protrudes above the B_4C absorber plates to a maximum fuel assembly protrusion of less than six in. (i.e., no more than 11.4 in. from the top of the bail handle to the top of the storage rack).

g. B_4C content in the absorber plates is constant over time; and

h. The B_4C plates contain no significant gaps.

The key assembly design parameters used in these calculations are listed in Table 9.1-1. The 9 x 9 assembly has 72 enriched uranium fuel rods. An internal water channel is located in the central portion of the assembly.

The SVEA-96 assembly has 96 fuel rods in a 10 x 10 array with four central rods missing. An internal cruciform water channel separates the 96 rods into four subassemblies of 24 rods each.

a. The neutron multiplication factors were calculated using KENO V.a,

b. Specular reflection was used with all models which means that no credit is taken for neutron leakage. In other words, k_∞ and k_{eff} are identical for the models used in this analysis, and

c. All codes and cross sections have been benchmarked against critical experiment data.

The major assumptions made in this analysis are as follows:

a. Fuel enrichment is the bundle average in all rod locations,

b. Fuel contains no burnable poisons,

c. No soluble poisons are present in the water,

d. Spent fuel pool bulk water temperature 68°F including a temperature decrease to 32°F,

e. B_4C content in the absorber plates is constant over time, and

f. The B_4C plates contain no significant gaps.

The first four assumptions make the analysis conservative. The last two are limiting conditions.

The ATRIUM-10 fuel assembly is a 10 x 10 fuel rod array with an internal water channel offset in the center of the assembly (displacing nine fuel rod locations). The assembly contains part length fuel rods constituting a "top" lattice (above the part length fuel rods) and a "bottom" lattice (below the part length fuel rods). The ATRIUM-10 nominal design parameters are listed in Table 9.1-1.

The following conservative assumptions are made:

a. The results are based on a moderator temperature of 4°C (39°F), which gives the highest reactivity for the fuel pool racks;

b. Fuel assemblies are assumed to contain the highest enriched lattice (highest reactive lattice) for the entire length of the assembly;

c. Each fuel assembly in the array is assumed to be at the peak reactivity of its lifetime;

d. Analyses assumes infinite fuel in the axial direction (no axial reflector);

e. Neutron absorption in fuel structural components is neglected; and

f. The maximum reactivity values include all significant manufacturing and calculational uncertainties.

The GNF2 and GE14 fuel assemblies are a 10 x 10 fuel rod array with 2 internal water rods offset in the center of the assembly (displacing 8 fuel rod locations). The GNF2 and GE14 nominal design parameters are listed in Table 2-1 of Reference 9.1-14.

The GNF2 and GE14 analysis 12 x 16 spent fuel storage rack model assumes several key assumptions:

a. Fuel assemblies are assumed to contain the highest enriched lattice for the entire length of the assembly and are associated with a peak in-core reactivity of 1.33 with benchmark uncertainties included.

b. The analysis assumes infinite fuel in the axial direction (no axial reflector).

c. Neutron absorption in fuel structural components is neglected.

d. The outer sides of the 12 x 16 storage rack array (Figures 9.1-3 and 9.1-4) contain no boron carbide absorber plates. Boron carbide absorber plates are only located along the inner walls of the spent fuel rack lattice structure. The 12 x 16 infinite array model is bounding for the actual spacing and rack configurations in the spent fuel pool with mixed adjacent 12 x 16 and 12 x 11 fuel arrays.

e. Up to three GNF2 and GE14 bundles can be safely handled in the spent fuel pool, outside of the spent fuel rack, in any configuration.

f. The results of the analysis include a statistical rollup of all significant manufacturing and calculation uncertainties and abnormal storage condition biases.

g. The following abnormal conditions have been evaluated as part of this analysis and have been accounted for within the bias of the maximum k-effective result:

    i. Four damaged fuel bundles surround the non-borated intersection of the four 12 x 16 array spent fuel storage racks. This model approximates the damage to the bundles by optimizing the fuel rod pitch of the design basis bundle within the fuel box without consideration of the bundle channel. The fuel rod arrays in each of the four fuel boxes are placed as close to the intersection of the four 12 x 16 arrays as possible. This model does not consider damage to the storage rack.

ii. Misplaced/dropped fuel bundle in between storage rack modules.

iii. An infinitely long fuel bundle is modeled to lie horizontally at 1 cm above the active fuel region of the rack.

iv. A single bundle protruding from the top of the borated region of the spent fuel rack by a maximum distance of 6 in.

All normal and credible abnormal conditions are found to have an acceptable reactivity, (k_{eff}) of $\leq$0.95 after adding the calculational uncertainty. The assumption that the entire fuel storage rack contains 9 x 9-9X fuel with up to 4.0 wt % ^{235}U, SVEA-96 fuel with up to 3.77 wt % ^{235}U, ATRIUM-10 fuel with each lattice zone ≤4.6 wt % ^{235}U with ≥10 gadolinia rods at ≥2 wt % Gd_2O_3 and GE14 and GNF2 fuel with ≤ 4.9 wt% ^{235}U and a Gd_2O_3 loading that corresponds to an in-core reactivity of 1.33 conservatively accounts for the presence and potential intermixing of older and lower enriched 8 x 8 fuel bundles.

9.1.2.3.2 Spent Fuel Storage Rack Structural Design

In accordance with Regulatory Guide 1.13, Revision 1, the spent fuel storage racks are designed to Seismic Category I requirements. Structural integrity of the racks when subject to normal and abnormal loads, as well as seismic loads, is demonstrated in accordance with the load requirements and acceptance criteria of Standard Review Plan Section 3.8.4. The loads considered are

a. Dead loads which are the dead weight of the rack and fuel assemblies and hydrostatic loads,

b. Live loads, i.e., the effect of lifting empty racks during installation,

c. Thermal loads, which include the uniform thermal expansion of the racks due to increases in average pool temperature, and a thermal gradient between adjacent storage locations,

d. The seismic forces of the OBE and SSE,

e. Accidental drop of a fuel assembly from the maximum possible height consistent with fuel handling operations, which is 4 ft above the top of fuel rack, and

f. Postulated stuck fuel assembly causing an upward force of 1200 lb, equal to the fuel grapple load limit to be exerted on the assembly upon attempted withdrawal.

The spent fuel storage racks were analyzed for six combinations of these loads using elastic working stress design methods. The combinations are

a. Dead loads plus live loads,
b. Dead loads plus OBE,
c. Dead loads plus thermal loads plus OBE,
d. Dead loads plus thermal loads plus SSE,
e. Dead loads plus thermal loads plus fuel assembly drop, and
f. Dead loads plus thermal loads plus stuck fuel assembly.

Live loads are not included in load combinations b through f. The only live load on the rack is that due to lifting of the racks which is performed with the racks empty. In all cases the loads were below the strength limits, which were determined from Part I of the AISC "Specification for the Design, Fabrication and Reaction of Structural Steel for Buildings," February 12, 1969, and Supplements 1, 2, and 3. (Supplement 3 was effective June 12, 1974.)

Individual fuel racks are welded into either 1 x 2 or 2 x 2 rack arrays or "super modules." These super modules are then attached to the fuel pool walls at two elevations by adjustable seismic restraints which are essentially large turnbuckles. These restraints are designed and positioned to eliminate any significant thermal growth loads on the walls.

The fundamental frequency of lateral vibration of the welded rack array yielding the lowest frequency was determined using the STARDYNE3 (Reference 9.1-6) computer program. The model, consisting of beam and plate elements and lumped masses, represents a three-dimensional 2 x 2 rack array. The model has an array of beams, representing fuel storage cans, connecting the upper and lower grids, and resting on a base grid which is held off the pool floor by support feet. The rack is restrained laterally by two levels springs, representing the seismic restraints. The stiffnesses of the fuel assemblies and B_4C neutron absorber plates conservatively were neglected. However, the mass of the fuel assemblies, as well as the mass of the B_4C plates and an effective mass of water was considered to be uniformly distributed over the height of the fuel boxes. The results of the STARDYNE analysis showed a lateral natural frequency of 14.7 Hz. A dynamic analysis was performed using the horizontal floor response spectra (damping 0.5% of critical).

The fundamental frequency of vertical vibration of the rack was also determined using the STARDYNE computer program. The same model replacing lateral mass with vertical mass was utilized. In this case, since the fuel rests on the base frame, the entire mass of the fuel was lumped at the base grid. Since the calculated frequency was 50.9 Hz and the vertical floor response spectra (damping 0.5% of critical) showed constant acceleration at frequencies in excess of 18 Hz, the effects of the vertical accelerations were considered using the zero-period acceleration in a static analysis. The lateral and vertical loads were considered to be acting simultaneously.

In the general seismic/structural analysis of the fuel racks, the mass of a fuel assembly is assumed to be uniformly distributed along the length of each of the fuel storage cans. Since a maximum gap on the order of 3/8 in. exists between the side of a fuel assembly and the can (when the fuel is not encased in a channel), the fuel will actually move within the can during a seismic event and cause impact loads to be transmitted to the fuel rack restraints. The effects of this fuel can interaction are determined using a simplified finite element model of the rack and fuel. A nonlinear dynamic analysis is performed using the ANSYS computer program. Details of this analysis are given in NUS Corporation Technical Report 2060, entitled "Fuel-Can Interaction Analysis," October 1977.

Using the given loads, load combinations, and analytical methods, stresses were calculated at critical sections of the rack and compared to the structural acceptance criteria. In all cases, the calculated stress did not exceed the allowable stress.

To ensure the integrity of the spent fuel storage racks in the event that water has leaked into the racks, specially designed control samples, consisting of B_4C plates in vented (to pool water) canisters, are placed in a readily accessible position in the spent fuel pool. These samples are subjected to periodic examinations to check for possible deterioration and they are also analyzed to ensure that the boron has not leached from the plates.

Section 15.7.4 presents an analysis (for radiological considerations) of fuel handling accidents.

The high density fuel rack designer, NUS Corporation, analyzed the fuel racks from both a structural and criticality standpoint concerning a 1510-lb object dropped from the surface of the fuel pool. The results indicated that none of the fuel rack damage that might occur in this situation would lead to a criticality problem. Details of these analyses are given in NUS Corporation Technical Reports 5326-FA-01 and G-RA-17 entitled, "Structural Analysis of the CGS Rack and Fuel Assemblies for an Accidental Object Drop Loading Condition," and "Criticality Analysis of Dropped Object Accident for WNP-2 Spent Fuel Storage Racks," respectively.

Similarly, independent analysis of GNF2 and GE14 fuel indicates that none of the fuel rack damage that might occur would result in increased reactivity that could exceed the 0.95 safety limit. This evaluation is based the guidance of NUREG-0612 and includes damage to the four fuel bundles that surround the non-borated intersection of the four 12 x 16 array spent fuel storage racks (Figures 9.1-3 and 9.1-4). The 12 x 16 infinite array model is bounding for the actual spacing and rack configurations in the spent fuel pool with mixed adjacent 12 x 16 and 12 x 11 fuel arrays. This model approximates the damage to the bundles by optimizing the fuel rod pitch of the design basis bundle within the fuel box without consideration of the bundle channel. The fuel rod arrays in each of the four fuel boxes are placed as close to the intersection of the four 12 x 16 arrays as possible. The model does not consider damage to the storage rack.

During shutdown, crane operations over the spent fuel storage pool (when fuel assemblies are stored within) are suspended when operability of less than the required number of onsite and offsite power sources occurs, as defined in the Technical Specifications.

9.1.2.3.3 Spent Fuel and Cask Handling

The 125-ton reactor building crane traverses the full length of the refueling floor level of the reactor building. The design of the refueling floor provides aisles on both sides of the fuel pool for moving components past (and not over) the fuel storage pool. Interlocks on the reactor building crane prevent travel over the spent fuel racks. The interlock-controlled restricted area for crane travel is shown in Figure 9.1-5. The interlocks are bypassed only when it is necessary to operate the crane in the fuel pool area in conjunction with activities associated with fuel handling and storage. During these rare occasions when the interlocks are bypassed, administrative controls are used to prevent the crane from carrying loads that are not necessary for fuel handling or storage and which are in excess of the rack design drop load (one fuel assembly at 4 ft above the top of the fuel rack). See Section 9.1.2.3.2.

Transfer of fuel assemblies between the reactor well and the spent fuel pool is performed with the refueling platform (see Section 9.1.4.2.10.2). The fuel grapple or the auxiliary fuel hoist may be used, depending on the transfer operation.

The grapple and hoists are provided with load sensing and limiting devices designed to the following limits:

	NF-500 Fuel Grapple (lb)	Auxiliary Hoists (lb)
Load limiting switch NF500	1700	1000
Load sensing switch Auxiliary Hoist		535
Load sensing switch NF500	750	
Stall torque for hoist system	3000	3000

The load limiting features of the refueling platform grapple and auxiliary fuel hoist will prevent damage to the fuel racks if a fuel assembly accidentally engages a rack while being lifted.

These load limits provide a redundant safety feature since the fuel handling grapple is not lowered below the upper fuel rack and is designed to interface only with the fuel bail. Thus, the possibility of inadvertent direct lifting of the racks with the grapple is precluded.

Guard rails around the spent fuel pool prevent the falling of fuel handling area machinery into the pool. Other objects that could conceivably fall into the pool will not transfer energy amounts exceeding the specified limits of the fuel racks.

The preclusion of accidental dropping of the spent fuel cask on the spent fuel racks is accomplished by incorporating a separate cask storage area in the spent fuel pool, by interlocks on the reactor building crane, and by designing the path of the spent fuel cask to avoid passing over the spent fuel racks. The pool cask storage area is separated from the spent fuel racks by a wall over which the spent fuel is transferred.

For removal of spent fuel from the plant, a spent fuel cask is lowered into the cask area. Transfer of fuel to the cask is made over the wall between the spent fuel racks and the cask storage area. When the main hook of the reactor building crane removes the cask from the cask area, it follows the travel path shown in Figure 9.1-5. In addition, sufficient redundancy is provided in the reactor building crane such that no credible postulated failure of any crane component will result in the dropping of the fuel cask. See Section 9.1.4.2.2.

Failure of the gates between the reactor well and the spent fuel storage pool is improbable. However, in the event of this failure, the loss of water from the storage pool into the reactor well would not uncover the stored spent fuel due to the elevation of the weir wall under the gates. This elevation ensures that sufficient water is retained in the pool to cover the spent fuel.

To avoid unintentional draining of the spent fuel storage pool to levels below that required for adequate shielding of the spent fuel, no inlets, outlets, or drains that would normally permit the pool to be drained are provided. Discharge lines extending below the pool water level are designed to prevent any siphon back flow. Two skimmer surge tanks are provided and are sized to accommodate water displacement due to large items being placed into or removed from the spent fuel storage pool.

See Section 9.1.3 for additional evaluation of continuous cooling capabilities of the spent fuel pool cooling and cleanup (FPC) system.

9.1.2.3.4 Spent Fuel Rack Design Features

The rack, rack modules, and restraints are all stainless steel, as is the spent fuel pool liner, to minimize the potential for galvanic corrosion. Stainless steel has also been shown to be compatible with spent fuel pool water and the stored assemblies.

The fuel rack base is elevated above the floor to ensure adequate flow under the rack in each fuel assembly. Analyses have been performed and show that sufficient flow is induced by natural convection to preclude local boiling in the hottest storage location.

The analyses were based on the following assumptions:

a. The fuel element inlet temperature is the mixed hot design temperature of the pool,

b. A hot assembly peaking factor of 1.74 is applied to the core average assembly energy release rate of 5.3×10^4 Btu/hr,

c. The maximum local peaking factor is 2.49, giving a maximum local heat flux of 1334 Btu/hr-ft^2,

d. A film coefficient of 31 Btu/hr-ft^2-°F is based on pure conduction through a stagnant boundary layer at the fuel rod surface,

e. The downcomer region feeds 12 assemblies in a row, each assumed to be generating the maximum heat rate defined in assumption b, and

f. One dimensional fluid flow analysis applies.

During full core offload with the bulk pool temperature at a design value of 150°F, the mixed temperature of the water exiting from the hottest storage location is less than 181°F. This is 58°F below the local saturation temperature of 239°F, indicating that adequate margin to bulk boiling exists. Under normal operating conditions, the fuel rod surface temperature calculated on the basis of the heat flux and film coefficient defined above is more than 14°F below the local saturation temperature. Local boiling is thus precluded.

The fuel racks are designed, constructed, and fabricated with a high degree of reliability and integrity. A list of the industry design codes and standards used for the spent fuel storage racks is given below.

Design Codes

a. AISC Manual of Steel Construction, 7th Edition, 1970,

b. ASME Boiler and Pressure Vessel Code Section III-1971, Nuclear Power Plant Components. (Tables I-2.2, I-5.0, and I-6.0 are used for yield strength values, coefficients of thermal expansion, and moduli of elasticity),

c. AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, February 12, 1969 and Supplements 1, 2, and 3 (Supplement 3 effective 6/12/74),

d. ASTM Specification A 240-75a, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate Sheet and Strip for Fusion-Welded Unfired Pressure Vessels,

e. ASTM Specification A 320-74, Specification for Alloy Steel Bolting Materials for Low-Temperature Service,

f. AWS A 5.9, Corrosion Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes, and

g. ASME Boiler and Pressure Vessel Code Section IX-1974, Welding and Brazing Qualification.

9.1.2.3.5 Spent Fuel Storage Facilities Design

The spent fuel storage pool is designed to Seismic Category I requirements to prevent earthquake damage to the stored fuel. The exterior walls and roof of the reactor building are designed as low-leakage barriers to confine potential airborne radiation (contamination) within the reactor building and the exhaust air treatment systems.

Release of radioactive products from damaged or failed fuel in the spent fuel pool will be detected by a high level gamma radiation monitor located in the fuel pool vicinity. This instrument has a range of 100 to 10^6 mrem/hr with remote readout and alarm in the main control room. Backup detection provided by high radioactivity monitors in the reactor building ventilation system exhaust plenum (see Section 9.4.2) will initiate reactor building ventilation system isolation and operation of the standby gas treatment system (see Section 6.5.1) to block potential leakage of contaminated air to the environment. See Chapter 15 for radiological considerations.

The spent fuel storage pool contains a minimum water depth of 22 ft above the top of the irradiated fuel assemblies seated in the spent fuel storage racks. A low water level alarm is provided in the control room in the event of loss of pool water. As a backup, flow alarms are provided in the drain lines to detect leakage in the reactor vessel to drywell seal, drywell to concrete seal, and fuel pool gate. An adequate fuel pool water level can be maintained, even in the unlikely event of a pipe break between the skimmer surge tanks and the FPC system pumps, since fuel pool discharge to the skimmer surge tanks is by overflow only. A pipe break would drain the skimmer surge tank but would not reduce the spent fuel storage level. A check valve in each supply pipe from the FPC system prevents siphon back flow to the cleanup system. Provision is also made so that standby service water (SW) can be used as backup for fuel pool makeup upon failure of the normal makeup system. This connection is capable of supplying enough water to prevent the uncovering of the spent fuel. By use of the standby SW as makeup, the fuel pool will be cooled by evaporation of the pool water. The residual heat removal (RHR) system can be operated in parallel with the fuel pool cooling system, to remove abnormal heat loads in the fuel pool. See Section 9.1.3 for details.

The reactor building below the refueling floor is designed to be tornado proof. Tornado missiles below this elevation cannot impair the structural integrity of the pool. Missiles which could reach the pool from above are small enough that they could not impair the structural integrity of the pool. Metal siding above the refueling floor blows out during a tornado. All large objects on the refueling floor are secured so that they cannot be carried into the fuel pool. See Section 3.3 and GE Topical Report, APED-5696, Tornado Protection for the Spent Fuel Storage Pool.

Leak detection channels are provided on the concrete sides of the spent fuel storage pool liner. Surveillance of flow indications from these leak channels permits early determination and localization of any leakage.

9.1.2.3.6 Radiological Considerations

9.1.2.3.6.1 Normal Operation. Three sources of exposure to personnel in the area of the spent fuel storage pool are considered:

a. Direct dose from the stored fuel,
b. Dose from the radionuclides in the spent fuel pool water, and
c. Dose from airborne tritium.

Direct dose from the stored fuel is negligible due to the height of water above the storage positions. Calculations indicate a direct dose from stored fuel of less than 1×10^{-5} mrem/hr.

Most of the personnel exposure in the area of the spent fuel storage pool comes from the radionuclide inventory in the water. Estimates of the dose from this source were calculated to be 3.5 mrem/hr during the first refueling, increasing to 6.9 mrem/hr during the eleventh refueling. These calculated values are given in Table 9.1-2.

The dose from airborne tritium is limited by spent fuel storage pool water temperature limitations as described in Section 9.1.3 and by the fuel pool exhaust ventilation described in Section 9.4.2.

9.1.2.3.6.2 Radiological Consequences of Accidents. See Chapter 15.

The storage racks, storage pool and associated equipment, and the reactor building in which the pool is located, are designed to remain functional through and after an SSE.

The impact of heavy objects on the racks has been considered in the design. The reactor building below the refueling floor is tornado proof and tornado missiles that could reach the pool from above this level are small enough that the structural integrity of the pool (and racks therein) could not be impaired. The drop of a spent fuel shipping cask is precluded by redundancy features of the crane and other design features discussed in Section 9.1.2.3.3.

9.1.2.3.7 Conclusions

From the foregoing analyses, it is concluded that the spent fuel storage arrangement and design comply with the objectives in Regulatory Guide 1.13, Revision 1.

9.1.3 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM

9.1.3.1 Design Bases

The FPC system has been designed to comply with the objectives in Regulatory Guides 1.13, Revision 1, and 1.26, Revision 3, to the extent specified in the following subsections. The system and equipment are designed to the classifications given in Tables 3.2-1 and 9.1-3.

During normal reactor operation the system is designed to remove decay heat released from the stored spent fuel elements and maintain a specified fuel pool water temperature, water clarity, and water level by accomplishing the following:

a. Minimizing corrosion product buildup and controlling fuel pool water clarity so that fuel assemblies can be efficiently handled underwater,

b. Minimizing fission product concentration in the fuel pool water thereby minimizing the release of fission products from the pool to the reactor building environment,

c. Monitoring surge tank water level to thereby maintain a pool water level above the fuel sufficient to provide shielding for normal building occupancy and to control makeup flow rate from the condensate transfer system, and

d. Maintaining the fuel pool water temperature below 125°F under normal (nonrefueling) operating conditions. The maximum heat load in the fuel pool occurs during refueling. The magnitude of this heat load will vary for each refueling based on the number of irradiated fuel assemblies moved from the reactor core to the fuel pool, the burnup of each fuel assembly, and the decay time of each fuel assembly.

Additionally, the system also provides cleanup for purity and clarity control to the reactor well, dryer-separator pool, and the suppression pool.

During shutdown conditions, the RHR system may be operated to remove the decay heat load. However, the RHR assist mode may only be credited for spent fuel pool cooling during a full core offload.

In Section 1.3.2 it was indicated that a significant change was made in the fuel pool cooling system between the time of the PSAR and FSAR. The design basis originally relied on fuel pool boiling following a severe seismic event and provided for safety grade makeup from the standby SW system. In the final design, the design basis of the fuel pool cooling portion of the system was changed to Seismic Category I. Following a seismic event or major plant disturbance, the system is designed to prevent fuel pool boiling and maintain adequate water level in the spent fuel pool by means of the following:

a. Automatic isolation on low fuel pool water level of the Seismic Category I cooling portion of the system from the Seismic Category II cleanup portion of the system,

b. Remote-manual startup from the control room of redundant, active components of the fuel pool cooling portion of the system, and initiation of safety grade cooling water from the standby SW system, to the fuel pool cooling heat exchangers,

c. Remote valve operation, from the control room, to initiate SW cooling to the FPC heat exchangers, and

d. Redundant SW system makeup to the fuel pool (see Section 3.1.2.6.2) and fuel pool level monitoring from the control room.

9.1.3.2 System Description

The FPC system must operate in a variety of conditions. During normal reactor operations the FPC provides for cooling and cleaning of the spent fuel pool containing discharged fuel assemblies. During refueling outages, the FPC system may be required to provide additional decay heat removal. The spent fuel pool cooling function can be provided by operating both trains of FPC. The RHR B loop may only be credited for FPC assist during a full core offload. The RHR B loop may be operated, but not credited, to provide supplemental cooling as required. The RHR B loop can be cross connected to the FPC system. In addition, with the reactor cavity flooded and fuel pool gates removed, RHR A or B may be lined up to take suction from the surge tanks and discharge to the RPV.

The FPC system flow diagram is shown in Figures 9.1-6.1 and 9.1-6.2.

System performance data are summarized in Table 9.1-5. Major components of the system are summarized in Table 9.1-3. The system is designed to dissipate the fuel pool heat load during normal operation and refueling conditions.

The FPC system consists of two separate trains, each containing a circulating pump and a heat exchanger. The system also contains two filter demineralizers and two skimmer surge tanks, as well as the required piping, valves, and instrumentation. Except for the pumps, heat exchangers and filter demineralizers, common piping headers are used. The FPC pumps normally circulate the pool water in a closed loop, taking suction from the surge tanks, circulating the water through a heat exchanger and a filter demineralizer, and discharging it through the diffusers at the bottom of the fuel pool. During refueling, pool water is discharged through the fuel pool diffusers or through diffusers in the reactor well. The water flows from the pool surface through skimmer weirs to the surge tanks. Makeup water for the system is normally transferred from the condensate storage tank to a skimmer surge tank to make up pool water losses. The fuel pool pumps and heat exchangers are located in an enclosed room on the 548-ft level of the reactor building beneath the fuel pool.

Instrumentation is provided for both automatic and remote manual operation. Indication is provided in the control room. Surge tank high and low water level switches are provided. Control of flow to or from the reactor well can be accomplished during refueling. A fuel pool high/low water level switch sounds an alarm in the control room whenever the level is either too high or too low. The alarm points are fixed at the bottom of the weirs (low) and 1-1/8 in. above the normal water level (high).

The pumps are controlled from instrument racks on the 522 ft el. and the control room. Pump low suction pressure automatically shuts down the operating pump(s). A pump low discharge pressure alarm annunciates in the control room and starts the standby pump.

A high rate of leakage through the reactor drywell refueling bellows assembly, drywell to reactor well seal, or the fuel pool gates is indicated locally and is alarmed in the control room.

Failure of the reactor closed cooling water system (RCC), RHR, or a loss of inventory, are addressed in procedures. The FPC system operation and RHR/FPC assist modes of operation are each discussed in the following sections in more detail.

9.1.3.2.1 System Operation

9.1.3.2.1.1 FPC System Cooling Function

The system normally cools the fuel pool by transferring the spent fuel decay heat from the tube side of the two fuel pool cooling heat exchangers to the RCC. Standby SW can be manually aligned as the alternate heat sink for the heat exchangers (see Section 9.1.3.2.3 for additional details). The fuel pool is maintained at or below 125°F during normal plant operations. The fuel pool temperature may rise above this value during refueling activities or during an anticipated operational transient of the loss of one train of the FPC system. The RHR system can also be manually aligned into several configurations to provide supplemental cooling of the fuel pool. One of these RHR configurations is the RHR/FPC assist mode of RHR (see Section 9.1.3.2.2 for additional details).

The maximum heat load is present in the spent fuel pool during refueling activities when recently irradiated fuel bundles are discharged from the reactor core to the fuel pool. The magnitude of this heat load is contingent upon the cycle-specific refueling activities, i.e., the number of the bundles discharged, the burnup of the discharged bundles, and the decay time of each bundle when it is placed in the fuel pool. The heat load associated with a planned discharge can be calculated with the ORIGEN-ARP computer code assuming a .34% thermal power uncertainty or other acceptable means to account for code bias and uncertainties. During refueling activities, the fuel pool temperature is managed by controlling the number and schedule of fuel assemblies discharged, controlling the number of heat removal systems in service, and controlling the temperatures of the systems (RCC or SW) used to remove the heat from the FPC heat exchangers.

The fuel pool cooling system was originally designed to maintain the pool at a temperature of less than or equal to 125°F during refueling activities with both trains of fuel pool cooling in operation and RCC cooling water at 95°F. The decay heat load assumed for the original design basis (normal offload) was based on the original licensed power of 3323 MW-thermal, a one-year fuel cycle, and a quarter core offload with a 20-day decay period.

Since the original design, the licensed power was increased to 3544 MW-thermal and the operating cycle was revised from a one-year cycle to a two-year cycle. These changes resulted in an increased heat load in the fuel pool, particularly during refueling outages. For the current design (3544 MW-thermal and a two-year cycle), a 150°F fuel pool temperature limit (see Table 9.1-6) applies to normal refueling activities for the scenario of both trains of fuel pool cooling in operation.

The FPC system is also designed to provide sufficient cooling for an anticipated operational transient of the loss of one train of the FPC system. For this transient, the maximum bulk fuel pool water temperature is limited to 175°F. This limit applies to both normal operation and normal refueling activities (i.e., excluding a full core offload).

The system's ability to satisfy these temperature limits could be challenged based on outage-specific plans or activities. Outage-specific calculations are performed, as needed, to ensure acceptance criteria limits are maintained and adequate decay heat removal capability exists. Management of the rate and magnitude of the heat load added to the fuel pool during refueling activities and the temperature of the credited heat sink (i.e., RCC or SW) are considered.

Energy Northwest does not routinely perform full core offloads at Columbia and as such, a full core offload is considered a non-routine evolution. If performing a full core offload, supplemental RHR cooling (RHR/FPC assist mode) is required to maintain fuel pool temperatures below 145°F. The limit for this scenario is 175°F. A single failure scenario involving the loss of one train of the FPC is not postulated for a full core offload. This exemption from a single failure is reasonable based on the expected infrequent performance of a full core offload.

During normal plant operations, the heat load in the fuel pool will be less than the heat load experienced during refueling activities. There are three fundamental operational scenarios considered in the design and licensing basis of the FPC. These scenarios are: 1) normal operations with both FPC trains available; 2) normal operations with an anticipated operational transient of the loss of one train of the FPC system; and 3) a design basis LOCA condition. The fuel pool temperature limits for each of these scenarios are presented in Table 9.1-6.

The FPC system is not credited for mitigating the consequences of a design basis event. For a postulated LOOP/LOCA event, RCC will be lost (automatically load sheds in response to an F or A signal) and one train of the FPC system is lost as the result of an assumed single failure. Standby SW can be manually aligned from the control room to replace the lost RCC. Prior to the postulated LOCA, the SW is maintained at a temperature of less than or equal to 77°F in accordance with the Technical Specifications. During the mitigation of the design basis LOCA, the SW will rise to approximately 90°F. The heat up of the fuel pool following a design basis LOCA has been evaluated using a heat load of approximately 10.1 MBTUs/hr and the peak temperature is within the acceptance criteria of 175°F. This temperature is consistent with the design limits of the FPC system.

9.1.3.2.1.2 FPC System Clean-Up Functions

Water purity and clarity in the storage pool, reactor well, and dryer-separator pool are maintained by filtering and demineralizing the pool water through the FPC system filter demineralizers. In addition to fuel pool water demineralization, the system may be used to mix and demineralize the suppression pool water. The suppression pool cleanup portion of the FPC may also be used to periodically let down suppression pool water inventory.

To establish a circulating pattern of flow in the reactor well and fuel storage pool, the diffusers and skimmer drains are placed to sweep particles dislodged during refueling operations away from the work area and out of the pool.

Particulate material is removed from the water by the pressure precoat filter demineralizer units. The finely divided disposable filter medium is replaced when the pressure drop is excessive or the ion exchange resin is depleted. The spent filter medium is backwashed to the waste sludge phase separator tank for processing in the solid radwaste handling system. New filter medium is mixed in a precoat tank and is transferred as a slurry by a precoat pump where the solids deposit on the filter elements. The holding pump connected to each filter demineralizer maintains circulation through the filter in the interval between the precoating operation and the return to normal system operation. A strainer is provided in the effluent stream of the filter demineralizers to limit the migration of the filter material.

The two filter demineralizer units are located separately in shielded cells in the radwaste building. Sufficient clearance is provided in the cells to permit removal of the filter elements from the vessels. Each cell contains only the filter demineralizer and its associated piping. All valves are located on the outside of one shielding wall of the cell, together with necessary piping and headers, instrument elements, and controls. The FPC cleaning portion of the system is controlled from the radwaste control room.

The flow rate through the filter demineralizers is given by a flow indicator in the radwaste control room located on the demineralizer control panel.

Differential pressure and conductivity instrumentation is provided for each unit to indicate when backwash is required. Suitable alarms, differential pressure indicators, and flow indicators are provided to monitor the condition of the filter demineralizers.

There are two sampling points: SP-25A&B, at the effluent from the fuel pool filter demineralizers, FPC-DM-1A&B. There are also sample points: SP-69, at the fuel pool return line, and SP-24, at common inlet header to the demineralizers. All four sample points are piped to the sample room. All four sample points continuously transmit conductivity measurements to a 4-point recorder and also provide grab samples at the nearby associated fume hood.

Weekly fuel pool analyses is performed to ensure that the water quality specifications for the fuel pool are maintained. The water quality parameters are as follows:

Conductivity	3 µS/cm at 25°C
Chloride	0.5 ppm
pH	5.3-7.5 at 25°C
Total insolubles	1 ppm
Heavy metals	0.1 ppm

Weekly gamma analyses are performed following fuel load or when irradiated fuel is stored in the pool. Special tests on iodine or other significant radionuclide removal by the fuel pool filter demineralizers will be performed when gross gamma activity levels in the fuel pool exceed 10^{-3} mCi/cm^3 during normal power operation.

Continuous influent and effluent conductivity for the fuel pool demineralizers are monitored and recorded. A high conductivity effluent alarm setpoint of 1.5 µS/cm is chosen to reflect marginal performance of the demineralizer since they will eventually saturate with air saturated water at an equilibrium level of about 1.1 μS/cm. Differential pressure drop is continuously monitored across the filter demineralizers and at a pressure alarm setpoint of 10.5 psid, the units are removed from service and re-precoated with a combined filteration/ion exchange media.

9.1.3.2.2 Residual Heat Removal/Fuel Pool Cooling Cleanup Assist Mode Operation

As discussed in Section 9.1.3.2.1, the RHR loop B may be operated to assist the FPC system, however, the RHR system may only be credited for the decay heat removal function during a full core offload.

The cross connect between RHR and FPC is provided by two flanged spool pieces. The installation and removal of the spool pieces is administratively controlled. However, design evaluation of the system found it acceptable to leave them permanently installed. Procedures direct initiation and operation of the RHR/FPC assist mode and provide guidance to mitigate the consequences in the event of the loss of this mode.

The supplementary cooling provided by RHR/FPC assist is not required the majority of the time. The separation of the two systems is maintained by system operating procedures and administrative controls on the valves needed to isolate the spool pieces. The two valves on the discharge side of RHR-P-2B (RHR-V-104 and FPC-V-119) are maintained as locked closed valves. The suction side isolation is provided by the locked closed FPC-V-141 and RHR-V-261 and locked open FPC-V-101 and the check valve, RHR-V-105. The initiation of the RHR/FPC assist mode is not a routine evolution. The installation, testing, and operation of this mode will require an evaluation of plant conditions and requirements. While operating in RHR/FPC assist mode, the RHR B loop will not be able to provide the low-pressure coolant injection (LPCI), shutdown cooling (SDC), or containment spray functions without local manual operations.

While in RHR/FPC assist, RHR and FPC take a suction on the skimmer surge tanks. Water directed to RHR B loop is cooled by SW and the FPC system provides for cleaning of the fuel pool water. As in normal FPC operation, the water is directed to the surge tank by skimmers near the top of the spent fuel pool. The cooled and cleaned water is returned to the pool through the 8-in. diffusers normally used by the FPC system. To limit RHR flow rates while operating in FPC assist, two restricting orifices are installed in the FPC system. While in the FPC assist mode, an optional, additional return path for the RHR B discharge is into the reactor cavity through the line normally providing RPV head spray (Section 5.4.7.2.1). During refueling outage conditions the head spray line is disconnected at a flange in the cavity and removed with the reactor head insulation package. Normally this flange is then blanked off. However, for the additional cooling, the blank can be left off providing the additional flow path of RHR to the cavity, with a rate of up to 1000 gpm.

9.1.3.2.3 Fuel Pool Cooling System Operation Following a Seismic Event or Major Plant Disturbance

The portion of the FPC system that is required for cooling the fuel pool is located within the reactor building and is designed to Seismic Category I criteria. The portion of the FPC system which is used for fuel pool cleanup is located within the radwaste building and is isolable from the reactor building by means of two Seismic Category I isolation valves per line located within the reactor building. The isolation valves are either check valves or motor-operated gate valves. The motor-operated valves close automatically on a fuel pool low water level condition.

The redundant, active components required for fuel pool cooling are powered from Division 1 and 2 power sources. Following a loss of offsite power, these components can be energized from onsite emergency power. On a loss of RCC to the fuel pool heat exchangers, the RCC supply lines to the heat exchangers can be isolated by redundant Seismic Category I motor-operated gate and check valves and the return lines by redundant Seismic Category I motor-operated gate valves. Standby SW can be supplied to the heat exchangers through motor-operated valves which are normally key locked closed. Radiation detectors are located on the SW return lines. The SW system can also be used to mitigate inventory reduction.

To preclude leakage of service water into the spent fuel pool during operation of the SW system or leakage of fuel pool cooling water into the SW system when the SW system is not operating, the manual valves (SW-V-75AA and SW-V-75BB) and the motor-operated valves (SW-V-75A and SW-V-75B) are kept normally closed when spent fuel pool temperatures are below 138°F. If during normal plant operations the spent fuel pool temperature rises above 138°F, the manual valves will be maintained open. The manual valves are located on the west side of the 522-ft el. of the reactor building and are accessible and can be opened if necessary following a LOCA prior to spent fuel pool temperatures exceeding 175°F. The access route to these manual valves is shown in Appendix J. Once the manual valve(s) are opened, spent fuel pool level can be maintained using the remote-manual valves from the main control room.

Operation and monitoring of fuel pool cooling portion of the FPC system can be done entirely from the control room.

All components required for fuel pool cooling are qualified to the reactor building accident environment. The fuel pool equipment room located on the 548 ft el. is provided with redundant Seismic Category I room coolers with one each on Division 1 and 2 power sources.

9.1.3.3 Safety Evaluation

The maximum heat load is the decay heat of one full core load of the fuel plus the remaining decay heat of previously discharged fuel assemblies. The RHR B loop is operated in parallel with the FPC system during this condition or other events which require supplemental cooling.

To permit this use of the RHR system, normally locked closed valves interconnecting the RHR system to the FPC system are opened after verification of the installation of the flanged spool pieces. A full core offload is a non-routine evolution. A single failure is not postulated to occur during this evolution and credit for RHR/FPC assist is allowed. During this evolution, sufficient cooling should be provided to maintain the fuel pool temperature at less than 145°F. The licensing basis limit is 175°F.

The fuel pool heat exchangers are normally cooled by the RCC system to contain released radioactivity in the event of a fuel pool heat exchanger tube failure. During normal operations, the system maintains the fuel pool water temperature below 125°F when removing the nominal heat load from the fuel pool. During normal refueling outage conditions, the system is evaluated to ensure it has the capability to maintain the fuel pool water temperature below 150°F. This limit applies to core offloads up to, but not including a full core offload, and is based on the assumption of 2 FPC trains in service. The system maintains fuel pool water temperature below 175°F in the event that only one pump and one heat exchanger are available. Depending on the heat load in the pool during refueling activities, RCC or SW temperature is controlled to ensure the FPC system can perform its design functions within the acceptance criteria shown in Table 9.1-6.

Following a seismic event or major plant disturbance the SW system is available to cool the fuel pool (by means of FPC or RHR-B heat exchangers) to preclude boiling of the fuel pool water. The SW pressure is higher than the fuel pool pressure; thus, any leakage will be into the fuel pool system. In addition, radiation monitors of the SW return line detect any gross failure in the heat exchangers.

The fuel pool design precludes any condition which could allow the fuel pool to be drained below the pool gate between the reactor well and the fuel pool. Two diffusers are placed in both the reactor well and the fuel pool to distribute cooled return water efficiently. Diffusers are placed to minimize stratification of either temperature or contamination. Valving is provided to prevent water from being siphoned out of the pool. All piping connected to the fuel pool and reactor well, except for drains and liner drains, are Seismic Category I, including any normally closed manual or normally open automatic valves that provide isolation from the Seismic Category II portion of the system. Drain and liner drain piping connected to the fuel pool, reactor well, and dryer separator pool are Seismic Category II supported to Seismic Category I requirements. Since the fuel pool system is at low temperature and pressure (moderate energy system) postulated breaks in the Seismic Category I portion are limited to cracks.

Fuel pool cooling can be established and monitored from the control room following a design basis LOCA. One of the two FPC trains is adequate to prevent fuel pool boiling by a large margin. However, during normal plant operation, one or both trains operate to maintain 125°F pool water. Should one of the trains be unavailable, the second train operates to maintain pool water temperature below 175°F. The 175°F value is applicable for an anticipated operational transient involving the loss of one FPC loop. If the fuel pool heat load is such that the resulting temperature transient exceeds 125°F, procedural guidance is in place to restore the fuel pool temperature to < 125°F. Due to the large thermal capacity of the fuel pool sufficient operator time is available for the operator to take necessary corrective action to supplement cooling.

A makeup water valve controlled by skimmer surge tank level switches supplies water from the condensate transfer system to the fuel pool to replace losses. The backup source of makeup water is from the Seismic Category I, safety class 3 SW system. This source supplies makeup for long-term pool water losses.

Each filter demineralizer is capable of continuous operation at a normal fuel pool water flow rate of 575 gpm or a maximum fuel pool water flow rate of 1000 gpm and will maintain water conditions as specified in Section 9.1.3.2.

A radiological evaluation of the cleanup system is presented in Chapter 12.

From the foregoing analysis, it is concluded that the FPC system meets its design basis and satisfies the requirements of Regulatory Guide 1.13, Revision 1.

9.1.3.4 Testing and Inspection Requirements

Special testing is not required for the system except as noted below because, when fuel is stored in the pool, at least one pump, heat exchanger, and filter demineralizer are routinely in operation.

Routine, periodic visual inspection of system components, instrumentation, and alarms are adequate to verify system operability. Likewise, the interconnecting valves between the FPC system and the RCC, SW, and RHR systems are periodically inspected to verify their operability.

9.1.4 FUEL HANDLING SYSTEM

9.1.4.1 Design Bases

The fuel handling system is designed to provide a safe and effective means for transporting and handling fuel from the time it reaches the plant until it leaves the plant after postirradiation cooling. Safe handling of fuel includes design considerations for maintaining occupational radiation exposures as low as reasonably achievable during transportation and handling.

Design classification criteria for major fuel handling system equipment is provided in Table 3.2-1 which lists the safety class, quality class, quality group, and seismic category for the equipment.

The cask storage area in the spent fuel pool and the cask handling facilities are designed to accommodate a spent fuel cask of 125 tons. The reactor building crane is designed to transport the spent fuel cask between the cask receiving area, the cask storage area in the spent fuel pool, and the cask washdown area without inducing a permanent deformation of any crane element. Adequate safety features are designed into the reactor building crane system and controls to ensure that no credible postulated failure of any crane component will result in the dropping of the fuel cask.

The transfer of new fuel assemblies between the uncrating area and the new fuel inspection stand and/or the new fuel storage vault is accomplished using the jib crane or the reactor building crane auxiliary hoist.

The refueling floor jib cranes are used to transfer new fuel from the new fuel vault to the fuel storage pool. From this point on, the fuel will be handled by the telescoping grapple on the refueling platform.

The refueling platform is General Class G and Seismic Category 1M from a structural standpoint in accordance with 10 CFR Part 50, Appendixes A and B. Allowable stress due to SSE loading is 120% of yield or 70% of ultimate, whichever is less. A dynamic analysis is performed on the structures using the response spectrum method with load contributions resulting from each of three components earthquake motion being combined by the RMS procedure.

Working loads of the platform structures are in accordance with the AISC Manual of Steel Construction. All parts of the hoist systems are designed to have a safety factor of five, based on the ultimate strength of the material. A redundant load path is incorporated in the fuel hoists so that no single component failure could result in a fuel bundle drop. Maximum deflection limitations are imposed on the main structures to maintain relative stiffness of the platform. Welding of the platform is in accordance with AWS D14-1. Gears and bearings meet AGMA Gear Classification Manual and ANSI B3.5. Materials used in construction of load bearing members are to ASTM specifications. For personnel safety, OSHA Part 1910-179 is applied. Electrical equipment and controls meet ANSI-ANS C1, National Electric Code, and NEMA Publications No. IC1 and MG1.

The general purpose grapples and the main telescoping fuel grapples have redundant hooks. The main telescoping fuel grapple has an indicator which confirms positive grapple engagement.

The fuel grapple is used for lifting and transporting fuel bundles. It is designed as a telescoping grapple that can extend to the proper work level and in its fully retracted state still maintains adequate water shielding over fuel.

In addition to redundant electrical interlocks to preclude the possibility of raising radioactive material out of the water, the cables on the auxiliary hoists incorporate an adjustable, removal stop that will jam the hoist cable against the platform structure to prevent hoisting when the free end of the cable is at a preset distance below water level.

Sufficient redundancy is provided in the reactor building crane such that no credible postulated failure of any crane component will result in dropping of the fuel cask and rupturing the fuel storage pool. Furthermore, limitation of the travel of the crane handling the cask will preclude transporting the cask over any fuel storage rack. See Chapter 15 for accident considerations.

9.1.4.2 System Description

Table 9.1-7 is a listing of typical tools and servicing equipment supplied with the nuclear system. The following paragraphs describe the use of some of the major tools and servicing equipment and address safety aspects of the design, where applicable.

9.1.4.2.1 Spent Fuel Cask

The designs of cask storage and dry cask handling facilities are based on a design cask weighing approximately 125 tons and being approximately 17 ft long by 8 ft in diameter.

The following description of the spent fuel cask is based on the licensed Holtec HI-STORM 100 System. That system includes a canister that contains the fuel and a transfer cask that contains the canister. The canister confines the fuel. The transfer cask provides shielding and structural protection of the canister during canister loading or movement.

Overland offsite transportation of the cask will conform to transportation rules and regulations, 49 CFR Part 173.

9.1.4.2.2 Reactor Building Crane

9.1.4.2.2.1 Description. The main purpose of the reactor building crane is to handle the spent fuel cask between the cask receiving area, the cask loading area in the spent fuel pool, and the cask decontamination washdown area. Secondary purposes of the crane include servicing and refueling the reactor pressure vessel, and handling of equipment or parts thereof received or shipped through the loading facility in the reactor building.

The reactor building crane is a single-trolley top-running electric overhead traveling crane with a 125-ton capacity main hoist, and a span of approximately 126 ft. The general arrangement of the crane in the reactor building is shown in Figures 1.2-11 and 1.2-12. The crane is Class A1 as defined for nuclear fuel handling by the Crane Manufacturers Association of America Specification No. 70 for Electric Overhead Traveling Cranes, (CMAA No. 70). The reactor building crane is designed, fabricated, installed, and tested in accordance with ANSI Standard B30.2, Safety Code for Cranes, Derricks and Hoists, and CMAA Specification No. 70. The crane is Seismic Category I.

Operation of the reactor building crane is from the cab or from the floor by radio control. The crane radio control system uses crystals highly tuned to a narrow frequency band, thereby precluding interferences from other signaling systems. Control at any one time is from one point only.

The structure of the crane bridge consists of welded box type girders with truck saddles and truck frames of welded-steel construction. The trolley side frames, sheave frames, and truck frames are of structural steel-welded construction.

The rated full-load capacities, lifts, and full-load speeds are as follows:

Main Hook

Rated full-load capacity, tons	125
Hook travel, ft	190 ft 0 in.
Hoisting speed, fpm at full load	5.5

Auxiliary Hook

Rated full-load capacity, tons	15
Hook travel, ft	199 ft 8 in.
Hoisting speed, fpm at full load	20

Travel Speeds

Trolley, fpm at full load	40
Bridge, fpm at full load	50

The crane is capable of raising, lowering, holding, and transporting a test work load at 125% of rated load without damage to any parts and without inducing a permanent deformation of any crane element.

Structural members not covered by the CMAA Specification No. 70 are designed in accordance with the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings (September 1972).

All parts of the crane are designed to resist the maximum stresses caused by loading combinations called for in the CMAA Specification No. 70 and for the following loading combinations:

a. Dead load + trolley weight and rated load + SSE, not to exceed 90% of the yield strength,

b. Dead load + weight of unloaded trolley + tornado loading, not to exceed 90% of the yield strength, and

c. Rated breakdown torque of the motors, not to exceed allowable stresses.

The lateral loads on the crane runway, in the normal operating condition, are taken as 10% of the sum of the weights of the hook load and the crane trolley, plus the seismic load of the crane dead load, acting simultaneously at the top of each rail in either direction normal to the runway rails.

Safety factors for the main hoist cables are discussed in Section 9.1.4.2.2.2. The main hook and auxiliary hook are capable of sustaining the full-rated load with a design safety factor of five.

9.1.4.2.2.2 Safety Features. The single hoist motor drives two separate shafts. The motor has two centrifugally tripped limit switches, one outboard of each hoist input pinion at each end of the motor shaft assembly. These provide an automatic safety shutdown and protection from any control or motor malfunction which might result in a runaway condition of the load. Each motor driven shaft passes through a 150% capacity solenoid-actuated brake. A failure of either the motor shaft, the connecting shafts, or the shaft couplings would not result in a load drop since the redundant dual solenoid actuated brakes would be effective in holding the load. On loss of power to the motor, both brakes engage. They can also be engaged by the operator. Additionally, there is a 90% capacity eddy current brake to limit the rate of load lowering.

After the brake, each motor shaft enters its own gear reducer. If a component of one gear case (gear teeth, shafts, bearings, or structural component) should fail, the other gear reducer will hold the load with its brake. The brake is designed with a safety factor of five.

Each gear case is fitted on its output end with a pinion meshing with the drum gear. A failure of a pinion, drum gear, pinion shaft, or pinion bearing will result in the load being carried by the other similar set of parts on the other end of the drum. Each functioning part is designed with a safety factor of five. In each of the main hoist gear cases, there is a mechanical load brake with cooling of the gear case oil to offer additional safety in loading handling.

In the event of failure of the drum shaft, drum bearing, or drum bearing bracket, the drum flange will drop a fraction of an inch onto structural seats so located that the drum is supported. The remaining pinion and gear will stay in mesh to restrain the load. Again, a safety factor of five is incorporated into the design of these parts.

Two separate wire ropes are led from the main hoist drum, each being reeved through a set of sheaves, upper and lower (block sheaves), and back to an equalizer bar arranged for equal division of the load between the two ropes. The individual wire rope safety factors for maximum static load and static plus inertia load (dynamic) are 9.7 and 9.0 respectively. The equalizer bar is fitted with double acting springs to minimize the shock when the entire load is transferred to one rope. Therefore, load drop is precluded. To protect against overloading of the cables and to provide indication of load balancing, a load sensing system consisting of tension type load cells is installed in each of the hoist cables at its connection to the equalizer bar assembly under the trolley.

All sheaves, both upper and block sheaves, are contained in heavy structural casings which usually carry a negligible load. In the event of a sheave pin failure, the sheaves would rise to the top of the block or drop to the base of the upper sheave housing and stop at those points. Thus a load drop is precluded. The block assembly contains two 100% capacity load carrying devices consisting of a sister hook and an eye hook. This redundancy, in attachment to lifting assembly and in load carrying capability, is such that a single failure will not cause load drop. Additional non-destructive examination (NDE) (ultrasonic and magnaflux testing for the load block swivel and the sheave shafts of the upper assembly) provide further assurance that this crane is of a quality suitable for nuclear services. Sufficient electrical circuitry is provided such that no single credible electrical component failure will cause the load to drop.

To preclude any dislodgement of the crane bridge girder and trolley system during seismic or tornado excitation, the following is provided:

a. From the bridge trucks, lugs or brackets are attached to the truck frame to limit total crane drop to 1 in. or less should a wheel or axle break, and

b. The trolley is provided with latches to engage racks attached to the bridge girder; the bridge trucks are provided with latches to engage racks attached to the crane runway girders. The latches and racks ensure that the trolley is rigidly attached to the crane runway girders. These provisions are used when the crane is not operational.

9.1.4.2.3 Fuel Servicing Equipment

The major fuel servicing equipment described below has been designed in accordance with the classification criteria listed in Table 3.2-1.

9.1.4.2.3.1 <u>Fuel Preparation Machine</u>. The fuel preparation machine, Figure 9.1-7, is mounted on the wall of the fuel storage pool and is used for stripping reusable channels from the spent fuel and for rechanneling of the new fuel. The machine is also used with the fuel inspection fixture to provide an underwater inspection capability, and with the defective fuel storage container to contain a defective fuel assembly for stripping of the channel.

The fuel preparation machine consists of a work platform, a frame, and a movable carriage. The frame and movable carriage are located below the normal water level in the fuel storage pool, thus providing a water shield for the fuel assemblies being handled. The fuel preparation machine carriage has an up-travel-stop to prevent raising fuel above the safe water shield level. The movable carriage is operated by a foot pedal controlled air hoist.

9.1.4.2.3.2 New Fuel Inspection Stand. The new fuel inspection stand, Figure 9.1-8, serves as a support for the new fuel bundles undergoing receiving inspection and provides a working platform for technicians engaged in performing the inspection.

The new fuel inspection stand consists of a vertical guide column, a lift unit to position the work platform at any desired level, bearing seats and upper clamps to hold the fuel bundles in position.

9.1.4.2.3.3 Channel Bolt Wrench. The channel bolt wrench, Figure 9.1-9, is a manually operated device approximately 12 ft in overall length. The wrench is used for removing and installing the channel fastener assembly while the fuel assembly is held in the fuel preparation machine.

The channel bolt wrench has a socket which mates and captures the channel fastener capscrew.

9.1.4.2.3.4 Channel Handling Tool. The channel handling tool, Figure 9.1-10, is used in conjunction with the fuel preparation machine to remove, install, and transport box fuel channels in the fuel storage pool.

The tool is composed of a handling bail, a lock/release knob, extension shaft, angle guides, and clamp arms which engage the fuel channel. The clamps are actuated (extended or retracted) by manually rotating lock/release knob.

The channel handling tool is suspended by its bail from a spring balancer on the channel handling boom located on the fuel pool periphery.

Similar tooling is provided as appropriate by the current reload fuel vendor.

9.1.4.2.3.5 Fuel Pool Sipper. The originally supplied equipment is not used. Any fuel sipping is performed by the refueling vendor using their own equipment and procedures. Fuel sipping heads, panels, and containers are separate pieces of equipment used for out-of-core wet sipping at any time. They are used to isolate a fuel bundle while circulating water through the fuel bundle in a closed system. The containers cannot be used for transporting a fuel bundle. The bail on the container head is designed not to fit into any of the grapples.

9.1.4.2.3.6 Fuel Inspection Fixture. The fuel inspection fixture, Figure 9.1-11, is used in conjunction with the fuel preparation machine to permit remote inspection of fuel elements. The fixture consists of two parts: (1) a lower bearing assembly, and (2) a guide assembly at the upper end of the carriage. The fuel inspection fixture permits the rotation of the fuel assembly in the carriage, and, in conjunction with the vertical movement of the carriage, provides complete access for inspection.

9.1.4.2.3.7 Channel Gauging Fixture. The originally supplied equipment is not used. Any channel gauging is performed by the refueling vendor using their own equipment and procedures.

9.1.4.2.3.8 General Purpose Grapple. The general purpose grapple, Figure 9.1-12, is a handling tool used generally with the fuel. The grapple can be attached to the jib crane and the auxiliary hoists on the refueling platforms. The general purpose grapple or other rigging controlled by plant procedures may be used to remove new fuel from the fuel container, place it in the inspection stand or vault, and transfer it to the fuel pool. It can be used to handle new fuel during channeling.

9.1.4.2.4 Servicing Aids

General area underwater lights are provided with a suitable reflector for illumination. Suitable light support brackets are furnished to support the lights in the reactor vessel and to allow the light to be positioned over the area being serviced independent of the platform. Local area underwater lights are small diameter lights for additional illumination. Drop lights are used for illumination where needed.

A radiation hardened designed portable underwater closed circuit television camera is provided. The camera may be lowered into the reactor vessel and/or fuel storage pool to assist in the inspection and/or maintenance of these areas. The camera is also equipped with a right angle lens to allow viewing at 90 degrees.

A general purpose, plastic viewing aid is provided to float on the water surface to permit better visibility. The sides of the viewing aid are brightly colored to allow the operator to observe it in the event of filling with water and sinking. A portable, submersible type, underwater vacuum cleaner is provided to assist in removing crud and miscellaneous particulate matter from the pool floors, or the reactor vessel. The pump and the filter unit are completely submersible for extended periods. The filter “package” is capable of being remotely changed, and the filters will fit into a standard shipping container for offsite burial. Fuel pool tool accessories are also provided to meet servicing requirements.

9.1.4.2.5 Reactor Vessel Servicing Equipment

The following is a description of the equipment designs.

9.1.4.2.5.1 Reactor Vessel Service Tools. These tools are used when the reactor is shut down and the reactor vessel head is being removed or reinstalled. Tools in this group are

a. Stud handling tool,
b. Stud wrench,
c. Nut runner,
d. Stud thread protectors,
e. Thread protector mandrel,
f. Bushing wrench,
g. Seal surface protector,
h. Stud elongation measuring rods, and
i. Head guide cap.

These tools are designed for a 40-year life in the specified environment. Lifting tools are designed for a safety factor of five or better with respect to the ultimate strength of the material used. When carbon steel is used, it is either hard chrome plated, parkerized, or coated with an acceptable paint.

9.1.4.2.5.2 Steam Line Plug. The steam line plugs are used during reactor refueling or servicing; they are inserted in the steam outlet nozzles from inside of the reactor vessel to prevent a flow of water from the reactor well into the main steam lines during servicing of safety/relief valves, main steam isolation valves, or other components of the main steam lines. (The reactor water level is raised to the refueling level during servicing.)

The steam line plug design provides two seals of different types. Each one is independently capable of holding full head pressure. The equipment is constructed of noncorrosive materials. All calculated safety factors are five or greater.

9.1.4.2.5.3 Shroud Head Bolt Wrench. This is a hand held tool for operation of shroud head bolts. It is designed for a 40-year life, and it is made of aluminum to be easy to handle and to resist corrosion. Testing has been performed to confirm the design.

9.1.4.2.5.4 Head Holding Pedestal. Three pedestals are provided for mounting the reactor vessel head on the refueling floor. The pedestals have studs which engage three evenly spaced stud holes in the head flange. The flange surface rests on replaceable wear pads made of aluminum. When resting on the pedestals, the head flange is approximately 3 ft above the floor to allow access to the seal surface for inspection and O-ring replacement.

The pedestal structure is a carbon steel weldment, coated with an approved paint. It has a base with bolt holes for mounting it to the concrete floor. The structure is designed in accordance with "The Manual of Steel Construction" by AISC.

9.1.4.2.5.5 Head Nut and Washer Racks. The RPV head nut and washer racks are used for transporting and storing up to six nuts and washers. The rack is a box-shaped aluminum structure with dividers to provide individual compartments for each nut and washer. Each corner has a lug and shackle for attaching a four-leg lifting sling.

The racks are designed in accordance with the "Aluminum Construction Manual" by the Aluminum Associations and for a safety factor of five.

9.1.4.2.5.6 Head Stud Racks. The head stud racks are used for transporting and storage of up to six reactor pressure vessel studs. They are suspended from the auxiliary building crane hook when lifting studs from the reactor well to the operating floor.

The racks are made of aluminum to resist corrosion.

9.1.4.2.5.7 Dryer and Separator Slings. The dryer and separator slings are lifting device assemblies used for transporting the steam dryer or the steam separator between the reactor vessel and the equipment pool. Each sling assembly consists of a cruciform shaped structure which is suspended from a hook box with four slings. The hook box engages the reactor service crane sister hook, with two hook pins, and the hook lifting eye with one pin. On the end of each arm of the cruciform is a socket with a pneumatically operated pin for engaging the four lift eyes on the steam dryer or shroud head.

Each sling assembly has been designed such that one hook pin and one main beam of the cruciform is capable of carrying the total load and so that no single component failure will cause the load to drop or swing uncontrollably out of an essentially level attitude.

The safety factor of the lifting members is five or better in reference to the ultimate breaking strength of the material. The structure is designed in accordance with "The Manual of Steel Construction" by AISC. The completed assembly is proof tested at 125% or greater of rated load and all structural welds are magnetic particle inspected after load test.

9.1.4.2.5.8 Head Strongback. The RPV head strongback is used for lifting both the pressure vessel head and the drywell head. It is a cruciform shape with four equally spaced lifting points on the ends of the arms. In the center it has a hook box which engages with two pins to the reactor service crane sister hook and one pin to the hook lifting eye.

The strongback is designed such that one leg of the cruciform will support the rated load and such that no single component failure will cause the load to drop or swing uncontrollably out of an essentially level attitude. The structure is designed in accordance with "The Manual of

Steel Construction" by AISC. All welding is in accordance with the ASME Boiler and Pressure Vessel (B&PV) Code Section IX. A safety factor of five or greater in reference to the ultimate material strength is used for the design. The completed assembly is proof tested at 125% rated load. After the load test, all structural welds are magnetic particle inspected.

9.1.4.2.5.9 Steam Line Plug Installation Tool. The steam line plug installation tool is suspended from the building crane auxiliary hook or refueling platform monorail or auxiliary hoist for transporting and installing the steam line plugs in the steam line nozzles of the reactor vessel. This tool is designed for a safety factor of five.

9.1.4.2.5.10 Auxiliary Work Platform. The auxiliary work platform provides an alternate work space over the reactor cavity and equipment pool for maintenance work. The platform spans the reactor cavity and travels on the same rails as the refueling platform. The platform is equipped with two jib cranes, two electrically operated jib hoists, three jib crane support pedestals, and is driven by electric motors. To increase accessibility for maintenance work above the cavity, the center floor section of the platform is removable.

Positioning of the platform over the reactor cavity is controlled by administrative procedures.

The auxiliary work platform is designed structurally to meet Seismic Category I requirements. The structural design is in accordance with "The Manual of Steel Construction" by AISC. Materials are in accordance with ASTM Standards. The structure is coated with an approved paint.

The cranes are exempted from the NUREG 0612 requirement because the definition of heavy loads at CGS is 1200 lb. Each 500 lb hoist is equipped with a load limiting device to prevent lifting fuel bundles or unauthorized heavy loads. Interlocks on the platform or hoists are not provided since the hoists and platform are controlled administratively and will not be used for reactivity manipulation.

9.1.4.2.5.11 Cavity In-Vessel Service Platform (CISP). The CISP, Figures 9.1-17 and 9.1-18, serves as a circular H-shaped platform with an inside diameter equal to that of the reactor vessel. The CISP has an opening which may be aligned with the transfer canal (cattle chute). The CISP is used to allow personnel access over the reactor vessel annulus, between the vessel wall and the core shroud, while core alterations are in process using the refueling platform. The CISP can be oriented to allow access to either the spent fuel pool or the dryer-separator pit. The CISP is attached to three support frame legs which rest on the upper cavity shield block ledge. The platform is partially submerged with the walkway floor at a depth of approximately 16 in. when the cavity is flooded up for refueling operations. The CISP also has a 750 lb capacity electric hoist which may be positioned around the inside diameter of the CISP.

The CISP was designed and constructed to Seismic I criteria and all lifting components meet NUREG 0612 requirements for a single failure proof lift. The platform is designed to meet the requirements of the AISC Manual of Steel Construction and the NUREG 0800, Standard Review Plan (SRP) Section 3.8.4. It may be installed in the reactor cavity after the steam separator is removed from the vessel, the cavity is flooded up to normal refueling level and the fuel pool gates are removed. The CISP is removed from the cavity prior to the commencement of vessel restoration.

During movement of the CISP to and from the temporary lay-down area (north of the spent fuel pool), a small portion of the CISP must pass over the spent fuel pool in order to clear the stack monitoring equipment along the center of the refueling floor north wall. The lifting of the CISP is accomplished by the single failure proof reactor building crane, and with NUREG 0612 compliant rigging and handling equipment. Therefore drop of the CISP into the spent fuel pool is not a credible accident. In addition the distance that the CISP can extend over the spent fuel pool is administratively controlled such that only a small portion of the CISP passes over the spent fuel pool and the center of gravity of the CISP is at least 7.5 ft north of the spent fuel pool north curb.

9.1.4.2.5.12 Head Stud Tensioner Carousel/Strongback. The RPV head stud tensioner carousel/strongback is a lifting device that provides an alternate means to remove and install the RPV head. It combines the functions of the original stud tensioner handling frame, RPV head lifting strongback, and head nut and washer racks. The design allows the carousel/strongback to be released from the reactor building crane once it has been mounted onto the four lifting lugs of the RPV head. The head stud tensioners, which ride on the carousel/strongback's integral monorail, are positioned to effect head stud nut removal and reinstallation. The nuts and washers for all 76 of the RPV head studs can be stowed on the carousel/strongback's head stud nut storage ring. The RPV head, head stud nuts and washers, and carousel/strongback (with the RPV head attached) are together lifted by the reactor building crane.

The head stud tensioner carousel/strongback was designed, fabricated, and tested to meet the requirements of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" and the guidelines of ANSI N14.6, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials."

9.1.4.2.6 In-Vessel Servicing Equipment

The instrument strongback attached to the reactor building crane auxiliary hoist is used for servicing neutron monitor dry tubes should they require replacement. The strongback initially supports the dry tubes into the vessel. The in-core dry tube is then decoupled from the strongback and is guided into place while being supported by the instrument handling tool. Final in-core insertion is accomplished from below the reactor vessel. The instrument handling tool is attached to the refueling platform monorail hoist and is used for removing and installing fixed in-core dry tubes as well as handling neutrons source holders and the source range monitor/intermediate range monitor dry tubes.

Each in-core instrumentation guide tube seals by metal-to-metal contact with the guide tube flange seal. In the event that the seal needs replacing, an in-core guide tube seal tool is provided. The tool is inserted into an empty guide tube and sits on the beveled guide tube entry in the vessel. When the drain on the water seal cap is opened, hydrostatic pressure seats the tool. The flange can then be removed for seal replacement.

The auxiliary hoists on the refueling platform are used with appropriate grapples to handle control rods, fuel support pieces, double blade guides, flux monitor dry tubes, sources, and other internals of the reactor. Interlocks on the fuel grapple hoist and both auxiliary hoists are provided for safety purposes; the refueling interlocks are described and evaluated in Section 7.7.1.13.

The Westinghouse Multi-Lift Tool (MLT) is used exclusively with the Monorail Auxiliary Hoist. The MLT is used to remove and replace a control rod blade with its associated fuel support piece and double blade guide. The MLT may also be used for uncoupling the control rod drive mechanism from the control rod blade to be removed. The monorail hoist backup emergency stop block position is procedurally controlled to accommodate the length of the MLT and grappled components.

9.1.4.2.7 Refueling Equipment

Fuel movement and reactor servicing operations are performed from a platform which spans the refueling, servicing, and storage cavities.

9.1.4.2.7.1 Refueling Platform. The refueling platform is a gantry crane that is used to transport fuel and reactor components to and from pool storage and the reactor vessel. The platform spans the fuel storage and vessel pools on rails bedded in the refueling floor.
A telescoping mast and grapple suspended from a trolley system is used to transport and orient fuel bundles for core, storage rack, or spent fuel cask placement. Control of the platform is from an operator station on the main trolley with a position indicating system provided to position the grapple over core locations. The platform control system includes interlocks to verify hook engagement and grapple load, prevent unsafe operation over the vessel during control rod movements, and limit vertical travel of the grapple. Two 1000-lb capacity auxiliary hoists, one main trolley mounted and one auxiliary trolley mounted, are provided for servicing such as local power range monitor (LPRM) replacement, fuel support replacement, jet pump servicing, and control rod replacement. The grapple in its normal up position provides 7 ft 6 in. minimum water shielding over the active fuel during transit.

9.1.4.2.8 Storage Equipment

Specific storage equipment is used for new, used, or spent fuel, for control rods, and for other core components.

Specially designed fuel storage racks are provided in the spent fuel pool and in the new fuel vault. Additional storage equipment is listed in Table 9.1-7. For fuel storage racks description and fuel arrangement, see Sections 9.1.1 and 9.1.2.

9.1.4.2.9 Under Reactor Vessel Servicing Equipment

The primary functions of the under reactor vessel servicing equipment are to (a) remove and install control rod drives, (b) service thermal sleeve and control rod guide tube, and (c) install and remove the neutron detectors. Table 9.1-7 lists the equipment and tools required for servicing. Of the equipment listed, the equipment handling platform and the control rod drive handling equipment are powered electrically.

The control rod drive handling equipment is used for the removal and installation of the control rod drives from their housings. This equipment is designed in accordance with the requirements of National Electrical Manufacturers Association (NEMA, MG1: Motor and Generator Standards), American National Standards Institute Standards (ANSI C1, National Electric Code), Occupational Safety and Health Administration (OSHA, 1910.179), and American Institute of Steel Construction (AICS, Manual of Steel Construction). All lifting components are equipped with adequate brakes or gearing to prevent uncontrolled movement on loss of power or component failure.

The equipment handling platform provides a working surface for equipment and personnel performing work in the under vessel area. It is a polar platform capable of 360 degree rotation. This equipment is designed in accordance with the applicable requirements of OSHA (Vol. 37, No. 202, Part 191 ON), AISC, and ANSI C1 (National Electric Code).

The spring reel is designed to be used to pull the in-core guide tube seal or in-core detector into the in-core tube during in-core servicing.

The thermal sleeve installation tool locks, unlocks, and lowers the thermal sleeve from the control rod drive guide tube.

In-core flange seal test plug is used to determine the pressure integrity of the in-core flange seal. It is constructed of noncorrosive material. The key bender is designed to install and remove the antirotation key that is used on the thermal sleeve.

9.1.4.2.10 Description of Fuel Transfer

The fuel handling system provides a safe and effective means for transporting and handling fuel from the time it reaches the plant until it leaves the plant after postirradiation cooling. The previous subsection has described the equipment and methods used in fuel handling. The following paragraphs describe the integrated fuel handling system that ensures the design bases of the fuel handling system is satisfied.

9.1.4.2.10.1 Arrival of Fuel on Site. The new fuel arrives at the site in either one of two types of special shipping containers. The one type of container, designated the "RA Series," has space for two fuel bundles and the other type of container, designated "927 Series," has space for four fuel bundles.

The RA Series container consists of a metal inner container positioned by means of cushioning materials within an outer container. These containers with their contents meet all NRC requirements. Both inner and outer containers are reusable.

The 927 Series container is a steel unit with a removable cover. The fuel bundles are secured in the interior by a series of steel brackets. These containers also meet all NRC requirements.

After arrival of the fuel shipment the containers are visually inspected for evidence of damage during shipping. If there are indications of rough handling or damages, further investigation, for possible damage to fuel bundles, will be performed. With the RA Series the inner metal container is then removed from the outer container with appropriate lifting equipment. The containers are then taken to the refuel floor using lifting rigging designed for the task and the container is placed in a horizontal position. The covers are then removed to expose the fuel bundles. The fuel is then visually inspected for any obvious damage and a radiation survey for contamination is made.

Bundle restraints will be installed on the metal container in preparation for raising it to the vertical position. The container is then raised to the vertical position and secured using the reactor building auxiliary hoist with rigging designed for the task.

New fuel may also be shipped with channels already installed, in which case channel installation will not occur in the inspection stand or the fuel pool.

9.1.4.2.10.2 Refueling Procedure. Fuel handling procedures are described below and shown visually in Figure 9.1-13 through Figure 9.1-16.

The refueling floor layout is shown in Figure 9.1-5 and component drawings of the principal fuel handling equipment are shown in Figures 9.1-7 through 9.1-12.

During core alterations (except movement of control rods with their normal drive system), direct communication is maintained between the control room and refueling platform personnel. Direct communication is demonstrated within 1 hr prior to the start of and no less than once per 15 hr during core alterations (with the exceptions noted above). When direct communication cannot be maintained, core alterations (with the exceptions noted above) are immediately suspended.

The fuel handling process takes place primarily on the refueling floor above the reactor. The principal locations and equipment are shown on Figure 9.1-13. The reactor and fuel pool are connected to each other by slot (A) which is open during reactor refueling. At other times the slot is closed by means of blocks and gates, which make watertight barriers.

Since provisions for portable shielding are not provided in the drywell, administrative control is used during refueling operations to avoid overexposure of personnel as the result of a postulated fuel drop accident such as a drop occurring on the reactor seal plate.

New fuel in shipping containers is brought up to the refueling floor through the hatches.

The handling of new fuel on the refueling floor is illustrated in Figure 9.1-14. The transfer of the bundles between the fuel container (C), and the new fuel inspection stand (D), the new fuel storage vault (E) and the fuel pool storage racks (F) is accomplished using the reactor building crane auxiliary hoist or jib crane.

The jib crane is also used to transfer new fuel from the new fuel vault or inspection stand to the fuel prep machine in the spent fuel pool. From this point on the fuel is handled by the telescoping grapple on the refueling platform.

The storage racks in both the vault and the fuel pool hold the fuel bundles or assemblies vertical, in an array which is subcritical under all possible conditions.

The new fuel inspection stand holds one or two bundles in vertical position. The inspector(s) ride up and down on a platform, and the bundles are manually rotated on their axes. Thus the inspectors can see all visible surfaces on the bundles.

The refueling platform uses a grapple on the telescoping mast for lifting and transporting fuel bundles or assemblies. The telescoping mast can extend to the proper work level, and, in its normal up position, maintains adequate water shielding over the fuel being handled.

The reactor refueling procedure is shown schematically in Figure 9.1-15. The refueling platform moves over the fuel pool, lowers the grapple on the telescoping mast (H), and engages the bail on a new fuel assembly which is in the fuel storage rack. The assembly is lifted clear of the rack and moved through slot (A) and over the appropriate empty fuel location in the core (J). The mast then lowers the assembly into the location, and the grapple releases the bail.

The operator then moves the platform until the grapple is over a spent fuel assembly which is to be discharged from the core. The assembly is grappled, lifted, and moved through slot (A) to the fuel pool.

To preclude the possibility of raising radioactive material out of the water, redundant electrical limit switches are incorporated in the hoist and interlocked to prevent hoisting above the preset limit. In addition, the cables on the auxiliary hoists incorporate adjustable stops that will jam the hoist cable against the hoist structure, which prevents hoisting if the limit switch interlock system should fail. Prior to moving irradiated fuel in the reactor pressure vessel, the reactor is verified to have been subcritical for at least 24 hr. This is consistent with fuel handling accident assumptions described in Section 15.7.4.5.

When spent fuel is to be transferred, it is placed in a cask, as shown in Figure 9.1-16. The refueling platform grapples a fuel bundle from the storage rack in the fuel pools, lifts it, carries it to the transfer cask area of the pool, and lowers it into the canister within cask (M). When the canister is loaded, the building crane sets the cover on the canister, and then lifts the cask out of the pool. The cask is then decontaminated and lowered through the open hatchways (P) to the cask transport system at near grade level.

9.1.4.2.10.2.1 New Fuel Preparation.

9.1.4.2.10.2.1.1 Receipt and Inspection of New Fuel. The incoming new fuel shipping container will be visually inspected for shipping damage as the containers are offloaded from the transport vehicle. The fuel is also visually inspected upon opening the container on the refuel floor.

Incoming fuel is inspected as governed by plant procedures prior to being placed in the reactor vessel. Preferably, the inspection will be done before the fuel is stored. However, depending on specific plans for the initial fueling and/or subsequent refueling, fuel may be stored until a more desirable time for inspection.

Inspections may be performed onsite or at the vendor facilities. Onsite inspections are performed with the fuel bundles secured in the fuel inspection stand. Inspections are performed, by qualified inspectors, in accordance with plant approved procedures.

If a fuel bundle fails inspection, discrepancies are noted and action will be taken to repair the fuel bundle or it will be set aside for disposition by the fuel manufacturer.

After satisfactory inspection, the fuel bundle is then transferred to a storage rack in the new fuel vault or to a storage rack in the spent fuel storage pool. The fuel bundle may or may not be channeled prior to storage.

9.1.4.2.10.2.1.2 Channeling New Fuel (Non Westinghouse Fuel). New fuel is channeled with new channels after the fuel is inspected in the inspection stand. The channels are visually inspected for defects prior to installing on the fuel. The inspected channel is then attached to lifting rigging and installed on the fuel while in the inspection stand.

The fuel can also be channeled in the spent fuel pool. For a channel located in the channel rack in the pool, the channel handling tool (fastened to the channel jib crane) is attached to the channel and raised manually with the assistance of the channel jib crane then positioned over the bundle to be channeled. The bundle is then raised into the channel and the channel fastener is installed with the channel bolt wrench.

9.1.4.2.10.2.1.3 Channeling New Fuel (Westinghouse Fuel Only). Westinghouse Fuel (SVEA-96 type) requires the fuel bundle to be inserted into the combination fuel channel/lower tie plate. The new channels will be received up on the refueling floor and inspected then installed into the new fuel storage vault or the fuel prep machine. The Westinghouse fuel is inspected in the inspection stand then moved to the storage vault or fuel prep machine by use of the jib crane. The bundle is positioned over the channel and the temporary lower tie plate, installed for shipping purposes, if not removed earlier, is then removed and the four mini bundle assemblies are inserted into the channel. With the bundle seated, the rigging is removed, the temporary upper bale handle is removed and the permanent bail handle is installed and torqued. The bundle, if channeled in the new fuel storage vault, is then ready to be transferred to the spent fuel pool prep machine.

9.1.4.2.10.2.1.4 Equipment Preparation. Prior to use for refueling, refueling equipment will be placed in readiness. All tools, grapples, slings, strongbacks, stud tensioners, etc. will be given a thorough check and any defective (or well worn) parts will be replaced. Air hoses on the main grapples will be routinely leak tested. Crane cables will be routinely inspected. All necessary maintenance and interlock checks will be performed to ensure no extended outage due to equipment failure.

The channeled new fuel will be ready in the storage pool.

9.1.4.2.10.2.2 Reactor Shutdown. The reactor is shut down according to a prescribed procedure. During cooldown the reactor pressure vessel is vented. The reactor well shield plugs are removed using the reactor building crane and the supplied slings.

This operation can be immediately followed by removal of the canal plugs. These activities are covered in Sections 9.1.4.2.10.2.3.3 and 9.1.4.2.10.2.4.

9.1.4.2.10.2.2.1 Drywell Head Removal. Immediately after removal of the reactor well shield plugs, the work to unbolt the drywell head can begin. The drywell head is attached by removable bolts. The bolts are unscrewed and together with their nuts are removed and stored.

The head strongback is attached to the unbolted drywell head and lifted by the overhead reactor building crane to its appointed storage space on the refueling floor.

9.1.4.2.10.2.2.2 Reactor Well Servicing. When the drywell head has been removed, an array of piping is exposed that must be serviced. Various vent piping penetrations through the reactor well must be removed and the penetrations made watertight. Vessel head piping and head insulation must be removed and transported to storage on the refueling floor.

Water level in the vessel is now adjusted in preparation for head removal.

9.1.4.2.10.2.3 Reactor Vessel Opening.

9.1.4.2.10.2.3.1 Vessel Head Removal. The stud tensioners are transported by the reactor building crane and positioned on the reactor vessel head. Each stud is tensioned and its nut loosened in a prescribed manner to uniformly detension the head. When the nuts are loose, they are backed off using a nut runner until only a few threads remain engaged. The vessel nut handling tool is engaged in the upper part of the nut and the nut is rotated free from the stud. The nuts and washers are placed in the racks provided for them and transported to the refueling floor for storage. With the nuts and washers removed, the vessel stud protectors and vessel head guide caps are installed.

The head strongback, transported by the reactor building crane, is attached to the vessel head and the head transported to the head holding pedestals on the refueling floor. The head holding pedestals keep the vessel head elevated to facilitate inspection and O-ring replacement.

Alternatively, the reactor vessel head can be removed using the RPV head stud tensioner carousel/strongback, a tool that combines the functions of the stud tensioner handling frame and the head lifting strongback. The carousel/strongback, with the stud tensioners suspended from its integral monorail, is transported by the reactor building crane and attached to the RPV head. Using the stud tensioners, the nuts are removed from the RPV head studs in the manner previously described, the nuts placed in a circular nut storage transporting rack, also integral to the carousel/strongback. When all the head stud nuts are removed, the RPV head stud tensioner carousel/strongback, with the RPV head attached and all head stud nuts stowed in the integral nut rack, is transported by the reactor building crane to the head holding pedestals on the refueling floor.

The studs in line with the fuel transfer canal are removed from the vessel flange and placed in the rack provided. The loaded rack is transported to the refueling floor for storage.

9.1.4.2.10.2.3.2 Dryer Removal. The dryer sling assembly is lowered by the reactor building crane and attached to the dryer lifting lugs. The dryer is lifted from the reactor vessel and transported to its storage location in the dryer-separator storage pool adjacent to the reactor well. The dryer is sprayed with water to control the spread of contamination during transfer and until water level in reactor well and dryer-separator pool cover the dryer.

9.1.4.2.10.2.3.3 Separator Removal. The four main steam lines are plugged from inside the vessel using the furnished plugs for this duty. Servicing of the safety and relief valves can thus be accomplished without adding to the critical refueling path time. The separator is unbolted using the shroud head bolt wrenches furnished. The fuel pool slot plugs are then removed.

The separator sling assembly is lowered into the vessel and attached to the separator lifting lugs. The water in the reactor well and in the dryer-separator storage is raised to fuel pool water level, and the separator is transferred to its allotted storage place in the equipment pool.

9.1.4.2.10.2.3.4 Fuel Bundle Sampling. During reactor operation, the core offgas radiation level is monitored. If a rise in offgas activity indicating a fuel failure has been noted, the reactor core will be sampled during a refueling outage to locate any leaking fuel assemblies.

9.1.4.2.10.2.4 Refueling and Reactor Servicing. The gates isolating the fuel pool from the reactor well are now removed thereby interconnecting the fuel pool, the reactor well, and the dryer-separator storage pool. The actual refueling of the reactor can now begin.

9.1.4.2.10.2.4.1 Refueling. The refueling pattern will depend on various factors such as fuel performance, plant loading, and fuel design.

Detailed procedures will be developed for various refueling tasks such as fuel receipt, fuel inspection, fuel transfer from vault to pool, fuel movements within the pool, fuel movements within the reactor, or between the spent fuel pool and the reactor, as well as procedures for handling of other core components.

During a normal equilibrium outage, approximately 33% of the fuel is removed from the reactor vessel, 33% of the fuel is shuffled in the core (generally from center to peripheral locations), and 33% new fuel is installed. The actual fuel handling is done with the fuel grapple which is an integral part of the refueling platform. The platform runs on rails over the fuel pool and the reactor well. In addition to the fuel grapple, the refueling platform is equipped with two auxiliary hoists which can be used with various grapples to service other reactor internals.

To move fuel, the fuel grapple is aligned over the fuel assembly, lowered and attached to the fuel bundle bail. The fuel bundle is raised out of the core, moved through the refueling slot to the fuel pool, positioned over the storage rack and lowered to storage. Fuel is shuffled and new fuel is moved from the storage pool to the reactor vessel in the same manner.

9.1.4.2.10.2.5 Vessel Closure. The following steps, when performed, will return the reactor to operating condition. The procedures are the reverse of those described in the proceeding sections. Many steps are performed in parallel and not in the sequences listed.

a. Core verification. The core position of each fuel assembly must be verified to ensure the desired core configuration has been attained;

b. Control rod drive tests. The control rod drive timing, friction and scram tests are performed;

c. Install inner fuel pool gate;

d. Replace separator and drain dryer-separator storage pool and reactor well;

e. Bolt separator and remove the four steam line plugs;

f. Replace steam dryer;

g. Install reactor vessel head;

h. Decontaminate reactor well;

i. Open drywell vents, install vent piping;

j. Replace slot plugs;

k. Replace vessel studs;

l. Install vessel head piping and insulation;

m. Replace dryer-separator canal plugs;

n. Hydrotest vessel, if necessary;

o. Install drywell head;

p. Install reactor well shield plugs; and

q. Startup tests. The reactor is returned to full power operation. Power is increased gradually in a series of steps until the reactor is operating at rated power. At specific steps during the approach to power, the in-core flux monitors are calibrated.

9.1.4.2.10.3 Departure of Spent Fuel From the Reactor Building. Spent fuel is removed from the Reactor Building in an NRC licensed shielded cask. The reactor building and cask handling facilities (see Section 9.1.4.2.2 for a description of the crane) are designed to handle casks up to 125 tons.

The following description of the spent fuel departure is based on the licensed Holtec HI-STORM 100 System which includes a transfer cask of 125 tons maximum weight with a capacity of 68 BWR fuel bundles.

After the cask has been inspected and prepared for lifting, it is transferred to the reactor operating floor and placed onto the cask decontamination pad where it is prepared for placement into the spent fuel cask loading area. The cask provides shielding for a canister contained within the cask. The canister, when sealed, is a confinement for the fuel.

The cask is next raised and transferred into the spent fuel cask loading area. The cask lifting yoke is lowered until it is disengaged from the cask trunnions.

Spent fuel is transferred under water from storage in the fuel pool to the cask using the telescoping fuel grapple mounted on the refueling platform. When the cask is filled with spent fuel, the canister closure head is placed on the cask and the lift yoke engaged with the cask trunnions. The loaded cask is raised and transferred to the cask decontamination pad.

The cask is checked by health physics personnel and decontamination is performed with high pressure water sprays, chemicals, and hand scrubbing, as required, to clean the cask. The canister is sealed, dewatered and inerted. The cask lid is installed and the cask prepared for lifting.

The sealed canister is then transferred to a storage cask. The storage cask and canister are moved to the spent fuel storage area.

9.1.4.3 Fuel Handling Safety Evaluation

Stresses in all structural and mechanical parts of the reactor building crane system are far below the endurance limits for infinite life of the various materials for both the rated crane capacity and the test load of 125% of rated load. All loads to be handled are below rated crane capacity. Therefore, stresses should never reach allowable working stresses. Loads on the structural parts vary but do not reverse. The only critical parts with stress reversals are the rotating parts, and these are provided with single failure protection. Since the crane is to operate under normal temperature conditions and since the stress levels are below the endurance limits for infinite life, testing of the crane to 125% of rated capacity provides reasonable assurance that the crane will not fail while handling a spent fuel cask.

As described in Section 9.1.4.2.2.2, sufficient redundancy is provided in the reactor building crane so that no credible postulated failure of any crane component will result in the dropping of the fuel cask. Therefore, the consequences of a cask drop accident are precluded. In addition, crane travel over the spent fuel pool is controlled by travel path (Figure 9.1-5) and interlocks that prohibit the crane from traveling over the spent fuel racks. At no time while being transported does the cask pass over any safe shutdown items. The objectives of Regulatory Guide 1.13 are met. Furthermore, when the crane is carrying the cask over the refueling floor area, the clear distance between the bottom of the cask and the refueling floor is minimized by good operating practice. Should any crane failure occur while the crane is moving the cask over the refueling floor area, the crane drop of less than one inch described in Section 9.1.4.2.2.2 prevents the cask from physically contacting the floor. See Section 9.1.4.2.2.2 for safety features which ensure crane stability during tornado and seismic excitation.

Jib cranes MT-CRA-9A and 9B are designed and equipped to meet the Class A1 (standby) service requirements of CMAA Specification #70. Each crane is capable of raising, lowering, holding, and transporting a test work load of 125% of rated work load without damage to or excessive deflection in a part and without inducing permanent deformation in any crane element. Cables are of the nonrotating type to prevent rotation of load during raising or lowering operations.

The following factors of safety are used in design and are based on the maximum stress produced by worst load combinations and the average ultimate strength of the material, unless otherwise stated herein:

a. All load carrying components except structural members and hoisting ropes are designed to have a minimum safety factor of five;

b. All mechanical parts subject to dynamic strains, such as gears, shafts, drums, blocks, and other integral parts, have a minimum safety factor of five;

c. All hoisting ropes are designed to have a minimum safety factor of five based on the published breaking strength of the rope;

d. Components of the jib cranes are adequately proportioned to limit the overall deflections of the crane to safe limits under any position of the loaded trolley hoist. Maximum vertical static deflection of the boom with nameplate rated hook load is less than 0.6 in.; and

e. Structural members/shapes not covered by the above safety factors are designed in accordance with CMAA Specification No. 70, and if not covered by CMAA Specification No. 70, in accordance with the AISC Specification for the design, fabrication, and erection of structural steel for buildings except that the allowable stress shall not exceed 80% of the AISC allowable design stress.

Jib cranes MT-CRA-9A and 9B are designed to Seismic Category I requirements (with lifted load).

The cranes are equipped with switches to limit their lifted load to 1000 lb.

The cranes are exempted from the NUREG 0612 requirement because the definition of "Heavy Loads" at CGS is 1200 lb. The cranes are also not required to hold their lifted load during a seismic event since the maximum load of 1000 lb (or 1200 lb) is enveloped by analysis that indicates the high density spent fuel storage racks can withstand a drop (both from a structural and criticality standpoint) of 1510 lb from the height of the fuel pool water surface. Licensee Controlled Specifications limit the loads over spent fuel in the spent fuel pool to 1500 lb whenever irradiated fuel assemblies are in the spent fuel storage pool. Crane operations with loads will be suspended in the spent fuel storage pool area if there is less than 22 ft of water over the top of fuel assemblies seated in the storage racks. Based on the analysis presented in Section 15.7, the radiological consequences of a fuel bundle (with or without a channel) dropped by the jib crane are bounded by the fuel handling analysis which assumed a bundle dropped from 34 ft into the reactor core. This resulted in a much higher kinetic energy level. In comparing the jib crane drop to the reactor core drop, it is not possible to cause the release of more fission gases from the damaged fuel than assumed in the Section 15.7 analysis due to the shorter drop distance and resulting lower kinetic energy.

The cranes are designed so as to be capable of operating within the following tolerances:

a. With all brakes adjusted for normal operation, it is possible to control the vertical movement to within 0.25 in. under all conditions of loading,

b. Cranes operate through full hook lift without noticeable rotation of load, and

c. With hook carrying 100% of rated load and lowering at full speed, the motor does not exceed 125% of synchronous speed.

Since jib cranes MT-CRA-9A and 9B are to be used on and around the fuel pool for handling new and spent fuel and other components in the work area, the following safety features are provided:

The hoist is motorized with a motorized boom and jib. To preclude the possibility of inadvertently raising radioactive materials out of the water, a specially prepared sling or handling tool will be used when handling materials not intended to be raised out of the water. The length of the sling or tool will be administratively controlled such that with the crane at full mechanical up travel the top of the active fuel will be at a minimum of 7 ft 6 in. below water level.

The unit is equipped with two full capacity brakes. A mechanical force gauge is supplied to automatically stop the hoist on an overload signal of 1000 +50 lb. Two additional microswitches are wired in parallel and the three leads are brought out with the power leads for connection to a platform receptacle. The two additional switches are designed to open at 400 ±50 lb (these switches are not normally used for any function).

Safety aspects (evaluation) of the fuel servicing equipment are discussed in Section 9.1.4.2.3 and safety aspects of the refueling equipment are discussed throughout Section 9.1.4.2.7. A description of fuel transfer, including appropriate safety features, is provided in Section 9.1.4.2.10. In addition, the following summary safety evaluation of the fuel handling system is provided below.

The fuel prep machine can remove and install channels with all parts remaining under water. Mechanical stops in use when handling irradiated fuel prevent the carriage from lifting the fuel bundle or assembly to a height where water shielding for the active fuel is less than 7.5 ft. Irradiated channels, as well as small parts, such as bolts and springs, are stored underwater. The spaces in the channel storage rack have center posts which prevent the loading of fuel bundles into this rack.

There are no nuclear safety problems associated with the handling of new fuel bundles, singly or in pairs. Equipment and procedures prevent an accumulation of more than two bundles in any location.

The refueling platform is designed to prevent it from toppling into the pools during a SSE. The refueling mast has normal up limit switches to prevent raising the top of active fuel to a height of less than 7.5 ft below the water surface. The grapple is hoisted by redundant cables inside the mast and is lowered by gravity. A digital readout is displayed to the operator, showing him the exact coordinates of the grapple over the core.

The mast is suspended and gimbaled from the trolley, near its top, so that the mast can be swung about the axis of platform travel to remove the grapple from the water for servicing and storage.

The grapple has two mechanically coupled hooks, operated by a single air cylinder. Engagement is indicated to the operator.

In addition to the main hoist on the trolley, there is an auxiliary hoist on the trolley, and another hoist on its own monorail. These three hoists are precluded from operating simultaneously because control power is available to only one of them at a time.

The two auxiliary hoists have electrical interlocks which will prevent lifting the top of the active fuel on lifted fuel assemblies higher than 7.5 ft under water. Adjustable mechanical jam-stops on the cables back up these interlocks.

In summary, the fuel handling system complies with Regulatory Guide 1.13, Revision 1, GDC 2, 3, 4, 5, 61, 62, and 63, and applicable portions of 10 CFR Part 50.

The safety evaluation of the new and spent fuel storage is presented in Sections 9.1.1.3 and 9.1.2.3.

9.1.4.4 Testing and Inspection Requirements

9.1.4.4.1 Testing and Inspection of Cranes

The main and auxiliary hooks of the reactor building crane are proof tested in the vertical, direction with a total uniformly applied load equal to 150% of their rated capacity. Tests on the main hook are made with a load suspended. After the load tests, the hooks are checked by magnetic particle inspection and for any dimensional change. When completely assembled, the crane components (except for wire ropes), are operated to ensure the accuracy of fabrication and the quality of workmanship.

After erection in the reactor building, the crane is statically tested to 125% of rated capacity (156.25 tons for the main hoist and 18.75 tons for the auxiliary hoist). The tests are performed in accordance with written procedures which include movement in all positions of hoisting, lowering and trolley and bridge travel. After completion of the static test, a full performance test with 100% of the design rated load is performed.

Operational tests and visual inspections are made at periodic intervals during the life of the crane to demonstrate its ability to safely perform its functions. The crane hooks are to be inspected by the magnetic particle or liquid penetrant methods as applicable. These inspections and tests will be scheduled to precede major fuel handling activities.

Jib crane hooks (9A and 9B) shall be either magnetic particle inspected in accordance with ASTM E-109 (July, 1975) or liquid penetrant inspected in accordance with ASTM E-165 (July, 1975). Standard shop tests shall be performed on all equipment. Field tests shall be performed upon each piece of equipment, after completion of erection and installation, in order to verify the overall performance of the equipment against requirements and to check the mechanical performance of the equipment with regard to applicable specification requirements.

Periodic operational tests and inspection will be performed on the jib cranes to demonstrate their ability to perform their safety function.

9.1.4.4.2 Inspection and Testing Requirements of Refueling and Servicing Equipment

9.1.4.4.2.1 Inspection. Refueling and servicing equipment is subject to the strict controls of quality assurance, incorporating the requirements of 10 CFR Part 50, Appendix B. Components defined as important to safety, such as the fuel storage racks and refueling platform, have an additional set of engineering specified "quality requirements" that identify safety-related features which require specific quality assurance verification of compliance to drawing requirements.

For components classified as ASME Section III, the shop operation must secure and maintain an ASME "N" stamp, which requires the submittal of an acceptable ASME quality plan and a corresponding procedural manual.

Additionally, the shop operation must submit to frequent ASME audits and component inspections by resident state code inspectors.

Prior to shipment, every component inspection item is reviewed by quality assurance supervisory personnel and combined into a summary product quality checklist (PQL). By issuance of the PQL, verification is made that all quality requirements have been confirmed and are on record in the product's historical file.

9.1.4.4.2.2 Testing. Qualification testing is performed on refueling and servicing equipment prior to multiunit production. Test specifications are defined by the responsible design engineer and may include; sequence of operations, load capacity and life cycles tests. These test activities are performed by an independent test engineering group and, in many cases, a full design review of the product is conducted before and after the qualification testing cycle. Any design changes affecting function, that are made after the completion of qualification testing, are requalified by test or calculation.

Functional tests are performed in the shop prior to the shipment of production units and include electrical tests, leak tests and sequence of operations tests.

When the unit is received at the site, it is inspected to insure no damage has occurred, during transit or storage. Prior to use and at periodic intervals, each piece of equipment is again tested to ensure the electrical and/or mechanical functions are operational.

Passive units, such as the fuel storage racks are visually inspected prior to use.

There is an operation and maintenance instruction manual for each tool that additionally requires a series of functional checks each time the unit is operated for reactor refueling or servicing.

Fuel handling and vessel servicing equipment preoperational tests are described in Section 14.2.12.1.12.

9.1.4.5 Instrumentation Requirements

9.1.4.5.1 Instrument Requirements - Cranes

Operation of the reactor building crane is from the cab or from the floor by radio control. Control at any one time is from one point only. Sufficient electrical circuitry in the system is provided such that no single credible electrical component failure will cause the load to drop. The reactor building crane and its safety features are described in Section 9.1.4.2.2.

The refueling platform contains a position-indicating system that indicates the position of the fuel grapple over the core. Interlocks on both the fuel grapple hoist and the auxiliary hoists are provided for safety purposes. The refueling interlocks are described and evaluated in Section 7.7.1.13.

For a description of jib crane safety-related interlocks, see Section 9.1.4.3. Except for jib cranes MT-CRA-9A and MT-CRA-9B, limit switches are provided for all electrically operated hoists to prevent overhoisting. Pushbutton pendant controls are provided with stepped controls for multispeed motions.

9.1.4.5.2 Instrumentation Requirements - Refueling and Servicing Equipment

The majority of the refueling and servicing equipment is manually operated and controlled by the operator's visual observations. This type of operation does not necessitate the need for a dynamic instrumentation system.

However, there are several components that are essential to prudent operation that do have instrumentation and control systems.

The refueling platform has a non-safety-related X-Y-Z position indicator system that informs the operator which core fuel cell the fuel grapple is accessing. Interlocks and control room monitor are provided to prevent the fuel grapple from operating in a fuel cell where the control rod is not in the proper orientation for refueling. Refer to Section 7.7.1.13 for discussion of refueling interlocks.

Additionally, a programmable logic controller (PLC), which is a part of the refueling platform control system, provides indications to the operator for grapple limits, hoist load conditions, and confirmation that the grapple hook is either engaged or released.

The load for the main hoist, auxiliary frame hoist, and monorail hoist is determined by electronic load cells and strain gauge transmitters. The load for the main hoist and auxiliary frame hoist is input to the PLC. The PLC provides hoist loaded and hoist overload signals for both the main hoist and auxiliary frame hoist, and provides slack cable signal for the main hoist. Setpoint modules monitor the monorail hoist load and provide hoist loaded and hoist overload interlock signals. Automatic shutdown occurs whenever threshold limits are exceeded on either the main hoist, the auxiliary frame hoist, or the monorail hoist.

9.1.4.5.3 Fuel Support Grapple

Although the fuel support piece grapple is not important to safety, it has an instrumentation system consisting of mechanical switches and indicator lights. This system provides the operator with a positive indication that the grapple is properly aligned and oriented and that the grappling mechanism is either extended or retracted.

The Westinghouse MLT, also used to grapple and remove fuel support pieces, is designated Safety Class 3. The instrumentation system for the MLT consists of flag-type indicators directly linked to each grapple mechanism to show when the grapple is engaged to the fuel support piece. The MLT also incorporates internal guide tubes for underwater cameras, allowing the MLT operator to view and verify proper seating and alignment of the fuel support piece on its guide pin.

9.1.4.5.4 Other

See Table 9.1-7 for additional refueling and servicing equipment.

9.1.4.5.5 Radiation Monitoring

The radiation monitoring equipment for the refueling and servicing area is discussed in Sections 11.5.2.1.2 and 12.3.4.

9.1.5 CONTROL OF HEAVY LOADS

9.1.5.1 Introduction/Licensing Background

Columbia Generating Station controls heavy load lifts by implementing NUREG-0612 recommended guidelines in its plant procedures. Columbia's heavy loads program procedures focus on areas where a load drop could impact stored spent fuel, fuel in the reactor core, or equipment that may be required to achieve safe shutdown or permit continued decay heat removal. Columbia reduces the likelihood of dropping heavy loads by implementing criteria for establishing safe load paths, procedures for load handling operations, training of crane operators, design, testing, inspection, and maintenance of cranes and lifting devices, and analyses of the impact of heavy load drops. Columbia also mitigates the consequences of a heavy load drop with the use of a single-failure-proof crane in certain applications for increased handling system reliability. In other areas where a single-failure-proof crane is not used, load drop and consequence analyses are performed for assessing the impact of dropped loads on plant safety and operations.

9.1.5.2 Safety Basis

The recommended guidelines established in NUREG-0612 are the safety basis that provides a defense-in-depth approach to controlling the handling of heavy loads near spent fuel and safe shutdown equipment. These guidelines are reflected in Columbia's heavy loads handling procedures. These procedures incorporate NUREG-0612 requirements except for those deviations approved by the NRC. Columbia's heavy loads handling procedures ensure that the risk associated with load handling failures is acceptably low, based on meeting requirements of Phase 1 of NUREG-0612, Section 5.1.1, and based on increasing the handling system reliability by meeting NUREG-0612 Phase II guidelines with the utilization of a single-failure-proof crane where a load drop could impact on stored spent fuel and fuel in the reactor core. An exception to NUREG-0612 Phase I, Section 5.1.1(1) was approved to not require load paths marked on the floor for monorail hoists because the single available path cannot vary. Additionally, load paths for the Reactor Building Crane loads are not required to be permanently marked on the refueling floor because the multiple paths would overlap in places and would be difficult to follow. Furthermore, protective coverings on the refueling floor would cover the paths for many lifts. The main Reactor Building crane (MT-CRA-2) has been approved as single-failure-proof crane that meets the criteria established in either NUREG-0554 or NUREG-0612 Appendix C. Additional defense-in-depth analyses and evaluations are performed for heavy load lifts not associated with the use of a single-failure-proof crane in areas where a load drop could impact equipment that may be required to achieve safe shutdown or permit continued decay heat removal.

9.1.5.3 Scope of Overhead Heavy Load Handling Systems

At CGS, overhead handling systems are used to handle heavy loads in the area of the reactor vessel or spent fuel in the spent fuel pool. Additionally, loads are handled in other areas where their accidental drop may damage safe shutdown systems or systems that permit continued decay heat removal. The following is the committed heavy lifts along with their associated cranes/hoists.

Committed Heavy Lifts

	Committed Heavy Load Lift		Committed Heavy Load Lift
1	Vessel Cavity Shield Plug (MT-CRA-2)	21	MPC Lid (MT-CRA-2)
2	Dry/Separator Pool Plugs Top (MT-CRA-2)	22	HI-STORM Lid (MT-CRA-2)
3	Dry/Separator Pool Plugs Bottom (MT-CRA-2)	23	MPC with contents (MT-CRA-2)
4	Spent Fuel Gates (MT-CRA-2)	24	MPC without contents (MT-CRA-2)
5	Fuel Pool Shield (Slot) Plugs (MT-CRA-2)	25	Sea Van Container & other loads during plant operation (MT-CRA-1)
6	"Cattle" Chute (MT-CRA-2)	26	Standby Service Water Pumps (MT-HOI-6A & 6B)
7	Space Frame (w/head insulation) (MT-CRA-2)	27	RHR A&B Shield Blocks (MT-HOI-6)
8	Drywell Head (MT-CRA-2)	28	RHR A&B Pumps (MT-HOI-6)
9	Reactor Head (MT-CRA-2)	29	RHR C Shield Blocks (MT-HOI-8)
10	Steam Dryer (MT-CRA-2)	30	RHR C Pumps (MT-HOI-8)
11	Moisture Separator (MT-CRA-2)	31	RCIC Shield Blocks (MT-HOI-7)
12	Reactor Vessel Service Platform (MT-CRA-2)	32	RCIC Pump & Turbine (MT-HOI-7)
13	RHR HX Floor Plugs (MT-CRA-2)	33	LPCS Shield Blocks (MT-HOI-9)
14	New Fuel Pit Floor Plugs (MT-CRA-2)	34	LPCS Pump/Motor (MT-HOI-9)
15	FPC Skimmer Surge Tank Plugs (MT-CRA-2)	35	HPCS Shield Blocks (MT-HOI-10)
16	Refueling Basket (MT-CRA-2)	36	HPCS Pump (MT-HOI-10)
17	RPV Head Stud Tension/Carousel (MT-CRA-2)	37	RRC Motors (MT-HOI-16)
18	Mating Device (MT-CRA-2)	38	Steam (Pipe) Tunnel Shield Blocks (MT-HOI-18)
19	HI-TRAC Cask with or without MPC, lid, etc. (MT-CRA-2)		
20	HI-TRAC Top Lid (MT-CRA-2)		

9.1.5.4 Control of Heavy Loads Program

Columbia's Control of Heavy Loads Program consists of the following:

1. Commitments to NUREG-0612, Phase I General Requirements.

2. Commitments to NUREG-0612, Phase II with the utilization of a single-failure-proof crane for Reactor Pressure Vessel Head (RPVH) lifts and for spent fuel cask lifts over the spent fuel pool. Additional defense-in-depth analyses and evaluations are performed for heavy load lifts not associated with the use of a single-failure-proof crane in areas where a load drop could impact equipment that may be required to achieve safe shutdown or permit continued decay heat removal.

9.1.5.4.1 Columbia Generating Station Commitments in Response to NUREG-0612 Section 5.1.1, Phase I Guidelines

9.1.5.4.1.1 Safe Load Path. Safe load paths are defined in Columbia's heavy load lifting procedures and some temporary paths may be marked when it can help assure safe load handling. A person in charge, other than the operator, is responsible for inspecting the load path for potential interferences. Load paths are not marked on the floor for monorail hoists because the single available path can not vary. Load paths for the Reactor Building Crane loads are not permanently marked on the refueling floor because the multiple paths would overlap in places and would be difficult to follow. Protective coverings on the refueling floor would cover the paths for many lifts. The above exceptions are approved NRC deviations.

9.1.5.4.1.2 Procedures. Procedures are implemented to prevent personnel errors consistent with the requirements of Section 5.1.1(2) of NUREG-0612.

9.1.5.4.1.3 Crane and Hoist Operators. Plant-wide training and qualification procedures have been implemented and meet the requirement found in Section 5.1.1(3) of NUREG-0612.

9.1.5.4.1.4 Special Lifting Devices. Special lifting devices satisfy the guidelines of ANSI N14.6-1978 are identified, maintained and controlled by plant procedures. These requirements are consistent with Section 5.1.1(4) of NUREG-0612. Dynamic loads determined as a percentage of static loads are added to the static load to obtain the design load.

9.1.5.4.1.5 Lifting Devices that are not Specially Designed. Lifting devices that are not specially designed are used in accordance with ANSI B30.9-1971. Usage is restricted to properly trained and qualified site rigging personnel consistent with the requirements found in Section 5.1.1(5) of NUREG-0612. Dynamic loads determined as a percentage of static loads are added to the static load to obtain the design load.

9.1.5.4.1.6 Crane Inspection, Testing and Maintenance. Cranes are inspected, tested, and maintained in accordance with the guidance in Chapter 2-2 of ANSI B30.2-1976 by inspection, maintenance and testing procedures. This is consistent with the requirements found in Section 5.1.1(6) of NUREG-0612.

9.1.5.4.1.7 Hoist and Crane Design

9.1.5.4.1.7.1 Hoist Design. In the absence of specific guidance from NUREG-0612, hoists are designed to applicable requirements of industry standards CMAA 74, ANSI B30.11 and ANSI B30.16.

9.1.5.4.1.7.2 Crane Design. Cranes are designed according to applicable criteria and guidelines of Chapter 2-1 of ANSI B30.2-1976. These crane requirements are consistent with Section 5.1.1(7) of NUREG-0612.

9.1.5.4.2 Reactor Pressure Vessel Head Lifting Procedures

Columbia Generating Station RPV handling procedures are used to control the lift and replacement of the reactor pressure vessel head. These procedures rely on the use of the main Reactor Building Crane (MT-CRA-2) which is a single-failure-proof crane.

9.1.5.4.3 Single-Failure-Proof Cranes for Spent Fuel Casks

The Spent Fuel Casks lifts and movements are controlled by CGS procedures. These procedures rely on the use of the main Reactor Building Crane (MT-CRA-2) which is a single-failure-proof crane.

9.1.5.4.4 Other Analyses

Additional defense-in-depth analyses and evaluations are performed for heavy load lifts not associated with the use of a single-failure-proof crane in areas where a load drop could impact equipment that may be required to achieve safe shutdown or permit continued decay heat removal.

9.1.5.5 Safety Evaluation

The heavy loads handling activities at CGS are controlled in a manner consistent with the requirements of Phase I of NUREG-0612, except as allowed by the NRC, and with industry standards to ensure defense-in-depth is maintained during heavy load movements. A single-failure-proof crane is used for Reactor Pressure Vessel Head and Spent Fuel Cask movements. Evaluations are performed for heavy load lifts not associated with the use of a single-failure-proof crane and appropriate measures are implemented as necessary to ensure adequate safety is maintained. Risks associated with heavy load lifting are identified, assessed and managed through usage of CGS lifting procedures.

9.1.6 REFERENCES

9.1-1 EMF-2837(P), Revision 0, "Columbia Generating Station New Fuel Storage Vault Criticality Safety Analysis for ATRIUM-10 Fuel," Framatome ANP, December 2002.

9.1-2 WAPD-TM-678 PDQ-7 Reference Manual by W. R. Caldwell, Bettis Atomic Power Laboratory, January 1967.

9.1-3 NUS-894 NUMICE-2, A Spectrum Dependent Non-spatial Cell Depletion Code by Y. S. Kim, NUS Corporation, March 1972. Numice is NUS' version of LEOPARD.

9.1-4 ORNL-4938 KENO-IV An Improved Monte Carlo Criticality Program by L. M. Petrie and N. F. Cross, ORNL, November 1975.

9.1-5 ORNL-TM-3706 AMPX-L Modular Code System for Generating Coupled Multi-Group Neutron Gamma Libraries from ENDF/B by N. M. Greene et al., ORNL, November 1974.

9.1-6 MRI/STARDYNE3 (Version 3), developed by Mechanics Research, Inc., Los Angeles, California.

9.1-7 ANF-91-069(P), "Criticality Safety Analysis Washington Public Power Supply System WNP-2 Spent Fuel Storage Rack with 9 x 9-9X Fuel," March 1991.

9.1-8 CE NPSD-786-P, Revision 1, "WNP-2 SVEA-96 Spent Fuel Storage Criticality Safety Evaluation," September 1998.

9.1-9 EMF-2874(P), "Columbia Generating Station Spent Fuel Storage Pool Criticality Safety Analysis for ATRIUM-10 Fuel," Framatome ANP, February 2003.

9.1-10 MCNP4A - A General Monte Carlo N-Particle Radiation Transport Code, Version 4A, LA-12625, March 1994.

9.1-11 GEH-0000-0075-4920, GE14 Fuel Design Cycle-Independent Analyses for Energy Northwest Columbia Generating Station (most recent version referenced in the COLR).

9.1-12 NUREG-0612, Control of Heavy Loads at Nuclear Power Plants, Resolution of Technical Activity A-36, July 1980.

9.1-13 002N3439, GNF2 Fuel Design Cycle-Independent Analyses for Energy Northwest Columbia Generating Station (most recent version referenced in the COLR).

9.1-14 NEDC-33270P "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," Global Nuclear Fuel, (most recent version referenced in COLR).

Table 9.1-1

9 x 9-9X, SVEA-96, and ATRIUM-10 Assembly Parameters

Parameters	9 x 9-9X	SVEA-96	ATRIUM-10
Enrichment (wt % ^{235}U)	Bundle average up to 4.0	Bundle average up to 3.77	Lattice average up to 4.6
Pellet diameter (in.)	0.3665	0.3224	0.3413
Pellet density (% TD)	95	95.8	95.85
Average fuel length (in.)	Infinite (tie plates not modeled)	95.8	Infinite
Clad I.D./ O.D. (in.)	0.374/0.433	0.329/0.379	0.3480/0.3957
Gd_2O_3 content	None	None	≥10 rods at ≥2 wt % Gd_2O_3
Fuel rods per assembly	72	96	91
Internal water channel	1	1	1
Rod pitch (in.)	0.569	0.488	0.510

Table 9.1-2

Calculated Dose Rate During Refueling

Refueling	5 Ft Above Fuel Pool Water Level (mrem/hr)
1	3.5
2	4.3
3	4.8
4	5.3
5	5.7
6	6.0
7	6.2
8	6.4
9	6.6
10	6.8
11	6.9

Table 9.1-3

Fuel Pool Cooling and Cleanup System

Equipment	Data
Fuel pool heat exchangers	
Number	2
Type	Tube and shell
Material tube/shell	SS/CS
Capacity, Btu/hr/heat exchanger	4.0×10^6
Cooling water flow, gpm/heat exchanger	575
Code and standards	ASME/III, Class 3, and TEMA, Class R
Seismic Category	I
Fuel pool circulation pumps	
Number	2
Type	Horizontal, centrifugal
Material	SS
Flow, gpm	575
Head, ft of H_2O	160
Motor size, hp	50
Seismic Category	I
Code	ASME/III, Class 3
Fuel pool filter demineralizer	
Number	2
Design flow rate, gpm	1000
Design pressure, psig	150
Design temperature, °F	150
Material	CS-plastic lined
Code	ASME/III, Class 3
Seismic Category	II

Table 9.1-3

Fuel Pool Cooling and Cleanup System (Continued)

Equipment	Data
Piping and valves	
Design pressure, psig	150 HX tube side/300 HX shell side
Material	CS/SS
Code	ASME/III, Class 3
Seismic Category	
Fuel pool cooling portion	I
Cleanup portion	II

Table 9.1-4

Spent Fuel Pool Projected Heat Loads

Table 9.1-4 is deleted. The cycle-specific information provided in this table is obsolete. The heat load in the spent fuel pool during normal refueling activities will vary based on outage-specific activities and the transfer of spent fuel to the Independent Spent Fuel Storage Installation.

Table 9.1-5

Fuel Pool Cooling and Cleanup System
Performance Data

Design heat load, Btu/hr	8.0×10^6
Maximum heat load, Btu/hr	44.3×10^6 (see note)
System design pressure, psig	150
System design temperature, °F	150 normal, 175 maximum
Fuel pool water volume, gal	350,000
Dryer-separator pool water volume, gal	293,600
Reactor well water volume, gal	210,000

NOTE: The maximum heat load is the decay heat of one full core load of the fuel plus the remaining decay heat of previously discharged fuel assemblies. The heat load and the fuel pool cooling system will be controlled such that the temperature limits shown in Table 9.1-6 are maintained.

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Table 9.1-6

Bounding Fuel Pool Cooling Events

Fuel Pool Heat Load/Scenario	Fuel Cycle Length (Months)	FPC Loops		RHR Loops in FPC Assist Mode		Acceptance Criteria[a] (°F)
		Available	Credited	Available	Credited	
Normal refueling[b] (non-transient condition)	24	2	2	1	0	150
Normal refueling[c] (anticipated operational transient condition)	24	1	1	1	0	175
Full core offload refueling[d]	24	2	0	1	1	145/175
Normal Operations[e] (non-transient/non-accident condition)	24	2	2	0	0	125
Normal Operations[f] (anticipated operational transient condition)	24	1	1	0	0	175
Normal Operations[g] (design basis LOCA condition)	24	2	1	0	0	125 (pre-accident) 175 (post-accident)

Table 9.1-6

Bounding Fuel Pool Cooling Events (Continued)
Performance Data

Table Notes:

[a] Outage-specific/Cycle-specific calculations are performed, as needed, to ensure acceptance criteria limits are maintained.

[b] A normal refueling does not involve a full core offload. The normal refueling temperature limits go into effect upon placing the plant in cold shutdown and remain in effect until plant start-up. The 150°F acceptance criterion is applicable for the case of both FPC loops available.

[c] A normal refueling does not involve a full core offload. The 175°F acceptance criterion is applicable for an anticipated operational transient of the loss of one FPC loop.

[d] A full core offload is a non-routine evolution. Although no single failure is postulated to occur during this evolution, only credit for RHR/FPC assist is taken. During this evolution, sufficient cooling is provided to maintain the fuel pool temperature at less than 145°F. The licensing basis limit is 175°F.

[e] Normal Operations is defined as any plant condition other than a refueling outage. The normal operation temperature limits become applicable upon plant start-up following a refueling outage. The 125°F value supports the initial (i.e., pre-accident) fuel pool temperature assumption in the design basis LOCA analysis.

[f] Normal Operations is defined as any plant condition other than a refueling outage. The 175°F value is applicable for an anticipated operational transient involving the loss of one FPC loop. If the fuel pool heat load is such that the resulting temperature transient exceeds 125°F, procedural guidance is in place to restore the fuel pool temperature to < 125°F.

[g] Normal Operations is defined as any plant condition other than a refueling outage. The 125°F and 175°F values support the initial fuel pool temperature assumption and the calculated peak fuel pool temperatures, respectively, in the design basis LOCA analysis. For this event, RCC is assumed to be lost and SW is manually aligned to the FPC system heat exchangers. An equilibrium temperature of 90°F is assumed for the SW.

Table 9.1-7

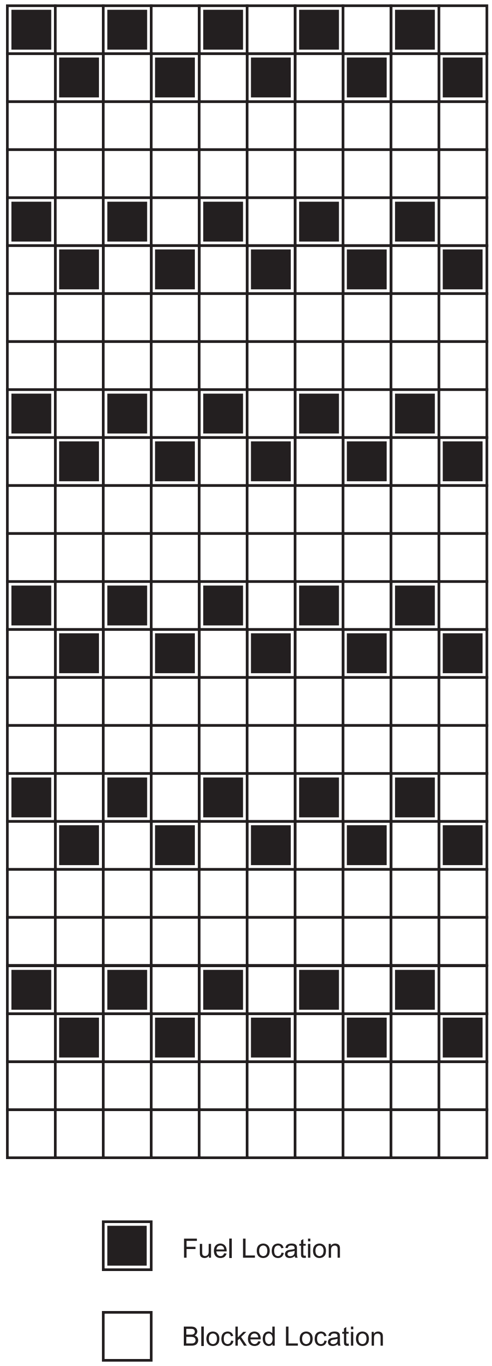
Tools and Servicing Equipment

Fuel Servicing Equipment	In-Vessel Servicing Equipment
Fuel preparation machines	Instrument strongback
New fuel inspection stand	Control rod grapple
Channel bolt wrenches	Control rod guide tube grapple
Channel handling tool	Fuel support grapple
Fuel pool sipper	Grid guide
Channel gauging fixture	Control rod latch tool
General purpose grapples	Instrument handling tool
Fuel bundle inspection fixture	Control rod guide tube seal
	In-core guide tube seals
Servicing Aids	Blade guides
Pool tool accessories	Fuel bundle sampler
Actuating poles	Peripheral orifice grapple
General area underwater lights	Orifice holder
Local area underwater lights	Peripheral fuel support plug
Drop lights	Fuel bail cleaner
Underwater TV monitoring system	Dummy fuel assembly
Underwater vacuum cleaner	Multi Lift Tool (MLT)
Viewing aids	
Light support brackets	Refueling Equipment
In-core detector cutter	Refueling equipment servicing tools
In-core manipulator	Refueling platform
Reactor Vessel Servicing Equipment	Storage Equipment
Reactor vessel servicing tools	Spent fuel storage racks
Steam line plugs	Channel storage racks
Shroud head bolt wrenches	In-vessel racks
Head holding pedestals	New fuel storage rack

Table 9.1-7

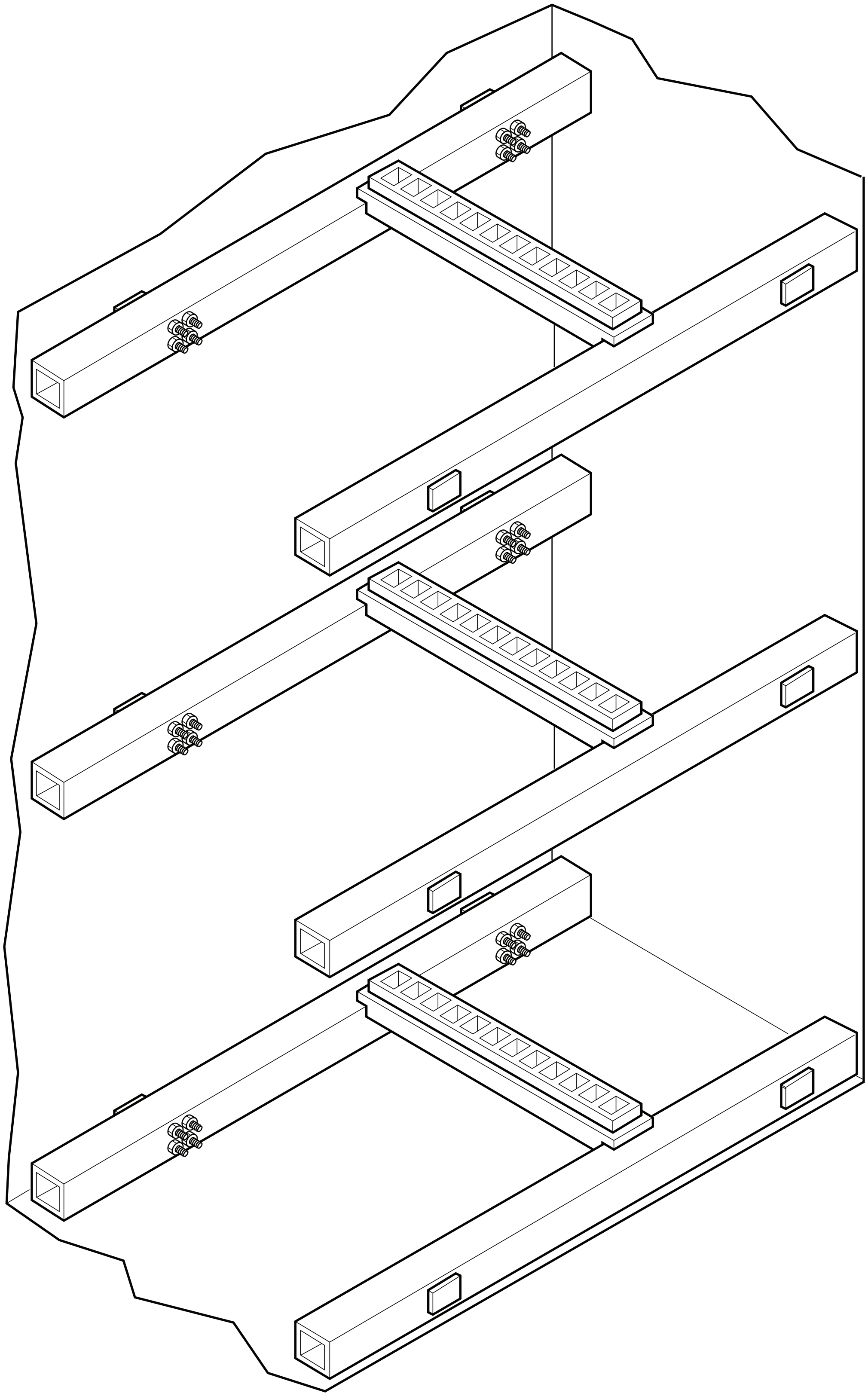
Tools and Servicing Equipment (Continued)

Reactor Vessel Servicing Equipment (Continued)	Under Reactor Vessel Servicing Equipment
Head stud rack	Control rod drive servicing tools
Dryer-separator sling	Control rod drive hydraulic system tools
Head strongback	Spring reels
Steam line plug/installation tool	Control rod drive handling equipment
Auxiliary work platform	Equipment handling platform
Head stud tensioner carousel/strongback	Thermal sleeve installation tool
	In-core flange seal test plug
	Keybender



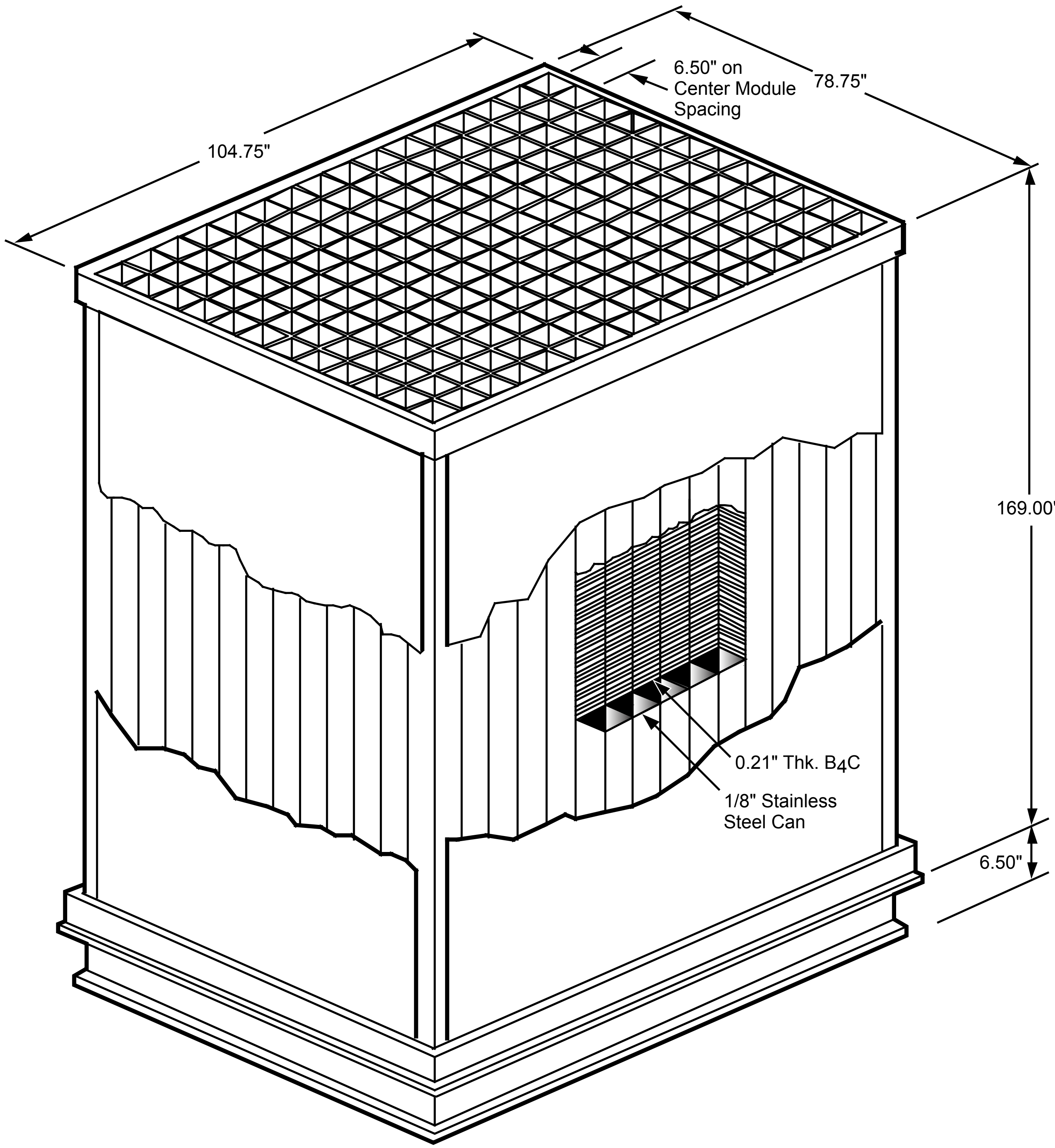
New Fuel Storage Vault Fuel Loading Pattern

Draw. No. 900547.33 | Rev. | Figure 9.1-1

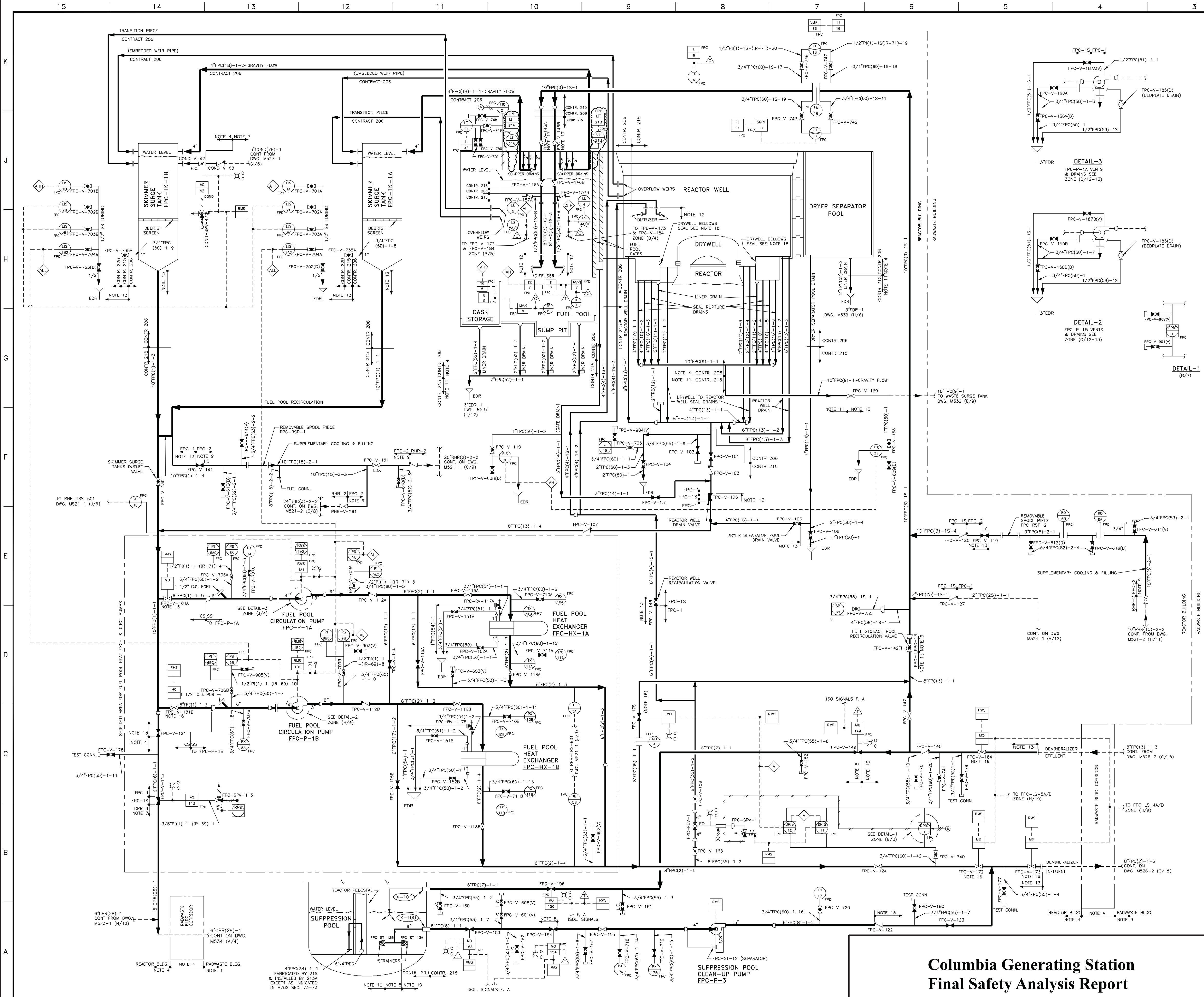


New Fuel Storage

Draw. No. 960690.63 | Rev. | Figure 9.1-2



Typical Spent Fuel Rack 12 x 16 Array



NOTES:

1. ALL EQUIPMENT, VALVES, SPECIALTIES, AND INSTRUMENTATION UPSTREAM OF CHEMICAL WASTE AND WASTE SLUDGE PHASE SEPARATOR TANKS AND DOWNSTREAM OF RADWASTE BUILDING PENETRATION SHALL BE FURNISHED UNDER CONTRACT E-2808-20 WITHIN LIMITS SHOWN.

2. ALL PRESSURE, SAMPLING, AND/OR FLOW INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES, UNLESS SPECIFICALLY NOTED OTHERWISE.

3. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING, EXCEPT AS NOTED IN OTHER NOTES, SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY II
   CODE GROUP C

4. ALL PIPING ON THIS DRAWING IN THE REACTOR BUILDING AND RADWASTE BUILDING CORRIDOR, EXCEPT AS NOTED IN FOLLOWING NOTES, SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY II ⊕
   CODE GROUP C
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

5. ALL PIPING REFERRING TO THIS NOTE SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP B

6. (DELETED)

7. PIPING, VALVES, & COMPONENTS SHOWN ON THIS DRAWING IN THE CPR(29)-1, MWR(38)-1, MWR(40)-1, CF(ALL), SA(1)-1, COND(ALL) SYSTEM SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY II ⊕
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

8. ALL INSTRUMENTATION, PIPING, AND TUBING DOWNSTREAM OF THE INSTRUMENT ROOT VALVE SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II ø
   SEISMIC CATEGORY II ø
   CODE GROUP D ø
   ø EXCEPT AS NOTED ON M619, INSTRUMENT CONN. DIAGRAMS

9. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS REFERRING TO THIS NOTE SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP C

10. PIPING, VALVES, & ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS: (BREAK POINTS ARE INDICATED ON THIS DIAGRAM)
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP D *
   * STRAINERS SHALL HAVE ALL FABRICATION & MATERIALS TO APPLICABLE REQUIREMENTS OF ASME III-2, EXCEPT CODE STAMP IS NOT REQUIRED & PERFORATED PLATE MAY BE ASTM MATERIAL & COMPLIANCE WITH NA-3700 IS NOT MANDATORY. FURNISHED & INSTALLED BY CONTR. 213A

11. ALL PIPING FOR FPC(9)-1 UPSTREAM OF FPC-V-169, FPC(10)-1, FPC(11)-1, & FPC(52)-1 SHALL HAVE ALL WELDS EXAMINED BY LIQUID PENETRANT EXAMINATION, AND SHALL HAVE ALL FABRICATION AND MATERIALS TO APPLICABLE REQUIREMENTS OF ASME III-3, EXCEPT CODE STAMP IS NOT REQUIRED.
   QUALITY CLASS II
   SEISMIC CATEGORY II ⊕
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

12. DIFFUSERS SHALL BE CLASSIFIED AS STATED IN NOTE 9 FOR MATERIAL FABRICATION AND INSTALLATION ONLY. CODE STAMP NOT REQUIRED.

13. ALL PIPING, VALVES, & ASSOCIATED COMPONENTS REFERRED TO BY THIS NOTE, IF PURCHASED OR INSTALLED PRIOR TO 1 JAN. 1980, SHALL BE:
   QUALITY CLASS II
   SEISMIC CATEGORY I
   CODE GROUP C
   AND, IF PURCHASED OR INSTALLED AFTER 1 JAN. 1980, SHALL BE:
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP C

14. ALL PIPING DOWNSTREAM OF THE LAST ISOLATION VALVE AND OPEN TO THE ATMOSPHERE WITH THE SUBSYSTEM DESIGNATION "SYSTEM" (50) THRU (59) SHALL BE CLASSIFIED AS CODE GROUP "D" WITH QUALITY CLASS AND SEISMIC CATEGORY PROVIDED BY THE APPLICABLE NOTES ON THIS DRAWING, EXCEPT WHERE THE APPLICABLE NOTES CALL FOR QUALITY CLASS II+, PIPING SHALL BE QUALITY CLASS II.

15. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS REFERRED TO BY THIS NOTE SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II+
   SEISMIC CATEGORY II ⊕
   CODE GROUP D+
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
   + SEE NOTE 12, WNP-2 SPEC. SECT. 15B.1, TABLE 2 NOTES.

16. VALVE IS NOT ASME III CLASS 3, IT IS CONSIDERED SA105 MATERIAL WELDED TO THE SYSTEM. THE FOLLOWING WASHINGTON STATE SPECIAL NUMBERS ARE IDENTIFIED WITH CORRESPONDING VALVES.

VALVE TAG NO.	WASHINGTON STATE SPECIAL NUMBER
FPC-V-172	WS-17-83W
FPC-V-173	WS-18-83W
FPC-V-175	WS-19-83W
FPC-V-181A	WS-20-83W
FPC-V-181B	WS-26-83W
FPC-V-184	WS-21-83W

17. FPC-V-145A AND FPC-V-145B INTERNALS HAVE BEEN REMOVED.

18. DWG. M837 CONTAINS INFORMATION ON THE INNER DRYWELL BELLOWS AND ASSOCIATED DRAINS.

19. FPC-PS-16A AND FPC-PS-16B ARE DEACTIVATED IN PLACE.

20. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE, EXCEPT AS NOTED.

2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.

3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

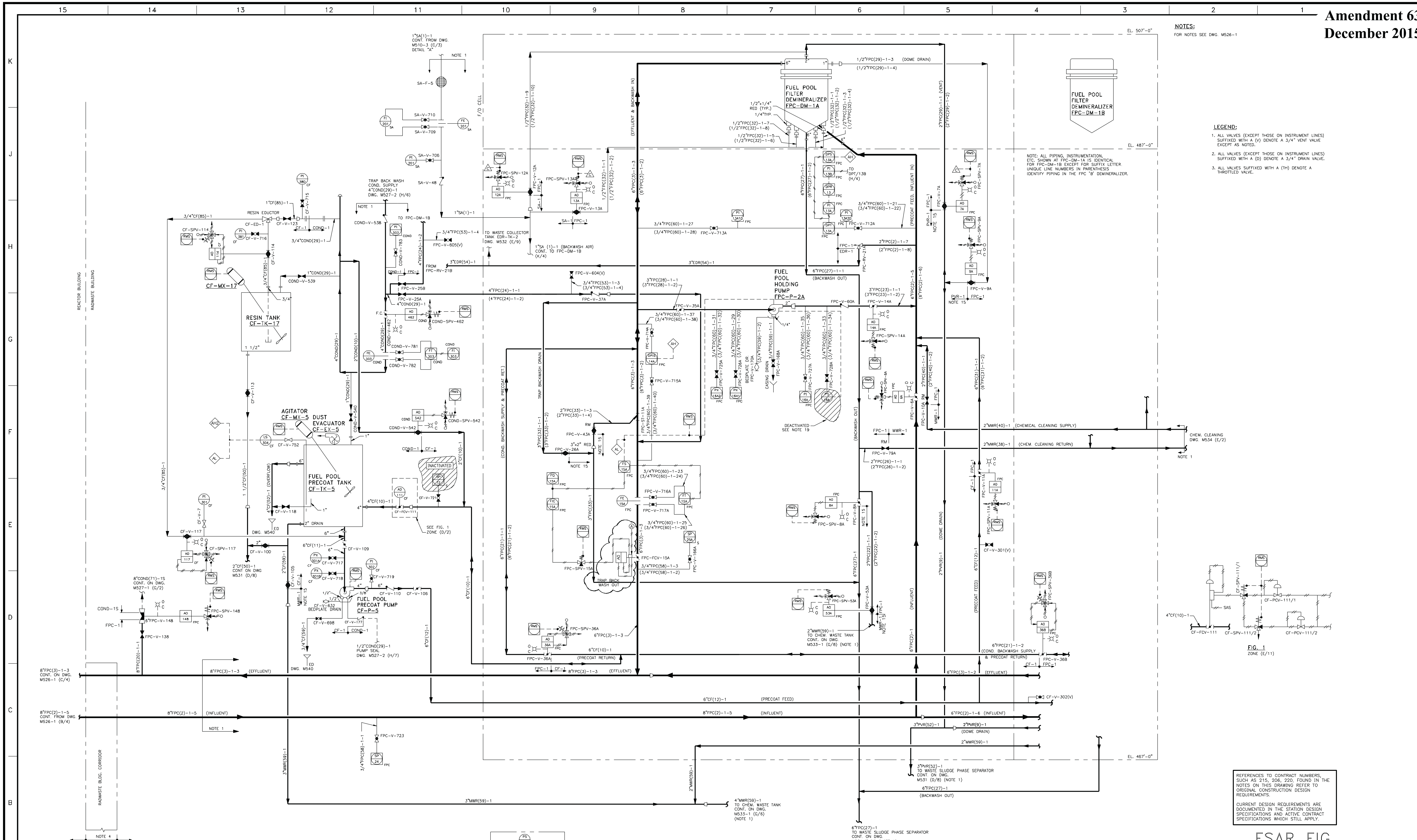
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Fuel Pool Cooling and Clean-Up System

Draw. No. M526-1	Rev. 103	Figure 9.1-6.1

Amendment 63
December 2015



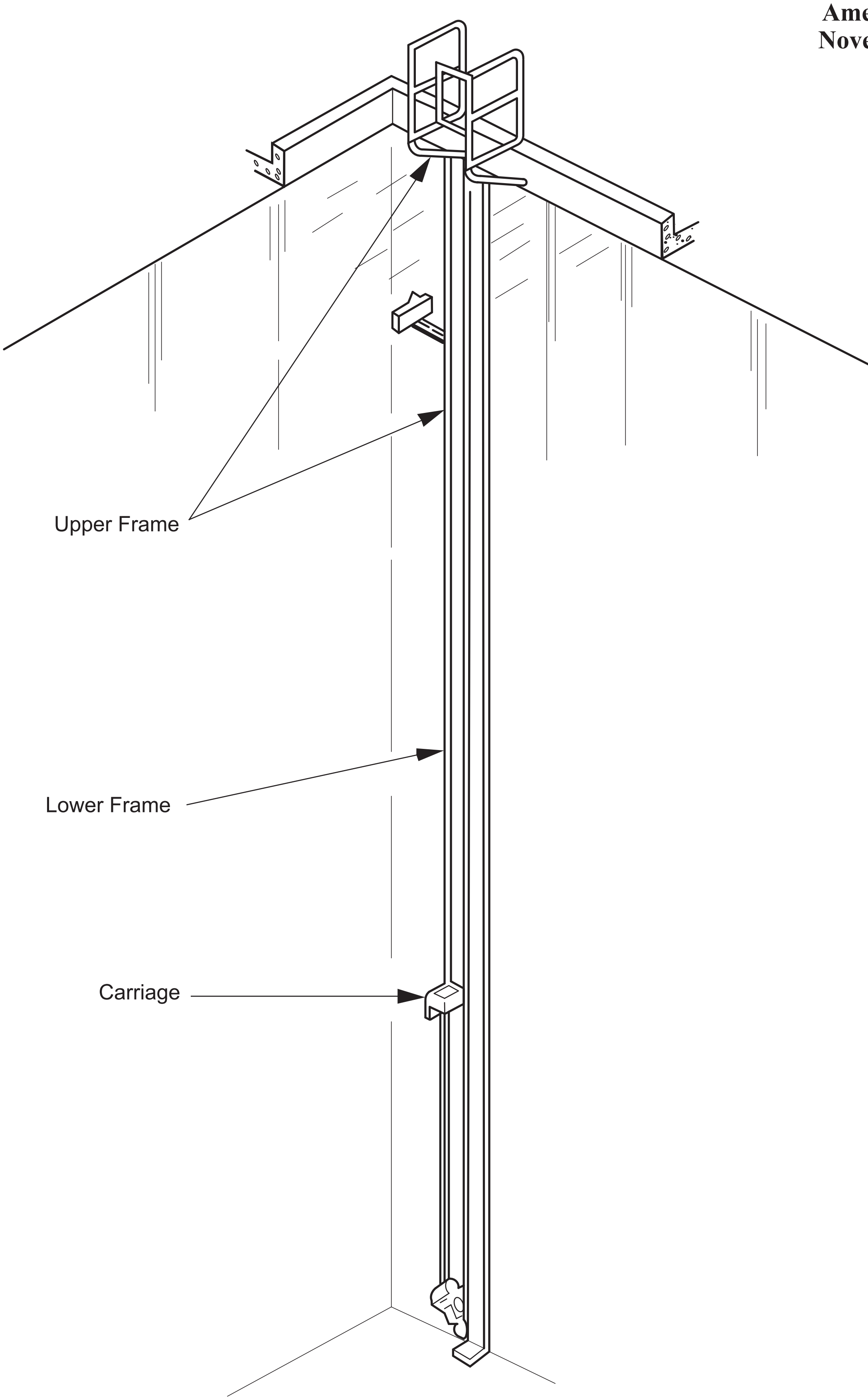
Columbia Generating Station
Final Safety Analysis Report

Fuel Pool Cooling and Clean-Up System

Draw. No. M526-2 | Rev. 2 | Figure 9.1-6.2

Form No. 960690ai

Amendment 53
November 1998

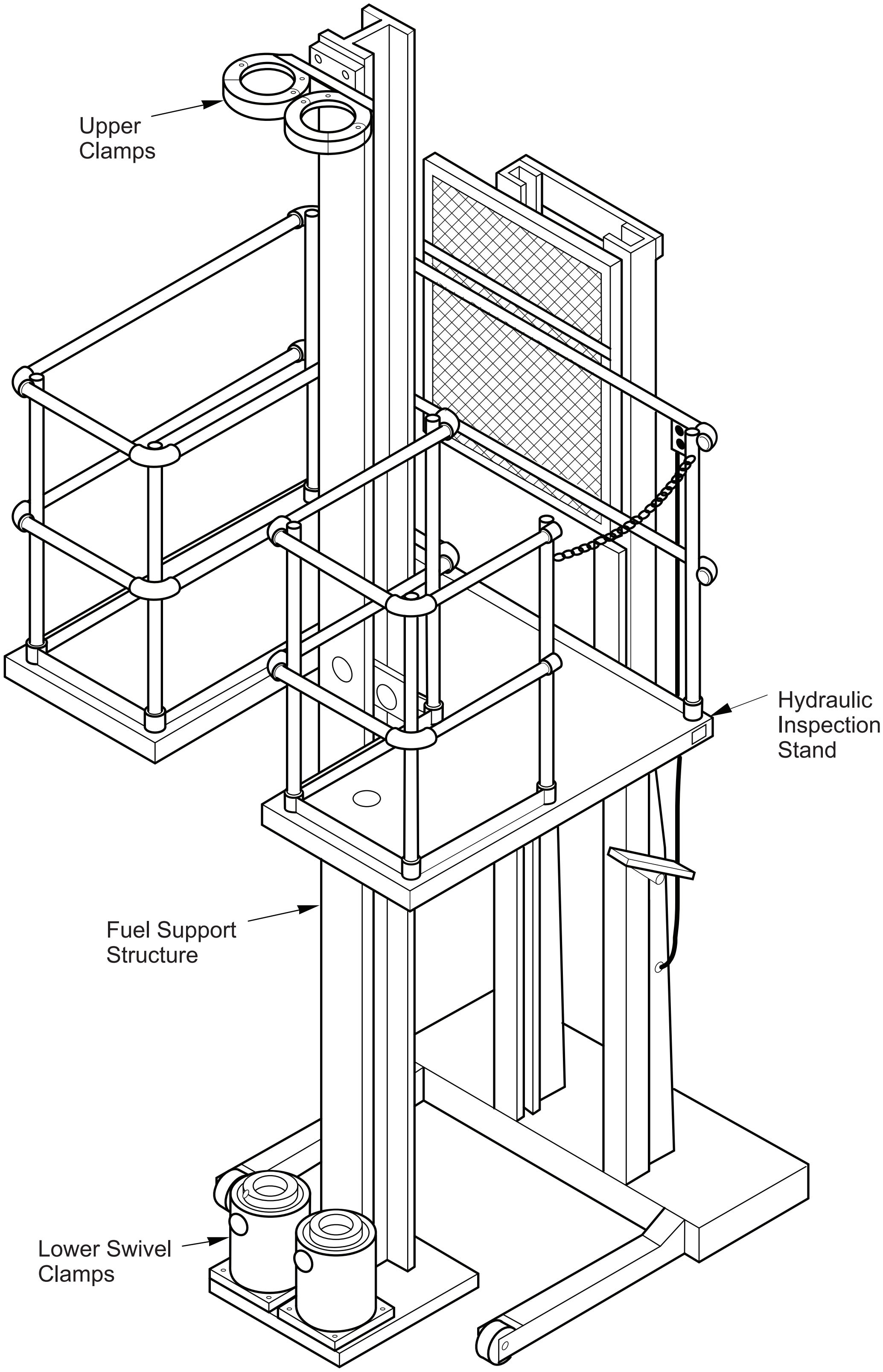


Columbia Generating Station
Final Safety Analysis Report

Fuel Preparation Machine Shown Installed in Facsimile Fuel Pool

Draw. No. 960690.66	Rev.	Figure 9.1-7

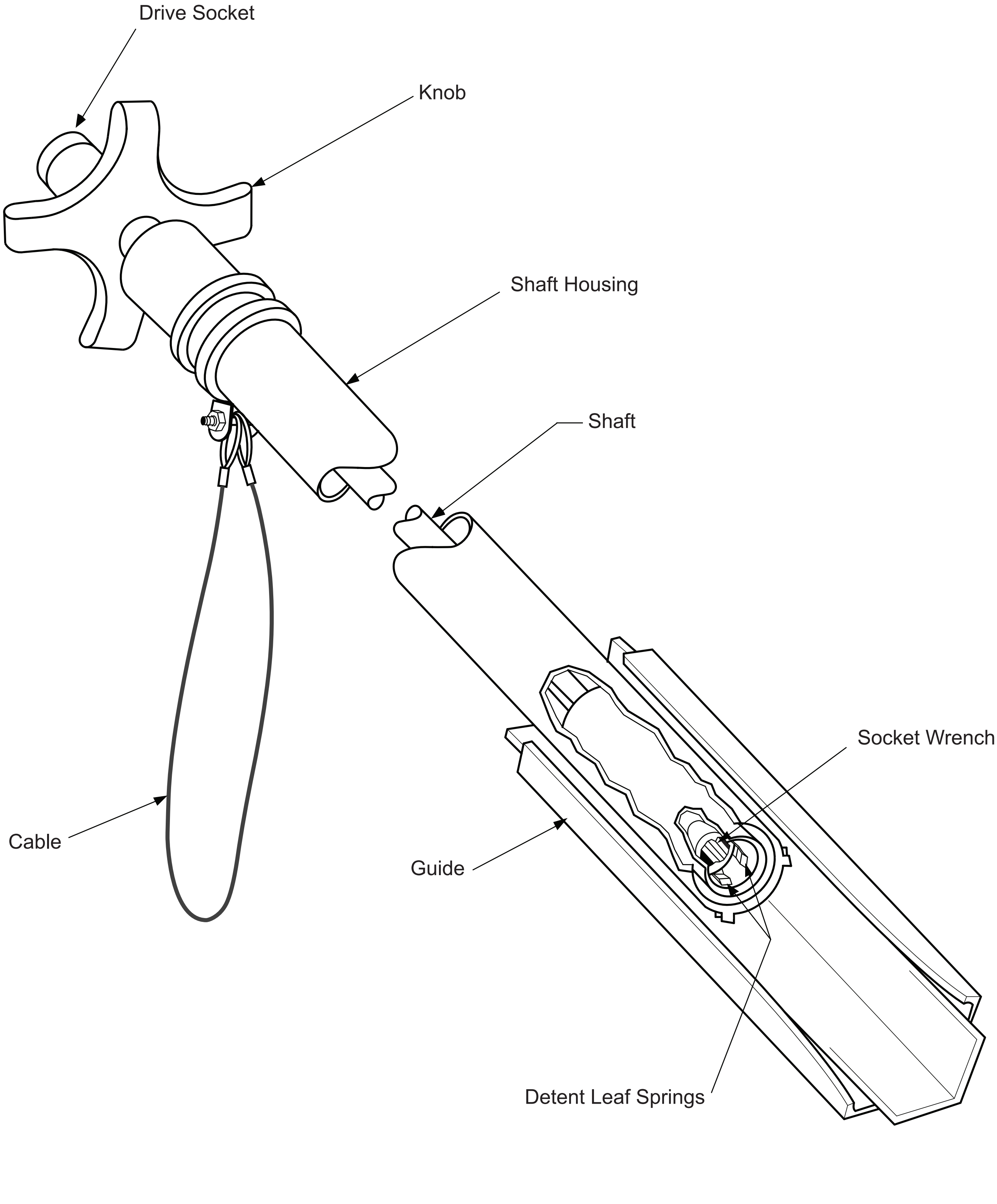
Form No. 960690



Columbia Generating Station
Final Safety Analysis Report

New Fuel Inspection Stand

Draw. No. 960690.68 | Rev. | Figure 9.1-8

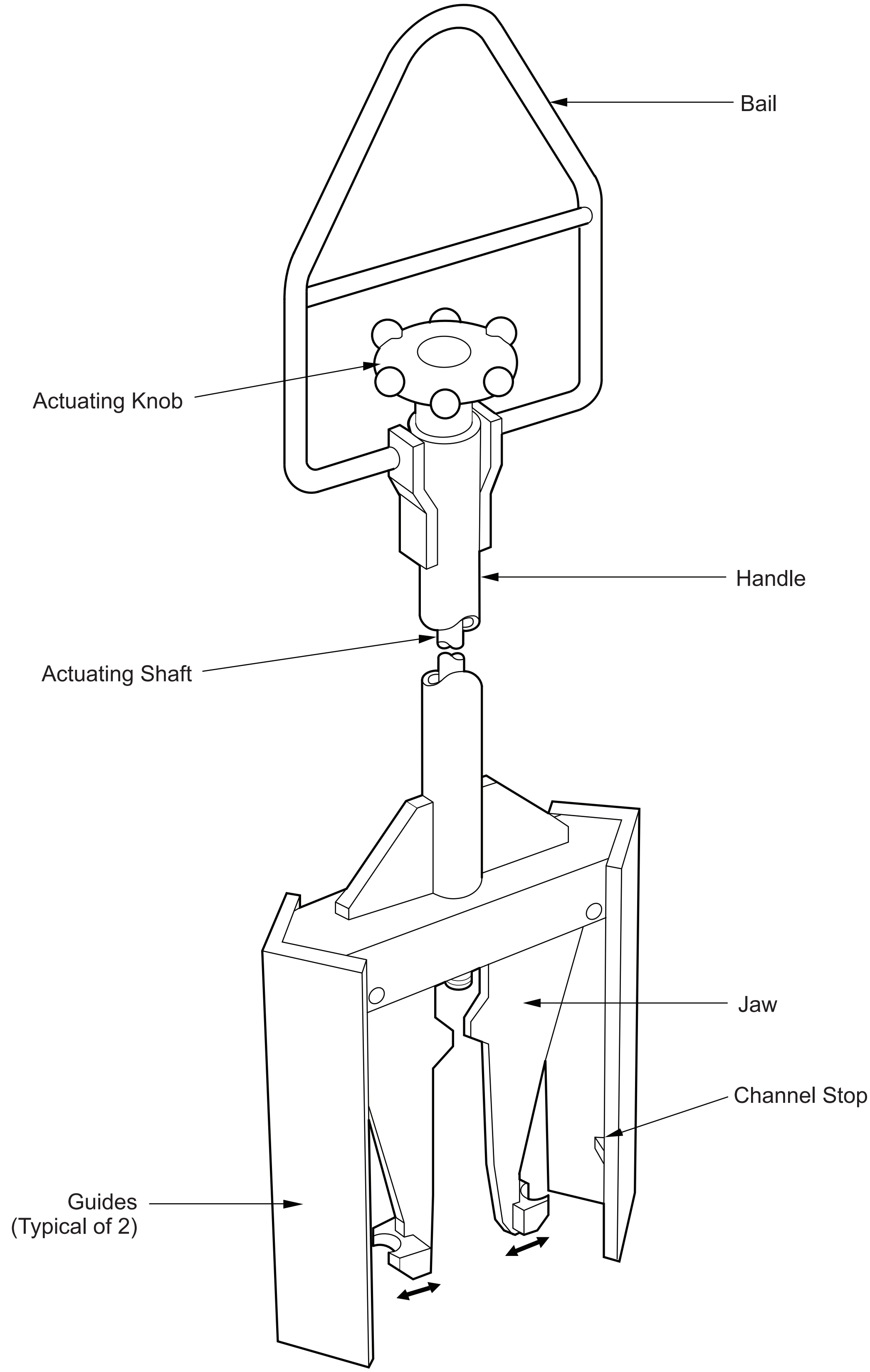


Columbia Generating Station
Final Safety Analysis Report

Channel Bolt Wrench

Draw. No. 960690.69 | Rev. | Figure 9.1-9

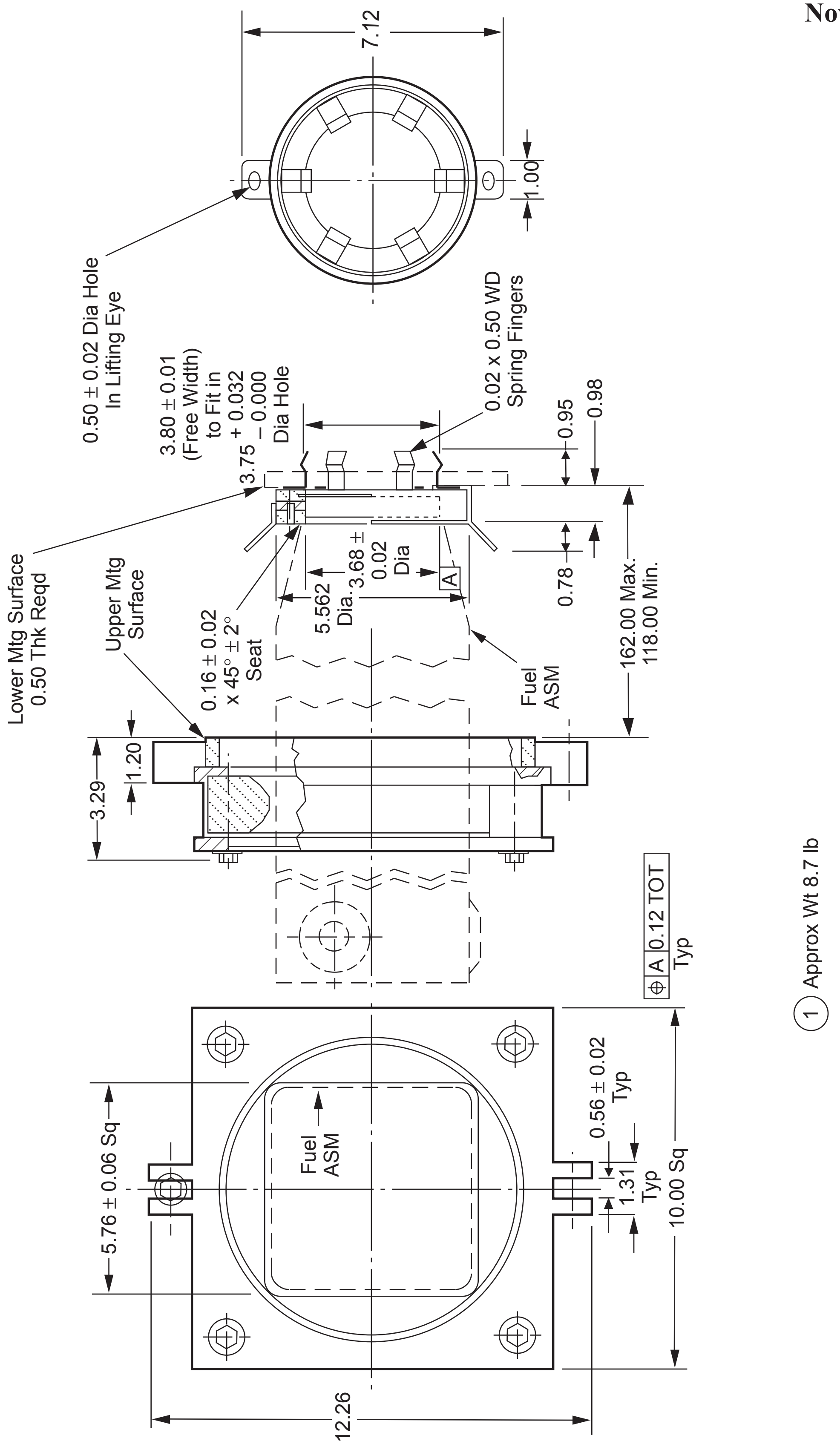
Form No. 960690



Columbia Generating Station
Final Safety Analysis Report

Channel Handling Tool

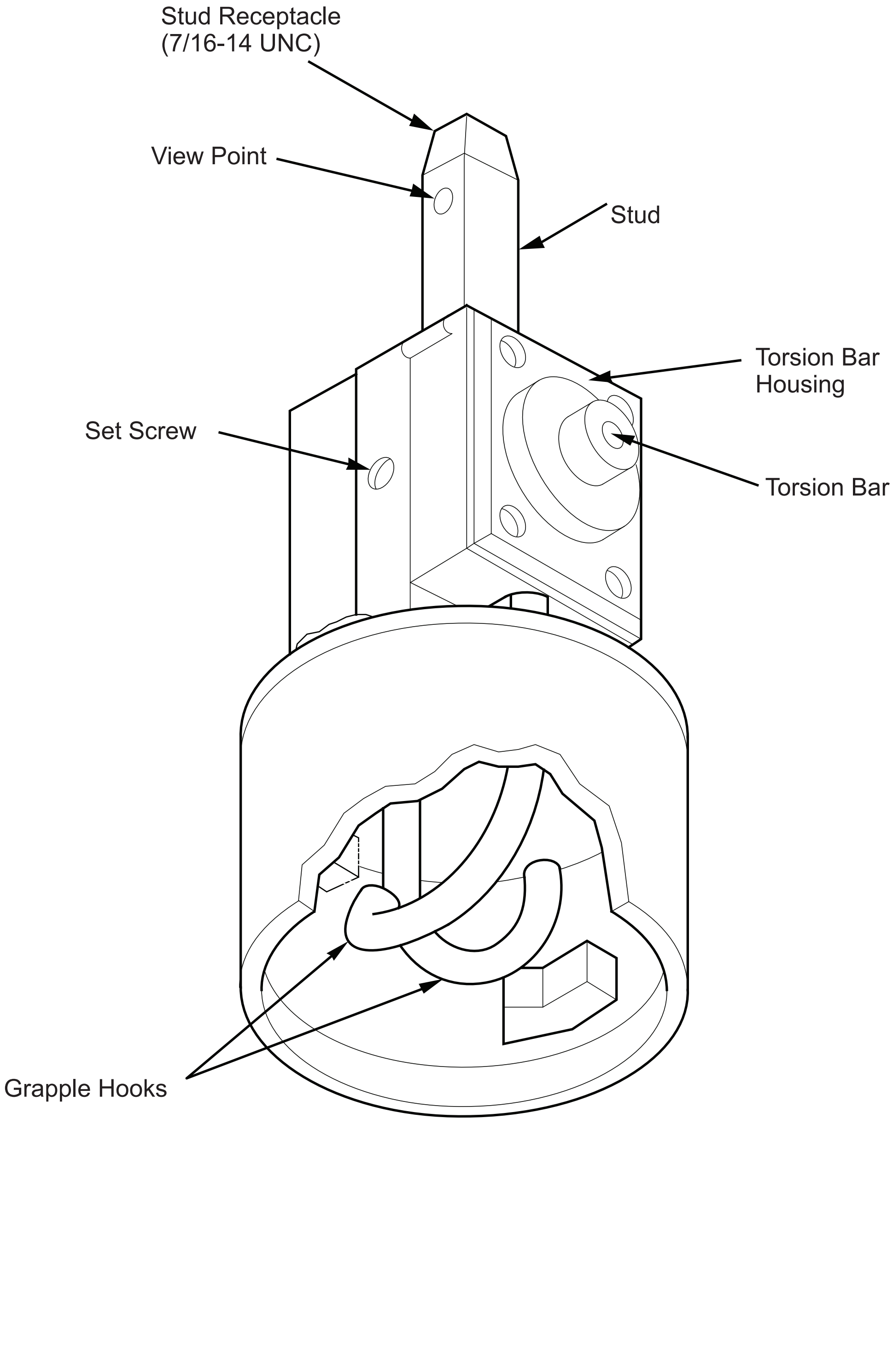
Draw. No. 960690.70 | Rev. | Figure 9.1-10



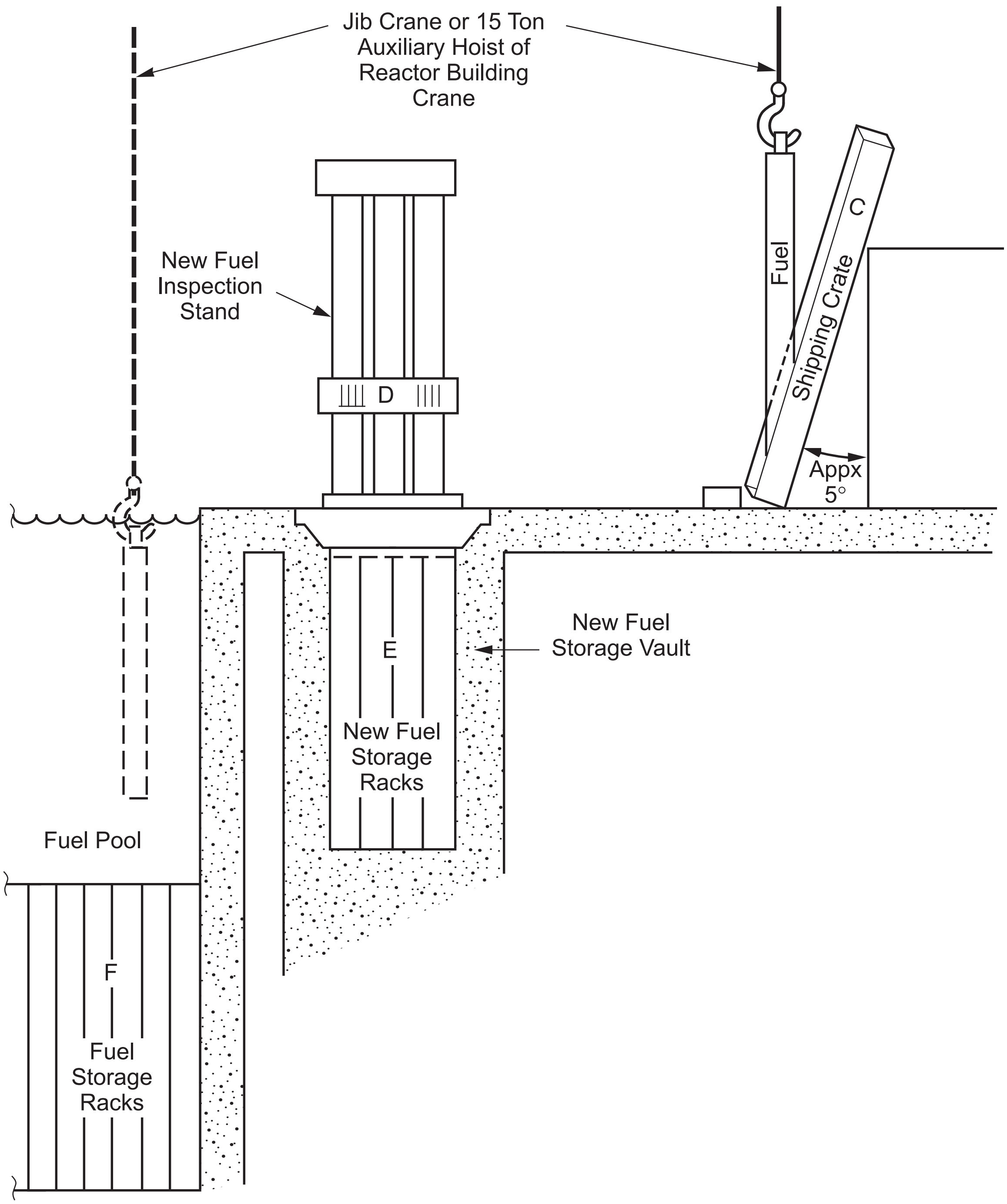
Columbia Generating Station
Final Safety Analysis Report

Fuel Inspection Fixture

Draw. No. 960690.71	Rev.	Figure 9.1-11

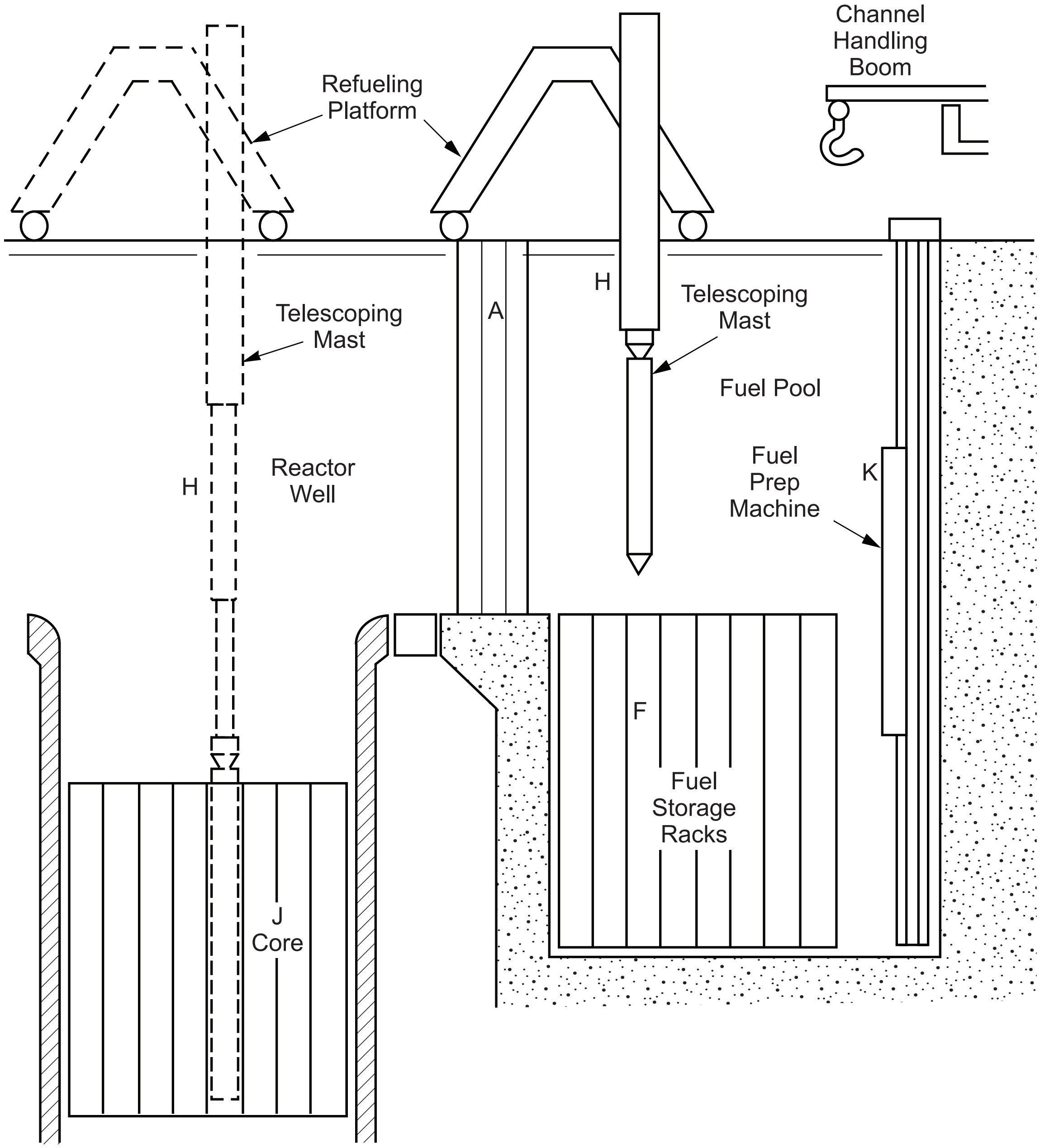


General Purpose Grapple

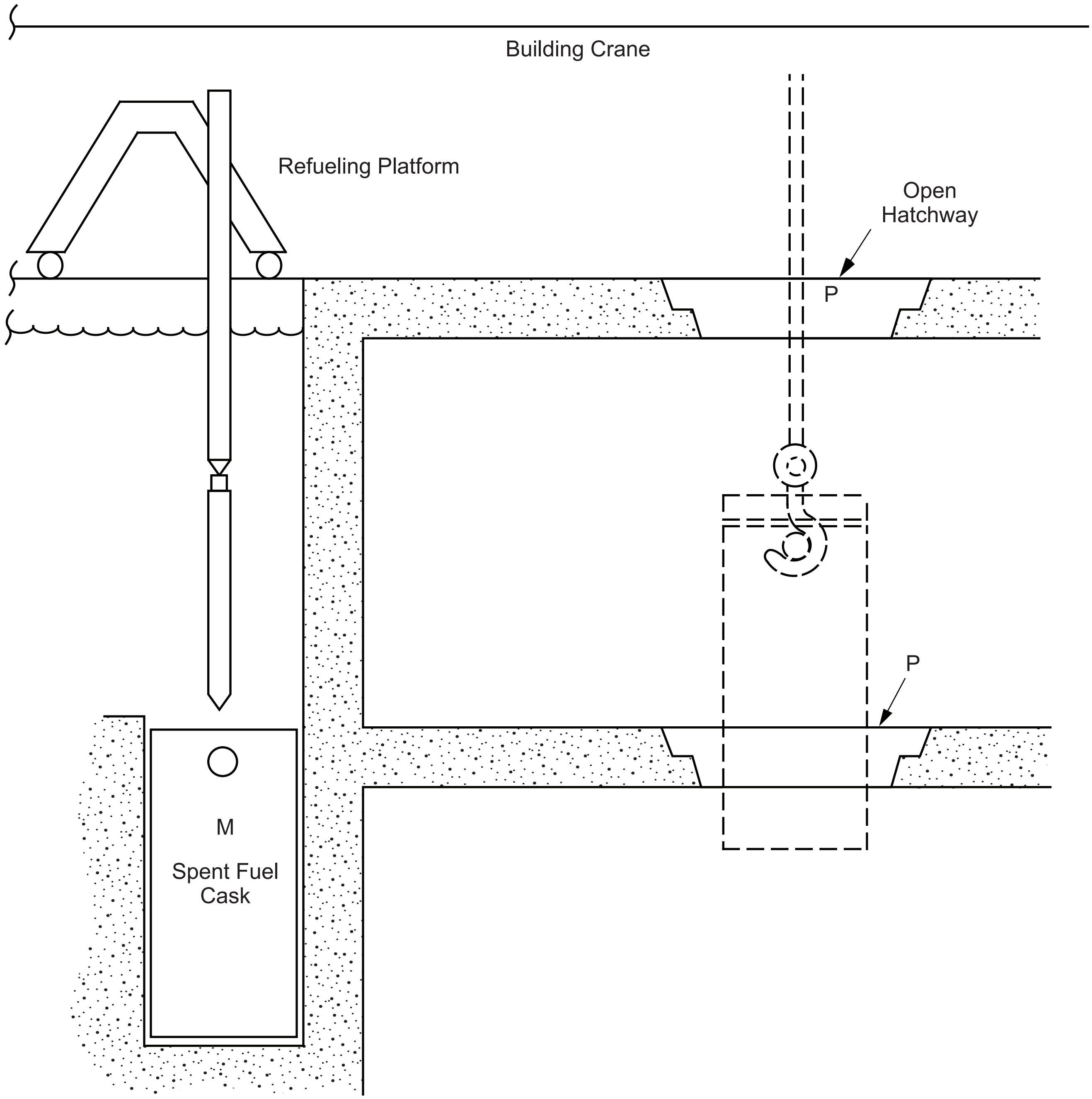


Simplified Section of New Fuel Handling Facilities (Section X-X)

Draw. No. 960690.74 | Rev. | Figure 9.1-14



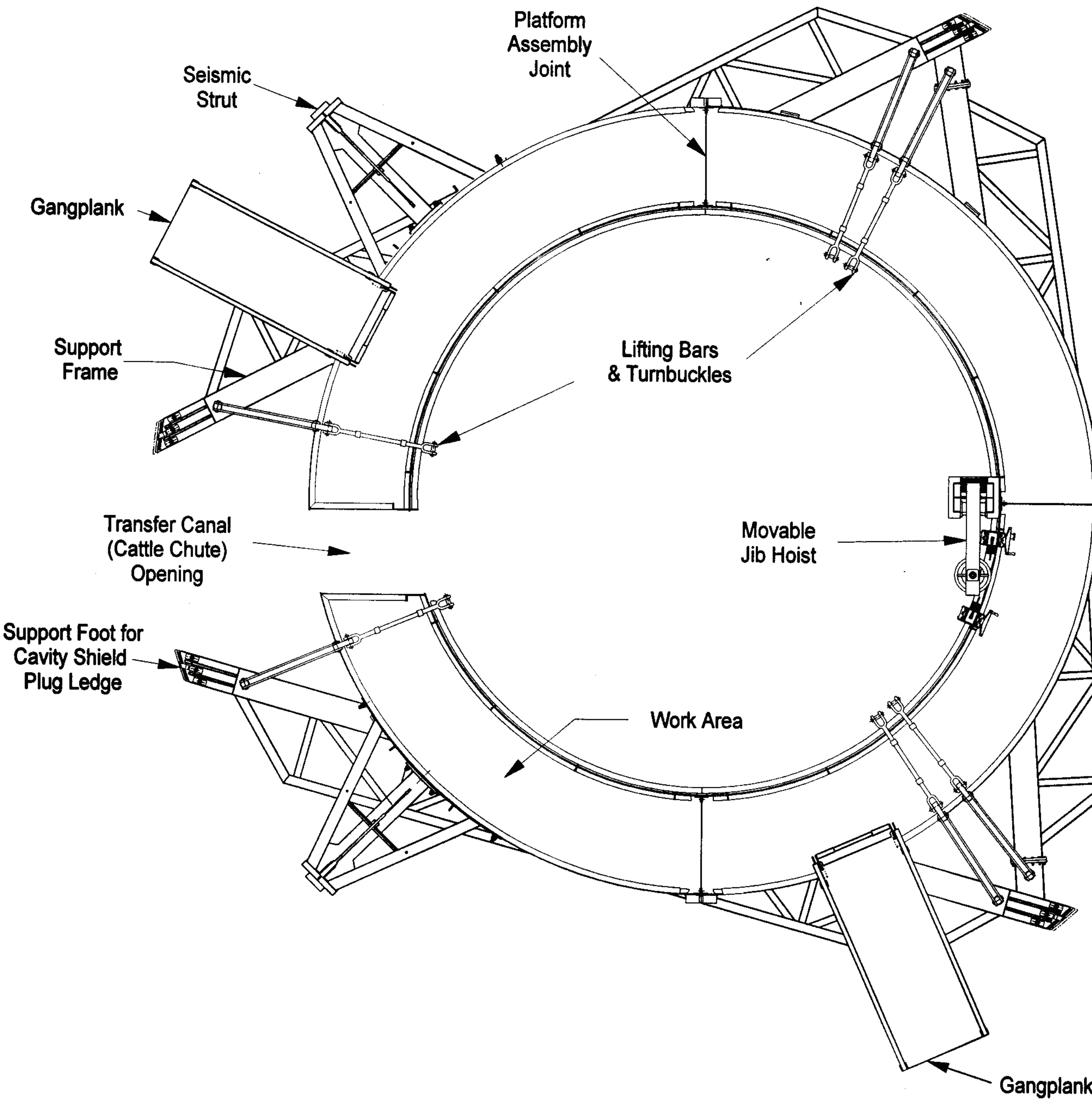
Columbia Generating Station Final Safety Analysis Report	Simplified Section of Refueling Facilities (Section Y-Y)		
	Draw. No. 960690.67	Rev.	Figure 9.1-15



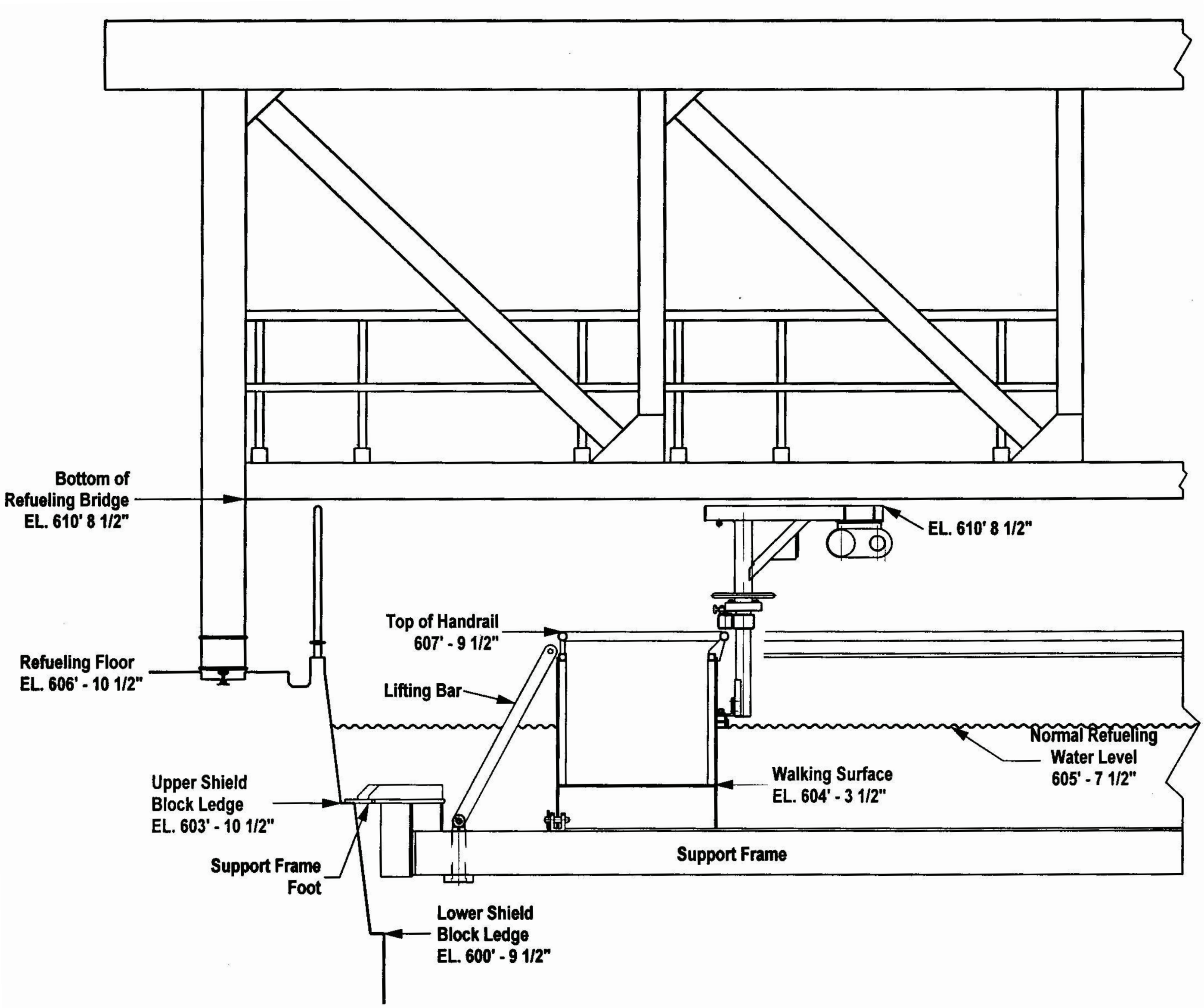
Columbia Generating Station
Final Safety Analysis Report

Simplified Section of Fuel Shipping Facilities (Section Z-Z)

Draw. No. 960690.75	Rev.	Figure 9.1-16



Columbia Generating Station **Final Safety Analysis Report**	**Cavity In-Vessel Service Platform (CISP) Plan View**		
	Draw. No. **910402.45**	Rev.	Figure **9.1-17**



Columbia Generating Station Final Safety Analysis Report	Cavity In-Vessel Service Platform (CISP) Sectional View		
	Draw. No. 910402.44	Rev.	Figure 9.1-18

9.2 WATER SYSTEMS

9.2.1 PLANT SERVICE WATER SYSTEM

9.2.1.1 Design Bases

a. The plant service water (TSW) system is designed to provide cooling water for removal of heat rejected from auxiliary (nonessential) equipment, including turbine generator and reactor auxiliaries located throughout the plant, and

b. The plant service water system is designed to remove the maximum expected heat load of the equipment under normal operating conditions.

9.2.1.2 System Description

The plant service water system consists of two 100% capacity pumps (TSW-P-1A, TSW-P-1B) taking suction from the circulating water intake structure and supplying cooling water to equipment located throughout the plant (see Figure 9.2-1).

Plant service water is returned to the circulating water tunnel for heat removal by the circulating water system cooling towers.

The plant service water system is designed to function continuously during all modes of operation except during loss-of-coolant accident (LOCA) with loss of offsite power. Following loss of power under nonLOCA conditions, the plant service water pumps will be supplied from standby power buses (see Section 8.3.1.1.1). The plant service water radiation monitor is continuously recorded in the control room and will alarm if the water becomes contaminated except during loss of offsite power when plant service water will be manually monitored for radiation. The circulating water system blowdown line radiation monitor serves as backup (see Figure 10.4-4). On detecting radiation in the blowdown line, it automatically isolates the blowdown to the river except during plant outages as described in Section 11.5.2.2.2.4.

In addition to the biocide treated circulating water supply utilized by the plant service water system, the plant service water system is equipped with a biocide treatment system to retard biological growth. Additional chemical treatment capability is provided to minimize silt deposition, scale formation, corrosion, and consequent fouling of heat transfer surfaces.

Required makeup to the plant service water system is included as part of the overall circulating water system makeup requirements. The makeup flow can be directed in to the circulating water bay or to one or both of the plant service water pump suctions. This is accomplished by means of a weir box and sluice gate arrangement in the circulating water mixing bay (see Section 10.4.5).

Water for plant service water pump bearing lubrication is supplied from the plant service water pump during operation of the pump and is filtered before being injected to lubricate the bearings. The Fire Protection system provides TSW pump bearing lubrication water for initial system startup after both pumps have been secured (or tripped) (see Appendix F.2, Section F.2.4.1).

The plant service water system piping is designed in accordance with ANSI B31.1. The two service water pumps are designed in accordance with the Standards of the Hydraulic Institute, Centrifugal Pump Section.

9.2.1.3 Safety Evaluation

The operation of the plant service water system is not required to ensure any of the following conditions:

a. The integrity of the reactor coolant pressure boundary (RCPB),

b. The capability to shut down the reactor and maintain it in a safe shutdown condition, or

c. The ability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures in excess of the guideline exposures of 10 CFR Part 100.

A single-failure analysis has not been provided for the plant service water system since this system serves only nonessential systems and is not required to perform a safety function. See Section 3.6 for a discussion of piping failures. The system, however, incorporates features that ensure continuity and reliability of operation. Plant service water pumps will be alternately operated to minimize wear, and the standby pump is available as a replacement during maintenance of the normally operating pump.

All piping, valves, and associated components of the plant service water system are classified Seismic Category II except in the reactor building and control building where system hangers are designed for Seismic Category I loads (seismic 1M).

9.2.1.4 Testing and Inspection Requirements

The components used in this system were tested and inspected at the manufacturer's plant for conformance with specifications. After installation, major components were checked and the system hydrostatically tested to ensure leak tightness prior to plant startup. Preoperational testing included testing of automatic controls for actuation at the proper setpoints, calibration of instruments and alarms. Routine visual inspection of system components, instrumentation, and trouble alarms verify system operability and performance.

9.2.1.5 Instrumentation Requirements

Suitable alarms and indicators are provided to monitor and control the system throughout the system to allow the control room operator to take corrective action as required.

Each pump is manually started from the main control room. The standby pump is automatically started by actuation of a low pressure switch in the operating pump discharge line. The pressure at the discharge of each pump is indicated locally and also in the main control room. A pressure switch provides annunciation in the main control room on low pump discharge pressure signal.

9.2.2 REACTOR BUILDING CLOSED COOLING WATER SYSTEM

9.2.2.1 Design Bases

a. The RCC is designed to provide adequate cooling water to auxiliary plant equipment in the reactor and radwaste buildings during all normal modes of operation, and

b. The RCC is designed to provide a closed cooling water loop between nonessential systems which are potentially contaminated and the plant service water which is used for cooling. This loop provides an additional barrier between the potentially contaminated systems and the plant service water discharged to the circulating water system.

9.2.2.2 System Description

The RCC is a closed loop system which provides parallel-flow cooling to auxiliary equipment in the primary containment, the reactor building, and radwaste building. The system consists of pumps, heat exchangers, tanks, piping, valves, and instrumentation as shown in Figure 9.2-2. Each of the three pumps and three heat exchangers are half capacity based on maximum normal cooling requirements. Heat is removed from the RCC system by the plant service water system. The plant service water is passed through the tube side of the RCC heat exchangers and the closed-loop water is passed through the shell side. A 550-gal surge tank accommodates volume changes from thermal expansion and contraction. Makeup water to the system is supplied to the surge tank by the demineralized water system.

The RCC cools the following equipment:

a. Reactor recirculation pumps,
b. Drywell fan unit cooling coils,
c. Drywell equipment drain condenser,

d. Reactor water cleanup (RWCU) nonregenerative heat exchangers,
e. Reactor building equipment drain heat exchanger,
f. Control rod drive pumps,
g. Fuel pool heat exchangers,
h. RWCU recirculating pumps, and
i. Offgas glycol refrigeration machines.

The RCC piping inside primary containment is constructed in accordance with ASME Section III, Class 3, and Seismic Category II requirements. The RCC piping outside of primary containment is constructed in accordance with ANSI B31.1. In the reactor building and inside primary containment, RCC piping is supported to Seismic Category I. In the radwaste building, RCC piping is supported to Seismic Category II requirements. System primary containment penetrations and isolation valves are constructed to Seismic Category I, and ASME Code Section III, Class 2, requirements. The RCC pumps are constructed to Seismic Category II, and RCC heat exchangers are constructed to ASME Code Section VIII and the Standards of the Tubular Exchanger Manufacturers Association, Class R. The system design pressure is 195 psig. The design temperature is 150°F for all piping except the RWCU nonregenerative heat exchanger discharge piping. The piping from the RWCU heat exchanger to the 18-in. return line has a design temperature of 175°F. The system operates at pressures and temperatures below the stated design values.

Equipment Design Parameters

Closed Cooling Water Pumps (RCC-P-1A, RCC-P-1B, RCC-P-1C)

Quantity	3
Driver	200 hp motor - ac
Design capacity	2500 gpm
Head	200 ft
Speed, rpm	1775

Closed Cooling Water Heat Exchangers (RCC-HX-1A, RCC-HX-1B, RCC-HX-1C)

Quantity	3
Heat duty	25×10^6 Btu/hr

	Shell side	Tube side
Flow rate	2500 gpm	3333 gpm
Inlet temperature	115°F	85°F
Outlet temperature	95°F	100°F
Pressure drop	11.2 psig	5.0 psig

A chemical addition tank (RCC-TK-2) and metering pump (RCC-P-2) were included in the original design for the addition of corrosion inhibiting chemicals if required. This chemical addition equipment is not normally used.

The RCC pumps supply water to the specified auxiliary plant equipment during all modes of operation except under LOCA conditions. Following loss of normal power and under nonLOCA conditions, the RCC pumps are supplied from standby power.

9.2.2.3 Safety Evaluation

The RCC provides a barrier between nonessential, potentially contaminated systems, and the plant service water discharged to the circulating water system. A radiation monitor is provided in the RCC to detect inleakage to this system from any contaminated system. Leakage is also detected by pressure instrumentation in the system supply headers or by monitoring system surge tank level.

Portions of the RCC which penetrate the primary containment are provided with containment isolation valves which can be remotely actuated by the operator in the main control room and close automatically on the high drywell pressure (F) and the reactor vessel low water level (A) containment isolation signals.

A pressure bypass line exists around the inboard isolation valve on the return line to prevent overpressurization of the piping between the inboard and outboard isolation valve. The bypass line has a check valve that acts as an inboard isolation valve in parallel with the normal inboard isolation valve.

A single-failure analysis has not been provided for the RCC since this system serves only nonessential systems and is not required to perform a safety function. See Section 3.6 for a discussion of piping failures.

9.2.2.4 Testing and Inspection Requirements

Pumps in the RCC are proven operable by their continuous use during normal plant operation. The motor-operated isolation valves are tested to ensure that they are capable of opening and closing by operating manual switches in the main control room and observing the position lights. The check valve in the bypass line across the inboard isolation valve on the return line is tested to ensure that it is capable of opening and closing by manual means during an outage. Routine visual inspection of the system components, instrumentation, and trouble alarms is adequate to verify system operability.

9.2.2.5 Instrumentation Requirements

The RCC is a balanced constant-flow system. Local pressure and temperature gauges and test points are provided throughout the system. Temperature in the primary containment is transmitted to the main control room, as is pressure downstream of the closed cooling water heat exchangers. A temperature switch downstream of the heat exchangers actuates an alarm in the main control room on high water temperature. When an operating pump trips, the standby pump is automatically brought on line. Alarms are actuated in the main control room following a decrease in pressure sensed by pressure switches on each pump discharge.

The system water volume is maintained from the plant demineralized water system by a level control valve actuated by level switches in the surge tank.

9.2.3 PLANT MAKEUP WATER TREATMENT AND DEMINERALIZED WATER SYSTEMS

9.2.3.1 Design Basis

a. The plant potable water system provides the supply water for the plant makeup water treatment system. A vendor furnished and maintained trailer-mounted demineralizer provides the purified water to the demineralized water system using the potable water source.

b. The demineralized water system is designed to utilize the demineralized effluent from the plant makeup water treatment system to provide demineralized water to the condensate storage tanks and to distribute demineralized water throughout the plant.

9.2.3.2 System Description

9.2.3.2.1 Plant Makeup Water Treatment System

The plant makeup water treatment system is shown in Figure 9.2-3. Raw water is normally supplied from the Columbia River through a branch line of the tower makeup system (TMU). From this line a branch is routed to the service building basement and is isolated. Another branch line continues to pump house 3, where raw water is processed into potable water. Here the water is chemically deflocculated and transferred to a 300,000-gal potable water storage tank. Sodium hypochlorite is injected into the potable storage tank influent line. In case the TMU is temporarily not in service, water is supplied from a cross tie with the WNP-1 potable water system.

The trailer-mounted demineralizer is supplied with water from the potable water pump PWC-P-103 which runs continuously. Demineralized water is pumped from the trailer demineralizer to tank DW-TK-1 in the basement of the service building through a tank level control valve.

Demineralized water is stored in a 50,000-gal epoxy-lined carbon steel demineralized water storage tank (see Figure 9.2-4 and Section 9.2.3.2.2).

The effluent from the trailer-mounted demineralizer is continuously recorded with associated alarms.

9.2.3.2.2 Demineralized Water System

The demineralized water system shown in Figure 9.2-4 consists of a 50,000-gal steel, epoxy-lined storage tank (DW-TK-1) with two 200-gpm transfer pumps with a 265-ft head (DW-P-1A, DW-P-1B). Among the components being supplied by the pumps are the following:

a. Condensate storage tanks,
b. RCC surge tank,
c. Diesel generator expansion tanks,
d. Auxiliary boiler condensate return tanks,
e. Chemical addition tanks,
f. Stator cooling makeup,
g. Refueling floor service boxes,
h. Decontamination facilities,
i. Flushing and washdown services,
j. Sealing water,
k. Laboratory water,
l. Reactor containment services,

m. Instrument flushing water, and
n. CJW surge pipe.

During operation one demineralized water transfer pump runs continuously to keep the system headers pressurized to supply demineralized water on demand. The operating pump recirculates a minimum flow back to the storage tank to prevent damage to the pump under low flow conditions.

9.2.3.3 Safety Evaluation

The demineralized water and plant makeup treatment systems are not required for a safe shutdown of the plant and are therefore, not safety related. A failure of these systems will not affect the operation of systems that are vital to safe shutdown of the plant. Alarmed instrumentation is provided to prevent delivery of out-of-specification water to safety-related systems or components. The piping associated with the demineralized water and plant makeup water treatment systems is designed in accordance with ANSI B31.1 except for piping that penetrates containment is designed ASME III, Class 2. All demineralized water and plant makeup water treatment system piping is classified Seismic Category II except that piping penetrating or routed inside primary containment, which is classified Seismic Category I. In the reactor and diesel generator buildings and inside primary containment, piping is supported to Seismic Category I requirements.

9.2.3.4 Testing and Inspection Requirements

The demineralized water and plant makeup water treatment systems are in daily use and as such do not require periodic testing to ensure operability. Grab samples are periodically tested in the laboratory to verify filter and demineralizer performance and to ascertain stored water quality. Periodic visual inspection and preventive maintenance are conducted.

The major components of these systems were subject to manufacturer shop tests including performance and hydrostatic tests.

Prior to initial operation the piping systems were subject to a hydrotest in accordance with their respective code groups. In addition, the completed systems were subjected to acceptance testing during plant startup as discussed in Section 14.2.

9.2.3.5 Instrumentation Requirements

Instrumentation and controls for the plant makeup water treatment and demineralized water systems are provided to control and monitor the operation of each of the subsystems.

Level controls in the demineralized water storage tank maintain the tank at the proper level by opening and closing a valve in the makeup demineralizer discharge piping.

9.2.4 POTABLE WATER AND SANITARY DRAIN SYSTEMS

9.2.4.1 Design Bases

The function of the potable water system is to supply potable water throughout the plant, provide supply water to the plant makeup water treatment system, and can be used to supply makeup water to the spray ponds.

The potable water system is designed to provide cold and/or hot water to the points of potable water usage such as lavatories, urinals, toilets, showers, eyewashes, sinks, electric drinking water coolers located in the various plant buildings, and site grounds irrigation.

The sanitary waste system is designed to drain the noncontaminated sanitary waste from the various buildings served.

All system fixtures, piping, and component material, as well as the fabrication, erection, and testing comply with applicable sections of appropriate codes and standards.

The potable water storage tank is designed and constructed in accordance with ASME Section VIII and Seismic Category II requirements.

9.2.4.2 System Description

9.2.4.2.1 Potable Water System

The potable water system is shown in Figure 9.2-5. Water is supplied to the potable water storage tank (PWC-TK-1). The makeup water treatment system is described in Section 9.2.3. The potable water tank is located in the basement of the service building from which potable water is pumped to all buildings serviced.

Potable hot water is provided to the various plant buildings by individual electric hot water heaters.

9.2.4.2.2 Sanitary Drain System

The plant sanitary waste system is shown in Figure 9.2-6. All noncontaminated sanitary waste from all buildings is directed into this system. Potentially contaminated drainage, such as that from the radiochemical laboratory sinks, is routed to the radioactive drainage system as described in Section 11.2.

All sanitary drains in the plant are collected into a main 6-in. sewage header which leaves the plant building complex, below grade, from the service building. All waste lines are vented to the atmosphere via roof vents in accordance with applicable codes except those in the reactor building, which are vented to the main reactor building exhaust system (see Section 9.4.6) and in the main control room are vented to the main control room exhaust system.

All sanitary lines drain by gravity flow into the main 6-in. sewage pipe which connects to an 8-in. line leading to a centrally located sanitary waste treatment facility (SWTF) serving WNP-1, Columbia Generating Station (CGS), WNP-4, the Kootenai Building (Plant Support Facility), and the Department of Energy's 400 Area (FFTF facility). Low levels of radioactive materials, particularly tritium from the 400 Area, are expected to be present in the treatment facility as a result of processing these waste streams. The SWTF is permitted and regulated by the State of Washington and is not part of the CGS licensing basis. Therefore, the radioactive material from FFTF is not considered to be licensed material.

9.2.4.3 Safety Evaluation

The potable water and sanitary drain systems are of conventional design and have no safety function. All contaminated drains are routed to the liquid radwaste system as discussed in Section 11.2. All system piping except that in the reactor building and control building is Seismic Category II as defined in Section 3.2.1. The piping in the reactor building and control building is Seismic Category I.

9.2.4.4 Testing and Inspection Requirements

Routine monitoring during normal operation verifies the system is performing acceptably.

9.2.4.5 Instrumentation Requirements

The system is provided with sufficient instrumentation and controls to monitor and operate the system to meet the normal operating requirements of the facility.

9.2.5 ULTIMATE HEAT SINK

9.2.5.1 Design Bases

a. The ultimate heat sink (UHS), a spray pond system, supplies cooling water to remove heat from all nuclear plant equipment that is essential for a safe and orderly shutdown of the reactor and to maintain it in a safe condition;

b. The UHS is capable of accomplishing its safety function for a normal cooldown or an emergency cooldown following a LOCA without the availability of offsite power. The sink provides this cooling capability for a period of 30 days without outside makeup (except following a tornado). Provisions are made for replenishment of the sink to allow continued cooling capability beyond the initial 30-day period. The sink will accomplish its safety function despite the occurrence of the most severe site-related natural events including earthquake, tornado, flood, or drought; and

c. Regulatory Guide 1.27 compliance is described in Section 1.8.

9.2.5.2 System Description

During all normal operating conditions, including normal shutdown as well as emergency conditions, waste heat from the reactor auxiliaries is transferred to the UHS by the standby service water (SW) system.

The UHS consists of two concrete ponds. The concrete ponds provide suction and discharge points for the redundant pumping and spray facilities of the SW system. The pond and pump house arrangements are shown in Figure 9.2-7. The ponds and pump houses are designed to Seismic Category I requirements. Standby service water loop A draws water from pond A, cools the Division 1 equipment required for safe shutdown, and discharges through a spray ring into pond B for heat dissipation. Similarly, SW loop B draws water from pond B, cools Division 2 equipment, and discharges through a spray ring into pond A. The high-pressure core spray (HPCS) SW system draws water from pond A, cools Division 3, and discharges without spray into pond A. A siphon between the ponds allows for water flow from one pond to the other.

The spray system illustrated in Figure 9.2-7 consists of two annuli of spray trees, one for each of the SW subsystems. Each annulus is 140.0 ft in diameter and contains 32 spray trees equally spaced (13.75 ft between vertical centerlines) on the circumference. The vertical trees are serviced by the annulus water pipe, 20 in. in diameter, mounted above the water level. The annulus pipe is fed by the main header from each respective pump house. Each spray tree consists of a vertical riser pipe or trunk 8 in. in diameter and horizontal limbs of 1.5-in. pipe. The limbs are attached to the riser at 2 ft-8 in. intervals of heights and are rotated at 90 degree subsequent angles from each other so that the arms resemble a counterclockwise helix with increasing height. The arms radial to the annulus are 4 ft-6-7/16 in. long. The lowermost arm is a tangent arm. The arms tangent to the annulus pipe are 3 ft-6 in. long. Spray nozzles are located at the end of each arm and are connected by fittings. The orientation of every nozzle is radially inward with an angle of 55 degrees upward from horizontal. The nozzles are 1-1/2-CX-27-55 Whirljet nozzles supplied by Spraying Systems Company. Since each tree nozzle is located at a different elevation, each nozzle pressure is different. The uppermost nozzle water pressure is approximately 17 psig, and the total water flow from a tree is approximately 300 gpm.

The HPCS SW flow is treated as a straight heat dump in the thermal analyses.

The combined water volume of the spray ponds is adequate to provide cooling water for 30 days without makeup. Although the ponds are not routinely used for cooling during normal operation, some small losses are to be expected due to normal evaporation from the surface, minor leakage from the ponds, and occasional blowdown needed to maintain water chemistry. A gravity makeup line is provided from the circulating water pump house to the spray ponds; however, the required pond level will normally be maintained by makeup directly from the TMU water pumps (see Section 10.4.5) or directly from the potable water system. The TMU is the makeup source credited in the event of water loss due to a tornado. Design parameters for the spray pond are given in Tables 9.2-1 and 9.2-2.

An SW pump is located in each spray pond pump house along with its associated equipment so that an accident, such as a fire or pipe break associated with one pump, would not affect the operation of the redundant pump.

The bottom of the pump sump is depressed below the pond bottom. This ensures that there is still sufficient submergence for the pumps at the lowest possible water level in the pond. A sand trap and screen precede the pump sump to prevent heavy debris from entering the pump sump area. A skimmer wall and fixed screen prevent floating debris from entering the pumps.

A spray ring bypass is provided that allows water to be returned directly to the pond through use of manually operated dump and spray ring isolation valves. This allows pond temperature to be controlled during cold weather operations, mixing of the pond volumes, minimization of drift losses, and other situations where bypass of the spray rings is desirable. If the spray ring header is bypassed, it will be realigned to allow spray mode of operation before pond temperature exceeds 70°F. Analysis demonstrates that at pond temperatures less than or equal to 70°F, sufficient time is available under accident conditions to permit realignment to the spray mode prior to pond temperature exceeding 77°F.

To prevent adverse operation during freezing weather, all SW piping and components are either below the frost line, within heated buildings, heat traced or drained when not in use.

To allow for infrequent maintenance of the spray pond piping and piping supports, a cross connection, consisting of a removable spool piece and two isolation valves, is available between the two redundant loops of SW. A removable siphon plug is available to prevent one pond siphoning to the drained pond. The cross connecting spool piece and siphon plug are normally not installed and are only used while the plant is shut down for refueling. This cross connection allows water to be pumped back directly to the pond from which it was removed, thus allowing for the other pond to be drained.

9.2.5.3 Safety Evaluation

An oriented spray cooling system (OSCS) is utilized for cooling the water inventory of the UHS. The OSCS was developed as a result of intensive analytical studies and experimental verification over a period of more than 6 years. Details of the OSCS experimental and analytical developmental efforts are described in Topical Report, Oriented Spray Cooling System (OSCS) for Ultimate Heat Sink Application (UHS), I-R 100, which has been submitted for Nuclear Regulatory Commission staff review.

The thermal performance model is based on the correlation of the Canadys test data described in Section 3.1 of the Topical Report, I-R 100. The resulting KAV/L for this application is 2.66. This includes a 10% derate of the KAV/L to cover conservatively the data scatter experienced at Canadys. Since the KAV/L represents the performance of the specified geometry and nozzle pressure, the KAV/L combined with the meteorological data are sufficient to determine the system cooling performance. The performance predicted by this model is modified as shown below.

$$CR = (-0.761 + 0.009 \times TWB) + (0.2677 + 0.004029 \times TWB) \times CP + (0.001179 - 7.14 \times 10^{-6} TWB) \times CP^2$$

CR = cooling range
TWB = wet bulb temperature
CP = cooling potential

The system model for both the thermal performance analysis and the mass loss analysis was based on the following assumptions:

a. The pond contains total inventory upon onset of LOCA less 0.5 ft for sedimentation of the pond basin;

b. Water losses result only from drift, leakage, evaporation of the sprayed droplets and evaporation due to heat rejection on the pond surface;

c. All the heat transfer is accomplished by evaporation, none of the heat transfer is accomplished by sensible heat transfer;

d. The first 3 days of the thermal performance analysis assume the worst single day of record conditions (Table 9.2-3). It was found that repeating the worst day conditions for 3 days resulted in the maximum peak. The 4 through 30 days are the average meteorological conditions of the worst 30-day period of record (Table 9.2-3). For conservatism, the root mean square (RMS) average wind speed during each period is used rather than the diurnal variation;

e. The 1 through 30 days of the mass loss analysis are the average meteorological conditions of the worst 30-day period of record (see Section 2.3.1.2 and Table 9.2-3). The analysis assumes a mass loss due to drift of 1.02% of the spray flow. This value is an upper bound obtained from results of tests performed on the spray ponds. Its conservatism was confirmed by testing reported in Reference 2 and shown in Figure 9.2-8;

f. For the design basis mass loss case evaluation, the spray flow is continuous for one spray ring for the first 3 days, with one SW pump in operation. The sprays are cycled on and off for the 4 through 30 days depending on pond temperature. The sprays are turned on when the SW temperature in the suction pond reaches 85°F and are turned off when the temperature drops below 80°F. This method of operation resulted in one cycle on and off per day;

g. Minor leakage was observed in testing of the spray ponds, so test results were used to establish a leakage rate of 3.94 gpm total for both ponds (170,000 gal per 30 days);

h. While not a design basis case, mass loss was also evaluated assuming two spray rings in continuous operation for 2 days, followed by one spray ring in cyclic mode described in item f;

i. The design basis fuel pool cooling heat load is included;

j. For design basis analysis, offsite power is lost and Division 2 diesel fails to start, resulting in a loss of the pond A spray header. (Division 1 heat loads are slightly higher); and

k. The major heat loads considered are reactor core decay heat, sensible heat from both the coolant and the reactor, fuel pool decay heat, pump work, and the heat removed from the station auxiliaries. These heat loads are listed in Table 9.2-4 (using the calculated heat load values) and Table 9.2-5. The fuel pool decay heat generation rate, listed in Table 9.2-4 as variable, is found in Table 9.2-5. No credit was taken for heat sinks in the primary containment other than the suppression pool volume.

The RMS average wind speed during the selected 30-day period for the mass loss analysis was 6.91 mph. The drift loss was based on the calculated drift value at the RMS wind speed. The mass loss analysis thus demonstrates that the spray ponds contain sufficient water inventory to meet drift losses significantly higher than expected. Figure 9.2-8 shows the conservatism demonstrated in confirmatory drift loss testing.

The analyses assume an initial temperature of 77°F. This is approximately the highest monthly average temperature expected if the sprays are not operated. To maintain the pond temperature below this limit, the spray headers will be operated and/or river water makeup to the cooling towers will be diverted through the spray ponds. Analyses were performed which demonstrate that the above operations can maintain the spray pond below 77°F.

An analysis was conducted which verified failure of Division 1 or Division 2 power results in the most severe service water transient. If the failure was postulated in Division 3 (HPCS) instead of Division 1 or 2, the peak pond temperature is lower. The HPCS SW flow is a straight heat dump; therefore, inasmuch as the spray pond is concerned, it raises rather than lowers the temperature transient.

The resulting peak spray pond temperature, 89.5°F, predicted by the "worst case" analysis is below the 90°F service water temperature assumed in the analysis performed in Section 6.2.1 for containment heat removal, adding further conservatism to the containment temperature and pressure transients therein presented. The service water temperature, however, exceeds the design basis temperature, 85°F, for short periods of time as shown in Figure 9.2-9.
A temperature of 90°F has been evaluated for those rooms served by emergency heating, ventilating, and air conditioning (HVAC) equipment, and room temperatures remain within the design limit.

A sensitivity study was performed to determine the effect of the RHR heat exchanger effectiveness on the spray pond temperature transient. The RHR heat exchanger effectiveness varies with the amount of fouling and with the flow rates. The RHR heat exchanger flows different from the rated values in Table 6.2-2 are anticipated only if the operator delays or fails to close the RHR heat exchanger shell side bypass valve as discussed in Section 6.2.2.3. Anticipated variations in fouling were determined to have essentially no affect on the spray pond temperature transient following a design basis LOCA. However, the combination of low SW to RHR cooling flow, low overall SW flow, design RHR HX fouling and no containment spray does adversely affect peak pond temperature. For this reason the temperature case uses low flow/design fouling while the mass loss case uses high flow/clean heat exchangers.

The results of the design basis mass loss analysis assuming an unfouled heat exchanger is shown in Figure 9.2-10 and is tabulated in Table 9.2-6.

Drift losses following loss of makeup to the ponds may be controlled during two spray ring operations by bypassing the spray header on one pond whenever spray pond temperatures drop below approximately 80°F. Continuous, simultaneous operation of both spray rings is not required after a LOCA. Since the two SW loops are redundant to each other, operators will be able to secure any redundant safe shutdown equipment when they determine that the peak temperatures have been passed.

Table 9.2-7 lists the available sources of makeup water to provide continued cooling beyond the initial 30-day period. This table assumes that offsite power is restored within the 30 days. No credit is taken for the water stored in the cooling tower basins. However, it is expected that this water will not be instantaneously lost and may flow to the pond for the same period of time. Table 9.2-7 also summarizes the effects of natural phenomena and of a LOCA on the water supplies to the spray pond.

The possibility of a tornado passing over the spray pond and removing a significant amount of water is considered a credible event. For this reason, the makeup water pump house is designed to be tornado proof, with all piping and electrical power supply between the plant and the pump house underground with adequate soil cover to provide protection from tornado-generated missiles. Since it is not credible to assume an earthquake coincident with a tornado, this system need not be Seismic Category I. Two 12,500-gpm tower makeup water pumps are provided, one powered from each emergency diesel generator. Should pond water be lost due to a tornado, one of these pumps will be started to provide makeup. If the spray headers are damaged by a tornado-generated missile, cooling is provided by a feed-and-bleed mode of operation. In the feed-and-bleed mode, cooling water is supplied to the spray ponds from the makeup water pump house. The service water system takes suction from the spray ponds to provide cooling to safe shutdown equipment. The cooling water is then routed to tornado-protected underground circulating water piping and discharged to the circulating water basin.

The design basis of the UHS includes a 6-in. sedimentation allowance for water inventory considerations. This allowance includes all forms of accumulation, such as dust, silt, or volcanic ash. The design basis ashfall is 3 in. which bounds the Mount St. Helens eruption of May 18, 1980. When sedimentation levels reach 3 inches, an administrative requirement to clean the spray ponds has been incorporated into plant procedures. This ensures adequate water supply even in the event of a design basis ashfall.

With regard to SW pump operation following a design basis ashfall, experience has shown that there may be some increased seal leakage as a result of ashfall. An evaluation was performed which concludes that the pumps would remain operable during a volcanic ashfall condition. Bearing life could be shortened, and bearings would be examined for wear when possible following a significant ashfall.

While the plant is shut down it may be necessary to drain one spray pond for maintenance using the cross connecting spool piece and siphon plug to provide a flow path back to the same pond from which the water was pumped. For this infrequently used mode, there is less than a 30-day supply of water available in one pond without makeup. However, with the reactor vessel depressurized, flooded up to 22 ft or greater above the reactor flange, the fuel pool gates removed, and the reactor at a relatively low temperature (less than about 140°F) prior to removal of a pond from service, the risk to public safety is very small. Alternative makeup water sources for the UHS can be made readily available. Experience has shown that temporary pipe lines can be run from the river in about 3 days. Even in the unlikely event of a loss of the siphon plug, the water inventory would not be lost and the system would remain operable. In that event, water in the inactive pond could be transferred back to the operating pond via portable pumps.

9.2.5.4 Testing and Inspection Requirements

Availability is ensured by periodic functional tests and inspections as required by the Technical Specifications.

9.2.5.5 Instrumentation Requirements

The spray pond is equipped with redundant level and temperature sensors which are alarmed and indicated in the main control room.

In the event that the spray pond level falls below the minimum level required for 30 days of cooling, an alarm is sounded and makeup to the spray ponds is provided using the TMU.

High and low temperature alarms are provided. If the pond water temperature approaches the upper design limit, the spray system is manually initiated to lower the temperature. On a low water temperature signal, return water is dumped directly into the ponds to prevent spray trees and spray headers from icing.

9.2.6 CONDENSATE SUPPLY SYSTEM

9.2.6.1 Design Bases

The condensate supply system (COND) is designed to:

a. Store and provide a condensate supply to the reactor core isolation cooling (RCIC) system, the HPCS system, and the RHR loops;

b. Maintain an adequate level of condensate in the condenser hotwell;

c. Provide a condensate supply for the control rod drive pumps;

d. Provide makeup water to the spent fuel pool;

e. Provide condensate for various radwaste processes;

f. Facilitate testing and/or flushing of the HPCS, low-pressure core spray (LPCS), RHR, and the RCIC;

g. Receive and accommodate a surge volume for condensate returned to the storage tanks after treatment in the liquid radwaste system; and

h. System piping is constructed to ANSI B31.1. Condensate storage tanks are constructed to ASME Section III, Class 3 requirements. System piping inside the reactor building is Seismic Category II, supported to Seismic Category I requirements. All other piping and system pumps are designed to Seismic Category II requirements. The radwaste building condensate supply pump and the condensate filter demineralizer backwash pump are constructed to ASME Code Section III, Class 3. The reactor building condensate supply pump is designed to the Standards of the Hydraulic Institute.

9.2.6.2 System Description

The demineralized water system and the liquid radwaste system are the primary sources of makeup water to the condensate storage tanks.

The COND is shown in Figure 9.2-11. The system consists of two storage tanks (COND-TK-1A, COND-TK-1B) each with a nominal capacity of 400,000 gal and equipped with electric heaters, a reactor building condensate supply pump (COND-P-3), a radwaste building condensate supply pump (COND-P-4), a condensate filter demineralizer backwash pump (COND-P-5), and necessary piping and instrumentation. The tanks are manufactured with a design pressure of atmospheric plus full static head and maximum design temperature of 140°F. Minimum operating temperature of the tanks is 40°F. The tanks are designed to withstand a wind load of 20 psf on the vertical projected area of the tank and a snow load of 20 psf.

The radwaste building condensate supply pump and the condensate filter demineralizer backwash pump each are designed to supply 1535 gpm at 185 ft total head. The radwaste condensate supply pump has a secondary operating point of 500 gpm at 220 ft total head. The reactor building condensate supply pump is designed to supply 200 gpm at 220 ft total head.

A minimum inventory of 135,000 gal in the condensate storage tanks is reserved for the RCIC and HPCS pumps. This ensures the immediate availability of a sufficient quantity of condensate for emergency core cooling, and reactor shutdown, as discussed in Section 9.2.6.3 and Station Blackout as discussed in Appendix 8A.

Makeup for the condenser hotwell is gravity fed from the storage tank. Bleedoff water from the condensate system is returned to the storage tanks from the discharge of the condensate demineralizer.

A separate line is provided to supply the control rod drive pumps with condensate. Condensate is supplied for various reactor building services, including fuel pool makeup by the reactor building condensate supply pump. The condensate storage tank can be drained to the condenser hotwell. Inadvertent overflow of the tanks is collected in the concrete retaining basin surrounding the tanks. This water can be drained to the radwaste system for processing if sampling indicates that the water is radioactively contaminated. Rain water collected in the retaining basin can be drained to the radwaste system for processing.

9.2.6.3 Safety Evaluation

The condensate storage facilities are not required to ensure any of the following:

a. The integrity of the RCPB,

b. The ability to shut down the reactor and maintain it in a safe shutdown condition, or

c. The ability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures in excess of the guideline exposure of 10 CFR Part 100.

Although a minimum of 135,000 gal is maintained in the condensate storage tanks as a source of water for the RCIC and HPCS pumps, the supply of water in the suppression pool is the emergency source of water for these pumps. The reserve of water is maintained by monitoring the level in the condensate storage tank and by preventing condensate transfer when this reserve level is reached. The RCIC and HPCS pumps are gravity fed from the condensate storage tanks.

The condensate storage tanks are Seismic Category II; however, they are located inside a Seismic Category I concrete dike which is designed to retain the condensate from both tanks. Drainage from the dike is routed to the radwaste system for processing. During precipitation, drainage from the dike is sampled and analyzed for radioactivity before being discharged to a Turbine Building sump and processed in the radwaste system.

The evaluation of radiological considerations for the COND is presented in Section 2.4.13.3. Since the dike is designed to contain any condensate from a postulated tank rupture in conjunction with the heaviest recorded precipitation, the resulting offsite dose rate from this occurrence would be no greater than the value presented in Section 2.4.13.3.

For corrosion protection, the tanks are made of carbon steel with a 1/16-in. corrosion allowance and lined with a modified phenolic coating. Quality control for the application of the coating was in accordance with ANSI N101.4. The interior surfaces of the tanks were blasted to white metal in accordance with SSPC-SP-5 prior to the application of a minimum of 10 mils dry film thickness of Plasite 7155. Coating repairs are made with a compatible amine cured epoxy coating.

9.2.6.4 Testing and Inspection Requirements

The components were inspected and cleaned prior to installation into the system. The condensate storage tanks side wall, side wall to bottom, and nozzle joints were examined in accordance with ASME Section III, Subsection NC-5000. The tank thickness was tested by magnetic means in accordance with ASTM E376. Underground portions of the HPCS and RCIC piping welds were 100% radiographed to ensure the integrity of the piping.

Periodic functional tests and inspections as required by the Technical Specifications ensure system availability for nonroutine functions. Routine monitoring during normal operation verifies satisfactory system operation to support plant requirements for normal operation.

9.2.6.5 Instrumentation Requirements

Condensate storage tank level is monitored in the main control room. High- and low-level alarms are provided to prevent overflow and to prevent the water level from dropping below the required reserve level for reactor pressure vessel (RPV) makeup. Level switches provide low-low annunciation and interlock with the HPCS and RCIC systems. Building condensate supply pumps are provided with manual controls for maintaining condensate supply pressure in the system headers so that condensate is available for system process services, based on demand.

The following parameters apply to the condensate storage tanks.

Reserve capacity for RPV makeup is provided between the setpoints of the low-level switch and the low-low-level switch. The elevation differential provides a reserve capacity of approximately 67,500 gal per tank.

Thermostatically controlled tank heaters are provided to maintain water temperature in the tanks at or above a nominal 40°F at all times. All above-ground piping that contains water is heat traced to prevent freezing.

System logic diagrams are given in Chapter 7.

9.2.7 STANDBY SERVICE WATER SYSTEM

9.2.7.1 Design Bases

a. The SW system is designed to remove heat from plant systems that are required for a safe reactor shutdown following a LOCA;

b. The system is designed to remove reactor decay heat from the residual heat removal system during normal plant shutdown;

c. The system is designed to perform its required cooling water function following a LOCA, assuming a single active failure;

d. The system is designed to provide a means of flooding the vessel and containment, if required during the post-LOCA period;

e. The system is designed to provide a long-term cooling and makeup source to the fuel pool cooling system following a loss of the RCC system which is the normal source of cooling to fuel pool cooling and cleanup (FPC); and

f. The system is constructed to Seismic Category I and ASME Code Section III, Class 3, requirements with the exception of that portion to and from the plant cooling towers, which is constructed to ANSI B31.1 and Seismic Category II requirements; the spray bypass line discharge orifice and mating flange, which are also constructed to ANSI B31.1 and supported Seismic Category I, the keep full subsystem located in the pump house which is constructed to ANSI B31.1 and supported Seismic Category I, and the spray pond crossover piping which is constructed to ANSI B31.1 and supported Seismic Category I.

9.2.7.2 System Description

The SW system includes vertical service water pumps located adjacent to the two spray ponds in two separate pump houses designed to Seismic Category I criteria. The pumps discharge to three independent piping systems which serve emergency core cooling system (ECCS) equipment, auxiliary plant equipment, and reactor shutdown cooling equipment (see Figures 9.2-7, 9.2-12 through 9.2-14).

The SW pumps consist of two independent 100% capacity pumps each supplying normal and emergency shutdown cooling equipment as shown in Table 9.2-4. A third 100% capacity HPCS service water pump (housed in pump house A) supplies the HPCS system cooling equipment as shown in Table 9.2-4.

Each of the three SW pumps receives its power from independent electrical buses. Each bus is powered from the offsite power supply or its own diesel generator.

During the normal and emergency shutdown modes of operation, water is circulated from the spray ponds to the equipment requiring cooling, and returned to the ponds. The two SW systems return via the spray rings prior to recycle. The HPCS service water returns directly to pond A with no sprays. Spray pond operation and a description of its ability to dissipate waste heat from the plant during normal, shutdown, and accident conditions are provided in Section 9.2.5.

The system is designed such that on receipt of an ECCS start signal, all three pumps are started automatically.

The two spray ponds are sized to have a combined equivalent storage for at least 30 days of operation, assuming no makeup and maximum evaporation and drift losses (see Section 9.2.5).

The SW system is chemically treated to control biological growth and to minimize corrosion.

A small keep-full subsystem is attached to the SW system piping. The keep-full subsystem was originally designed to provide back pressure on the pump discharge valve so that maintenance repairs on the valve could be minimized (i.e., the keep-full subsystem was never intended to keep the system piping completely full). The pump discharge valve design and the system start sequence were changed so that back pressure on the pump discharge valve during the start sequence was no longer necessary. The SW system is able to start from a partially drained condition without damage to system components. The keep-full subsystem has been deactivated and spared in place because it no longer provides a useful function.

The spray ponds are provided with makeup water by the TMU system or the potable water system. The makeup water system supplies Columbia River water to the cooling towers or spray pond to replace water lost during normal operation due to evaporation and drift. The potable water system replaces normal spray pond evaporation and drift losses. In addition, the makeup system is designed to replace spray pond water lost during a tornado. To ensure system availability for this mode of operation, the makeup system is designed to withstand a design basis tornado coincident with a loss of offsite power (see Section 9.2.5.2).

The SW system piping is carbon steel designed to 309 psig (some 150 psig), 150°F, and with a corrosion allowance of 0.080 in. Where SW piping degradation due to erosion/corrosion or other degradation mechanisms occurs, stainless steel material may be substituted to prevent future recurrence.

Standby makeup water to the fuel pool system can be supplied through normally closed Seismic Category I, Quality Class 1, isolation valves by remote manual operation from the control room for SW-V-75A and SW-V-75B and by manual operation for SW-V-75AA and SW-V-75BB (see Section 9.1.3.2.3).

EQUIPMENT DESIGN PARAMETERS

Standby Service Water Pumps (SW-P-1A, SW-P-1B)

Quantity	2
Driver	Motor - ac
Design Capacity	10,300 gpm
Head	500 ft

HPCS Service Water Pump (HPCS-P-2)

Quantity	1
Driver	Motor - ac
Design Capacity	1200 gpm
Head	123 ft

9.2.7.3 Safety Evaluation

The SW system provides cooling for plant equipment that is essential to a safe reactor shutdown following a design basis LOCA.

System failure mode and effects analyses of passive and active components of the SW system is presented in Table 9.2-8. Any of the assumed failures of the SW system is detected in the main control room by indications and/or alarmed from the various system instruments.

The SW is routed through the tube side of the RHR heat exchanger, through the shell side of the FPC heat exchangers, and through the shell side of the RHR pump seal coolers. The RHR heat exchanger, the FPC heat exchanger, and the RHR pump seal coolers are the only potential sources of radioactive leakage into the standby water system.

A restricting orifice and bypass valve is installed on return lines of loops A and B to maintain sufficient back pressure to ensure flow to all components and to maintain the pressure in the system at a level such that tube leakage in the RHR heat exchanger or pump seal cooler is from the service water system into the RHR system after the reactor is depressurized following shutdown or after a LOCA. Liquid effluent radiation monitors are provided in each of the two RHR heat exchangers outlet lines of the service water system to detect radioactivity resulting from a tube leak in one of the RHR heat exchangers. This condition can occur only for a short time when the RHR system is operated in the shutdown cooling mode in which the service water system pressure may be lower than the RHR system pressure. On detection of radioactive leakage in one of the subsystems, that subsystem is isolated by operator action in the main control room and the cooling requirements are met by the redundant train.* Per the CGS emergency procedures the operators are directed to utilize the alternate shutdown cooling mode when a degraded core condition has been identified. The alternate shutdown cooling mode does not have the potential for radiation leakage into the SW system due to the lower RHR pressure. Consequently, radioactivity released to the spray ponds and/or cooling tower basins is minimized.

Under emergency conditions, i.e., loss of RCC system, the SW system can be routed through the shell side of the FPC heat exchangers to provide long-term cooling. The SW system

* Note that the Safety Evaluation Report for CGS (NUREG – 0892) states in 5.2.5 that automatic isolation is provided. The response for CGS has always been by operator action.

pressure is higher than the FPC system pressure, so that any leakage will be into the FPC system.

An intertie with the RHR system is provided from the SW system supply header B which contains two remote manually operated isolation valves. These valves can be opened from the main control room in the event primary containment flooding is required following a LOCA.

An atmospheric syphon is provided to allow the transfer of water between the two spray ponds. In addition, the SW pumps are provided with double valved, normally closed bypass connections for transferring water from one pond to another.

Temperature controlled and/or manually operated throttle valves are located on the return side of all SW serviced coolers and heat exchangers. The system is balanced for optimum operation and the throttle valves left in that position. The RHR heat exchanger service water outlet valve, while open during normal standby lineup, is interlocked to open on starting of an SW pump to prevent excess flow conditions in other portions of the system.

Normal SW return is to the spray pond, with normally closed redundant isolation valves on the SW return line to the cooling towers. These valves are mechanically and electrically prevented from opening to preclude returning SW to the cooling towers during normal system operation. This is to ensure that the spray ponds always maintain the capability to meet the system requirements described in Section 9.2.5 and allows control of water chemistry by minimizing dilution.

The non-safety-related SW keep-full subsystem cannot inhibit the ability of the SW system to meet its safety function. Keep-full piping is small and any break in that piping would result in a flow change to SW that is insignificant. The potential flooding of the valve pit area has been evaluated to ensure continued system performance should a break occur in the deactivated keep-full system.

An orifice is installed on the discharge of each spray bypass line where it enters the spray pond. The purpose of the orifice is to mitigate cavitation damage that has occurred in the past due to the higher flow rate of the system in the spray bypass mode of operation. The orifice balances the flow in the bypass mode so it is approximately the same as that in the spray mode. The orifice and its mating flange serve no safety-related function and serve to reduce the potential for long-term effects of cavitation. Failure of the orifice cannot affect the ability of the SW system to fulfill its safety function. The elbow to which the orifice is attached directs the return water into the pond after it passes through SW-V-165A/B, and failure of the orifice would not obstruct or limit flow of return water to the spray pond.

During normal plant operation, the SW pumps are not operating. If a LOCA occurs, the diesel generators and respective SW pumps start automatically. Consequently, no operator action is required following a LOCA to start the SW system and put the system into its LOCA operating mode.

9.2.7.4 Testing and Inspection Requirements

The SW system is designed to permit periodic inspection of all active system components to ensure the integrity and capability of the system. For inservice inspection see Section 6.6.

The SW system is periodically tested as required by the Technical Specifications to ensure system availability and capability to perform its required design functions.

Requirements for monitoring of heat exchangers cooled by SW are discussed in Generic Letter 89-13. Energy Northwest response to Generic Letter 89-13 outlines compliance with these requirements.

9.2.7.5 Instrumentation Requirements

Each of the SW discharge lines from the RHR heat exchangers contains radiation monitors to detect any radioactivity resulting from a tube leak in the RHR heat exchanger.

Flow indicators and/or switches are provided for most serviced components to indicate low flow. The radiation monitors have transmitters but no indicators due to the use of gravity flow. There are no permanently installed flow instruments for the control room chilled water (CCH) since service water flow through the chiller condensers is controlled by temperature control valves. Temperature indicators, temperature switches, pressure indicators, and/or pressure switches are located in each system to determine pump, individual cooling coil, cooler, or heat exchanger performance.

To avoid excessive system surge pressures, SW pumps SW-P-1A and SW-P-1B are started only if the associated pump discharge valve is closed. HPCS-P-2 can auto start with its discharge valve open, in order to minimize running the HPCS DG without service water cooling (see Section 9.5.5 for discussion of the diesel generator cooling water systems). All three pumps start automatically when the associated diesel generator is started. For each of the three pumps, the pump discharge valve automatically opens when the associated pump is running and the pump discharge pressure is greater than 50 psig. The system instrumentation is shown in Figure 9.2-12.

9.2.8 COMPRESSOR JACKET WATER SYSTEM

9.2.8.1 Design Bases

a. The CJW system is designed to circulate clean water to remove heat from the control air system compressor oil coolers and aftercoolers,

b. The CJW system provides clean water to remove heat from the control air system refrigerated dryer condensers, and

c. Heat is rejected from the CJW system to the plant service water system (TSW).

The CJW system piping and valves are designed in accordance with the ANSI B31.1 Power Piping Code, using design conditions of 125 psig and 200°F, except for the fill and makeup supply piping at the surge pipe, which is designed to 150 psig and 150°F, the same as the demineralized water system. The CJW system is open to the atmosphere at the surge pipe, and the maximum system pressure at the pump discharge is less than design pressure. The heat exchangers are designed and constructed to the ASME Boiler and Pressure Vessel (B&PV) Code Section VIII for design conditions of 150 psig and 200°F.

9.2.8.2 System Description

The CJW system is shown diagrammatically in Figure 9.2-15. Fill and makeup water is supplied from the demineralized water system to the surge pipe through a float operated valve (CJW-LCV-1). An overflow line allows expansion volume to drain to an equipment drain. The surge pipe is connected to the circulating coolant return header at a high point and is open to the atmosphere to vent free air released from the heated water. A positive suction head of approximately 20 ft is provided at the circulating pump suction by the water level in the surge pipe.

Two full-capacity centrifugal pumps (CJW-P-1A and CJW-P-1B) are provided, permitting the system to remain in operation while one pump is isolated for servicing or repair. The operating pump draws water through the return header from the outlets of the compressor(s) and refrigerated dryers(s) in service at that time. This heated water is discharged from the pump toward two full-capacity plate and frame heat exchangers.

The heat exchangers (CJW-HX-1A and CJW-HX-1B) are designed for one to be in operation while the other is isolated. Heat is rejected from the CJW system to the plant service water system. The plant service water is essentially river water which may contain considerable amounts of particulate solids. The CJW to TSW heat exchangers are of the plate and frame type that maintain water velocities high through the passes on both sides, and are readily opened to clean the plate surfaces without disturbing the connecting piping. In the event a heat exchanger becomes fouled, it may be isolated and cleaned while both the CJW and TSW systems remain in operation. The cooled water from the heat exchangers is piped to the compressor and refrigerated dryer supply header. Coolant flow to the compressors and dryers is controlled by temperature control valves in each unit. The dryers will provide a minimal flow path so the CJW pumps do not deadhead because the dryers are designed for continuous operation.

Cooling water at each compressor and refrigerated dryer may be manually isolated when a compressor or dryer is taken out of service for repair, and the coolant may be drained, without disturbing coolant flow at the other compressors and dryers.

9.2.8.3 Safety Evaluation

Operation of the CJW system is not required for the initiation of any engineered safety feature system, or for safe shutdown of the reactor. However, plant availability depends on an adequate supply of compressed control air to operate nonnuclear plant systems, and the CJW system includes redundant components to ensure operability of the system under most conditions.

9.2.8.4 Testing and Inspection Requirements

Routine surveillance inspections while in operation will discover conditions requiring correction before functional failure of the system will occur.

9.2.8.5 Instrumentation Requirements

Sufficient instruments and controls are provided for system operation to support normal facility requirements.

9.2.9 REFERENCES

9.2-1 "1979 Ultimate Heat Sink Spray System Test Results," Washington Public Power Supply System Nuclear Project No. 2 Report (WPPSS-EN-81-01).

9.2-2 "WNP-2 Spray Pond Drift Loss Report," Washington Public Power Supply System, July 1985.

9.2-3 "Plant Service Water (TSW) System," Design Basis Document, Section 350.

9.2-4 "Standby Service Water (SW) System," Design Basis Document, Section 309.

Table 9.2-1

Ultimate Heat Sink Spray Cooling
Pond Design

Parameter	Quantity
Pond configuration	Square (250 ft x 250 ft)
Surface area (two ponds)	125,000 ft^2
Normal water elevation (above msl)	433 ft 6 in.
Maximum operating water elevation (above msl)	433 ft 9 in.
Overflow water elevation (above msl)	434 ft 6 in.
Pond bottom elevation (above msl)	420 ft 0 in.
Pump sump bottom elevation (above msl)	408 ft 3 in.
Freeboard above normal water level	1 ft 0 in.
Sedimentation allowance	6 in.
Normal pond capacity (two ponds at el. 433 ft 6 in.)	12,620,000 gal
Minimum pond capacity (two ponds at el. 432 ft 9 in.)	11,920,000 gal

Table 9.2-2

Spray System Design

Parameter	Quantity
Number of systems	2
Number of trees per system	32
Diameter of the ring headers	140 ft 0 in.
Circumferential spacing between trees	13 ft 9 in.
Number of horizontal arms per riser	7
Pressure at top nozzle	17.3[a] psig
Pressure at interface (flange)	24.5[a] psig
Flow rate per tree at design pressure	321.9[a] gpm
Total flow rate per system	10,300[a] gpm
Nozzle type	Spraying Systems Company 1-1/2-CX-27-55
Height of vertical riser	17 ft 9 in.
Spacing between arms	32 in.
Height of bottom nozzle elevation from system interface (flange) riser pipe diameter	6-11/16 in.
Riser pipe	8 in., Schedule 80
Horizontal branch arm pipe	1.5 in., Schedule 80

[a] Flow rates and pressures are for final design with fuel pool cooling system upgraded (see Section 9.1.3). Prior to completion of fuel pool cooling upgrade, total flow is approximately 9750 gpm.

Table 9.2-3

Diurnal Variation in Meteorological Data[a]
Data based on July 10, 1975

Hour	Dry Bulb (°F)	Dewpoint (°F)	Wet Bulb (°F)	Wind Speed[b] (mph)	Solar Radiation (Btu/hr)
Noon	100.91	59.41	72.98	6.60	276.56
1:00 p.m.	103.09	59.69	73.58	6.60	269.47
2:00	105.20	58.91	73.96	6.60	248.68
3:00	105.71	56.00	72.80	6.60	215.58
4:00	104.93	54.11	71.78	6.60	172.40
5:00	102.48	55.88	71.81	6.60	122.04
6:00	101.15	56.05	71.50	6.60	68.05
7:00	98.27	56.13	70.68	6.60	16.46
8:00	96.21	56.59	70.27	6.60	0.00
9:00	90.72	60.53	70.57	6.60	0.00
10:00	91.33	57.68	69.31	6.60	0.00
11:00	91.49	60.48	70.77	6.60	0.00
Midnight	90.91	58.03	69.35	6.60	0.00
1:00 a.m.	85.92	59.17	68.39	6.60	0.00
2:00	84.24	57.28	66.88	6.60	0.00
3:00	80.61	56.21	65.14	6.60	0.00
4:00	80.24	58.48	66.21	6.60	0.00
5:00	78.27	59.55	66.15	6.60	16.46
6:00	83.25	62.99	69.65	6.60	68.05
7:00	86.77	62.91	70.67	6.60	122.04
8:00	90.64	61.09	70.83	6.60	172.40
9:00	92.64	62.00	71.90	6.60	215.58
10:00	95.23	63.36	73.38	6.60	248.68
11:00	98.32	62.40	73.73	6.60	269.47

Table 9.2-3

Diurnal Variation in Meteorological Data[c] (Continued)
Data based on average values for the period July 9-August 8, 1961

Hour	Dry Bulb (°F)	Dewpoint (°F)	Wet Bulb (°F)	Wind Speed[b] (mph)	Solar Radiation (Btu/hr)
Noon	95.40	45.9	65.5	5.50	276.56
1:00 p.m.	96.80	46.1	66.0	5.50	269.47
2:00	97.30	46.1	66.2	5.50	248.68
3:00	96.80	46.2	66.0	5.50	215.58
4:00	95.40	46.2	65.5	5.50	172.40
5:00	93.10	46.0	64.7	5.50	122.04
6:00	90.10	45.6	63.6	5.50	68.05
7:00	86.60	45.6	62.3	5.50	16.46
8:00	82.80	45.6	61.0	5.50	0.00
9:00	79.00	45.2	59.6	5.50	0.00
10:00	75.60	45.6	58.4	5.50	0.00
11:00	72.50	46.0	57.3	5.50	0.00
Midnight	70.20	46.2	56.5	5.50	0.00
1:00 a.m.	68.80	46.0	56.0	5.50	0.00
2:00	68.30	46.3	55.8	5.50	0.00
3:00	68.80	46.1	56.0	5.50	0.00
4:00	70.20	46.2	56.5	5.50	0.00
5:00	72.50	45.8	57.3	5.50	16.46
6:00	75.60	46.0	58.4	5.50	68.05
7:00	79.00	46.6	59.6	5.50	122.04
8:00	82.80	45.8	61.0	5.50	172.40
9:00	86.60	45.6	62.3	5.50	215.58
10:00	90.10	45.8	63.6	5.50	248.68
11:00	93.10	45.8	64.7	5.50	269.47

Table 9.2-3

Diurnal Variation in Meteorological Data[d] (Continued)
Data based on average values for the period July 2-August 1, 1960

Hour	Dry Bulb (°F)	Dewpoint (°F)	Wet Bulb (°F)	Wind Speed[b] (mph)	Solar Radiation (Btu/hr)
Noon	96.40	42.50	64.70	6.91	276.56
1:00 p.m.	98.00	43.50	65.40	6.91	269.47
2:00	98.50	43.50	65.60	6.91	248.68
3:00	98.00	43.50	65.40	6.91	215.58
4:00	96.40	42.50	64.70	6.91	172.40
5:00	93.90	42.00	63.70	6.91	122.04
6:00	90.70	42.00	62.30	6.91	68.05
7:00	86.90	40.50	60.70	6.91	16.46
8:00	82.90	40.00	59.00	6.91	0.00
9:00	78.90	40.00	57.30	6.91	0.00
10:00	75.10	39.00	55.70	6.91	0.00
11:00	71.90	39.00	54.30	6.91	0.00
Midnight	69.40	39.00	53.30	6.91	0.00
1:00 a.m.	67.80	39.00	52.60	6.91	0.00
2:00	67.30	39.00	52.40	6.91	0.00
3:00	67.80	39.00	52.60	6.91	0.00
4:00	69.40	39.00	53.30	6.91	0.00
5:00	71.90	39.50	54.30	6.91	16.46
6:00	75.10	39.00	55.70	6.91	68.05
7:00	78.90	40.00	57.30	6.91	122.04
8:00	82.90	40.00	59.00	6.91	172.40
9:00	86.90	40.70	60.70	6.91	215.58
10:00	90.70	42.00	62.30	6.91	248.68
11:00	93.90	42.20	63.70	6.91	269.47

Table 9.2-3

Diurnal Variation in Meteorological Data (Continued)

[a] Worst single day of record used to analyze the pond thermal response during first 3 days following LOCA.

[b] Wind speed is the average wind speed for period.

[c] Day 4 through 30 used to analyze pond thermal response following LOCA.

[d] Day 1 through 30 used to analyze mass loss following LOCA.

Table 9.2-4

Flow Rates and Associated Heat Loads Used in the Ultimate Heat Sink Analysis[a]

	Equipment Cooled	Flow (gpm)	Heat Load (Btu/hr)
Division 1			
1.	Standby service water pump house cooler A (PRA-CC-1A)	80	300,000
2.	Diesel generator A	1,650	13,200,000
3.	Diesel generator building A coolers	144	Variable
4.	LPCS pump motor bearings	4	0
5.	LPCS pump room cooler (RRA-CC-5)	56	400,000
6.	RHR seal cooler A	7	120,000
7.	RHR Room Cooler A (RRA-CC-2)	33	200,000
8.	Motor control center (MCC) dc room cooler (RRA-CC-12)	20	30,000
9.	MCC (RRA-CC-11)	15	54,000
10.	Control room chiller (CCH-CR-1A)	161	764,750
11.	Cable spreading room cooler	40	130,000
12.	Switchgear room cooler	60	420,000
13.	Hydrogen recombiner MCC room cooler (RRA-CC-13)	11	40,000
14.	Hydrogen recombiner aftercooler A (DEACTIVATED)	0	0
15.	RHR heat exchanger A	6,750 to 7,400	Variable
16.	Analyzer room cooler (RRA-CC-15)	10	15,000
17.	Fuel pool pump room cooler (RRA-CC-20)	35	112,000
18.	Fuel pool heat exchanger A	575	Variable
	TOTAL	9,800 to 10,301	

Table 9.2-4

Flow Rates and Associated Heat Loads
Used in the Ultimate Heat Sink Analysis[a] (Continued)

	Equipment Cooled	Flow (gpm)	Heat Load (Btu/hr)
Division 2			
1.	Standby service water pump house cooler B (PRA-CC-1B)	80	300,000
2.	Diesel generator B	1,650	13,200,000
3.	Diesel generator building B coolers (DMA-CC-21&22)	144	Variable
4.	RHR pump seals B	7	120,000
5.	RHR pump seals C	0	0
6.	RHR room cooler B (RRA-CC-3)	33	162,000
7.	RHR room cooler C (RRA-CC-1)	33	190,000
8.	RCIC pump room cooler (RRA-CC-6)	12	97,000
9.	MCC room cooler (RRA-CC-10)	15	55,000
10.	Control room chiller (CCH-CR-1B)	161	764,750
11.	Cable spreading room cooler (WMA-CC-52B1)	40	130,000
12.	Switchgear room cooler (WMA-CC-53B1)	60	393,000
13.	Aftercooler hydrogen recombiner B (DEACTIVATED)	0	0
14.	Hydrogen recombiner MCC room cooler B (RRA-CC-14)	11	35,000
15.	RHR B heat exchanger B	6,550 to 7,400	Variable
16.	Analyzer room cooler (RRA-CC-17)	10	25,000
17.	Fuel pool pump room cooler (RRA-CC-19)	35	100,000
18.	Fuel pool heat exchanger B	575	Variable
	TOTAL	9,700 to 10,266	

Table 9.2-4

Flow Rates and Associated Heat Loads
Used in the Ultimate Heat Sink Analysis[a] (Continued)

Equipment Cooled	Heat Load (Btu/hr)
Division 3	
1. HPCS diesel generator	7,890,000
2. HPCS diesel building coolers	Variable
3. HPCS pump room cooler	600,000
TOTAL	

[a] Information in this table is data input into the thermal analysis of the UHS calculation. The thermal analysis is constructed to provide the peak pond temperature for a LOCA. As such, the data in this table was chosen to conservatively bound the conditions in the field and, therefore, does not necessarily represent exact plant conditions.

Table 9.2-5

Heat Load Rates Used in Ultimate Heat Sink Analysis

I. Core decay heat load[a]

Calculated using BTP ASB 9-2 data.

II. Reactor coolant sensible heat load[a]

The energy (414 x 10^6 Btu referenced to 32°F) of the reactor coolant is accounted for by starting the suppression pool at 150°F).

		Time (hr)	Rate (10^6 Btu/hr)
III.	Reactor vessel, piping, and core sensible heat load[a]	t ≤ 24 t > 24	8.14 Negligible
IV.	Metal-water reaction heat load[a]	t ≤ 1 t > 1	0.47 Negligible
V.	ECCS pump work load[a,b,c]	t ≤ 8 t > 8	13.168 5.534
VI.	HPCS (division 3) service water system heat load[c,d]	t ≤ 8 t > 8	8.623 0
VII.	Constant division 1 service water system heat load[e,f]	t ≥ 0	19.7
VIII.	Fuel pool heat load	t ≥ 0	8.2[g]

[a] Rejected initially to the suppression pool and subsequently transferred by the RHR heat exchangers to the UHS.

[b] RHR pump 1.972 x 10^6 Btu/hr
LPCS pump 3.5623 x 10^6 Btu/hr
HPCS pump 7.6335 x 10^6 Btu/hr

[c] HPCS system and HPCS SW system shut down after 8 hr.
LPCS system and RHR loop A maintain long-term cooling.

Table 9.2-5

Heat Load Rates Used in
Ultimate Heat Sink Analysis (Continued)

[d] HPCS service water pump work 0.132314 x 10^6 Btu/hr
HPCS coolers (Table 9.2-4) 8.49 x 10^6 Btu/hr

Does not include HPCS diesel building coolers.

[e] Division 1 service water pump work 3.91853 x 10^6 Btu/hr
Division 1 diesel generator, Coolers and misc. equipment (Table 9.2-4) 15.784 x 10^6 Btu/hr

[f] Excludes fuel pool, RHR heat exchanger, and diesel generator building "A" coolers.

[g] This heat load is treated as a constant.

Table 9.2-6

Spray Pond Water Losses and Content
(30 days after design basis LOCA event)

Analysis	Quantity (gal)
Drift losses[a]	3.042 x 10^6
Spray evaporation[b]	5.523 x 10^6
Surface evaporation	0.649 x 10^6
Hydrogen recombiner (DEACTIVATED)	0
Leakage	0.1728 x 10^6
TOTAL	9.387 x 10^6
Remaining inventory	2.533 x 10^6
Minimum volume required for system operation	2.26 x 10^6

[a] Based on conservative RHR heat exchanger flow rate of 7400 gpm and fuel pool cooling at 575 gpm.

[b] Based on inclusion of design basis fuel pool cooling heat load.

Table 9.2-7

Source of Spray Pond Makeup Water

Water Source	Design Basis Earthquake	Probable Maximum Flood	River Blockage or Drought	Tornado	LOCA
Plant makeup water pumps	N/A[a]	N/A[a]	N/A[a]	A[b]	A[b]
Cooling tower basin by gravity	N/A[a]	A[b]	A[b]	A[b]	A[b]
Tank truck or rail	A[b]	A[b]	A[b]	A[b]	A[b]

[a] Not available

[b] Available

Table 9.2-8

Standby Service Water System
Failure Analysis

Single Active Failure	Analysis
Loss of power on one emergency bus due to failure of a diesel generator to start or loss of offsite power.	The service water pump powered by the redundant emergency bus will be automatically started to provide the necessary cooling water.
Failure of pump to automatically start.	Same analysis as above.
Failure of an isolation valve in the service water piping to the cooling tower.	Redundant valve is operated to perform the isolation function.
Failure of ECCS pump room air cooling.	Essential plant cooling requirements met by the redundant ECCS subsystems which have their own independently cooled pump rooms.
Failure of a single service water pump during operation.	Essential plant cooling requirements met by the remaining operable redundant ECCS subsystems.
Failure of system return isolation valve.	Essential plant cooling requirements met by the remaining intact ECCS subsystem which includes its own independent return service water headers.
Failure of a pump discharge or RHR outlet isolation valve to open.	Essential plant cooling requirements met by the remaining operable redundant emergency core cooling subsystems.

Table 9.2-8

Standby Service Water System
Failure Analysis (Continued)

Single Active Failure	Analysis
Failure of any supply or return piping.	Essential plant cooling requirements met by the remaining intact ECCS subsystem which includes its own independent supply and return service water headers. Passive failures, i.e., pipe whip, missiles, jet loads are discussed in Sections 3.5 and 3.6.1. The SW system is a moderate-energy fluid system since it is operated at less than 275 psig and 200°F.
Failure of RHR heat exchanger.	Essential plant cooling requirements met by the remaining intact redundant RHR subsystem which includes its own 100% capacity heat exchanger.
Fire	All credible fires and their consequences were evaluated in Appendix F. Because of physical separation, redundancy, and low inventories of combustibles, there are no credible fires which could impede the SW from performing its function.
Failures of equipment by missile.	The HVAC equipment in the SW pump house is arranged in such a manner that would preclude any postulated missile from preventing the plant to be brought to a safe shutdown. External missiles are discussed in Section 3.5.

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Table 9.2-9

Integrated Heat Data - Ultimate Heat Sink Reanalysis
Peak UHS Temperature Case

Time After LOCA (minutes)	Q Decay[a]	Q Sens[b]	Q Aux 1[c]	Q Aux 2[d]	Q Aux 3[e]	Q Total[f]	Q SW[g,h]
	10^7 Btu						
1	1.141	0.014	0.022	0.045	0.015	1.237	0.158
2	2.050	0.027	0.044	0.090	0.031	2.242	0.317
4	3.605	0.054	0.088	0.180	0.062	3.989	0.641
10	7.367	0.136	0.219	0.450	0.155	8.327	1.641
20	12.538	0.271	0.439	0.900	0.310	14.458	3.384
40	20.805	0.543	0.878	1.800	0.621	24.647	7.082
90	36.910	1.220	1.975	4.052	1.399	45.556	17.169
120(2H)	45.085	1.630	2.634	5.404	1.868	56.621	23.616
240(4H)	73.582	3.260	5.267	10.809	3.744	96.662	51.190
360(6H)	98.348	4.880	7.901	16.180	5.593	132.902	80.381
480(8H)	120.603	6.510	10.534	21.514	7.408	166.569	110.210
720(12H)	160.016	9.770	12.748	32.106	7.408	222.048	169.181
960(16H)	195.082	13.02	14.962	43.623	7.408	273.095	225.503
1200(20H)	227.462	16.28	17.175	53.168	7.408	321.493	278.998

Table 9.2-9

Integrated Heat Data - Ultimate Heat Sink Reanalysis (Continued)
Peak UHS Temperature Case (Continued)

Time After LOCA (minutes)	Q Decay[a]	Q Sens[b]	Q Aux 1[c]	Q Aux 2[d]	Q Aux 3[e]	Q Total[f]	Q SW[g,h]
	10^7 Btu						
1440(1D)	258.019	19.54	19.389	62.867	7.408	368.223	329.810
2160(1.5D)	342.440	19.56	26.030	96.003	7.408	491.441	465.612
2880(2D)	419.033	19.56	32.671	128.199	7.408	606.871	588.078
4320(3D)	555.030	19.56	45.954	193.654	7.408	821.606	811.164
5760(4D)	674.009	19.56	59.236	259.407	7.408	1019.620	1017.191
7200(5D)	780.800	19.56	72.518	325.863	7.408	1206.149	1209.436
8640(6D)	878.638	19.56	85.801	391.122	7.408	1382.529	1387.436
11520(8D)	1055.541	19.56	112.365	522.633	7.408	1717.507	1726.759
14400(10D)	1215.309	19.56	138.930	654.180	7.408	2035.387	2047.600
17280(12D)	1363.194	19.56	165.495	785.644	7.408	2341.301	2355.179
23040(16D)	1633.357	19.56	218.624	1048.117	7.408	2927.066	2943.321
28800(20D)	1877.638	19.56	271.753	1310.437	7.408	3486.796	3504.390
34560(24D)	2101.496	19.56	324.882	1572.698	7.408	4026.044	4044.572
43200(30D)	2406.351	19.56	404.576	1967.206	7.408	4805.101	4827.357

LDCN-08-032

Table 9.2-9

Integrated Heat Data - Ultimate Heat Sink Reanalysis (Continued)
Mass Loss Case

Time After LOCA (minutes)	Q Decay[a]	Q Sens[b]	Q Aux 1[c]	Q Aux 2[d]	Q Aux 3[e]	Q Total[f]	Q SW[g,h]
	10^7 Btu						
1	1.141	0.014	0.022	0.045	0.015	1.237	0.241
2	2.050	0.027	0.044	0.089	0.030	2.240	0.484
4	3.605	0.054	0.088	0.179	0.061	3.987	0.979
10	7.367	0.136	0.219	0.447	0.152	8.321	2.505
20	12.538	0.271	0.439	0.894	0.305	14.447	5.156
40	20.805	0.543	0.878	1.788	0.610	24.624	10.728
90	36.910	1.220	1.975	4.024	1.375	45.504	25.524
120(2H)	45.085	1.630	2.634	5.366	1.833	56.548	34.689
240(4H)	73.582	3.260	5.267	10.716	3.658	96.483	71.755
360(6H)	98.348	4.880	7.900	16.025	5.449	132.602	108.096
480(8H)	120.603	6.510	10.534	21.281	7.189	166.117	142.981
720(12H)	160.016	9.770	12.748	31.674	7.189	221.397	207.088
960(16H)	195.082	13.02	14.962	42.054	7.189	272.307	264.650
1200(20H)	227.462	16.28	17.175	52.640	7.189	320.746	317.798

LDCN-08-032

Table 9.2-9

Integrated Heat Data - Ultimate Heat Sink Reanalysis (Continued)
Mass Loss Case (Continued)

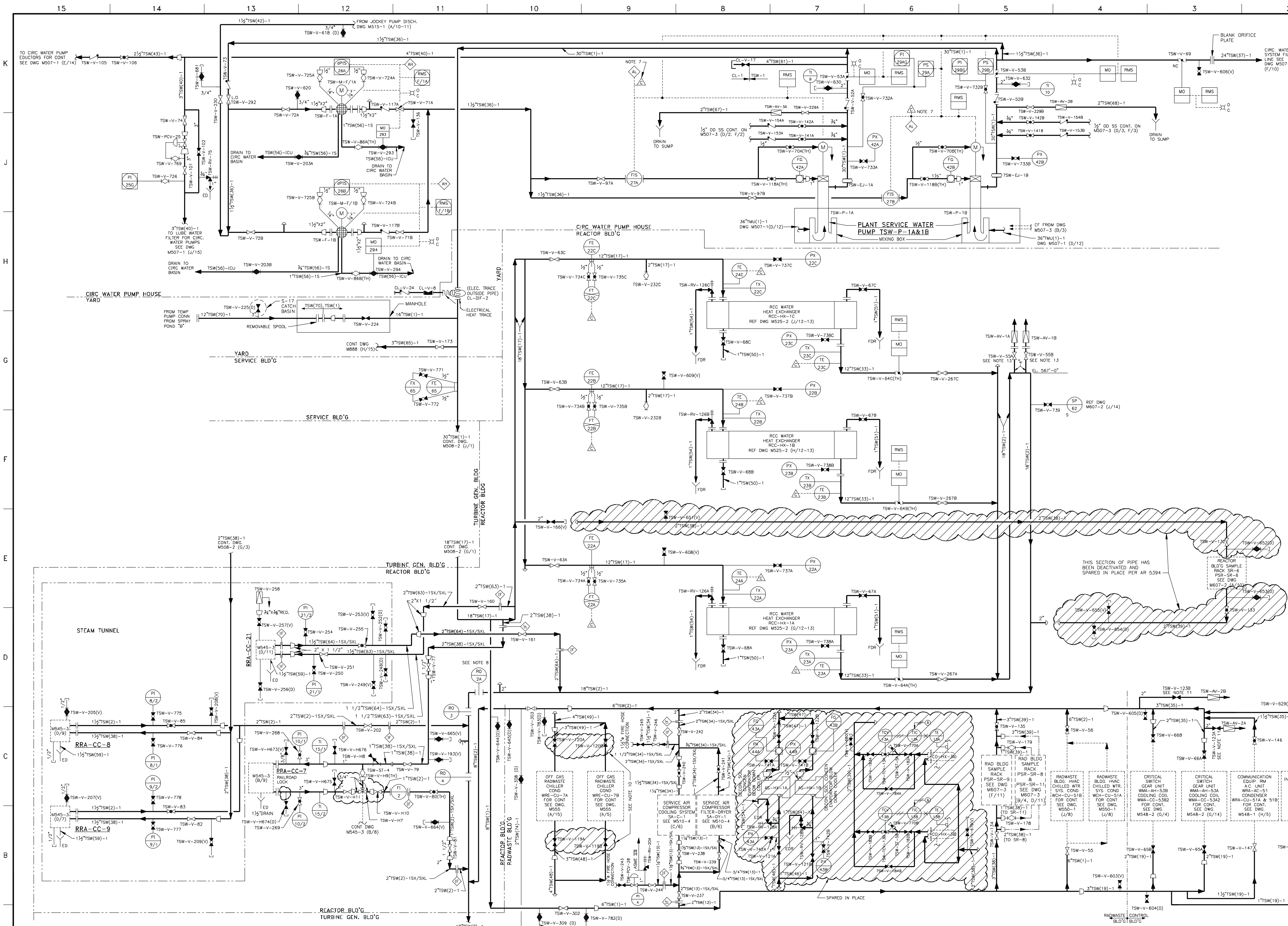
Time After LOCA (minutes)	Q Decay[a]	Q Sens[b]	Q Aux 1[c]	Q Aux 2[d]	Q Aux 3[e]	Q Total[f]	Q SW[g,h]
	10^7 Btu						
1440(1D)	258.019	19.54	19.389	63.466	7.189	367.603	367.578
2160(1.5D)	342.440	19.56	26.030	95.849	7.189	491.068	498.703
2880(2D)	419.033	19.56	32.671	128.533	7.189	606.968	619.615
4320(3D)	555.030	19.56	45.954	194.785	7.189	822.518	840.885
5760(4D)	674.009	19.56	59.236	259.697	7.189	1019.691	1036.572
7200(5D)	780.800	19.56	72.518	325.625	7.189	1205.692	1226.242
8640(6D)	878.638	19.56	85.801	391.033	7.189	1382.221	1404.952
11520(8D)	1055.541	19.56	112.370	522.481	7.189	1717.141	1741.809
14400(10D)	1215.309	19.56	138.93	653.818	7.189	2034.806	2060.639
17280(12D)	1363.194	19.56	165.50	785.138	7.189	2340.581	2367.082
23040(16D)	1633.357	19.56	218.62	1047.679	7.189	2926.405	2953.354
28800(20D)	1877.638	19.56	271.75	1310.168	7.189	3486.305	3513.470
34560(24D)	2101.496	19.56	324.88	1573.252	7.189	4026.377	4056.154
43200(30D)	2406.351	19.56	404.59	1967.899	7.189	4805.589	4836.358

Table 9.2-9

Integrated Heat Data - Ultimate Heat Sink Reanalysis (Continued)

[a] Q Decay	Integrated core decay heat suppression pool.
[b] Q Sensible	Integrated sensible heat rejected by the reactor vessel, piping, and core to the suppression pool.
[c] Q Auxiliary I	Integrated heat from ECCS pump work rejected to the suppression pool.
[d] Q Auxiliary 2	Integrated heat from auxiliary systems rejected to division 1 SW system. This heat includes all sources of heat into division 1 SW system except for the RHR heat exchanger. The RHR heat exchanger transfers heat from the suppression pool to division 1 SW system.
[e] Q Auxiliary 3	Integrated heat from HPCS SW system. This heat is a straight heat dump into spray pond A.
[f] Q Total	Sum of Q Decay, Q Sensible, Q Auxiliary 1, Q Auxiliary 2, and Q Auxiliary 3.
[g] Q Service	Sum of Q Auxiliary 2 and the heat rejected by the RHR heat exchanger into division 1 SW system, i.e, the sum of the heat rejected through the spray nozzles.

[h] The RHR heat exchangers provide suppression pool cooling from 10 minutes through to the end of an accident (30 days). No heat exchanger cooling is assumed for the first 10 minutes of an accident. See Sections 6.2.2.2 and 6.3.2.8 for further information on containment cooling.



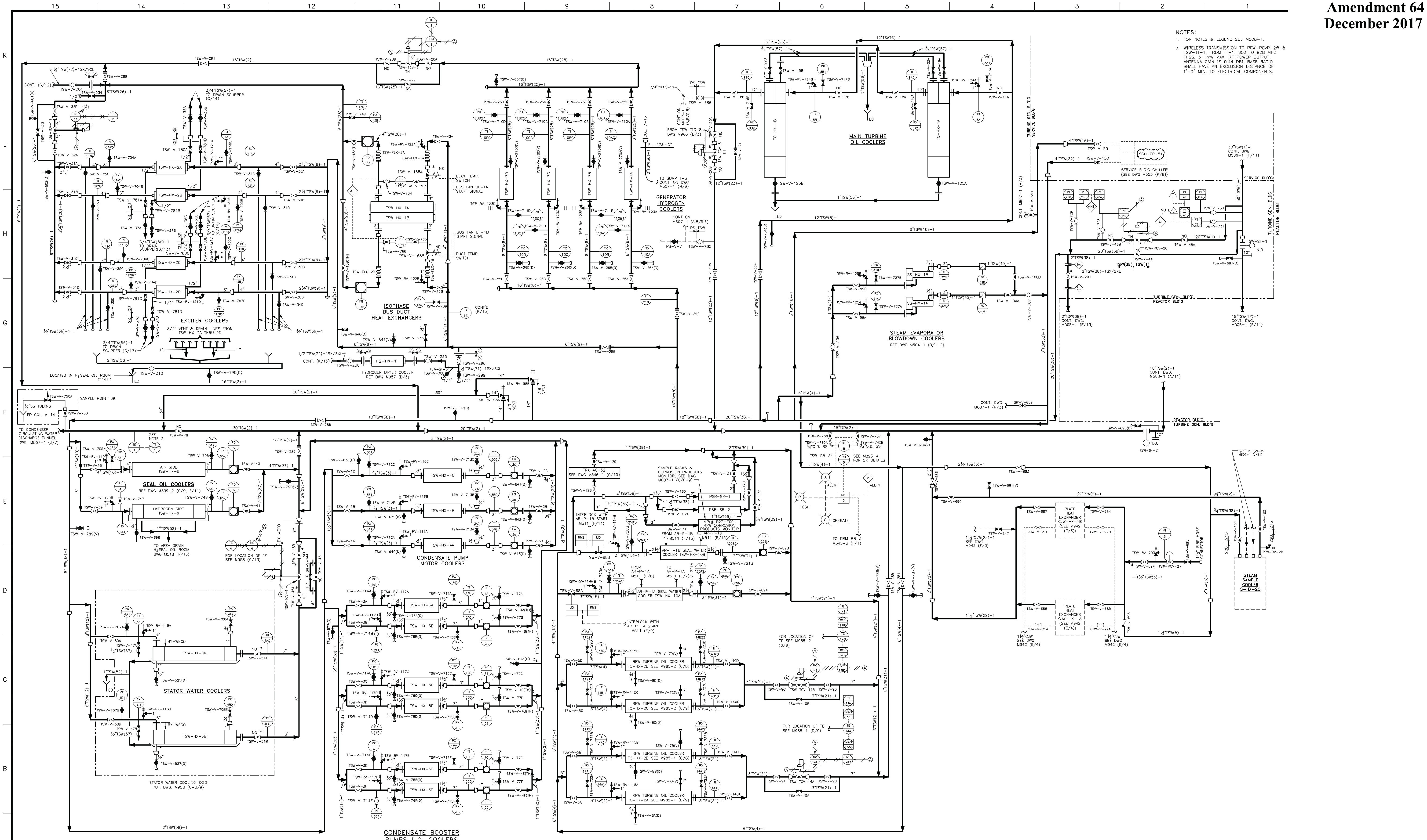
NOTES:

1. ALL TEMPERATURE WELL CONNECTIONS TO BE 1-1/2" UNLESS SPECIFICALLY NOTED OTHERWISE.
2. ALL INSTRUMENTATION ON THIS DRAWING TO BE IDENTIFIED BY PREFIX "TSW" UNLESS SPECIFICALLY NOTED OTHERWISE (TSW-TE-1A, TSW-FG-1A, ETC.)
3. ALL INSTRUMENT ROOT VALVES NOT LABELED TO BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
4. ASTERISK DENOTES SUPPLIED BY EQUIPMENT CONTRACTOR.
5. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING IN TSW SYSTEM SHALL BE CLASSIFIED AS FOLLOWS EXCEPT IN REACTOR BLDG. AND CONTROL BLDG.
   QUALITY CLASS II
   SEISMIC CLASS II
   CODE GROUP D
6. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING IN THE TSW SYSTEM IN THE REACTOR BLDG. AND CONTROL BLDG. SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II+
   SEISMIC CATEGORY II/1M*
   CODE GROUP D
   *HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
7. THESE COMPUTER INPUT POINTS ARE NOT USED.
8. TSW-RO-2B (SMALLER ORIFICE) & TSW-RO-2C (LARGER ORIFICE) ARE REPLACEMENTS FOR TSW-RO-2A IF ADJUSTMENT IS NEEDED.
9. TSW PUMP MIXING BOX SHALL BE CLASSIFIED
   QUALITY CLASS II
   SEISMIC CLASS II
   AISC COMMERCIAL QUALITY
10. THE TSW VALVES ASSOCIATED WITH OFF-GAS RADWASTE CHILLERS WRE-CU-7A AND 7B ARE DEACTIVATED AND SPARED IN PLACE SINCE THEY ARE NOT REQUIRED TO SUPPORT THE DESIGN FUNCTION OF THE OFF-GAS SYSTEM. THE TSW SYSTEM IS ISOLATED BY REMOVING THE SUPPLY AND RETURN LINE PIPING AND ADDING A CAP UPSTREAM OF THE 4 TSW VALVES.
11. TSW-V-123A AND TSW-V-123B TO BE OPENED TO VENT RADWASTE BUILDING PIPING, AS REQUIRED. OTHERWISE, MAINTAIN CLOSED DURING NORMAL SYSTEM OPERATION.
12. FOR FLOW DIAGRAM LEGENDS, SYMBOLS, NOTES AND ABBREVIATIONS, SEE DWG M501.
13. ONE VALVE, EITHER TSW-V-55A OR TSW-V-55B, IS MAINTAINED IN THE CLOSED POSITION TO LIMIT SECONDARY CONTAINMENT POTENTIAL LEAKAGE PATH SIZE.

LEGEND:

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE (EXCEPT WHERE NOTED)
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE (EXCEPT WHERE NOTED)
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station Final Safety Analysis Report	Plant Service Water System		
	Draw. No. M508-1	Rev. 126	Figure 9.2-1.1



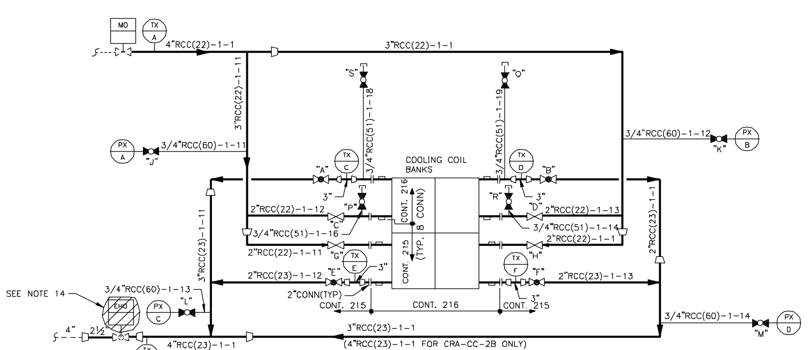
Columbia Generating Station
Final Safety Analysis Report

Plant Service Water System

Draw. No. M508–2	Rev. 25	Figure 9.2-1.2

FOR INSTRUMENT & VALVE PREFIX LETTERS SEE DETAIL "A"																											
COOLING COIL BANK NUMBER	RCC-TX-						RCC-PX-				RCC-V-																
	A	B	C	D	E	F	A	B	C	D	A**	B**	C	D	E**	F**	G	H	J	K	L	M	N	P	Q	R	S	T
CRA-CC-1A	30A	31A	32A	33A	34A	35A	25A	26A	27A	28A	81A	82A	83A	84A	85A	86A	87A	88A	769A	770A	771A	772A		628(V)	630(V)	631(V)	629(V)	
CRA-CC-1B	30B	31B	32B	33B	34B	35B	25B	26B	27B	28B	81B	82B	83B	84B	85B	86B	87B	88B	769B	770B	771B	772B		624(V)	626(V)	623(V)	627(V)	
CRA-CC-1C	30C	31C	32C	33C	34C	35C	25C	26C	27C	28C	81C	82C	83C	84C	85C	86C	87C	88C	769C	770C	771C	772C		622(V)	621(V)	620(V)	625(V)	
CRA-CC-2A	30D	31D	34D	33D	32D	35D	25D	26D	27D	28D	85D	82D	87D	88D	81D	86D	83D	84D	769D	770D	771D	772D		636(V)		637(V)		
CRA-CC-2B	30E	31E	35E	34E	33E	32E	25E	26E	27E		86E	85E	84E	83E	82E	81E	88E	87E	769E	770E	771E							

**THROTTLED VALVES

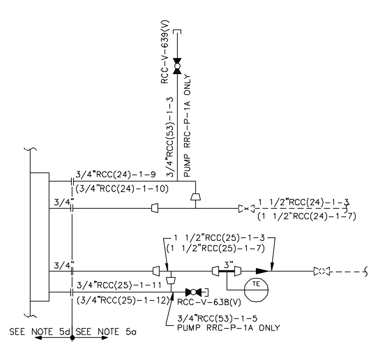


DETAIL "A"

TYPICAL DETAIL FOR COOLING COIL BANKS CRA-CC-1A, 1B, 1C, 2A, 2B.

NOTE:

FOR THE REMAINING UNITS, CHANGE THE INITIAL DIGIT OF THE UNIQUE LINE NUMBER TO CORRESPOND TO THE FOLLOWING: IF UNIT 1A (SHOWN) INDENTIFIES -1,-11,-12, ETC. THEN THE UNIT 1B WILL BE: -2,-21,-22, ETC; UNIT 1C: -3,-31,-33, ETC; UNIT 2A: -4,-41,-42, ETC, AND UNIT 2B: -5,-51,-52, ETC.



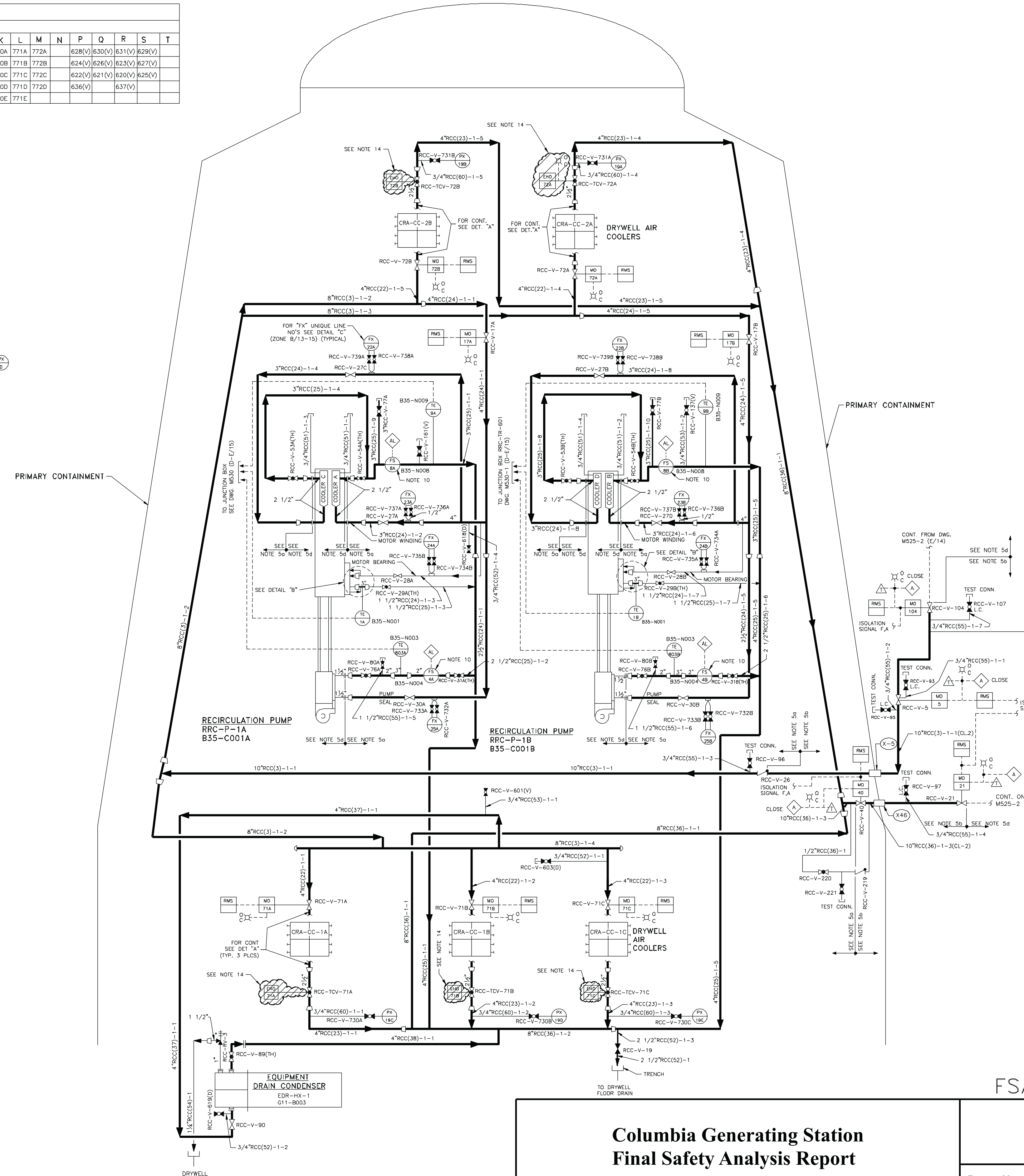
DETAIL "B"

(ZONE F/6,8)

LINE NUMBERS IN PARENTHESES DENOTE PUMP 1B SYSTEM IDENTIFICATION

DETAIL "C"				
INSTRUMENT NO.	LINE NO.			
	INLET FLOW	OUTLET FLOW	DRAWING	ZONE
RCC-FX-22A	1/2"RCC(60)-1-26	1/2"RCC(60)-1-27	M525-1	G/8
RCC-FX-22B	1/2"RCC(60)-1-28	1/2"RCC(60)-1-29	M525-1	G/6
RCC-FX-23A	1/2"RCC(60)-1-6	1/2"RCC(60)-1-7	M525-1	F/8
RCC-FX-23B	1/2"RCC(60)-1-16	1/2"RCC(60)-1-17	M525-1	F/5
RCC-FX-24A	1/2"RCC(60)-1-8	1/2"RCC(60)-1-9	M525-1	F/8
RCC-FX-24B	1/2"RCC(60)-1-18	1/2"RCC(60)-1-19	M525-1	F/5
RCC-FX-25A	1/2"RCC(60)-1-10	1/2"RCC(60)-1-15	M525-1	D/8
RCC-FX-25B	1/2"RCC(60)-1-20	1/2"RCC(60)-1-25	M525-1	D/5
RCC-FX-10A	1/2"RCC(60)-2-1	1/2"RCC(60)-2-2	M525-2	J/6
RCC-FX-10B	1/2"RCC(60)-2-6	1/2"RCC(60)-2-7	M525-2	G/6

DETAIL "C"



GENERAL NOTES:

1. ALL TEMPERATURE WELL CONNECTION TO BE 1 1/2" NPT UNLESS SPECIFICALLY NOTED OTHERWISE.
2. ALL INSTRUMENTATION ON THIS DRAWING TO BE INDENTIFIED BY PREFIX "RCC" UNLESS SPECIFICALLY NOTED OTHERWISE.
3. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
4. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
5. PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS, EXCEPT AS STATED IN NOTE 8. (BREAK POINTS ARE INDICATED ON THE FLOW DIAGRAM):
   a. INSIDE PRIMARY CONTAINMENT BEYOND THE INNERMOST CONTAINMENT ISOLATION VALVES:
      SEISMIC CATEGORY II ⊕
      QUALITY CLASS II
      CODE GROUP C
   b. PRIMARY CONTAINMENT ISOLATION VALVES AND ALL PIPING AND VALVES BETWEEN THESE ISOLATION VALVES:
      SEISMIC CATEGORY I
      QUALITY CLASS I
      CODE GROUP B
   c. THE RADWASTE BLDG. STARTING FROM THE RADWASTE BUILDING EAST WALL:
      SEISMIC CATEGORY II
      QUALITY CLASS II
      CODE GROUP D
   d. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING IN THE RCC SYSTEM, IN THE REACTOR BUILDING, AND THE RADWASTE BUILDING CORRIDOR SHALL BE CLASSIFIED AS FOLLOWS, EXCEPT AS NOTED:
      SEISMIC CATEGORY II ⊕
      QUALITY CLASS II
      CODE GROUP D

   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

   e. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING EXCEPT AS NOTED ABOVE:
      SEISMIC CATEGORY I
      QUALITY CLASS I
      CODE GROUP C
6. (DELETED)
7. (DELETED)
8. ALL PIPING DOWNSTREAM OF THE LAST ISOLATION VALVE AND OPEN TO THE ATMOSPHERE WITH THE SUBSYSTEM DESIGNATION "SYSTEM" (50) THRU (59) SHALL BE CLASSIFIED AS CODE GROUP D WITH QUALITY CLASS AND SEISMIC CATEGORY PROVIDED BY THE APPLICABLE NOTES ON THIS DRAWING.
9. CODE BREAK DEFINITIONS FOR THERMOWELLS ARE SHOWN ON M610, "INSTALLATION OF THERMOWELLS AND SAMPLE PROBES."
10. INSTRUMENTATION SO NOTED SHALL BE CODE GROUP E.
11. VALVE IS NOT ASME III CLASS 3, IT IS CONSIDERED SA105 MATERIAL WELDED TO THE SYSTEM.

    THE FOLLOWING WASHINGTON STATE SPECIAL NUMBERS ARE IDENTIFIED WITH THE CORRESPONDING VALVES:

VALVE TAG NUMBER	WASHINGTON STATE SPECIAL NUMBER
RCC-V-133A	WS-22-83W
RCC-V-133B	WS-25-83W

12. CROSS-HATCHED AND SCOPED EQUIPMENT IS NON-OPERATIONAL.
13. RCC-V-36A & RCC-V-36B HAVE BEEN GAGGED CLOSED.
14. VALVE OPERATOR HAS BEEN DEACTIVATED. VALVE IS IN THE OPEN POSITION AND FLUID DRAINED FROM OPERATOR.
15. SAMPLE POINT IS NO LONGER FUNCTIONAL. ALTERNATE METHOD OF SAMPLING IS DONE PER APPLICABLE PPM.
16. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE, EXCEPT AS NOTED.
2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

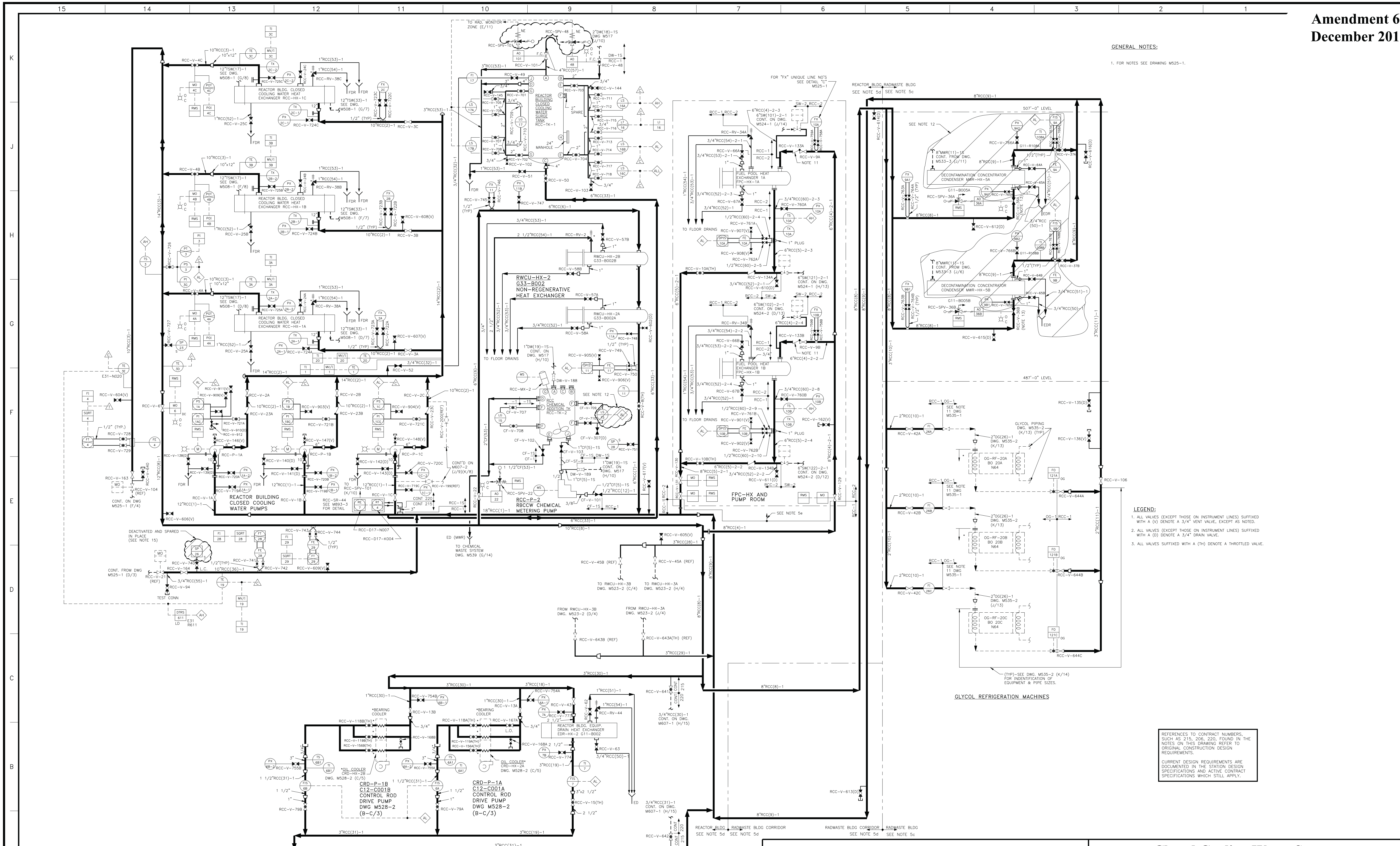
Closed Cooling Water System - Reactor and Radwaste Buildings

Draw. No. M525-1	Rev. 85	Figure 9.2-2.1

Amendment 62
December 2013

GENERAL NOTES:

1. FOR NOTES SEE DRAWING M525-1.



LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE, EXCEPT AS NOTED.
2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

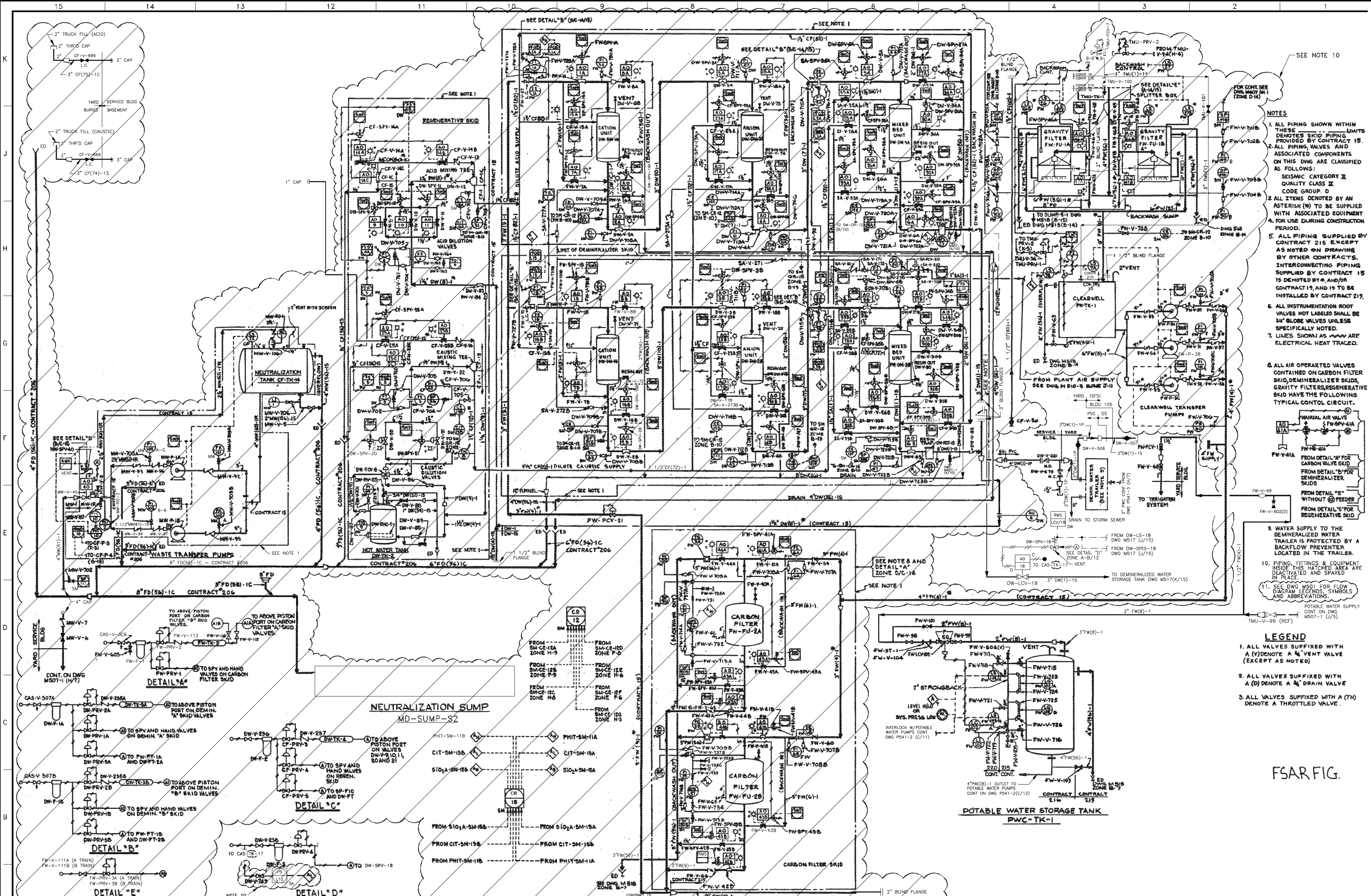
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Closed Cooling Water System -
Reactor and Radwaste Buildings

Draw. No. M525-2 | Rev. 1 | Figure 9.2-2.2

Amendment 63
December 2015

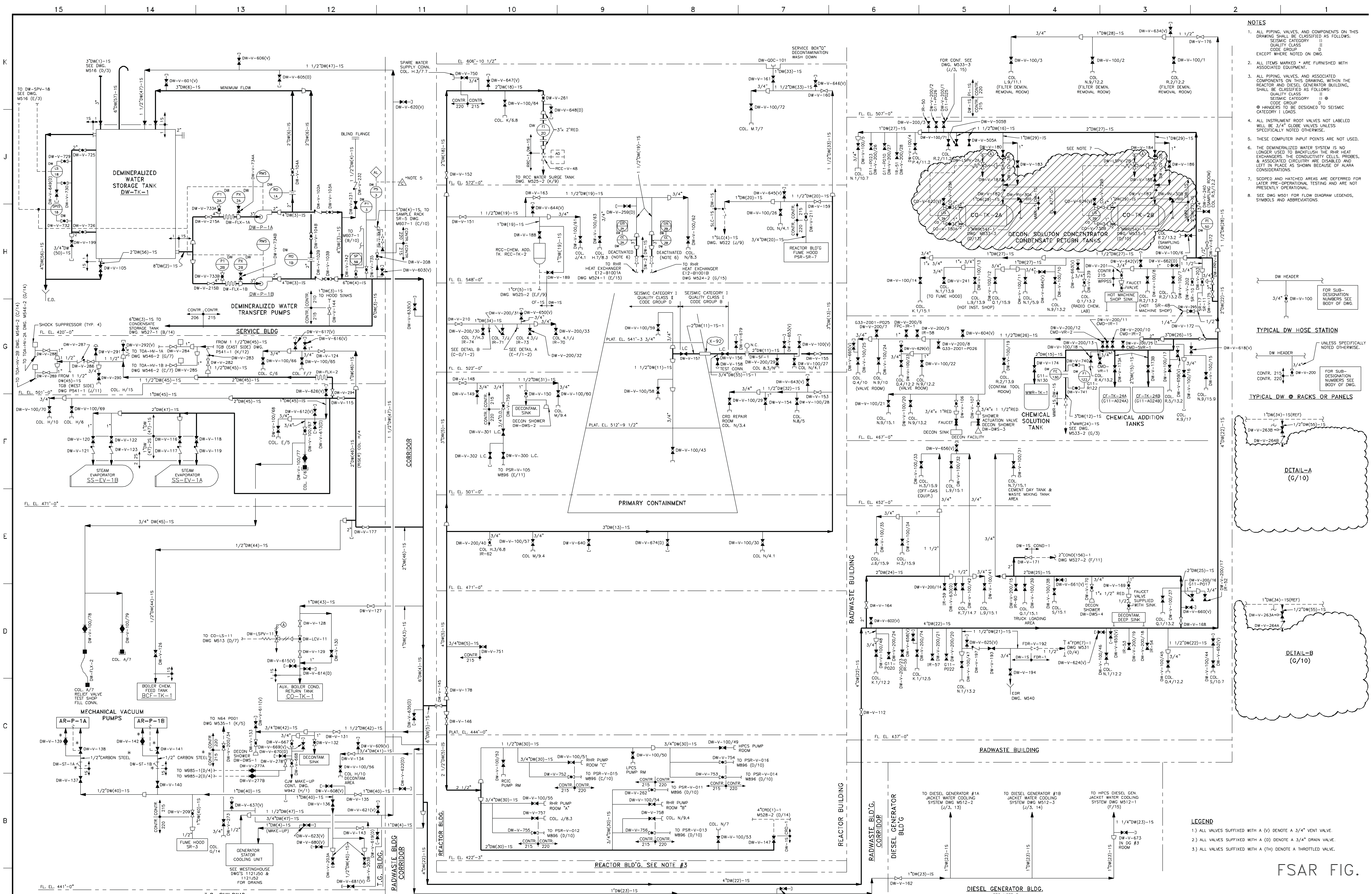


Columbia Generating Station
Final Safety Analysis Report

Makeup Water Treatment System

Draw. No. M516	Rev. 77	Figure 09.2-03

Amendment 64
December 2017

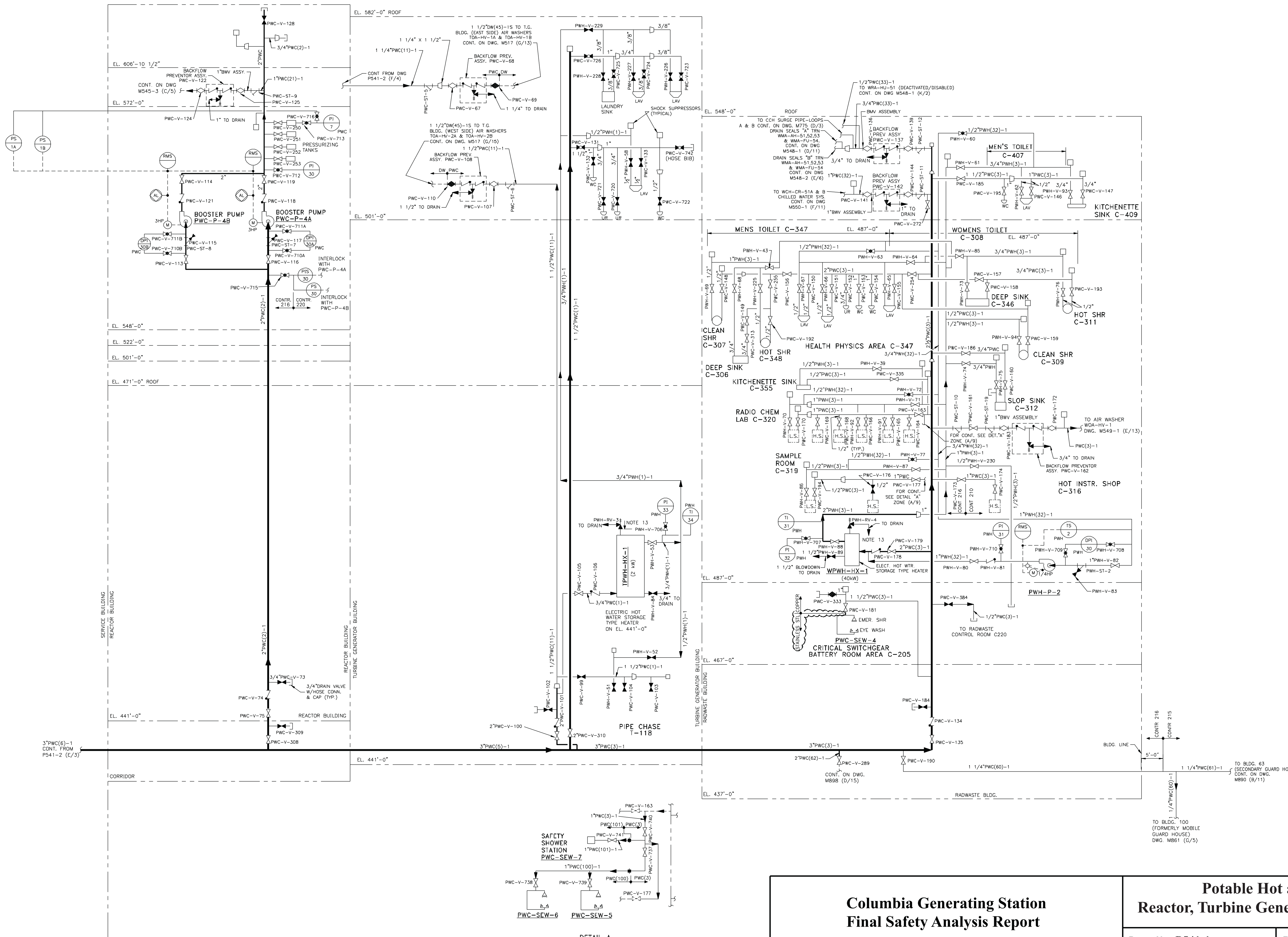


Columbia Generating Station
Final Safety Analysis Report

Demineralized Water System

Draw. No. M517	Rev. 108	Figure 9.2-4

Form No. 960690ai



NOTES:

1. USE 1/2" BRANCH SIZE FOR ALL LAVATORIES.
2. USE 3/4" BRANCH SIZE FOR ALL URINALS.
3. USE 1" BRANCH SIZE FOR ALL WATER CLOSETS.
4. USE 3/4" BRANCH SIZE FOR ALL SERVICE SINKS.
5. USE 1/2" BRANCH SIZE FOR ALL SHOWER HEADS.
6. USE 1/2" BRANCH SIZE FOR ALL ELECTRIC WATER COOLERS.
7. USE 1/2" BRANCH SIZE FOR ALL LAB SINKS.
8. SHOCK SUPPRESSORS SHALL BE PROVIDED FOR ALL HOT & COLD WATER SUPPLY BRANCHES AS SHOWN ON DIAGRAM BY SYMBOL.
9. ALL VALVES IN PWC & PWH SYSTEM SHALL BE 1/2" SIZE, UNLESS OTHERWISE NOTED.
10. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DWG. M501.
11. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES, UNLESS NOTED OTHERWISE.
12. ALL PIPING, VALVES, AND ASSOCIATED EQUIPMENT, ON THIS DWG. SHALL BE CLASSIFIED AS SEISMIC CATEGORY II, QUALITY CLASS "G", EXCEPT AS NOTED BELOW.

    ALL PIPING AND PIPING SUPPORT IN REACTOR BLDG. & CONTROL BLDG. SHALL BE CLASSIFIED AS FOLLOWS (SEE WNP-2 SPECIFICATIONS SECT. 15D.2, PLUMBING AND 15Q, HANGERS).

    A. SEISMIC CATEGORY:
       PIPING & PIPING SUPPORTS – I
       VALVES & ASSOC. COMPONENTS – II

    B. QUALITY CLASS:
       PIPING SUPPORTS – I
       PIPING, VALVES, & ASSOCIATED COMPONENTS – G

    PLUMBING FIXTURES HAVE NO SEISMIC REQUIREMENTS.

    CODE GROUP FOR ALL PIPING ON THIS DWG. – D
13. ELECTRICAL CONTROLS FOR ELECTRIC HOT WATER HEATER IN ACCORDANCE WITH SPECS.
14. ALL TAGS FOR INSTRUMENT ROOT VALVES WILL BE FURNISHED & INSTALLED BY OWNER.
15. POTABLE WATER SIZING CALCULATIONS ARE 09.51.03 AND 09.51.06.
16. THESE VALVES ARE REVERSE OPERATING BALL VALVES.
17. TO BURIED, ONE CUBIC YARD GRAVEL FIELD.
18. FOR OTHER PWC DIAGRAM INFORMATION SEE DWG. M573-1.
19. THE FOLLOWING BACKFLOW PREVENTERS ARE LOCATED WITHIN BUILDING:

BLDG.	EPN	BLDG.	EPN
33	PWC-V-378		
33	FP-V-345	27	TMU-V-BFP-1
33	TMU-V-105		

LEGEND:

1. H.S. – HOODED SINK
   L.S. – LAB SINK
   S.S – SERVICE SINK
   W.C. – WATER CLOSET
   LAV. – LAVATORY
   SH. – SHOWER
   E.W.C. – ELECT. WATER COOLER
   J.C. – JANITORS CLOSET
   UR. – URINAL
   BWV. – BACK WATER VALVE
2. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

FSAR FIG.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

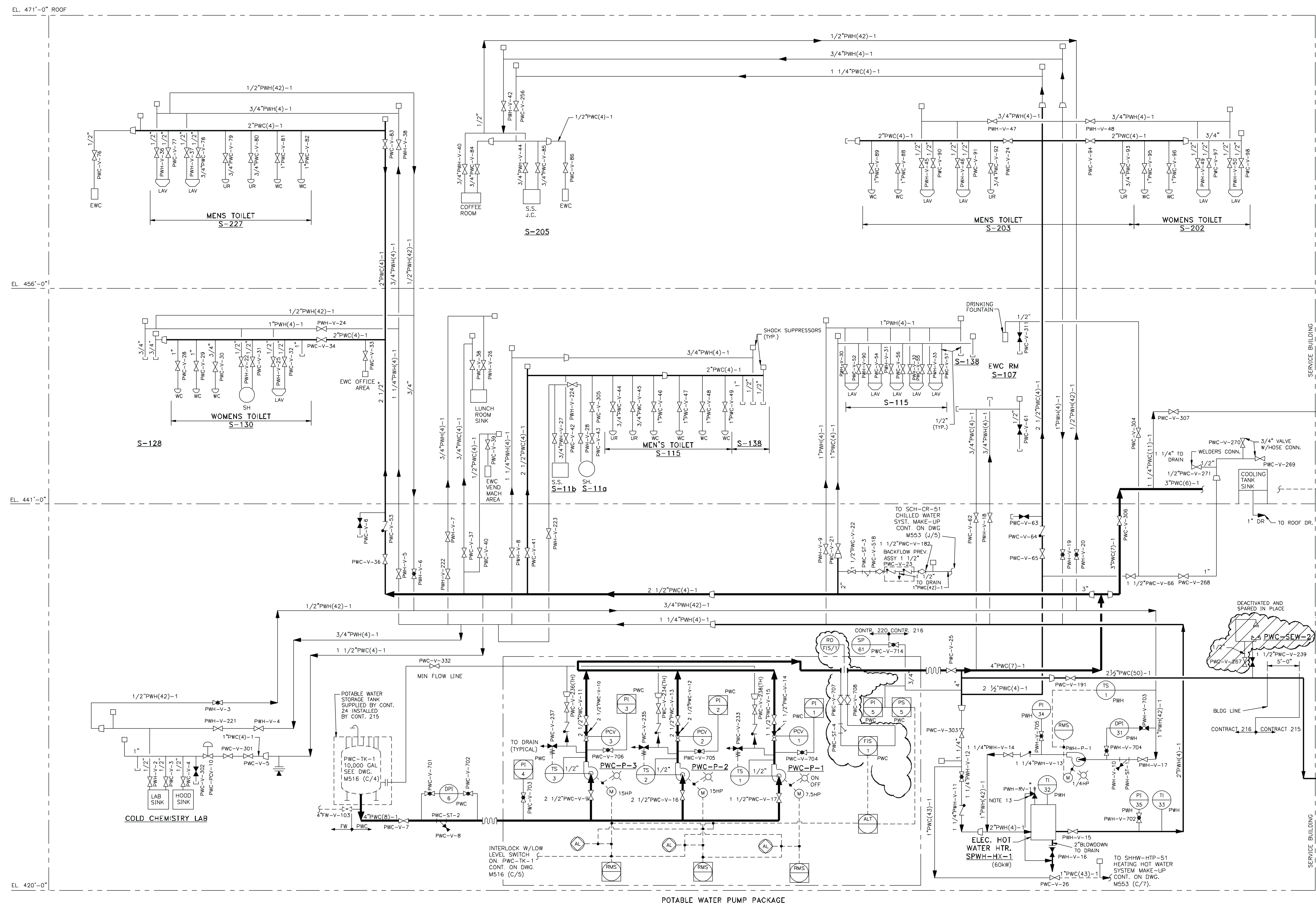
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Potable Hot and Cold Water
Reactor, Turbine Generator & Radwaste Bldgs.

Draw. No. P541-1 | Rev. 79 | Figure 9.2-5.1

NOTES:
1. GENERAL NOTES LOCATED ON P541-1.



LEGEND:
1. H.S. - HOODED SINK
L.S. - LAB SINK
S.S - SERVICE SINK
W.C. - WATER CLOSET
LAV. - LAVATORY
SH. - SHOWER
E.W.C. - ELECT. WATER COOLER
J.C. - JANITORS CLOSET
UR - URINAL
BWV. - BACK WATER VALVE

2. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

FSAR FIG.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

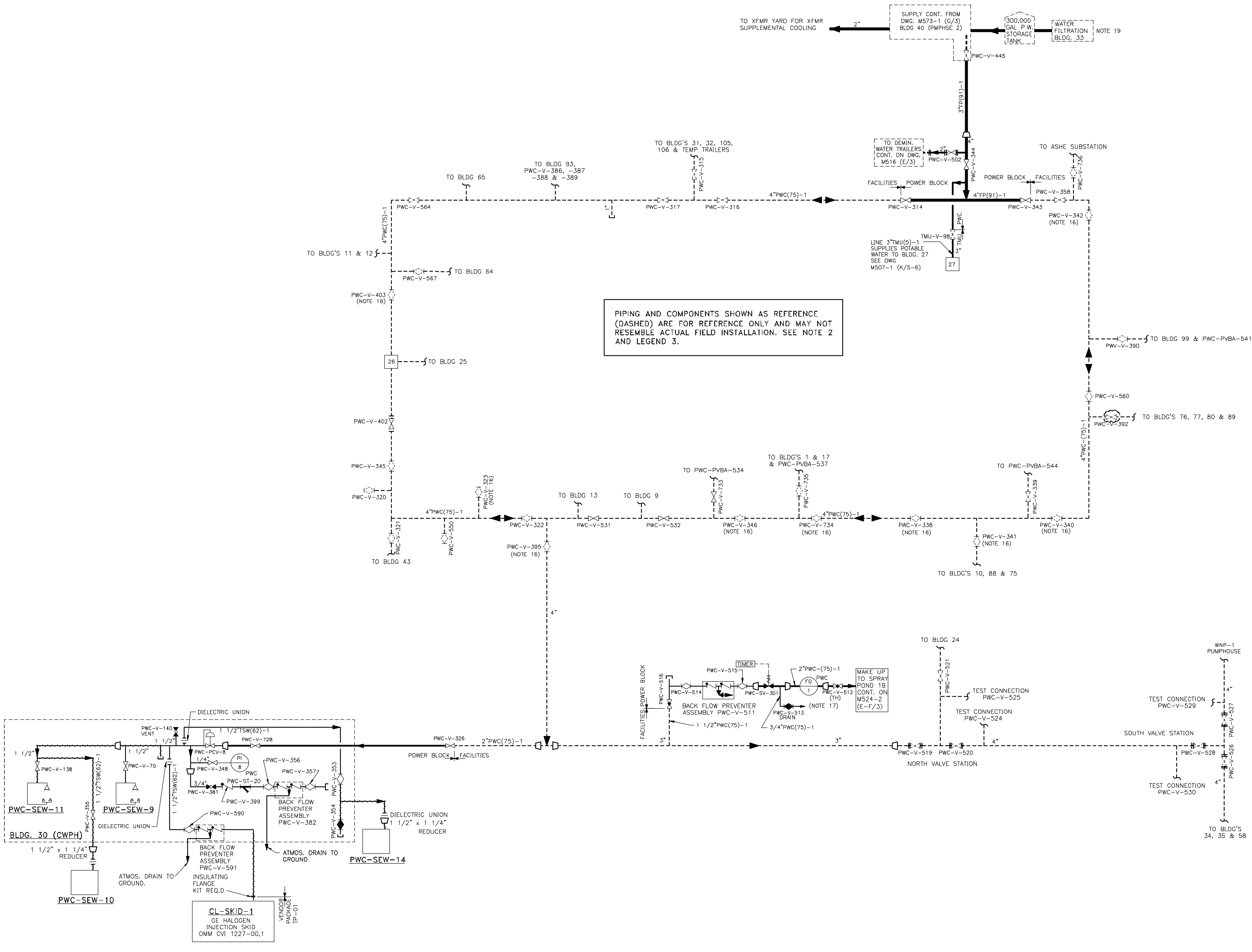
Potable Hot and Cold Water
Service Building and Yard

Draw. No. P541-2 | Rev. 8 | Figure 9.2-5.2

Form No. 960690ai

NOTES:

1. GENERAL NOTES LOCATED ON P541-1.
2. FOR FACILITIES PIPING, SEE FACILITIES DRAWING G20MP001.



LEGEND:

2. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

3. PWC-V-ZZZ PWC-V-YYY
DENOTES PIPING SHOWN ON FACILITIES DRAWING G20MP001

FSAR FIG.

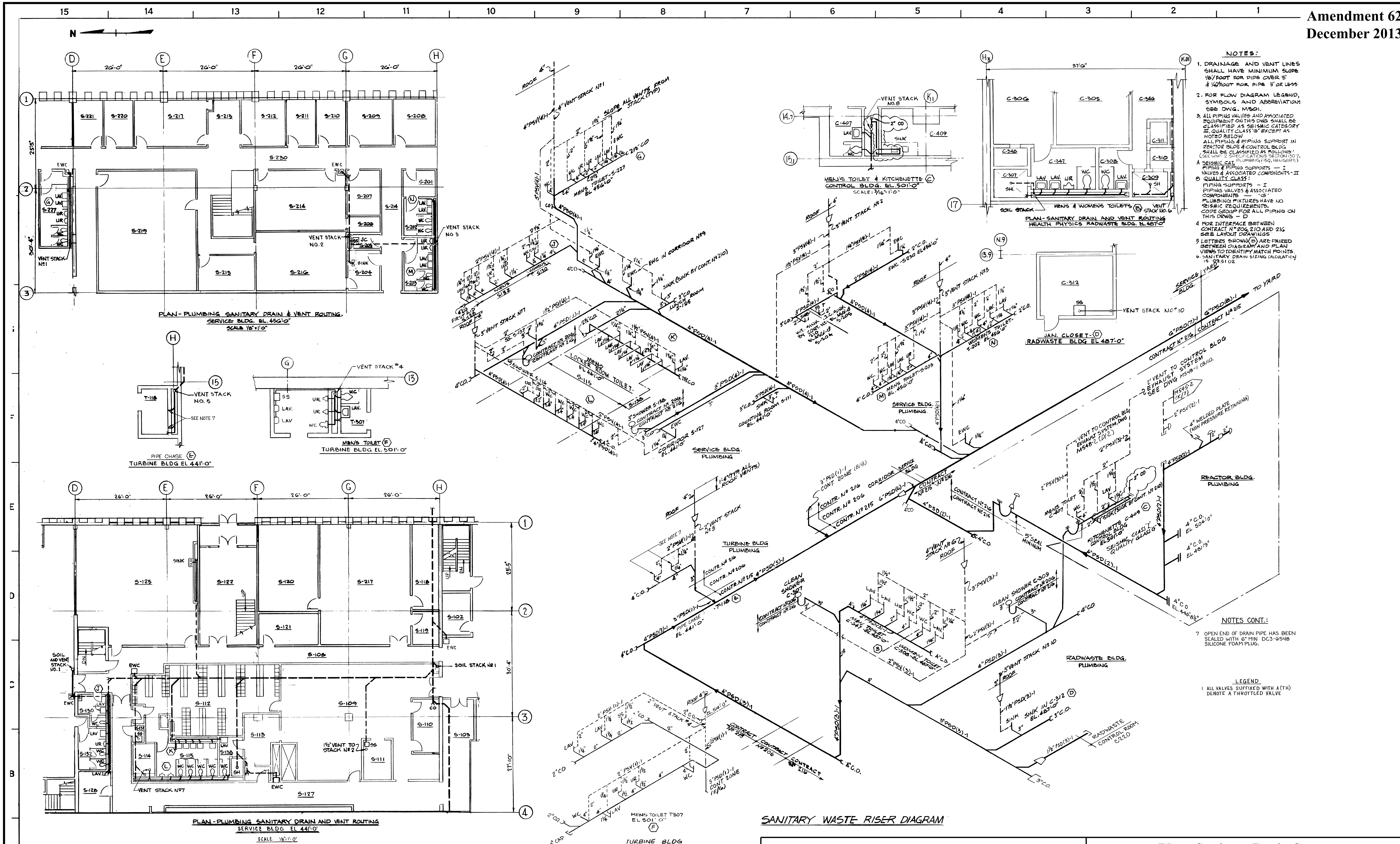
REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Potable Hot and Cold Water
Site Buildings

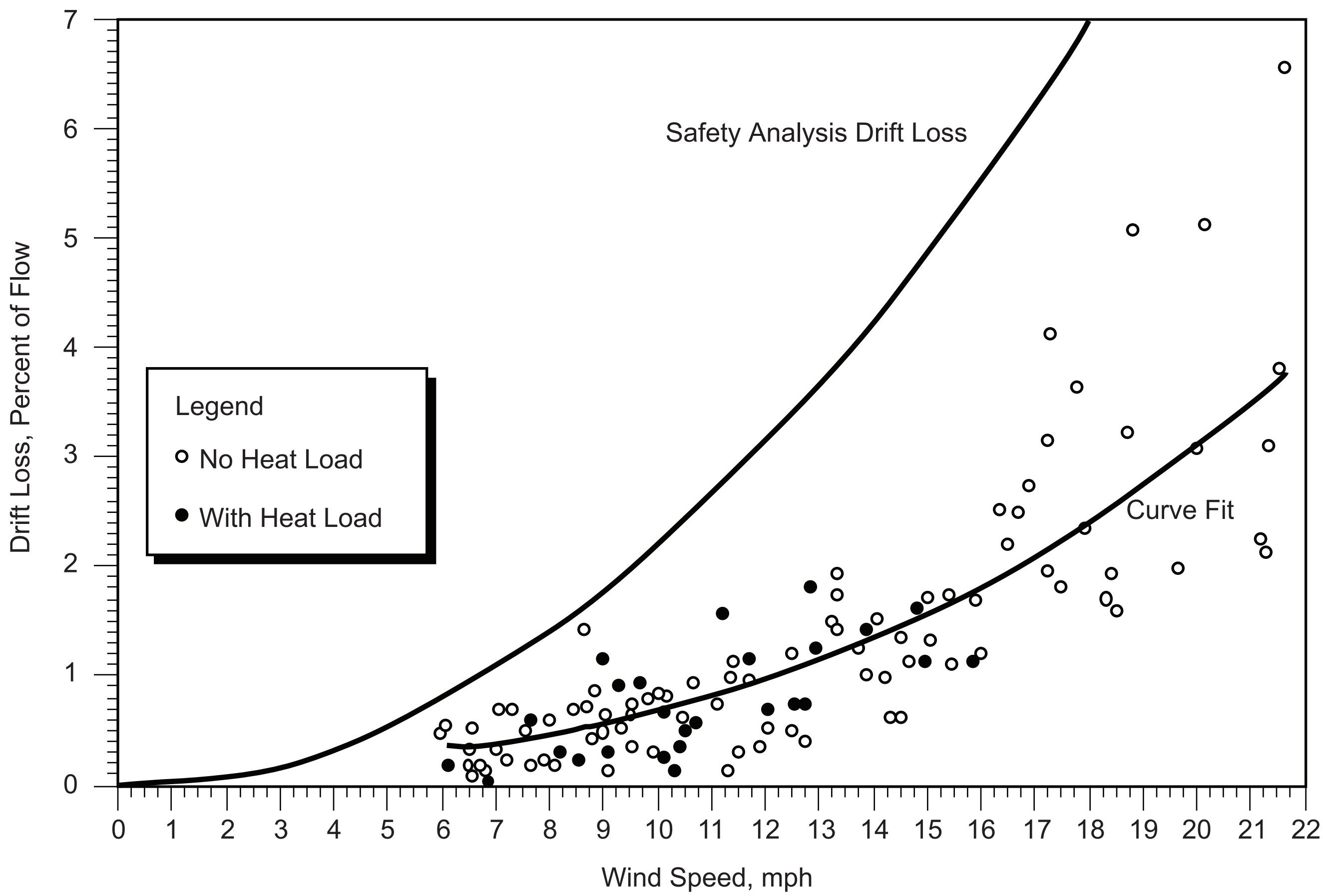
Draw. No. P541-3 | Rev. 14 | Figure 9.2-5.3



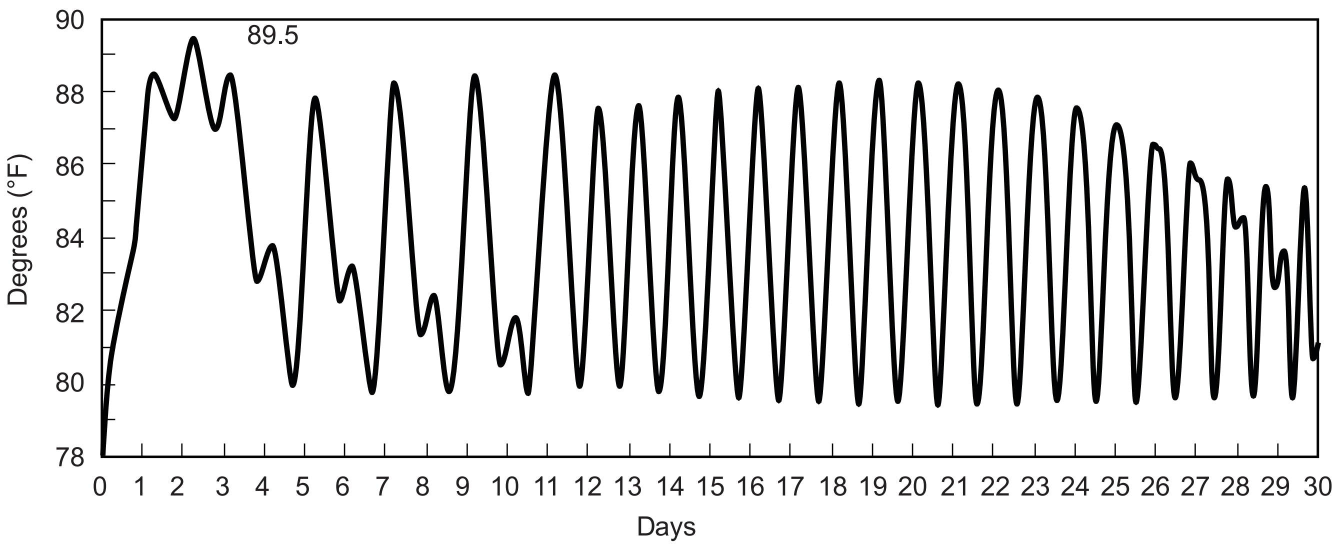
Columbia Generating Station
Final Safety Analysis Report

Plant Sanitary Drain System

Draw. No. P542 | Rev. 20 | Figure 9.2-6



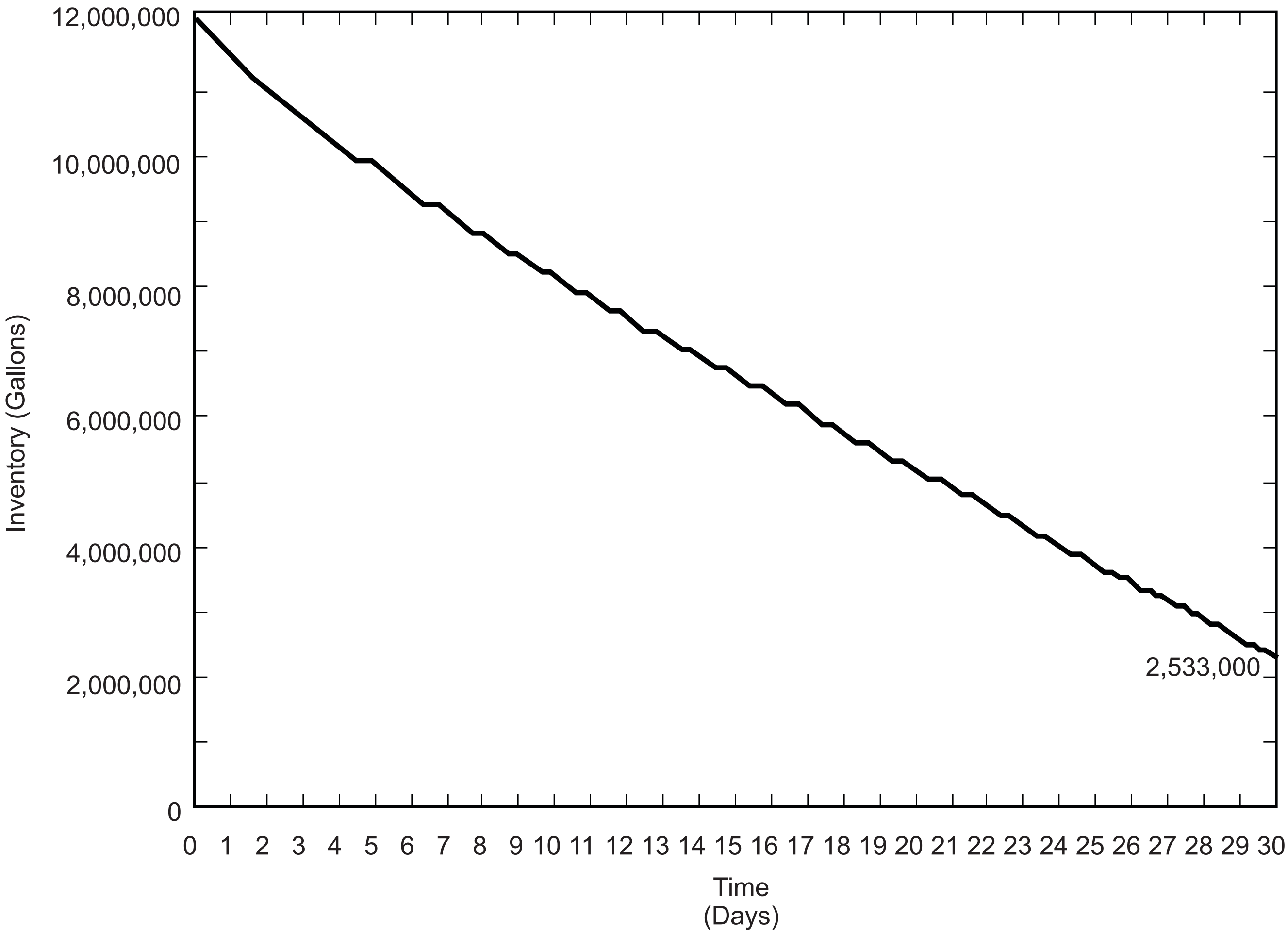
Drift Loss Test Results



Columbia Generating Station
Final Safety Analysis Report

Temperature Response Following Design Basis LOCA (Standby Service Water)

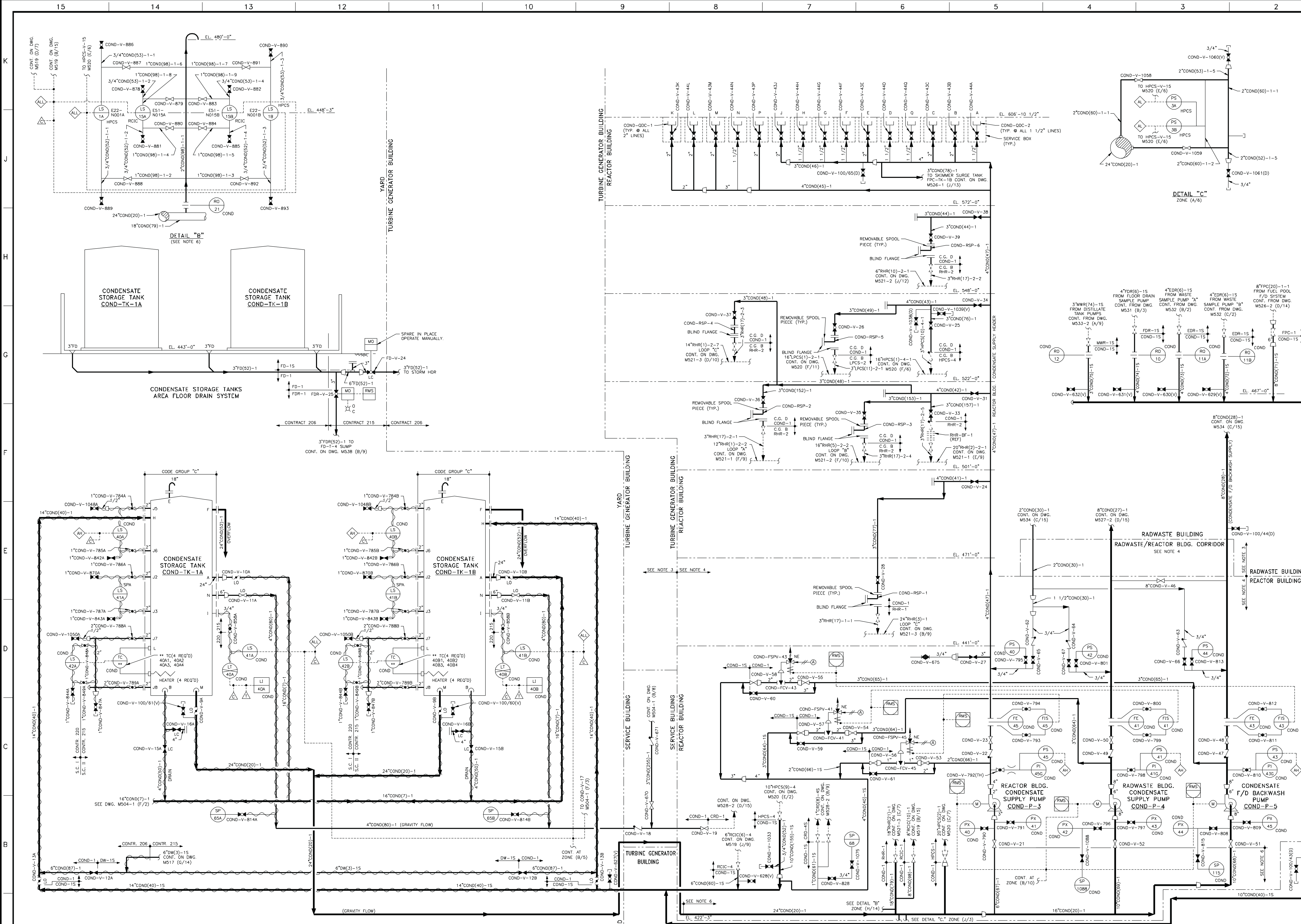
Draw. No. 960222.21 | Rev. | Figure 9.2-9



Columbia Generating Station
Final Safety Analysis Report

Water Inventory in UHS Following Design Basis LOCA

Draw. No. 960222.22 | Rev. | Figure 9.2-10



NOTES:

1. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES, UNLESS SPECIFICALLY NOTED OTHERWISE.
2. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
3. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DIAGRAM SHALL BE CLASSIFIED AS FOLLOWS, EXCEPT IN THE REACTOR BUILDING & AS NOTED:

   SEISMIC CATEGORY II
   QUALILTY CLASS II
   CODE GROUP D

4. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING IN THE CONDENSATE SUPPLY SYSTEM IN REACTOR BUILDING & THE RADWASTE BUILDING/REACTOR BUILDING CORRIDOR SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY II ⊕
   QUALITY CLASS II
   CODE GROUP D

   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS

5. SOLENOID VALVE IS NOT REQUIRED FOR PUMPS CF-P-4 & CF-P-5. REF. START-UP PROBLEM REPORT NUMBERS SPR-M-613 & SPR-M-1047.
6. PIPING AND ASSOCIATED COMPONENTS BETWEEN BREAK POINTS INDICATED ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY I
   QUALITY CLASS]
   CODE GROUP B **

   ** SEE SECTION 15B.1, PARAGRAPH 4.1.1, WNP-2 SPECS.

7. DELETED
8. EQUIPMENT IN HATCHED AREA IS NOT OPERATIONAL.
9. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

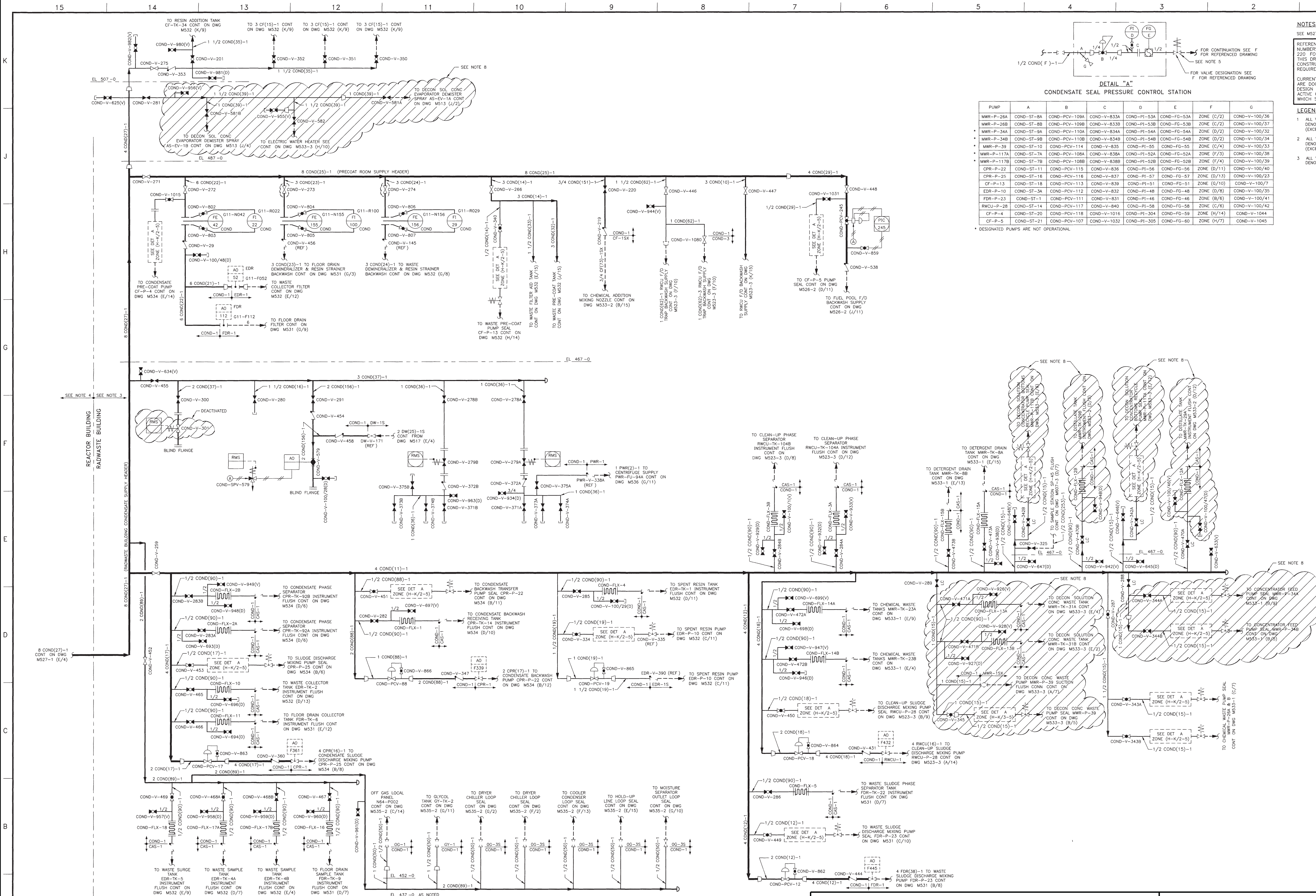
LEGEND:

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE (EXCEPT WHERE NOTED).
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE (EXCEPT WHERE NOTED).
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station
Final Safety Analysis Report

Condensate Supply System

Draw. No. M527-1 | Rev. 103 | Figure 9.2-11.1



	PUMP	A	B	C	D	E	F	G
	MWR-P-26A	COND-ST-8A	COND-PCV-109A	COND-V-833A	COND-PI-53A	COND-FG-53A	ZONE (C/2)	COND-V-100/36
	MWR-P-26B	COND-ST-8B	COND-PCV-109B	COND-V-833B	COND-PI-53B	COND-FG-53B	ZONE (C/2)	COND-V-100/37
*	MWR-P-34A	COND-ST-9A	COND-PCV-110A	COND-V-834A	COND-PI-54A	COND-FG-54A	ZONE (D/2)	COND-V-100/32
*	MWR-P-34B	COND-ST-9B	COND-PCV-110B	COND-V-834B	COND-PI-54B	COND-FG-54B	ZONE (D/2)	COND-V-100/34
*	MWR-P-39	COND-ST-10	COND-PCV-114	COND-V-835	COND-PI-55	COND-FG-55	ZONE (C/4)	COND-V-100/33
*	MWR-P-117A	COND-ST-7A	COND-PCV-108A	COND-V-838A	COND-PI-52A	COND-FG-52A	ZONE (F/3)	COND-V-100/38
*	MWR-P-117B	COND-ST-7B	COND-PCV-108B	COND-V-838B	COND-PI-52B	COND-FG-52B	ZONE (F/4)	COND-V-100/39
	CPR-P-22	COND-ST-11	COND-PCV-115	COND-V-836	COND-PI-56	COND-FG-56	ZONE (D/11)	COND-V-100/40
	CPR-P-25	COND-ST-16	COND-PCV-116	COND-V-837	COND-PI-57	COND-FG-57	ZONE (D/13)	COND-V-100/23
	CF-P-13	COND-ST-18	COND-PCV-113	COND-V-839	COND-PI-51	COND-FG-51	ZONE (G/10)	COND-V-100/7
	EDR-P-10	COND-ST-3A	COND-PCV-112	COND-V-832	COND-PI-48	COND-FG-48	ZONE (D/8)	COND-V-100/35
	FDR-P-23	COND-ST-1	COND-PCV-111	COND-V-831	COND-PI-46	COND-FG-46	ZONE (B/6)	COND-V-100/41
	RWCU-P-28	COND-ST-14	COND-PCV-117	COND-V-840	COND-PI-58	COND-FG-58	ZONE (C/6)	COND-V-100/42
	CF-P-4	COND-ST-20	COND-PCV-118	COND-V-1016	COND-PI-304	COND-FG-59	ZONE (H/14)	COND-V-1044
	CF-P-5	COND-ST-21	COND-PCV-107	COND-V-1032	COND-PI-305	COND-FG-60	ZONE (H/7)	COND-V-1045

* DESIGNATED PUMPS ARE NOT OPERATIONAL

NOTES

SEE M527-1 FOR NOTES

REFERENCES TO CONTRACT NUMBERS SUCH AS 215 206 220 FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY

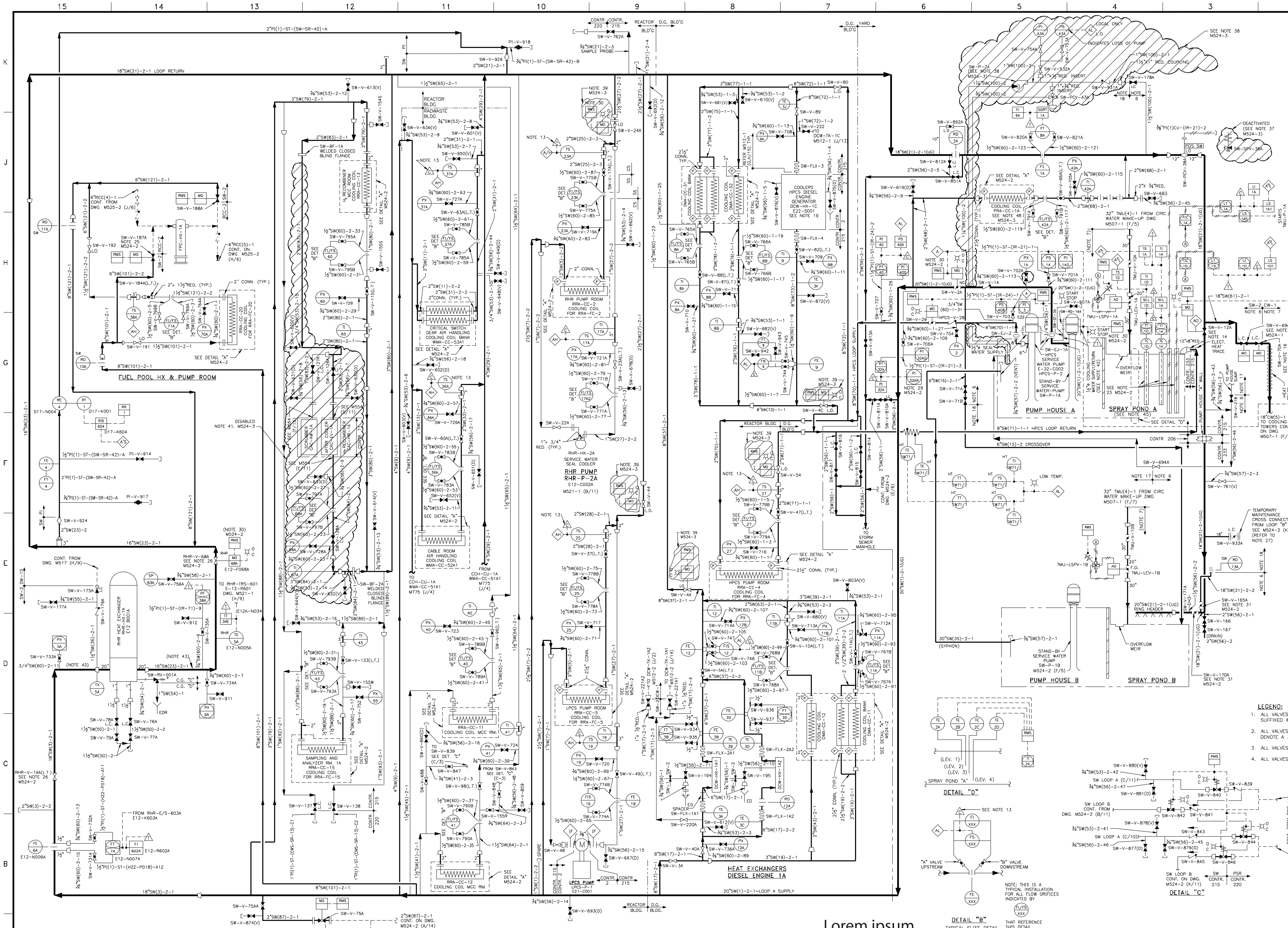
LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4 VENT VALVE (EXCEPT WHERE NOTED)
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4 DRAIN VALVE (EXCEPT WHERE NOTED)
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE

Columbia Generating Station
Final Safety Analysis Report

Condensate Supply System

Draw. No. M527-2 | Rev. 2 | Figure 9.2-11.2



Lorem ipsum

NOTES

1. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
2. VALVES SW-V-2A & B MUST BE CLOSED PRIOR TO PUMP START, AND ARE INTERLOCKED WITH PUMPS TO PREVENT PUMP START UNLESS VALVE IS CLOSED. VALVE SW-V-29 MUST BE CLOSED PRIOR TO PUMP MANUAL START, AND IS INTERLOCKED WITH PUMP TO PREVENT MANUAL PUMP START UNLESS VALVE IS CLOSED.
3. SW-RO-2A & 2B, AND SW-V-892A & B ARE PROVIDED TO MAINTAIN SYSTEM PRESSURE ABOVE RHR SYSTEM PRESSURE DURING COOLDOWN CONDITIONS.
4. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
5. ALL INSTRUMENTS ON THIS DWG. TO BE IDENTIFIED BY PREFIX "SW" UNLESS SPECIFICALLY NOTED (E.G.-SW-PS-40)
6. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS IN THE SW SYSTEM ON THIS DWG. (EXCEPT AS STATED IN NOTE 17) SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY I
   QUALITY CLASS I } ø
   CODE GROUP C
   ø(EXCEPT AS NOTED ON M619 INSTRUMENT CONNECTION DIAGRAMS).
7. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS IN THE CW AND TMU SYSTEMS AS INDICATED SHOWN ON THIS DWG. SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II ⊕
   QUALITY CLASS II (SEE BELOW)
   CODE GROUP D
   (EARTH WORK INSTALLATION SHALL BE QUALITY CLASS I FOR TORNADO AND MISSILE PROTECTION).
   ⊕ SUPPORTS ATTACHED TO SSWPH'S ARE DESIGNED TO SEISMIC CATEGORY I REQUIREMENTS.
8. ALL PIPING SHALL BE SUPPLIED AND ERECTED BY THE 215 CONTRACT (EXCEPT AS NOTED OTHERWISE).
9. FOR ALL PIPING ARRANGEMENTS AT COOLING COILS SEE DETAIL A.
10. THIS EQUIPMENT IS NORMALLY CONTROLLED FROM THE MAIN CONTROL ROOM. IF THE MAIN CONTROL ROOM MUST BE VACATED THIS CONTROL POINT MAY BE ISOLATED AND CONTROL TRANSFERRED TO THE REMOTE SHUTDOWN PANEL C61-P001.
11. ELECT. HEAT TRACING: 20 WATTS/LIN. FT., CHEMELEX TYPE 8 ATVI, WITH 34 AWG SS OVERSHIELD OR EQUAL PRIMARY FREEZE PROTECTION TO BE ACCOMPLISHED PER SYSTEM OPERATING PROCEDURE PPM 2.4.5.
12. DELETED
13. THESE COMPUTER INPUT POINTS ARE NOT USED.
14. SW-V-12A & B ARE NORMALLY CLOSED WHEN THE SW PUMP IS NOT RUNNING. ON PUMP START SIGNAL, THE RESPECTIVE VALVE (SW-V-12A OR B) OPENS AUTOMATICALLY AND RECLOSES ON PUMP SHUTDOWN. THESE VALVES MAY BE CLOSED DURING A TORNADO EVENT TO PROVIDE ONCE THROUGH COOLING. (SEE NOTE 16 & 36).
15. THE 3/8" DRAIN THREAD-O-LET ON THE INLET NOZZLES OF PRA-FC-1A AND 1B ARE TO BE PLUGGED. COILS PRA-CC-1A AND 1B MAY BE DRAINED BY USING VALVES SW-V-154F & G RESPECTIVELY.
16. SW-V-69A AND SW-V-70A HAVE MOTOR OPERATORS INSTALLED BUT HAVE NO ELECTRICAL POWER AND CAN ONLY BE OPERATED MANUALLY. THESE VALVES ARE MECHANICALLY LOCKED CLOSED TO MAINTAIN PROPER WATER CHEMISTRY AND TO MAINTAIN SPRAY POND INVENTORY DURING AN ACCIDENT. THEY MAY BE OPENED IN CONJUNCTION WITH THE CLOSURE OF SW-V-12A TO PROVIDE ONCE THROUGH COOLING DURING A TORNADO EVENT.
17. ALL PIPING DOWNSTREAM OF THE LAST ISOLATION VALVE AND OPEN TO THE ATMOSPHERE WITH THE SUBSYSTEM DESIGNATION "SYSTEM" (50) THRU (53) AND (55) THRU (59) SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II ⊕
   QUALITY CLASS II
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
18. PIPING REFERRING TO THIS NOTE DOWNSTREAM OF THE LAST ISOLATION VALVE AND OPEN TO THE ATMOSPHERE SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II ⊕
   QUALITY CLASS II
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
19. THE HPCS DIESEL GENERATOR HEAT EXCHANGER, DCW-HX-1C, IS GE SUPPLIED EQUIPMENT AND IN ACCORDANCE WITH THEIR CONTRACT, COMPLIES WITH SECTION 8, DIVISION 1 OF ASME B & PV CODE, 1968 EDITION, SUMMER 1970 ADDENDA. DCW-HX-1C WORKING PRESSURE IS 75 PSI. SEE JUSTIFICATION DOCUMENTED BY IOM SS2-PE-94-0420.

(NOTES CONTINUED ON DWG. M524-2)

LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES OR AS NOTED) SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.
4. ALL VALVES SUFFIXED WITH A (L.T.) DENOTE A LOCKED THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

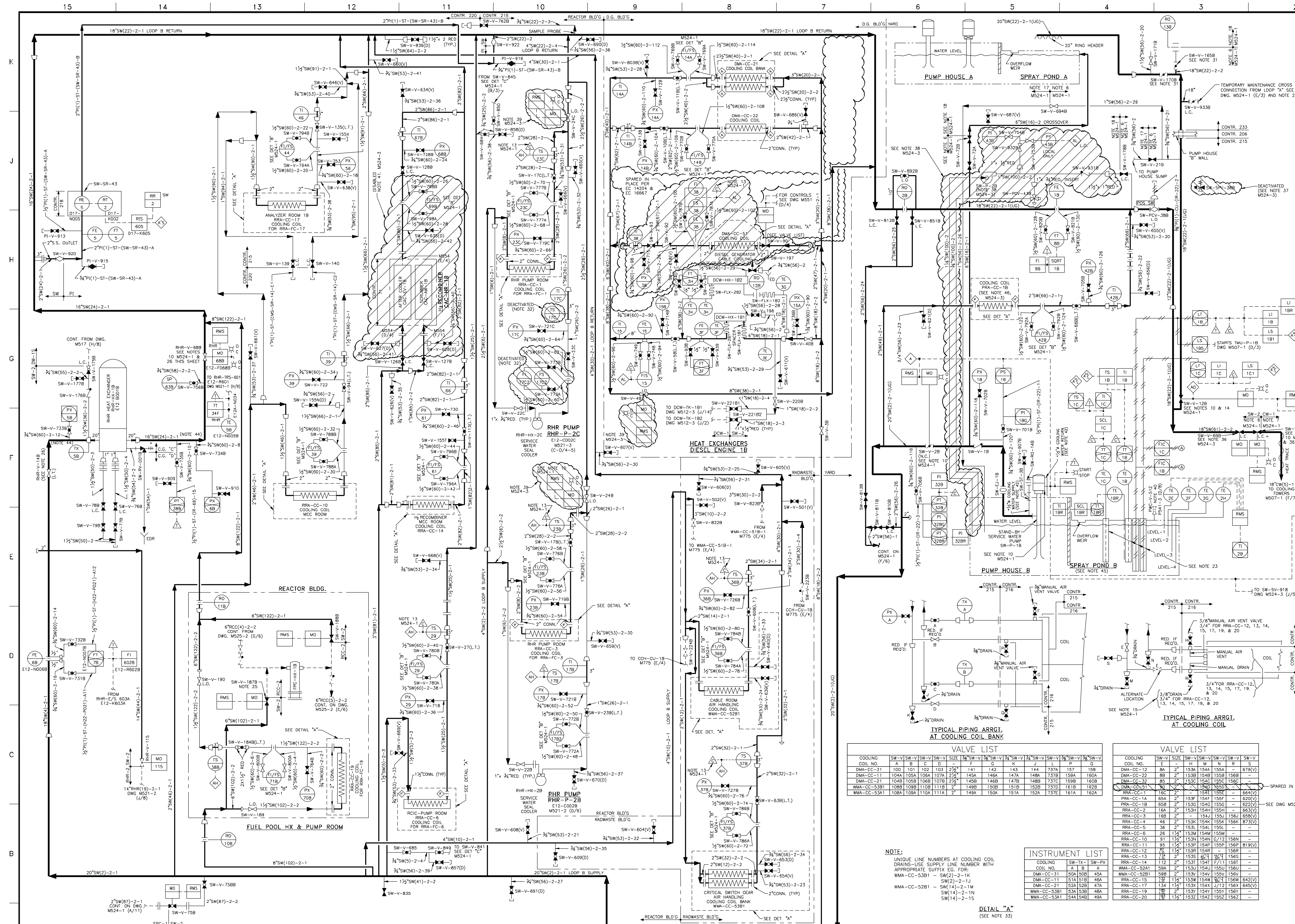
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

Standby Service Water System

Draw. No. M524-1	Rev. 135	Figure 9.2-12.1



NOTES:

-- (FOR NOTES 1 THRU 19 SEE M524-1)

20. UNIQUE LINE No.'s NOT PROVIDED FOR COIL ARRANGEMENTS AT HVAC UNITS.

21. ALL INSTRUMENT LINES ARE DESIGNATED BY CODE AND LINE NUMBER.

    EXAMPLE: LINES ORIGINATING OUTSIDE CONTAINMENT.
    ½"PI(I)-ST- (CODE DESIGNATION) H22-P021-A6 (LINE NUMBER)

22. "UG" DENOTES UNDER GROUND PIPING (SUPPLY AND RETURN OF LOOPS A & B)

23. THE STILL WELL PIPING CONTAINING THE SPRAY POND LEVEL & TEMP INSTM SHALL BE CLASSIFIED AS FOLLOWS:

    SEISMIC CATEGORY I
    QUALITY CLASS I
    CODE GROUP D

24. CODE BREAK DEFINITIONS FOR THERMOWELLS ARE SHOWN ON M610. "INSTALLATION OF THERMOWELLS AND SAMPLE PROBES"

25. VALVE IS NOT ASME III, CLASS 3. IT IS CONSIDERED SA105 MATERIAL WELDED TO THE SYSTEM. THE FOLLOWING WASHINGTON STATE SPECIAL NUMBERS ARE IDENTIFIED WITH THE CORRESPONDING VALVES

VALVE TAG NUMBER	WASHINGTON STATE SPECIAL NUMBER
SW-V-187A	WS-24-83W
SW-V-187B	WS-23-83W

26. THOUGH INDICATING FULL OPEN, RHR-V-68A/B & RHR-V-14A/B ARE MECHANICALLY THROTTLED TO ACHIEVE FLOW BALANCE.

27. TEMPORARY SPOOL PIECE TO BE USED ONLY WHEN ONE OF THE PONDS REQUIRES DRAINING FOR MAINTENANCE. TEMPORARY CROSS CONNECTION ALLOWS THE RETURN FROM PUMP SW-P-1A TO DRAIN INTO SPRAY POND "A" WHILE SPRAY POND "B" IS ISOLATED, AND VICE VERSA.

28. CROSS-HATCHED AND SCOPED EQUIPMENT IS NON-OPERATIONAL.

29. THESE INSTRUMENTS ARE LOCATED ON THE ALTERNATE REMOTE SHUTDOWN PANEL E-CP-ARS.

30. THIS EQUIPMENT IS NORMALLY CONTROLLED FROM THE MAIN CONTROL ROOM. IF THE MAIN CONTROL ROOM MUST BE VACATED THIS CONTROL POINT MAY BE ISOLATED & CONTROL TRANSFERRED TO THE ALTERNATE REMOTE SHUTDOWN PANEL E-CP-ARS.

31. DURING NORMAL SPRAY POND OPERATION SW-V-170A AND SW-V-170B SHALL BE LOCKED OPEN (LO) AND SW-V-165A AND SW-V-165B SHALL BE CLOSED. DURING SPRAY POND BYPASS OPERATION SW-V-165A AND SW-V-165B SHALL BE LOCKED OPEN (LO) AND SW-V-170A AND SW-V-170B SHALL BE CLOSED.

32. "SPARED IN PLACE." SEAL COOLING FROM SERVICE WATER IS ONLY REQUIRED FOR THOSE RHR PUMPS UTILIZED IN THE SHUTDOWN COOLING MODE. SINCE "C" PUMP IS NOT CAPABLE OF THIS LINEUP, COOLING FROM SERVICE WATER IS NOT REQUIRED.

33. DETAIL "A" IS TYPICAL AND VALVES MAY BE GLOBE OR GATE, DEPENDING ON THE INDIVIDUAL COIL.

(NOTES CONTINUED ON M524-3)

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (V) DENOTE A ¾" VENT VALVE EXCEPT AS NOTED.
2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A ¾" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.
4. ALL VALVES SUFFIXED WITH A (L.T.) DENOTE A LOCKED THROTTLED VALVE.

VALVE LIST

COOLING COIL NO.	SW-V A	SW-V B	SW-V C	SW-V D	SIZE –	⅜"SW-V F	⅜"SW-V G	¾"SW-V K	¾"SW-V J	SW-V L	⅜"SW-V P	⅜"SW-V Q
DMA-CC-31	100	101	102	103	2½"	141	142	143	144	737A	157	158
DMA-CC-11	104A	105A	106A	107A	2½"	145A	146A	147A	148A	737B	159A	160A
DMA-CC-21	104B	105B	106B	107B	2½"	145B	146B	147B	148B	737C	159B	160B
WMA-CC-53B1	108B	109B	110B	111B	2"	149B	150B	151B	152B	737D	161B	162B
WMA-CC-53A1	108A	109A	110A	111A	2"	149A	150A	151A	152A	737E	161A	162A

VALVE LIST

COOLING COIL NO.	SW-V E	SIZE –	SW-V H	SW-V M	SW-V N	SW-V R	SW-V S
DMA-CC-12	8A	2"	153A	154A	155A	–	679(V)
DMA-CC-22	8B	2"	153B	154B	155B	156B	–
DMA-CC-32	85	2"	153C	154C	155C	156C	–
DMA-CC-51	90	2"	–	154D	155D	–	–
RRA-CC-1	16C	2"	–	154E	155E	–	664(V)
PRA-CC-1A	65A	2"	153F	154F	155F	–	620(V)
PRA-CC-1B	65B	2"	153G	154G	155G	–	622(V)
RRA-CC-2	16A	2"	153H	154H	155H	–	663(V)
RRA-CC-3	16B	2"	–	154J	155J	156J	658(V)
RRA-CC-4	46	2"	153K	154K	155K	156K	873(V)
RRA-CC-5	36	2"	153L	154L	155L	–	–
RRA-CC-6	26	1½"	153M	154M	155M	–	–
RRA-CC-10	91	1½"	153N	154N	G/12	156N	–
RRA-CC-11	95	1½"	153P	154P	155P	156P	819(V)
RRA-CC-12	97 L.O.	1½"	153R	154R	–	156R	–
RRA-CC-13	114 L.O.	2"	153S	J/12 SH 1	H/12 SH 1	156S	–
RRA-CC-14	112	2"	153T	154T	F/11	156T	–
WMA-CC-52A1	59A	2"	153U	154U	155U	156U	–
WMA-CC-52B1	59B	2"	153V	154V	155V	156V	–
RRA-CC-15	132 L.O.	1½"	153W	154W	D/12 SH 1	156W	642(V)
RRA-CC-17	134	1½"	153X	154X	J/12	156X	645(V)
RRA-CC-19	185 L.O.	2"	153Y	154Y	155Y	156Y	–
RRA-CC-20	193 L.O.	1½"	153Z	154Z	155Z	156Z	–

SPARED IN PLACE (DMA-CC-51)
SEE DWG M524-3 (J/4) (PRA-CC-1B)

NOTE:

UNIQUE LINE NUMBERS AT COOLING COIL DRAINS-USE SUPPLY LINE NUMBER WITH APPROPRIATE SUFFIX EG. FOR:
WMA-CC-53B1 – SW(2)-2-1K
SW(2)-2-1J
WMA-CC-52B1 – SW(14)-2-1M
SW(14)-2-1N
SW(14)-2-1S

INSTRUMENT LIST

COOLING COIL NO.	SW-TX- A	SW-TX- B	SW-PX A
DMA-CC-31	50A	50B	45A
DMA-CC-11	51A	51B	46A
DMA-CC-21	52A	52B	47A
WMA-CC-53B1	53A	53B	48A
WMA-CC-53A1	54A	54B	49A

DETAIL "A"
(SEE NOTE 33)

FSAR FIG.

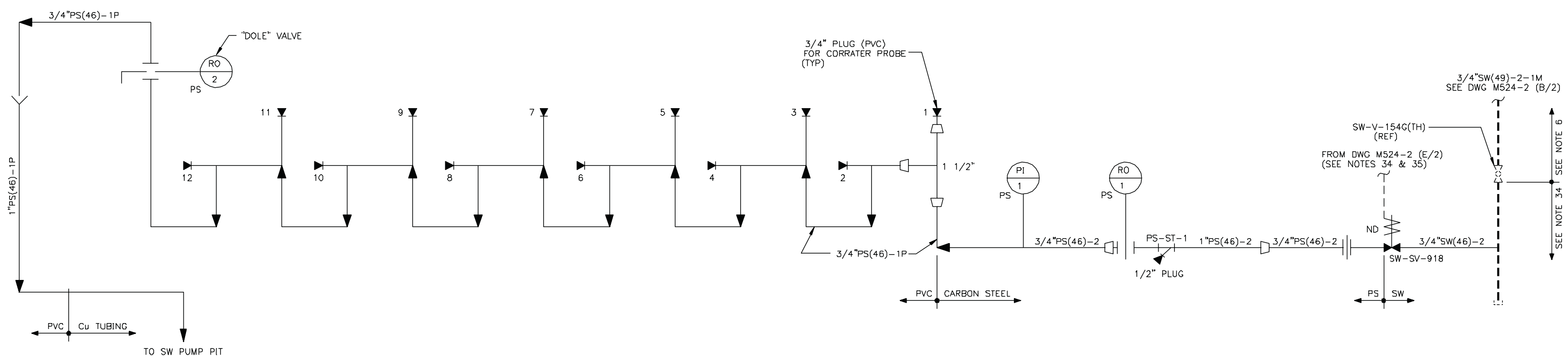
Columbia Generating Station
Final Safety Analysis Report

Standby Service Water System

Draw. No. M524-2 | Rev. 119 | Figure 9.2-12.2

11 10 9 8 7 6 5 4 3 2 1

K J H G F E



NOTES:

(FOR NOTES 1 THRU 19 SEE M524-1. FOR NOTES 20 THRU 33 SEE M524-2)

34. VALVE SW-SV-918 SHALL BE CLASSIFIED AS FOLLOWS:

SEISMIC CATEGORY	II⊕
QUALITY CLASS	II
CODE GROUP	D

CARBON STEEL SW AND PS PIPING DOWNSTREAM OF SW-V-154G SHALL BE CLASSIFIED AS FOLLOWS:

SEISMIC CATEGORY	II⊕
QUALITY CLASS	II
CODE GROUP	D

PVC PS PIPING DOWNSTREAM OF SW-SV-918 SHALL BE CLASSIFIED AS FOLLOWS:

SEISMIC CATEGORY	II
QUALITY CLASS	II
CODE GROUP	N/A

PIPING LINE NUMBER 1" SW (54)-1 LOCATED DOWNSTREAM OF RELIEF VALVES SW-RV-001A & SW-RV-001B SHALL BE CLASSIFIED AS FOLLOWS:

SEISMIC CATEGORY	I
QUALITY CLASS	II
CODE GROUP	D

⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS

35. SW-SV-918 IS INTERLOCKED WITH SW-V-12B SUCH THAT IT IS OPEN ONLY WHEN SW-P-1B IS RUNNING (SEE NOTE 14)

36. SW-V-69B HAS A MOTOR OPERATOR INSTALLED BUT HAS NO ELECTRICAL POWER AND CAN ONLY BE OPERATED MANUALLY. SW-V-70B HAS ITS MOTOR CONTROL CENTER COMPARTMENT LOCKED IN THE "OFF" POSITION. THESE VALVES ARE MECHANICALLY LOCKED CLOSED TO MAINTAIN PROPER WATER CHEMISTRY AND TO MAINTAIN SPRAY POND INVENTORY DURING AN ACCIDENT. THEY MAY BE OPENED IN CONJUNCTION WITH THE CLOSURE OF SW-V-12B TO PROVIDE ONCE THROUGH COOLING DURING A TORNADO EVENT.

37. "SPARED IN PLACE" SW-SPV-38A & SW-SPV-38B CONTROLLED AIR TO SW-PCV-38A & SW-PCV-38B.
SW-PCV-38A & SW-PCV-38B ARE LOCKED OPEN. THIS ELIMINATES THE NEED FOR SW-SPV-38A & SW-SPV-38B WHICH HAVE BEEN DISCONNECTED.

38. THE KEEPFULL SYSTEM IS NOT REQUIRED AND HAS BEEN DEACTIVATED AND SPARED IN PLACE.

39. VALVE MOTOR AND OPERATOR "SPARED IN PLACE". CABLES DE-TERMINATED.

40. MAKEUP WATER SUPPLY FROM THE POTABLE WATER SYSTEM. SEE P541 (G/13).

41. ALL ITEMS IN THE CROSSHATCHED AREA PROVIDED SERVICE WATER TO THE HYDROGEN RECOMBINER SYSTEM (CONTAINMENT ATMOSPHERE CONTROL-"CAC") WHICH HAS BEEN DISABLED. VALVES SW-V-126A, -127A, -128A, -126B, -127B AND 128B HAVE BEEN LOCKED CLOSED. (REF PDC 3539).
IN ADDITION, THE SUPPLY AND RETURN LINES HAVE BEEN BLOCKED CLOSED WITH A BLIND FLANGE WELDED IN LINE. (REF PDC 4533)

42. SW-M-P/1A AND SW-M-P/1B 1/2" COOLING WATER SUPPLY/RETURN PIPING SHALL BE CLASSIFIED AS FOLLOWS:

SEISMIC CATEGORY	I
QUALITY CLASS	I
CODE GROUP	D

43. FOR PERIODIC THERMAL PERFORMANCE TESTING OF RHR-HX-1A, FOUR THERMISTORS ARE INSTALLED ON THE SERVICE WATER INLET SIDE OF RHR-HX-1A AND EIGHT THERMISTORS ARE INSTALLED ON THE SERVICE WATER OUTLET SIDE OF RHR-HX-1A. THESE ARE MOUNTED QCII+, SC IM.

44. FOR PERIODIC THERMAL PERFORMANCE TESTING OF RHR-HX-1B, FOUR THERMISTORS ARE INSTALLED ON THE SERVICE WATER INLET SIDE OF RHR-HX-1B AND EIGHT THERMISTORS ARE INSTALLED ON THE SERVICE WATER OUTLET SIDE OF RHR-HX-1B. THESE ARE MOUNTED QCII+, SC IM.

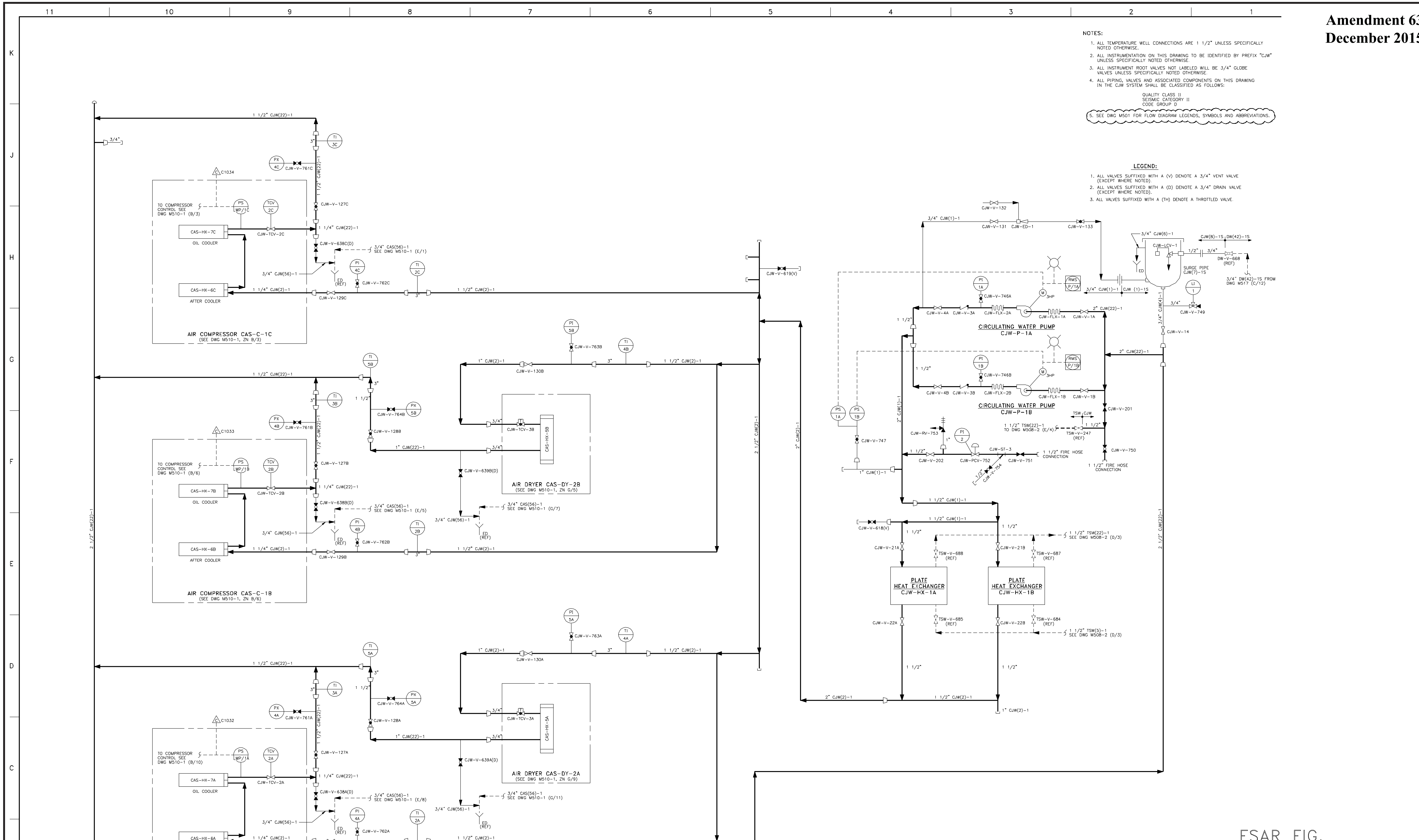
45. FOR SERVICE WATER CHEMICAL FEED (SWCF) ADDITION INTO SERVICE WATER PONDS "A" AND "B" SEE CVI 897-00,1 FOR DETAILS.

46. FOR PERIODIC THERMAL PERFORMANCE TESTING OF PRA-FC-1B, FOUR THERMOCOUPLES ARE INSTALLED ON THE SW INLET AND TWO THERMOCOUPLES ARE INSTALLED ON THE SW OUTLET OF PRA-CC-1B. THESE ARE MOUNTED QC II+ SC 1M.

47. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

48. FOR PERIODIC THERMAL PERFORMANCE TESTING OF PRA-FC-1A, FOUR THERMOCOUPLES ARE INSTALLED ON THE SW INLET AND TWO THERMOCOUPLES ARE INSTALLED ON THE SW OUTLET OF PRA-CC-1A. THESE ARE MOUNTED QC II+ SC 1M.

Columbia Generating Station Final Safety Analysis Report	Standby Service Water System		
	Draw. No. M524-3	Rev. 22	Figure 9.2-12.3



Columbia Generating Station
Final Safety Analysis Report

Flow Diagram - Compressor Jacket Water System
Turbine Generator Building

Draw No. M942 | Rev. 8 | Figure 9.2-15

9.3 PROCESS AUXILIARIES

9.3.1 COMPRESSED AIR SYSTEMS

The compressed air systems consist of the control and service air systems (CAS and SA) and the containment instrument air (CIA) system.

9.3.1.1 Design Bases

9.3.1.1.1 Control and Service Air Systems

The CAS and the SA system are supplied with oil-free compressed air from three rotary screw compressors, two refrigerated dryers, two sets of filters, and three air receivers located in the turbine generator building and by one rotary screw compressor and refrigerated filtered dryer in the radwaste building. The CAS receivers are maintained at a pressure between 110 psig and 120 psig by the compression loading control devices. Normally, the SA compressor and one CAS compressor will meet the plant demand for compressed air. Should the air pressure in the three CAS air receivers, which are interconnected, drop to less than the running CAS compressor setpoint, a second and if necessary, a third CAS compressor will start. If pressure in the CAS supply header drops to less than 80 psig, the SA system will be automatically isolated from the CAS air receivers to conserve air for use in the CAS.

The CAS provides instrument quality air, oil-free, maximum particle size of 1 micron, and dried to an atmospheric dewpoint of -40°F, throughout the plant for pneumatic instrumentation, controls and actuators. Air is drawn from the air receivers, is passed through prefilters, a desiccant dryer and afterfilters, to distribution piping.

A complete loss of control air will result in a plant shutdown, but none of the reactor systems require control air to achieve and maintain a safe shutdown condition.

The SA system provides oil-free compressed air from the CAS air receivers and/or from the SA receiver in the radwaste building, for use in process functions such as backwashing filters or demineralizers, for general services and maintenance uses throughout the plant, and as a source of breathing air.

The CAS and SA system are generally designed to Safety Class G, Seismic Category II requirements; however, piping and equipment in the reactor building, diesel generator building, and the standby service water (SW) pump houses are supported to Seismic Category I requirements. Pressure vessels are designed and constructed in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section VIII. Piping and valves are designed and constructed in accordance with the ANSI B31.1 Power Piping Code, except for piping or valves performing a primary containment function and the local control piping at the outer main steam isolation valves (MSIV). These portions of the piping are Quality Class I, Seismic Category I, and are designed and constructed in accordance with ASME B&PV Code Section III, Class 2 and Class 3, respectively.

9.3.1.1.2 Containment Instrument Air System

The CIA system is designed to deliver clean, dry, compressed gas, nitrogen or air, to the following valve actuator accumulators and valve pilot controls inside primary containment. Seven individual accumulators for the seven main steam relief valves (MSRV) dedicated to the automatic depressurization system (ADS) function are supplied with gas through two separate isolable headers at a nominal pressure of 180 psig. The four inboard MSIV actuator accumulators, 18 MSRV actuator accumulators for the power-assisted pressure relief function, and two reactor recirculation cooling (RRC) pump seal staging drain valve pilot control valves are supplied with gas at a reduced nominal pressure of 100 psig. The CIA system also provides nitrogen to the set pressure verification device (SPVD) system. For normal plant operation, nitrogen is supplied from the containment nitrogen (CN) system cryogenic storage vessel which is also the source of nitrogen for inerting the primary containment atmosphere. Should the normal nitrogen supply become unavailable, the gas supply piping to the ADS function accumulators will automatically isolate from the cryogenic nitrogen supply, and the ADS accumulator backup compressed gas manifold subsystems will provide a nominal pressure of 180 psig nitrogen from banks of high pressure compressed nitrogen cylinders. The designed pneumatic supply to the ADS accumulator is such that, following a failure of the safety-related pneumatic supply to the accumulator, at least two valve actuations can occur with the drywell at 70% of design pressure.

The 100 psig line does not have an automatic backup supply, but provision has been made for supplying air from the CAS system through the CIA dryer and filters via manually actuated intertie valves in lieu of the normal CN supply.

The piping for normal supply of compressed nitrogen or air, that is outboard of the primary containment isolation valves, is designed to the ANSI B31.1 Power Piping Code, and pressure vessels are constructed to the rules of the ASME B&PV Code Section VIII. Piping penetrating primary containment and inside of primary containment, from the outermost containment isolation valves to the point of use valve connections, is constructed to Safety Class 2, ASME B&PV Code Section III, Class 2, Seismic Category I, requirements; except that the flexible connectors at the four inboard MSIV actuator supply valves are equivalent to but are not ASME Section III stamped items. Piping located in the reactor building and the diesel generator building is supported by Seismic Category I supports, although most of the non-ADS piping itself is designed to Seismic Category II loadings. The ADS function accumulator backup compressed nitrogen supply subsystems, from the normal supply isolation valves and from the outboard containment isolation valves, to, but not including, the compressed nitrogen cylinders, pressure regulators and overpressure relief valves, are constructed to ASME B&PV Code Section III Class 3 rules including Seismic Category I load conditions. An exception to this

ASME statement occurs at the pressure control valve stations in the diesel generator building corridor, where the sections of line containing the pressure control valve in each station is non-ASME (due to the unavailability of ASME pressure control valves), but is isolable and bypassable via ASME manually operable valves. The compressed gas cylinders are U.S. Department of Transportation approved commercial shipping containers. The cylinder valves, connectors, pressure regulators, and overpressure relief valves are approved by the Compressed Gas Association. The supports for the compressed gas cylinders, cylinder valves, connectors, pressure regulators, and overpressure relief valves are designed to Seismic Category I requirements.

9.3.1.2 System Description

9.3.1.2.1 Control and Service Air System

The CAS and SA system are shown schematically in Figure 9.3-1. Three compressors and three interconnected CAS air receivers in addition to one SA compressor and SA air receiver supply both control and SA requirements.

Each CAS compressor has a run-standby-stop local selector switch. When the selector switch is set in the run position, the compressor runs continuously and loads and unloads to maintain receiver pressure. When the selector switch is in standby position, the standby CAS compressor will automatically start when the CAS supply header pressure falls below the running CAS compressor setpoint. Normally one CAS and the SA compressor are running with at least one CAS compressor on standby.

The CAS compressors take suction from the room through 10 μ filters. The air is filtered down to 0.1 μ before entering the air receivers. The CAS compressors are cooled by the compressor jacket water (CJW) system. The CJW system is a closed loop system that transfers heat from the CAS system to the plant SW system. Air quality is monitored by three carbon monoxide (CO) monitors.

The SA compressor takes suction from the outside to ensure that the air, which can be used for breathing purposes, is free from contaminants. A CO monitor alarms if CO levels rise above safe levels.

The CAS and SA compressors pump an air/oil mixture to an internal air receiver/oil separator and then the air enters an internal aftercooler for cooling and moisture separation. The air is then discharged to a refrigerated dryer for further moisture removal. The air then enters a series of filters to remove any remaining particles and oil vapor from the air before entering the main air receivers.

Control air for station instrumentation and controls is processed through a refrigerated air dryer, a filter array, one of two 100%-capacity air dryer skids. Each skid has two 100%

capacity prefilters and after filters arranged in parallel pairs to allow for replacement of the filter cartridge without interruption of air flow. The dryer on each skid is a heatless regenerative twin tower desiccant type which dries through one tower while the other is regenerating. A timer switches between towers and a purge economizer allows reduction in purge usage when the dryer is not operated at full capacity. There are two parallel refrigerated dryer and filter arrays, one or both of which may be operating at a given time.

Service air is distributed from the header to quick-disconnect hose connections where it is used for pneumatic service equipment and maintenance throughout the plant. Service air is also distributed for plant services such as demineralizer resin mixing and filter and demineralizer backwashing (see Figure 9.3-1).

Table 9.3-1 presents the major characteristics of the air compressors, receivers, and the air dryer for the control and SA.

9.3.1.2.2 Containment Instrument Air System

The CIA system is primarily a pressurized nitrogen system as shown in Figure 9.3-2. The location of components in this system in the Seismic Category I reactor building is shown in Figures 1.2-7, 1.2-8 and 1.2-9. During normal reactor operation, the CN system, discussed in Section 6.2.5.7, supplies pressurized nitrogen from an 11,000-gal (approximately 1 million-scf) cryogenic storage tank to meet the requirements of the following valves inside primary containment:

a. Full supply pressure (180 psig nominal) loads,

    1. Seven ADS function MSRVs and their individual ADS accumulators,

b. Reduced pressure (100 psig nominal) loads,

    1. Four inboard MSIV accumulators,

    2. Eighteen main steam safety/relief valves (SRVs) and their individual accumulators to be used for the power assisted pressure relief function, and

    3. Two RRC pump seal staging drain valve pilot control valves.

For a discussion of the function and operation of the ADS, see Sections 6.3 and 7.3. In case the cryogenic nitrogen source does not maintain supply pressure to the ADS accumulator supply headers, two backup nitrogen cylinder bank subsystems are provided to automatically supply a nominal pressure of 180 psig nitrogen. A bank of 15 nitrogen cylinders supplies three of the ADS function accumulators, and a separate bank of 19 nitrogen cylinders supplies the other four ADS function accumulators (see Figure 9.3-2). Of these backup subsystems, only 14 nitrogen bottles for three ADS accumulators and 17 nitrogen bottles for the four ADS accumulators are necessary to provide a 30-day supply of nitrogen for the ADS function during a postulated loss-of-coolant accident (LOCA) condition. The backup subsystems also provide for manual SRV operation during station blackout (Appendix 8A). A remote nitrogen cylinder connection is provided to each subsystem to permit supplementing the cylinder banks through manual connection of portable nitrogen cylinders, and thus maintain the ADS function for at least 100 days following a postulated LOCA event. The remote cylinder connections are located in the diesel generator building corridor, adjacent to the reactor building, outside the secondary containment boundary, permitting personnel access to the connections under postaccident conditions.

Remote pressure control stations, each consisting of a bypassable pressure control valve, are schematically located downstream of the junction of the backup nitrogen cylinders supply with the remote backup nitrogen cylinder supply, and are physically located in the diesel generator building corridor. Thus, any problems with the pressure control valve could be accommodated by isolating it, to allow maintenance to be performed, while the ADS function header pressure was being maintained with the manual bypass valve. The pressure control valve allows the cylinder regulators to be set at a higher, but broad range, pressure.

The backup nitrogen cylinder banks are located in the reactor building vehicle air lock (railroad bay) and are accessible during normal reactor operation. Cylinders are valved to the supply piping in a sequential manner by a pressure-controlled programmer for each bank, so that only the number of cylinders necessary to maintain pressure in the ADS accumulator supply lines are drawn on. During normal reactor operation, minimum cylinder pressure is maintained as required by the Technical Specifications. The gas cylinders used may only be charged to 3000 psig, a limitation imposed by the system piping.

Once opened, the ADS valves are not expected to be cycled during the postaccident period; nevertheless, the air supply was conservatively sized to allow for extra cycles, since they may be used for alternate shutdown cooling.

In the event the cryogenic nitrogen source totally fails to supply the system requirements, the backup nitrogen cylinder banks will supply their respective ADS supply headers as described above and the headers will be automatically isolated from the common CIA supply line. The reduced pressure loads will then be without a source of pressurized gas until the CAS intertie valves are opened. A normally open vent between the two in-line series block valves could then be closed (the vent is there to guarantee no backleakage from CIA to CAS, which could lower the oxygen content of CAS/SA and result in an adverse condition should a breathing-air tap be in use). The relatively low pressure CAS supply would still be inadequate for the ADS headers, though, and they would still automatically be supplied as discussed above.

9.3.1.3 Safety Evaluation

9.3.1.3.1 Control and Service Air System

Operation of the CAS and SA systems are not required for the initiation of any engineered safety feature systems or for safe shutdown of the reactor.

A complete loss of the CAS system during power operation results in a plant shutdown with the following expected to occur: The SA system is automatically isolated as the CAS system pressure decreases. Control rods drift into the core as the control rod drive (CRD) scram outlet valves begin to slowly open. The outboard MSIVs close causing an automatic reactor scram. Operator actions based on CAS failure would be taken in accordance with plant procedures to scram the rector, control reactor pressure vessel (RPV) pressure/water level, and to mitigate the effects of individual air-operated valve failure modes.

9.3.1.3.2 Containment Instrument Air System

Since each of the two backup nitrogen cylinder banks and the cryogenic nitrogen supply are independent of each other, a single component failure in one will not affect the operational function of the other. The two ADS header tie line isolation valves are each powered from a different division of the critical power supply.

During normal operation, the cryogenic nitrogen supply will maintain pressure in the inboard MSIV, the power-assisted MSRV, and the ADS function accumulators. The cryogenic nitrogen supply piping and the CAS supply piping are not assumed to be serviceable under accident conditions. In such an event, the local accumulators at the MSIVs and MSRVs provide a short-term source of pressure for actuating these valves. Further discussion of the effects of loss of pressure to the MSIVs and the normal function MSRVs is presented in Sections 5.2.2.4, 5.4.5, and 7.3.1.1.10. The backup nitrogen cylinder bank subsystems will supply operating nitrogen pressure to the ADS MSRV accumulators at any time the normal supply does not function.

The solenoid valves on the ADS function MSRVs could be pressurized to a pressure greater than their qualified pressure under certain accident conditions if the ADS header pressure were allowed to approach the piping design pressure; therefore, the ASME relief valves are set at a lower pressure to preclude this possibility. They are located in the diesel generator building to provide access (post-LOCA) should one open and stick open.

9.3.1.4 Testing and Inspection Requirements

A channel functional test of the ADS accumulator backup compressed gas system alarm is conducted no less than once every 115 days, (when ADS is required operable) with a channel calibration of the alarm performed no less than once every 22.5 months that verifies an alarm setpoint of greater than or equal to 135 psig (decreasing). At a frequency no less than once per 22.5 months, the nitrogen capacity in at least two accumulator bottles per division within the backup compressed gas system is verified. The backup compressed gas pressure instrumentation is periodically tested and calibrated as required by the Technical Specifications.

Instrument air sampling and testing is performed periodically to ensure that the air quality meets system design requirements. Routine maintenance and inspection along with operator observation during operation ensures the system is functioning properly to support normal plant operations.

9.3.1.5 Instrumentation Requirements

9.3.1.5.1 Control and Service Air Systems

Instrumentation and controls are provided in the main control room to control and monitor the operation of the systems. Low receiver air pressure, high air temperature, high filter differential pressure, and other system operating parameters (see Figure 9.3-1) are alarmed in the control room.

An air-operated control valve isolates the SA when its header pressure drops to 80 psig to enable sufficient air flow to the CAS. Nonlubricated control valves, a solid state timer, and a purge economizer regulate the air drying cycle.

9.3.1.5.2 Containment Instrument Air System

The instrumentation provided in the CIA system is shown in Figure 9.3-2. Pressure switches and alarms are provided in this system to regulate the nitrogen supply from the 15 nitrogen bottles in one bank and the 19 bottles in the second bank. Pressure switches in the tie lines between the CIA distribution header, which is itself supplied by either the CN system or the CAS system, and the ADS function lines monitor the supply pressure and cause tie line isolation valves to independently close if the tie line pressure should drop below the switch setpoint for a time period greater than 3 minutes. A pressure switch on each ADS function header then causes the nitrogen bottles to begin supplying their respective headers after the tie-line isolation valves actually close. A redundant pressure switch on each ADS function header set at a slightly lower pressure than the tie-line isolation setpoint, acts as a backup to either the isolation valve closed position switch, or the other pressure switch on the same ADS function header, to initiate supply from the nitrogen bottles. The redundant pressure switch also initiates an alarm in the control room to alert the operators to a low-pressure condition in the ADS function header.

In addition to the low pressure switches, each ADS function header has a pressure switch that provides control room annunciation to alert the operators to a high-pressure condition.

Local pressure indication is provided just downstream of each pressure control valve station should the station require isolation and the ADS function header pressure require regulation via the manual bypass valve.

9.3.2 PROCESS SAMPLING SYSTEM

9.3.2.1 Design Bases

The plant process sampling system is designed to provide representative samples, under controlled conditions, of plant process streams. Provisions for continuous monitoring of selected systems provide a means of analytical surveillance of system trends and performance during plant operations. Laboratory samples are taken to provide (a) comprehensive analytical information on plant operations, (b) a check on continuous monitoring instrumentation, and (c) regular reports on critical plant systems to ensure safe and proper operation.

The sample system is designed to the following criteria:

a. To ensure that the samples of the process stream are representative of the conditions that exist at the sample tap, the following design practices have been implemented:

   1. The shortest practical line length and smallest practical line diameter is used to reduce time lag and sample line plate-out;

   2. Sample lines are routed to prevent dead legs and are assembled to avoid traps and dips;

   3. Certain sample lines have a continuous purge flow of sufficient velocity to inhibit deposition of suspended solids and to satisfy the requirements of analytical instrumentation;

   4. To ensure representative sampling of gaseous effluents, special sampling probes are employed which consider the process line size, flow conditions, and flow direction. Where appropriate, isokinetic probes are used to ensure representative sampling of the particulates;

   5. Where precision measurements are to be made of high purity (low conductivity) water, the process sample flow stream is conditioned by constant temperature baths before in-line conductivity measurement to maintain the internal temperature compensation within the valid range. Hot process fluids are cooled by heat exchangers before entering grab sample hoods or analysis equipment to avoid measurement errors and the potential for injury; and

6. Sample line pressures are reduced at sample racks to protect in-line instruments and minimize the potential for personnel injury. Pressure regulators with relief valves are used to control and limit sample pressure.

7. Where tubing samples are taken from high temperature and pressure lines, flow will be isolated and the temperature allowed to decay to ambient before the system is depressurized, drained and then the sample removed.

b. In addition to limiting sample temperatures and pressures, the following safety precautions are taken:

1. The sample lines are made of stainless steel tubing with a minimum of joints or connections, and

2. Process sample lines containing highly radioactive fluids are routed to minimize personal radioactive exposure.

9.3.2.2 System Description

The sampling system consists of continuous flow in-line analytical instruments, plus numerous grab sample points which are either local or routed to a centralized sampling station. The sampling system is shown in Figures 9.3-3, 9.3-4, 9.3-5 and 9.3-17.

A sample station typically consists of a sample rack and a fume hood. Process fluids enter the conditioning rack and, where necessary, pass through one or more heat exchangers to reduce temperatures to 105°F or less. Pressure is reduced, where necessary, to limit sample pressure to 40 psig or less. If sampling criteria does not allow the temperature and pressure to be reduced at a sample rack, the flow will be isolated and the system brought to a safe temperature and pressure before sample removal to minimize the potential for injury to personnel. After conditioning, the process fluid is routed to the chemical fume hood where grab samples are taken. In the case of continuously monitored process streams, a portion of the fluid is diverted through a constant temperature bath, through conductivity cells and rotameters, and then to a drain line. Selected process fluids are continuously monitored by sample line sensors for conductivity and other parameters. Electric outputs of the sensors go to monitors and continuous recorders. Electrodes located in RWCU piping and inside of the RPV provide electro-chemical potential (ECP) signals to continuous recorders on PSR-CAB-1. Liquid effluents from the sample racks and chemical fume hoods are routed through closed drains to the liquid radwaste system.

The systems that require intermittent or continuous analytical sampling are arranged to permit sampling during normal and shutdown conditions. Many of the sample lines flow continuously. For those that do not, written procedures specify the flow rate and time required for sample line purge before taking the sample. This ensures that representative samples are obtained.

9.3.2.2.1 Sample Locations

The available process liquid sampling system points are described in Table 9.3-2 (not all available sample points are used). The sampling system for radiation monitoring equipment is described in Section 11.5.

9.3.2.2.2 Liquid Sample Taps and Probes

Sample line connections are, where possible, located after a straight run of pipe. Since process piping is designed for turbulent flow conditions, sample taps for nominal line sizes 3 in. and less can be taken from tees or welded-pipe connections. For nominal pipe sizes 4 in. and larger, sample probes are installed into the pipe line. Sample connections to process pipes are a minimum of 0.75 in. and have the root valves as close to process lines as possible. The root valve and connection are the same quality and code group as that of the process pipe.

The sample probes are fabricated in accordance with Figures 9.3-6, 9.3-7, and 9.3-8 and are designed to avoid failure through vibration or wear.

Sampling taps, where possible, are located at the sides of horizontal process lines rather than at the top or bottom.

9.3.2.2.3 Steam Samples

Two sample taps for main steam are installed, one of which is a spare.

The sample line is stainless steel tubing of sufficient total length (from sample point to sample rack) to allow for decay of ^{16}N to minimize radiation dose rate at the sample station. The steam sample is condensed near the process line tap and the resultant condensate is piped to the sample rack.

9.3.2.2.4 Sample Piping Design

The sample piping, from the root valve at the process tap to the sample conditioning rack in a sample room, is small diameter heavy wall stainless steel tubing to minimize corrosion or contamination of the sample. The small diameter also provides a passive flow restriction in the event of a sample line break.

Sample lines are sized to ensure turbulent flow conditions at the required flow rate. This turbulence alleviates stratification or plate-out of particles in the sample line.

Continuous flow lines containing fluids over 150°F are insulated to protect personnel. When warranted by high anticipated radiation levels, sample lines containing radioactive fluids are routed or shielded as described in Section 12.3.

9.3.2.2.5 Fume Hood Design and Grab Samples

All liquid sample lines entering the sample rooms have provisions for grab sampling. Each fume hood is an enclosed sheet metal structure (stainless steel) with manual grab sample valves positioned over a stainless steel sink, all located within the hood. The face of the hood has a transparent sash opening for hood access. Ambient air enters the opening to remove any gases or droplets released from the liquid sample. Air is exhausted from the top of the hood into the building ventilation exhaust system. The hood sink collects the sample liquids not collected in the grab sample and pipes the effluent to a closed drain system. A demineralized water faucet and a compressed air nozzle is located near the sink in the hood to flush and clean sampling apparatus.

9.3.2.3 Safety Evaluation

The process sampling system has no direct process control functions. Each continuously monitored sample line is provided with local indication and annunciation. This includes a high alarm, a low alarm where appropriate, and a continuous recorder. Remote indication is provided on certain samples.

Components of the process sampling system which form part of the reactor coolant pressure boundary (RCPB) or containment isolation system are designed in accordance with Seismic Category I requirements and other code and quality requirements as described in Section 3.2. Sample lines which form part of the containment isolation are provided with automatic fail-closed isolation valves both inside and outside of containment. The components of the process sampling system that do not form part of the RCPB or containment isolation system and are not in the reactor building are not designed to Seismic Category I requirements since they are not necessary to ensure any of the following:

a. The integrity of the RCPB,

b. The capability to shut down the reactor, and

c. The capability to prevent or mitigate the consequence of accidents which could result in potential offsite exposure in excess of the limits of 10 CFR 50.67.

The operation of the liquid sampling system is not necessary for plant safety. Therefore, in the unlikely event of an accident, all sample lines which pass through the containment are automatically isolated by fail-closed valves. Electrical power for the sampling subsystem is from a nonessential bus.

The routing of high temperature and high pressure sample lines outside the containment is not considered hazardous because of limited flow and limited stored energy as discussed in Section 3.6. The location of sample temperature and pressure reduction equipment outside the containment allows maintenance during plant operation.

The sample station is a closed system with grab samples taken under the safety of a chemical fume hood to minimize radiological hazard. The hood maintains a constant air velocity of approximately 100 ft/minute through the working face to ensure that airborne contamination will not enter the room.

Pressure control valves are installed in high-pressure sample lines so that operators will not be exposed to high sample pressure when obtaining grab samples.

At PSR-SR-49 sample rack, tubing samples are taken from high temperature and pressure lines that will utilize double isolation valves to protect the worker from harm due to the operating conditions of the high-energy line. This sample rack will be isolated then cooled to ambient temperature and then depressurized. The rack is then drained before the tubing sample is removed. This rack is located in the RWCU heat exchanger room, which minimizes exposure or contamination of personnel and maintains contamination control in case of a spill.

9.3.2.4 Tests and Inspections

The sample nozzles and associated piping, tubing, fittings, and valves are tested and inspected in accordance with the requirements of the main process pipes from which the samples are taken.

The process sampling system is proved operable by its use during normal plant operation. Grab sampling is provided for laboratory analysis for verification of proper operation and calibration of continuous analyzers.

9.3.2.5 Instrument Requirements

Continuous analyzers and associated recorders monitor conductivity and dissolved oxygen at selected points in the sampling system. Alarms annunciate in the main control room or the radwaste control room when the variables are out of specification to alert the control room operator that corrective action is required.

9.3.3 EQUIPMENT AND FLOOR DRAINAGE SYSTEMS

9.3.3.1 Design Bases

The equipment and floor drainage systems are designed to collect and convey the various operational waste liquids from their points of origin to their points of ultimate disposal under controlled conditions. The following design bases are used to ensure the system integrity during normal plant operation and preclude any danger to the health and safety of plant personnel, the environs, and the general public.

Drainage systems which carry radioactive waste are isolated from drainage systems which do not carry radioactive waste. Radioactive wastes are collected separately in tanks or sumps, based on their classification as floor drainage (low purity), equipment drainage (high purity), chemical drainage (nonneutral) and detergent drainage, to facilitate their treatment in the radwaste building.

Floor and equipment drains in the diesel generator building, service building, isolated areas of the turbine building, and storm water drainage are not intended to be operated as radioactive systems.

The majority of radioactive drainage piping 1-in. and above is of butt-welded construction to avoid the collection of radioactive solids, see Section 12.3.1.3.2. Drain lines are sloped to ensure complete drainage of piping. Appropriate shielding is used in locations which could result in increased radiation exposure. Cover plates are an integral part of all floor drains to prevent solids from entering drain piping and causing subsequent clogging.

9.3.3.2 System Description

Equipment and floor drainage systems are provided to handle radioactive and nonradioactive wastes in separate systems. Radioactive wastes are collected in the building sumps and transferred to the radwaste system (see Section 11.2) for treatment, sampling, and disposal or reuse within the plant. Roof drains are drained by gravity or pumped to the storm drain system.

9.3.3.2.1 Radioactive Equipment Drainage System

9.3.3.2.1.1 Reactor Building Drains. Reactor building equipment drains are collected in two separate subsystems (see Figure 9.3-9). One subsystem handles drainage from all equipment drains located in the primary containment. The other handles drainage from equipment drains located in remaining portions of the reactor building.

The primary containment equipment drain subsystem starts at funnel drains located at pieces of equipment, collects in branch lines, and discharges to the drywell equipment drain sump. The drywell equipment drain sump is the collecting point for valve leakoffs, the inner refueling bellows seal support drains, reactor recirculation pump seal leakoffs, and equipment vents and drains within the drywell.

The drywell equipment drain sump is drained through a 3-in. line penetrating the containment wall to the reactor building equipment drain sump. This drain line includes two isolation valves located outside the drywell and a flow meter for monitoring of the leakage into the drywell sump during reactor operation. Leakage into the drywell equipment drain sump is considered identified leakage (see Section 5.2.5.2). This drain line is provided with a loop seal to prevent gas flow between the drywell and the reactor building during normal operation.

The containment isolation valves in the drywell sump drain line will close on a high pressure signal in the drywell to prevent blowing out the water seals. All equipment drainage piping in the drywell has been designed to Seismic Category 1M requirements. The drywell equipment sump drain line is Seismic Category I and is constructed to ASME Section III Class 2 requirements from the sump outlet to the second containment isolation valve.

The equipment drains for the remainder of the reactor building start at funnel drains located at pieces of equipment, collect in branch lines, and discharge to the reactor building equipment drain sump. The reactor building equipment drain sump collects drainage and leakage from the following major sources:

a. Fuel pool gate drainage,

b. Residual heat removal system equipment,

c. Fuel pool cooling system equipment,

d. CRD system equipment,

e. Reactor water cleanup system equipment,

f. High-pressure core spray (HPCS) system equipment,

g. Low-pressure core spray system equipment,

h. Reactor core isolation cooling system equipment,

i. Condensate filter demineralizer backwash pump and auxiliary condensate pumps, and

j. Drywell equipment drain sump.

Two sump pumps are installed in the reactor building equipment drain sump to transfer the collected water to the selected collector tank located in the radwaste building. Only one pump is in service at a time. A manual selector switch is located near the pumps to select the active pump.

A level switch in the sump starts and stops the active pump and timers monitor the fill and pump out rate and energize an alarm(s) in the control room if the settings on the fill and pump out timers are exceeded. A temperature sensor in the sump starts the active sump pump and directs the sump water through a heat exchanger to cool the water prior to being pumped to the radwaste system. All drainage piping in the reactor building has been designed to Seismic Category 1M requirements.

To minimize the release of radioactive contaminants, the reactor building equipment drain sump and drain headers are maintained at a negative pressure and vented through a filter system (see Section 9.4.2).

9.3.3.2.1.2 Turbine Building Drains. The turbine building equipment drain sumps serve as the collection point for equipment drains from all floors of the building (see Figure 9.3-10).

The equipment drains start at funnel drains located at pieces of equipment, collect in branch lines, and discharge to one of two turbine building equipment drain sumps. The turbine building equipment drain sumps collect drainage and leakage collection includes the following major sources:

a. Low-pressure feedwater heaters,
b. High-pressure feedwater heaters,
c. Gland steam evaporators,
d. Reactor feed pumps,
e. Instrument racks,
f. Steam jet air ejector condensers,
g. Mechanical vacuum pumps, and
h. Main condenser.

Two sump pumps are installed in each turbine building equipment drain sump since the pumps are not accessible during plant operation due to their location in a high radiation area. These pumps transfer the collected water to the waste collector tank located in the radwaste building. Level switches are provided in each sump to start and stop the sump pumps at predetermined levels. Drainage piping in this system is designed to Seismic Category II requirements.

9.3.3.2.1.3 Radwaste Building Drains. The radwaste building equipment drainage is collected in a separate equipment drain sump (see Figure 9.3-11). The subsystem collects drainage from components containing high purity water. The sump contains a sump pump which transfers the water collected to the waste collector tank. The pump is controlled by a level switch in the sump.

To minimize the release of radioactive contaminants, the radwaste building equipment drain sump and drain header are maintained at a negative pressure and vented to the radwaste building ventilation system (see Section 9.4.3).

The radwaste building chemical waste sump collects wastes from equipment drains and floor drains associated with the chemical waste system (see Section 11.2.2) in a separate sump (see Figure 9.3-11). These wastes are collected and pumped to the chemical waste tank. The pump is controlled by a level switch located in the sump.

Drainage piping in these systems is designed to Seismic Category II requirements.

9.3.3.2.2 Radioactive Floor Drainage Subsystem

9.3.3.2.2.1 Reactor Building Floor Drains. Reactor building floor drainage is collected in two separate systems (see Figure 9.3-12). One handles drainage from the drywell which collects leakage from piping and equipment. The other handles drainage from all floor drains located in the remaining portions of the reactor building.

The drywell floor drains subsystem collects leakage in the drywell from piping, valves, and equipment in the drywell floor drain sump. In addition, drains from the drywell coolers are routed to this sump.

The floor drain sump system is a gravity flow feed from the drywell floor drain into one of the reactor building floor drain sumps. The floor drain sump geometry is such that the gravity feed is connected to a perforated standpipe in the center of the sump. Approximately 50 gal of liquid is required to fill a completely dry sump to the first row of holes in the perforated pipe outlet. A flow transmitter continuously measures flow from the drywell floor drain and supplies this flow information to a flow totalizer in the control room. Drywell floor drain flow is also provided to a recorder whose function is to actuate a control room alarm if flow exceeds a pre-established limit.

The drywell floor drain sump is drained through a 3-in. line penetrating the containment wall to one of the reactor building floor drain sumps. This drain line includes two isolation valves located outside the containment and an in-line flow meter for monitoring the flow from the drywell sump during reactor operation. Leakage into the drywell floor drain sump is considered unidentified leakage (see Section 5.2.5.2). The drain line is provided with a loop seal to prevent gas flow between the drywell and the reactor building during normal operation.

The containment isolation valves in the drywell sump drain line will close on a high-pressure signal in the drywell to prevent blowing out the water seal.

All floor drainage piping in the drywell has been designed to Seismic Category 1M requirements. The drywell floor drain sump piping is Seismic Category I and is constructed to ASME Section III Class 2 requirements from the sump out to the second containment isolation valve except 3 ft of 2-in. piping from the diaphragm floor seal, which does not require hydrotest or code stamp.

The floor drain system for the remainder of the reactor building contains four independent sumps. Each sump is located near one of the four corners of the building and collects drainage from roughly one quarter of the building.

The four sumps collect water from the following typical sources:

a. Floor drains throughout the building;

b. Drains from electrical trenches, refueling services boxes, valve boxes, cable reel pit and track drains on the refueling floor, pool liner drains, and the new fuel storage vault; and

c. Equipment drains from equipment containing low-purity water, such as reactor building closed cooling water system and standby gas treatment system.

As shown in Figure 9.3-12, the floor drain piping in the reactor building drains to one of four sumps listed below.

Floor Drain Sump	Room Locations	Rooms Served
FDR-SUMP-R1	RHR A pump room	RCIC RHR A
FDR-SUMP-R2	RHR B pump room	RHR B
FDR-SUMP-R3	HPCS pump room	HPCS CRD
FDR-SUMP-R4	RHR C pump room	LPCS RHR C

Each sump is equipped with level instrumentation which (a) controls the sump pumps, (b) alarms in the control room (on high sump level), and (c) initiates closure of the isolation valves in the piping between interconnected rooms. Class 1E level instrumentation is installed just above floor level in each emergency core cooling system (ECCS) pump room. This instrumentation alarms in the control room.

The floor drain system is analyzed against potential sources of flooding as described in Section 3.6.

The effects of passive failures in the ECCS during post-LOCA long term cooling is addressed in Section 6.3.

Two of the reactor building floor drain sumps are provided with one sump pump (FD-SUMP-R4 and FD-SUMP-R2). The other two sumps have two pumps, one of which is for backup. The two sumps (FD-SUMP-R3 and FD-SUMP-R1) which have a backup pump, serve rooms containing the reactor core isolation system, residual heat removal system loop A pumps, and the CRD pump, condensate supply pumps, and the HPCS pump.

Floor drain sump FDR-SUMP-R3 also receives the leakage from the drywell floor drain sump. Each FDR sump draining more than one pump room has an isolation valve installed in the drain header between the connected pump rooms. The valve will close on high water level signal from the sump. Thus, except for the sump valve, room doors and piping/cable penetrations, drainage in any pump room, exceeding the capacity of the sump pump, will be confined to that room with the exception of RCIC and CRD pump rooms which are connected by an unisolable sump pipe.

The reactor building floor drain pumps transfer the collected water to the floor drain collector tank located in the radwaste building. Level switches are provided in each sump to start and stop the sump pumps at predetermined levels. A timing switch in each sump monitors the fill-up rate in the sump. Abnormal sump fill-up rate is alarmed in the main control room.

In addition, wall-mounted level sensing instrumentation is provided in each ECCS pump room to detect passive failures in the ECCS during post-LOCA long-term cooling and to alarm in the control room. As discussed in Section 6.3.2.5, ample operator time is available after detection of the leak to identify and isolate the source before the leak has any adverse effect on the ECCS.

To minimize the release of radioactive contaminants the reactor building floor drain sumps and drain headers are maintained at a negative pressure and vented through a filter system (see Section 9.4.2).

9.3.3.2.2.2 Turbine Building Floor Drains. Turbine building radioactive floor drains are collected in two sumps located in the turbine building (see Figure 9.3-10). Each sump is equipped with two sump pumps. Floor drain water collected in these sumps is pumped to the floor drain collector tank in the radwaste building for processing.

Level switches are provided in each sump to start and stop the sump pumps at predetermined levels. A mechanical alternator installed in each sump alternates the operation of each pump.

Drainage piping in this system is designed to Seismic Category II requirements.

9.3.3.2.2.3 Radwaste Building Floor Drains. Three sumps collect radioactive floor drains and equipment drains and overflows from equipment containing water of low purity (see Figure 9.3-11). Two of these sumps pump to the floor drain collector tank. The remaining sump, which collects drainage from the solid waste handling area, discharges to the waste sludge phase separator.

Level switches are provided in each sump to start and stop the pump at predetermined levels.

Drainage piping in this system is designed to Seismic Category II requirements and supported to Seismic Category I requirements.

9.3.3.2.3 Nonradioactive Water Drainage System

9.3.3.2.3.1 Turbine and Service Buildings. Equipment and floor drains from normally uncontaminated areas of the turbine building are collected in three sumps (see Figure 9.3-13). All these sumps are routed to the radwaste system for processing (see Section 11.2).

Level switches are provided in each sump to start and stop the pumps at predetermined levels.

Area floor drains and equipment drains collected by this system are as follows:

a. Operating floor (el. 501 ft 0 in.)

Air handling units (equipment drains)
Air handling wash pumps (equipment drains)
Instrument panels (equipment drains)
Air washers (equipment drains)
Clean area drains

b. Mezzanine floor (el. 471 ft.0 in.)

Clean area drains
Turbine oil coolers (cooling water drains)
HP fluid reservoir (cooling water drains)

c. Ground floor (el. 441 ft 0 in.)

Clean area drains
H_2 seal oil unit (cooling water drains)
Stator cooling water unit (equipment drain)
Main condenser water box (equipment drain)
Elevator pit drain
Auxiliary boiler blowdown tank (equipment drain)
Auxiliary condensate tank (equipment drain)
Service and instrument air compressors (equipment drain)

Equipment and floor drains in the service building are collected in a single sump containing two sump pumps. Water collected in the service building floor drain sump is pumped to the storm water drainage system.

Equipment and floor drains in the diesel generator building are routed to the storm water drainage system. Building roof drains are collected in branch lines which empty into a header prior to discharge to the storm water system.

Water collected by the storm water drainage system is conveyed by a concrete pipe to a point approximately 1500 ft northeast of the plant. The pipe discharges to lined evaporation ponds. Grab samples of the discharge are analyzed as part of the radiological environmental monitoring program (REMP). A composite water sampler was installed in late 1992.

9.3.3.2.3.2 Miscellaneous Drainage System. Liquid waste from curbed oil equipment areas are directed to separate oil sumps for collection and disposal. These areas are as follows:

a. Turbine lube oil storage and conditioning area, and
b. H_2 seal oil room.

Curbs are provided around fuel oil tanks, auxiliary boiler, and other equipment to contain spillage and prevent oil from entering drainage systems.

9.3.3.3 Safety Evaluation

Each of the sumps in the reactor, radwaste, turbine generator, and service buildings are provided with high-high level alarm signals. The sump pump starts operating on actuation of the high water level switch and shuts down on actuation of the low level switch. On sumps containing two pumps the standby pump is started when a high-high water level switch is actuated and an alarm is actuated. Both pumps shut down on actuation of the low level switch.

Sumps in the reactor building are provided with timers which initiate an alarm when the fill-up rate of a sump exceeds a preset value. These sumps serve as leakage monitors for the CRD seals, the drywell equipment, the RCIC system, ECCS system, and other systems that support and protect the nuclear steam supply system.

Containment integrity is maintained in the transfer of liquid waste from the drywell sumps to the reactor building sump by a loop seal and isolation valves located outside the containment. These valves close on high containment pressure or low reactor vessel water level. In the reactor building, floor drain sumps that serve more than one ECCS equipment room isolate the rooms from one another on a high-high level sump signal that closes sump influent isolation valves.

In addition, if failure of the normal sump level detection and isolation system in the ECCS pump rooms should occur, a Class 1E leak detection system is installed (see Section 6.3).

9.3.3.4 Testing and Inspection Requirements

The equipment and floor drainage systems are in daily use and as such do not require periodic testing to ensure operability. Testing and calibration of the leak detection system components are discussed in Section 5.2.5.

9.3.3.5 Instrumentation Requirements

Sump pumps are equipped with run lights and elapsed time meters located on the radwaste control panel. High-high level alarms for the turbine and radwaste building sumps are also annunciated in the radwaste control room. Reactor building equipment drain sump temperature and reactor building sump level are monitored in the main control room.

9.3.4 CHEMICAL AND VOLUME CONTROL SYSTEM

Not applicable to BWRs.

9.3.5 STANDBY LIQUID CONTROL SYSTEM

9.3.5.1 Design Bases

The standby liquid control (SLC) system meets the following design bases:

a. Backup capability for reactivity control is provided, independent of normal reactivity control provisions in the nuclear reactor, to shut down the reactor if the normal control ever becomes inoperable. The SLC system equipment essential for injection of neutron absorber solution into the reactor is designed to Seismic Category I requirements (see Section 3.7). The system piping and equipment are designed in accordance with the requirements stated in Sections 3.2 and 3.9;

b. The system has the capacity for controlling the reactivity difference between the steady-state operating condition of the reactor with voids and the cold shutdown condition, including shutdown margin, to ensure complete shutdown from the most reactive condition at any time in core life;

c. The system has the capability to inject sodium pentaborate solution into the RPV in response to a LOCA to control the pH in the suppression pool. Re-evolution of iodine from the suppression pool water can be minimized by maintaining the suppression pool pH level greater than 7.0.

d. The system meets the requirements of 10 CFR 50.62 for response to anticipated transients without scram (ATWS). System modifications have been done in conformance with the criteria presented in the BWR Owner's Group ATWS Licensing Topical Report, NEDE-31096-P, and in Generic Letter 85-06;

e. The time required for actuation and effectiveness of the SLC system is consistent with the nuclear reactivity rate of change predicted between rated operating and cold shutdown condition. This system is not safety related and is not designed to provide a fast scram of the reactor or operation of fast reactivity transients;

f. The functional performance capability of the SLC system components can be verified periodically under test conditions consistent with system operating parameters. In addition, demineralized water, rather than the actual neutron absorber solution, can be injected during cold shutdown or refueling into the reactor to test the operation of all redundant components of the system;

g. The neutron absorber is dispersed within the reactor core in sufficient quantity to provide a reasonable margin for leakage or imperfect mixing; and

h. The possibility of unintentional or accidental shutdown of the reactor by this system is minimized.

9.3.5.2 System Description

The SLC system (see Figure 9.3-14) is manually initiated through two keylock switches from the main control room to pump a boron neutron absorber solution into the reactor if the operator determines the reactor cannot be shut down with the control rods or suppression pool pH control is required to mitigate the dose consequences of a LOCA. The key locked switches prevent inadvertent injection of neutron absorber by the SLC system.

The two key locked switches are provided to ensure positive action from the main control room should the need arise. Standard power plant procedural controls are applied to the operation of the key locked control room switches.

The boron solution tank, the test water tank, the two positive displacement pumps, the two explosive valves, the two motor-operated pump suction valves, and associated local valves and controls are located in the reactor building.

The solution is piped into the reactor vessel and discharged into the core via the HPCS spray header so it mixes with the cooling water (see Section 5.3). In the event of a LOCA, the mixed solution and cooling water flows to the suppression pool by flowing through the break and downcomers.

The SLC system can deliver enough sodium pentaborate solution into the reactor (see Figure 9.3-15) to ensure reactor shutdown. As well, the SLC system can inject sufficient sodium pentaborate solution to ensure the pH in the suppression pool is maintained greater than 7.0 following a LOCA. The sodium pentaborate solution is prepared in the SLC tank. The sodium pentaborate enrichment is verified prior to addition to the SLC tank by isotopic analysis. The required sodium pentaborate concentration and solution volume in the SLC tank to ensure reactor shutdown capability is included in the Technical Specifications. An air sparger is provided in the tank for mixing. To prevent system plugging, the tank outlet is raised above the bottom of the tank. Samples for analyses are taken in accordance with approved procedures.

The saturation temperature of the solution is 67°F at the maximum concentration of 15.0% (see Figure 9.3-16). An automatic electrical resistance heater system provides heat to maintain the solution temperature greater than saturation conditions for sodium pentaborate to prevent precipitation during storage. The pump suction piping from the storage tank to the pump suction valves is also electrically heat traced. Administrative controls limit the solution temperature to less than 150°F during heatup and mixing using manual temperature control.

Liquid level in the storage tank is alarmed at either high level or low level.

The positive displacement pumps are sized to inject the solution into the reactor in approximately 1 hr with both pumps operating. The system design pressure between the pump discharge and the explosive valves is 1400 psig, at which pressure the two relief valves are set. To prevent bypass flow from one pump in case of relief valve failure in the line from the other pump, a check valve is installed downstream of each relief valve line in the pump discharge pipe.

The two explosive-actuated injection valves provide assurance of opening when needed and ensure that boron will not leak into the reactor even when the pumps are being tested. Each explosive valve is closed by a plug in the inlet chamber. The plug is circumscribed with a deep groove so the end will readily shear off when pushed with the valve plunger. This opens the inlet hole through the plug. The sheared end is pushed out of the way in the chamber, and it is shaped so it will not block the ports after release.

The shearing plunger is actuated by an explosive charge with dual ignition primers inserted in the side chamber of the valve. The two ignition circuits of each explosive valve are monitored for continuity. If either circuit opens, a bypass and inoperable status indication (BISI) display occurs in the main control room.

The SLC system is actuated by two key locked switches on the main control room console. This ensures that switching from the "off" position is a deliberate act. Operating either switch starts one of the injection pumps, actuates both of the explosive valves, opens both pump suction motor-operated valves, and closes the RWCU system outboard isolation valve to prevent loss or dilution of the boron. (This is the sole purpose of this RWCU isolation. This isolation is not related to RWCU isolation to ensure containment integrity.)

A green light in the control room indicates that power is available to the pump motor contactor and that the contactor is deenergized (pump not running). A red light indicates that the contactor is closed to energize.

Storage tank liquid level, tank outlet valve position, pump discharge pressure, flow indication, and loss of continuity on the explosive valves indicate that the system is functioning. Cross piping and check valves ensure a flow path through either pump and either explosive valve. Pump discharge pressure and system flow is indicated in the control room.

Equipment drains and tank overflow are not piped to the radwaste system but to separate containers (such as 55-gal drums) that can be removed and disposed of to prevent any trace of boron from inadvertently reaching the reactor.

Instrumentation consisting of solution temperature indication and control, solution level, and heater system status is provided locally at the storage tank. The SLC system is seismically qualified from the storage tank (including the tank) to the injection point to the HPCS piping. Seismic category and quality class are included in Table 3.2-1. Principles of system testing are discussed in Section 9.3.5.4.

9.3.5.3 Safety Evaluation

The SLC system is a reactivity control system and is maintained in an operable status whenever the reactor is critical. The SLC system may also be used to maintain suppression pool pH above 7.0 following a LOCA and is maintained operable when critical or in hot shutdown.

The system is designed to bring the reactor from rated power to a cold shutdown at any time in core life. The reactivity compensation provided will reduce reactor power from rated to zero level and allow cooling the nuclear system to below 200°F with the control rods remaining withdrawn in the rated power pattern. It includes the reactivity gains that result from complete decay of the rated power xenon inventory. It also includes the positive reactivity effects from eliminating steam voids, changing water density from hot to cold, reduced doppler effect in uranium, reducing neutron leakage from boiling to cold, and decreasing control rod worth as the moderator cools.

The minimum average concentration of natural boron in the reactor to provide adequate shutdown margin, after operation of the SLC system, is 780 ppm. Calculation of the minimum quantity of sodium pentaborate to be injected into the reactor is based on the required 780 ppm average concentration in the reactor coolant, including recirculation loops, at 70°F and reactor normal water level. The amount is increased by 25% to allow for imperfect mixing and leakage. An additional 275 ppm is provided to accommodate dilution by the RHR system in the shutdown cooling mode. This concentration is achieved when the solution is prepared as described in Section 9.3.5.2 and maintained above saturation temperature.

The saturation temperature of the maximum concentration solution is 67°F. To ensure complete solubility of the solution, a tank operating heater is provided which turns on when the temperature drops below approximately 80°F. The tank heater turns off when the temperature increases to approximately 90°F.

Cooldown of the nuclear system requires a minimum of several hours to remove the thermal energy stored in the reactor, cooling water, and associated equipment. Use of the main condenser and various shutdown cooling systems requires 10 to 24 hr to lower the reactor vessel to room temperature (70°F); this is the condition of maximum reactivity and, therefore, the condition that requires the maximum concentration of boron.

To mitigate the consequences of an ATWS, the SLC system is capable of injecting the equivalent in reactivity control of 86 gpm at 13.0% (by weight) of sodium pentaborate solution per the requirements of 10 CFR 50.62. Each SLC pump injects at not less than 41.2 gpm at 13.6% concentration which is mathematically equivalent to 86 gpm at 13.0%. At this injection rate with only one pump, the solution is injected into the reactor in approximately 2 hr which provides negative reactivity insertion considerably quicker than the reactivity increase caused by the cooldown. The SLC injection path via the HPCS spray ring provides sufficient mixing so that any power oscillations are precluded. This same amount and concentration of boron, at the flow rate of a single pump is adequate to maintain the suppression pool pH greater than 7.0, when used in a LOCA.

The SLC system has redundant electrical components requiring AC power to actuate for sodium pentaborate solution injection. These divisional components are powered by separate safety-related AC divisions that are backed by onsite emergency diesel generators.

The SLC system and pumps have sufficient pressure margin, up to the system relief valve setting of approximately 1400 psig, to ensure solution injection into the reactor above the normal pressure in the reactor. The nuclear system safety/relief valves begin to relieve pressure at approximately 1100 psig. Therefore, the SLC system positive displacement pumps cannot overpressurize the nuclear system.

The SLC system is evaluated against the applicable General Design Criteria as follows:

Criterion 2:

The SLC system is located in the area outside of the primary containment and below the refueling floor. In this location, it is protected by walls from external natural phenomena such as earthquakes, tornadoes, hurricanes, and floods and also from the effects of internal postulated accident events.

Criterion 4:

The SLC system is designed for the expected environment in the compartment in which it is located. In this compartment, it is not subject to the conditions postulated in this criterion such as missiles, whipping pipes, and discharging fluids. The SLC system components are qualified in accordance with the CGS Equipment Qualification Program to operate in a post-LOCA environment for a minimum of 24 hours.

Criterion 26:

The SLC system is a backup reactivity control system for the normal reactivity control systems.

Criterion 29:

Although GDC 29 is not a design basis, certain valves outboard of the isolation valves are redundant. Two suction valves and two injection valves are arranged and cross-tied such that operation of either one of a pair results in successful operation of the system. The SLC system also has test capability. A special test tank is supplied for providing test fluid for the injection test.

Pumping capability and suction valve operability may be tested at any time. A trickle current continuously monitors continuity of the firing mechanisms of the injection squib valves.

Regulatory Guide compliance is described in Section 1.8.

This system is used in the special plant capability demonstration events, “Reactor Shutdown and Cooldown - ATWS” and “Reactor Shutdown and Cooldown Without Control Rods.” These events are extremely low probability non design basis postulated accidents. Various single failure analytical exercises can be examined to show additional capabilities to accommodate further plant system degradations. See GE Topical Report NEDO-20626, dated October 1974, Studies of BWR Design for Mitigation of ATWS.

9.3.5.4 Testing and Inspection Requirements

Operational testing of the SLC system is performed in accordance with applicable Technical Specifications. The SLC system injection train components and piping are included in the CGS Inservice Inspection (ISI) and Inservice Testing (IST) Programs. The reactor must be in mode 4 or 5 before changing from the SLC system standby mode to the injection test mode.

The concentration of the sodium pentaborate in the solution tank is determined periodically by chemical analysis using samples taken directly from the tank. The sodium pentaborate enrichment is verified prior to addition to the SLC tank by isotopic analysis.

Should the boron solution ever be injected into the reactor, either intentionally or inadvertently, the boron can be removed from the reactor coolant system by flushing, followed by operating the RWCU system. There is practically no effect on reactor operations when the boron concentration has been reduced below approximately 50 ppm.

The SLC system preoperational test is described in Section 14.2.

9.3.5.5 Instrumentation Requirements

The instrumentation and control system for the SLC system is designed to allow the injection of neutron absorber solution into the reactor and to maintain the neutron absorber solution well above the saturation temperature. A further discussion of the SLC system instrumentation is provided in Section 7.4.1.2.

9.3.6 REFERENCES

9.3-1 “Compressed Air Systems,” Design Basis Document, Section 305.

Table 9.3-1

Equipment Characteristics

Control air system	
a. Air compressors	
1. Quantity	3
2. Rated output (each)	387 ± 4% scfm
3. Rated discharge pressure	115 psig (after filters)
b. Air receivers	
1. Quantity	3
2. Volume (each)	96 ft^3
c. Air desiccant dryers	
1. Quantity	2
2. Type	Heatless regenerative
3. Desiccant	Activated alumina
4. Rated inlet drying capacity (each skid)	750 scfm
5. Dewpoint at outlet	-40°F
6. Cycle of operation	4 or 10 minutes
d. Air dryer (refrigerated)	
1. Quantity	2
2. Type	Freon R-22
3. Maximum capacity	830 scfm (each)
4. Dewpoint	39°F ± 4°F
5. Operation	Continuous
Service air system	
a. Air compressor	
1. Quantity	1
2. Rated output	630 scfm at 100 psig
3. Pressure modulating range	100 psig to 110 psig

Table 9.3-1

Equipment Characteristics (Continued)

b. Air Receiver	
1. Quantity (main header)	1
2. Volume	140 ft^3
c. Service air dryer	
1. Quantity	1
2. Type	Refrigerated (Freon R-22)
3. Maximum capacity	650 scfm
4. Dewpoint at outlet	+40°F
5. Operation	Continuous
Containment instrument air system	
a. Air receiver	
1. Quantity	1
2. Volume	34 ft^3
b. Air dryer	
1. Quantity	1
2. Type	Twin tower, heat regenerative
3. Media: active buffer	Silica gel Activated alumina absorbent
4. Peak inlet drying capacity	84 scfm (minimum)
5. Dewpoint at outlet	-40°F
6. Cycle of operation	"As needed" basis (moisture sensor)

Table 9.3-2

Available Sample Locations

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-1	Reactor water, recirculating inlet manifold	SR-9 (SR-48)	H	Conductivity (dissolved oxygen dissolved hydrogen)
SP-2A,B	Main steam	SR-1	H	Grab sample
SP-3	Feedwater, after heaters HP-6A,B	SR-1	L	Conductivity, dissolved oxygen, corrosion product
SP-4	Condensate, after condensate pumps 1A,B,C	SR-1	L	Grab sample
SP-5	Condensate after gland seal steam condenser	Local	L	Grab sample
SP-6	Condensate after ejector condensers	Local	L	Grab sample
SP-8	Influent to cleanup filter demineralizers A,B	SR-9 (SR-48)	H	Conductivity (dissolved oxygen dissolved hydrogen)
SP-9A,B,C	Condensate after low pressure heater 1A,B,C	Local	L	Grab sample
SP-10	Waste collection filter EDR-DM-9 outlet	SR-8	L	Grab sample
SP-11	Condensate after condensate pumps 1A,B,C	SR-1	L	Conductivity
SP-12A,B,C	Condensate after low pressure heaters 4A,B,C	SR-1	L	Grab sample
SP-13A	Condensate after low pressure heater 5A	SR-1	L	Grab sample

Table 9.3-2

Available Sample Locations (Continued)

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-13B	Condensate after low pressure heater 5B	SR-1	L	Grab sample
SP-14A	Condensate after filter demineralizer 1A	SR-9	L	Conductivity
SP-14B	Condensate after filter demineralizer 1B	SR-9	L	Conductivity
SP-14C	Condensate after filter demineralizer 1C	SR-9	L	Conductivity
SP-14D	Condensate after filter demineralizer 1D	SR-9	L	Conductivity
SP-14E	Condensate after filter demineralizer 1E	SR-9	L	Conductivity
SP-14F	Condensate after filter demineralizer 1F	SR-9	L	Conductivity
SP-15	Combined condensate after filter demineralizers	SR-9	L	Conductivity, dissolved oxygen
SP-17A	Condenser hotwell	SR-1		Spared in place
SP-19A	RCIC pump P-1 discharge	SR-6		Spared in place
SP-19B	RCIC water to containment	SR-6		Spared in place
SP-20	HPCS pump P-1 discharge	SR-6		Spared in place
SP-21	LPCS pump P-1 discharge	SR-6		Spared in place
SP-22A	After RHR heat exchanger A	SR-6	H	Grab sample

Table 9.3-2

Available Sample Locations (Continued)

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-22B	After RHR heat exchanger B	SR-6	H	Grab sample
SP-23	After RCC heat exchangers 1A,B,C	Local	L	Grab sample
SP-24	Inlet to fuel pool demineralizers	SR-9	L/H	Conductivity
SP-25A	Outlet from fuel pool demineralizer A	SR-9	L	Conductivity
SP-25B	Outlet from fuel pool demineralizer B	SR-9	L	Conductivity
SP-26	Drywell equipment cooling water return	SR-6		Spared in place
SP-27A	After cleanup filter A	SR-9	H	Conductivity
SP-27B	After cleanup filter B	SR-9	H	Conductivity
SP-28	Nonregenerative heat exchanger shell outlet	Local	L	Grab sample
SP-29	Waste collector pump EDR-P-11, discharge	SR-8	L	Conductivity
SP-30	Waste surge pump EDR-P-15, discharge	SR-8	L	Grab sample
SP-31	Floor drain collector pump FDR-P-16 discharge	SR-8	L	Conductivity
SP-32	Floor drain filter FDR-FU-10, discharge	SR-8	L	Grab sample
SP-33A	Waste demineralizer EDR-DM-29 inlet	SR-8	L	Conductivity

Table 9.3-2

Available Sample Locations (Continued)

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-33B	Waste demineralizer EDR-DM-29 outlet	SR-9	L	Conductivity
SP-34A	Waste sample pump EDR-P-14A, discharge	SR-8	L	Grab sample
SP-34B	Waste sample pump EDR-P-14B, discharge	SR-8	L	Grab sample
SP-35A	Floor drain demineralizer FDR-DM-111, inlet	SR-8	L	Conductivity
SP-35B	Floor drain demineralizer FDR-DM-111, outlet	SR-9	L	Conductivity
SP-36	Floor drain sample pump FDR-P-21, discharge	SR-8	L	Grab sample
SP-37	Effluent from centrifuges PWR-FU-94A,B	Local	L	Grab sample
SP-38A	Chemical waste pump MWR-P-26A, discharge	SR-8	L	Grab sample
SP-38B	Chemical waste pumps MWR-P-26B, discharge	SR-8	L	Grab sample
SP-43	Detergent drain pumps MWR-P-20A,B discharge	Local	L	Grab sample
SP-44	Cleanup decant pump RWCU-P-27 discharge	SR-8	H	Grab sample
SP-46	Condensate decant pump CPR-P-24 discharge	SR-8	L	Grab sample

Table 9.3-2

Available Sample Locations (Continued)

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-47	Condensate sludge discharge mixing pump CPR-P-25 discharge	Local	L	Grab sample
SP-48A	Auxiliary boiler feedwater	Local	N	Grab sample
SP-48B,C	Auxiliary boiler blowdown	Local	N	Grab sample
SP-59	Demineralized water system supply	SR-5	N	Grab sample
SP-61	Potable water supply	SR-5	N	Grab sample
SP-62	RCC heat exchangers 1A,B,C, service water outlet	Local	N	Grab sample
SP-63A	RHR heat exchanger 1A service water outlet	Local	N	Grab sample
SP-63B	RHR heat exchanger 1B service water outlet	Local	N	Grab sample
SP-65A	Condensate storage tank 1A	Local	N	Grab sample
SP-65B	Condensate storage tank 1B	Local	N	Grab sample
SP-67C	Polishing demineralizer MWR-DM-4D, outlet	SR-8	L	Conductivity
SP-69	Fuel pool demineralizer outlet	SR-9	L	Conductivity
SP-70A,B	Carbon filter FW-FU-2A,B inlet	Local	N	Grab sample

Table 9.3-2

Available Sample Locations (Continued)

Sample Point[a]	Description[b]	Sampling Location[c]	Activity[d]	Analysis[e]
SP-71	Condensate filter demineralizer, inlet header	SR-9	L	Conductivity
SP-115	COND-P-5 suction combined CSTs	Local	L	Grab sample
SP-1088	COND-P-4 suction combined CSTs	Local	L	Grab sample

[a] Sequential numbering of sample points.

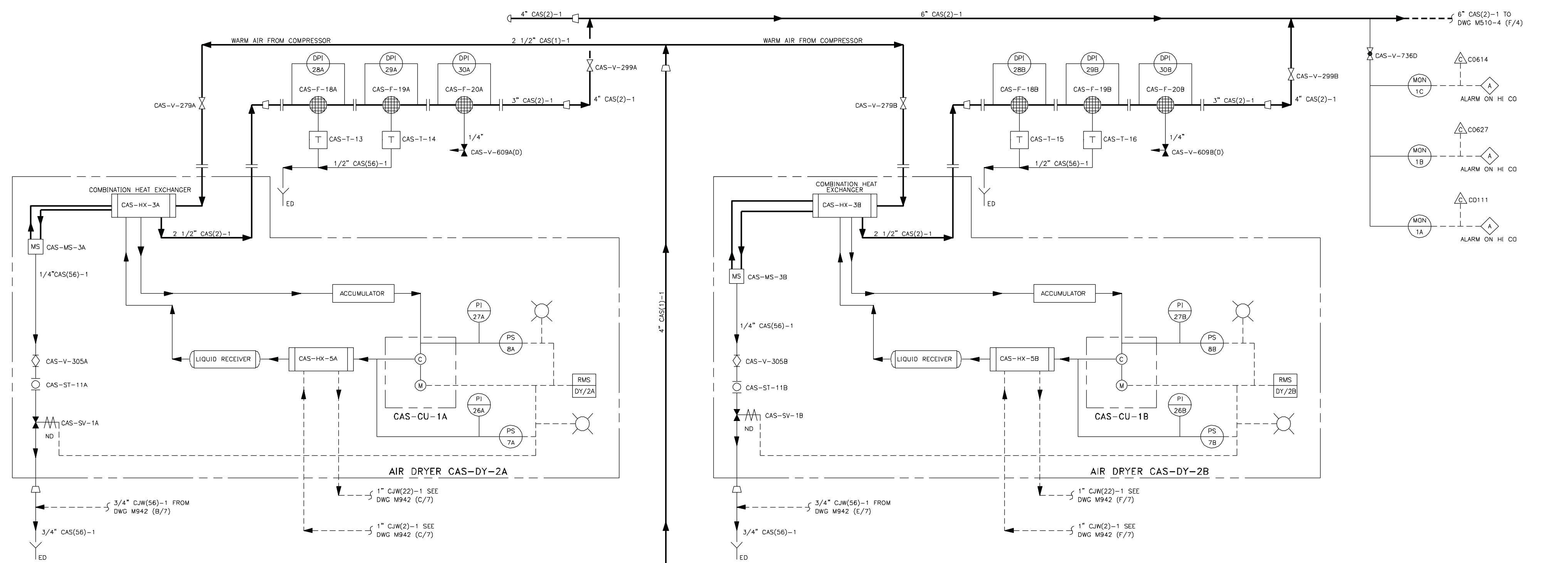
[b] Indicates type of system being sampled, i.e., reactor water, main steam, condensate, etc., and general location of the process line tap.

[c] Sample is taken from either a local process line tap or in a sample station rack, i.e.,

TBSR	Turbine building sample rack, SR-1
RWSR	Radwaste building sample racks, SR-8, SR-9
RBSR	Reactor building sample rack, SR-6
SBSL	Service building sample laboratory, SR-5

[d] The sample is expected to have H (High), L (Low), or N (No) radioactivity.

[e] Type of continuous monitor and/or a grab sample.



NOTES:

1. ALL INSTRUMENTS ON THIS DRAWING TO BE IDENTIFIED BY PREFIX "CAS" OR "SA" AS APPLICABLE, UNLESS SPECIFICALLY NOTED OTHERWISE.
2. ALL EPN'S LOCATED WITHIN SKID OUTLINE OR THOSE ITEMS MARKED MARKED "*" ARE FURNISHED W/ ASSOCIATED EQUIPMENT.
3. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
4. ALL PIPING, VALVES AND ASSOCIATED COMPONENTS ON THIS DRAWING ARE CLASSIFIED AS FOLLOWS EXCEPT IN THE REACTOR, CONTROL AND DIESEL GENERATOR BUILDINGS:
   QUALITY CLASS II
   SEISMIC CATEGORY II
   CODE GROUP D
5. ALL PIPING, VALVES AND ASSOCIATED COMPONENTS ON THIS DRAWING IN THE CONTROL AND SERVICE AIR SYSTEM IN THE REACTOR, CONTROL AND DIESEL GENERATOR BUILDINGS SHALL BE CLASSIFIED AS FOLLOWS (BREAK POINTS ARE INDICATED ON THE FLOW DIAGRAM):

   a – ALL PIPING EXCEPT AS NOTED IN b , c AND d BELOW:
   QUALITY CLASS II
   SEISMIC CATEGORY II ⊕
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

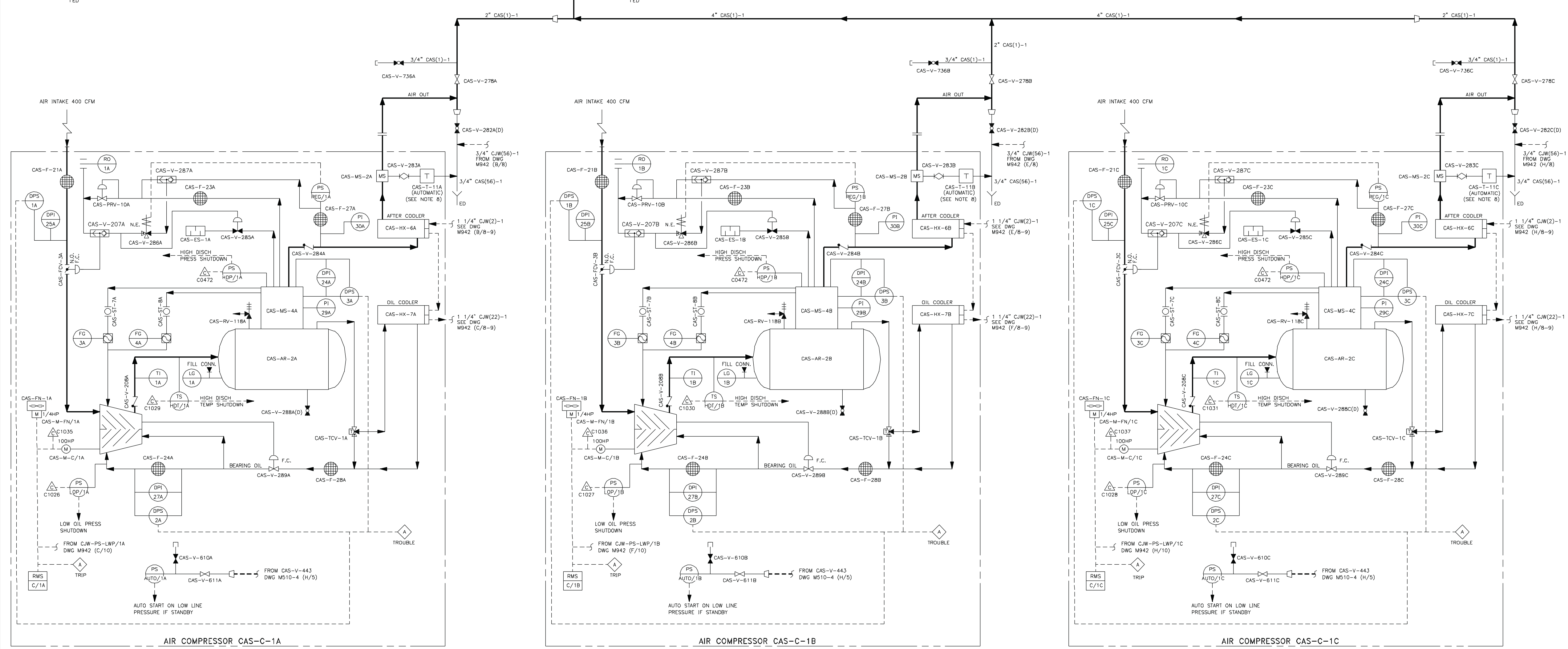
   b – CAS (5) DOWNSTREAM OF AND INCLUDING THE LAST SYSTEM ISOLATION VALVE (AS SHOWN IN DETAIL B ON M510-2A ZONE H-K/7-9):
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP C

   c – CAS (5) DOWNSTREAM OF THE OUTER CONTAINMENT ISOLATION VALVE (AS SHOWN ON M510-2 ZONE H/11):
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP B

   d – SA(1)-1 DOWNSTREAM OF AND INCLUDING THE LAST CONTAINMENT ISOLATION VALVE (AS SHOWN ON M510-3 ZONE H/7):
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP B
6. THESE COMPUTER POINTS ARE NOT USED.
7. (DELETED)
8. THIS AUTOMATIC TRAP IS MADE UP OF A Y-STRAINER AND AN ELECTRIC REMOTE POV AS DEPICTED ON CVI 759-99.3.
9. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND:

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

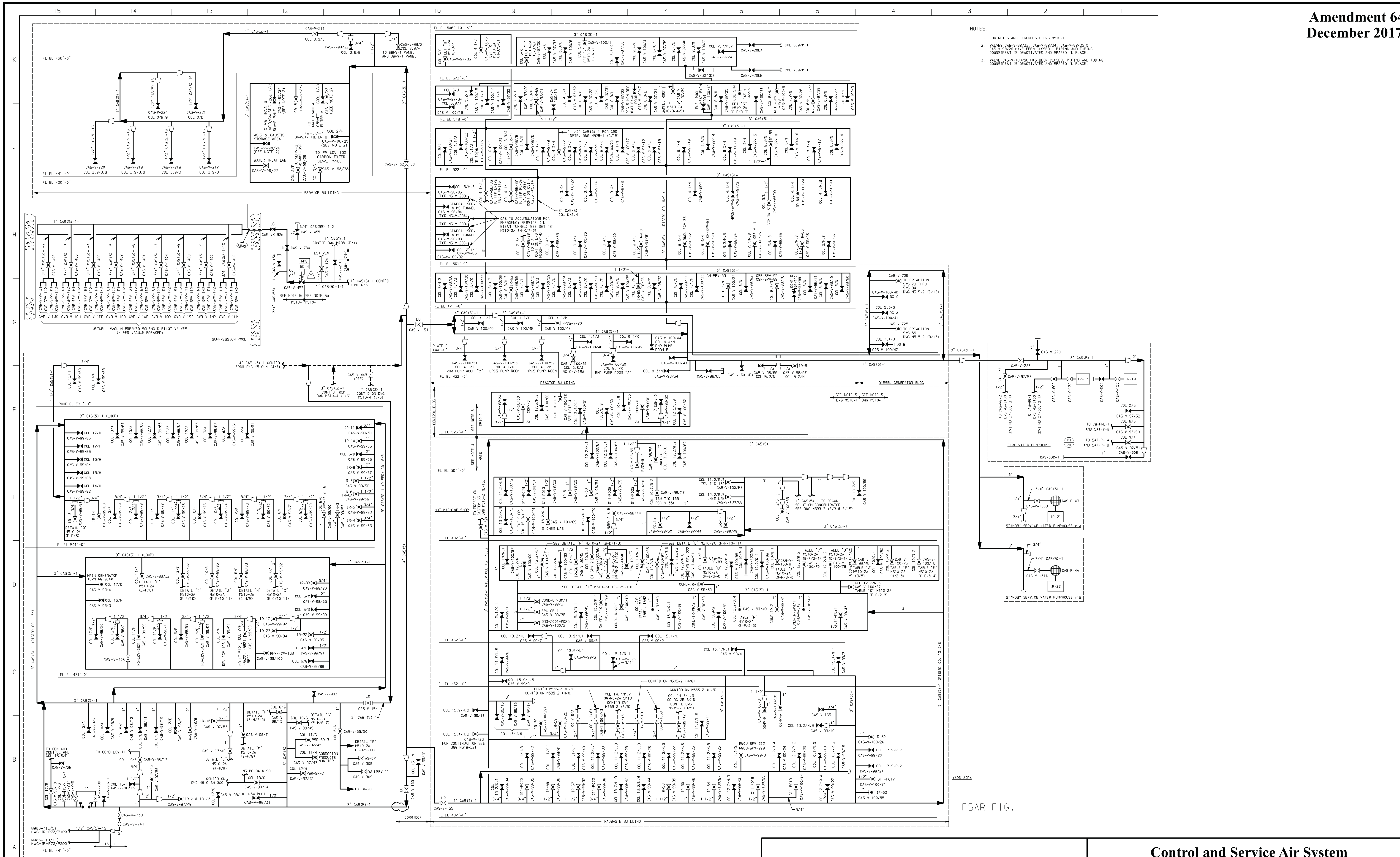


FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

Control and Service Air System

Draw. No. M510-1	Rev. 82	Figure 9.3-1.1



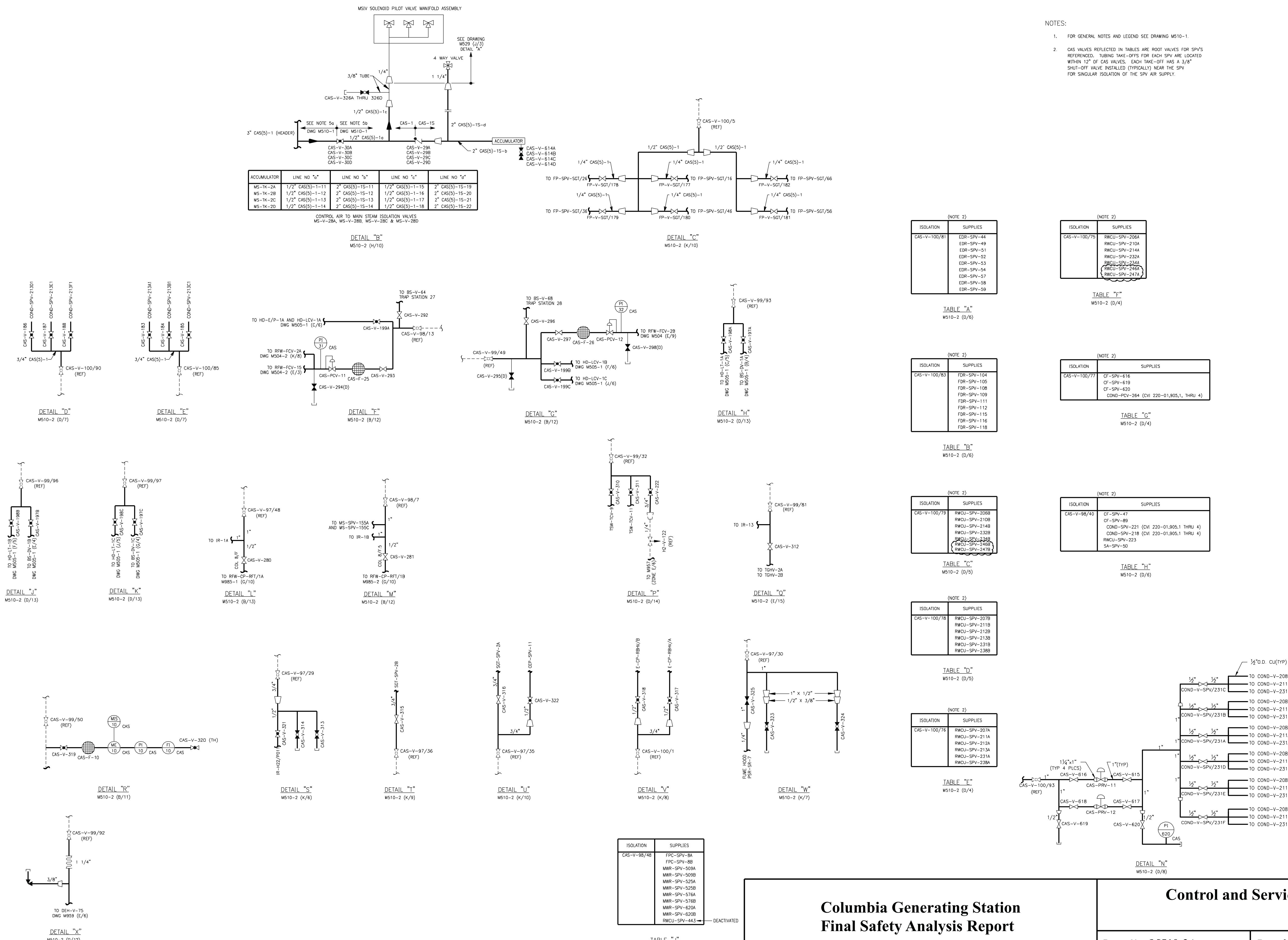
Columbia Generating Station
Final Safety Analysis Report

Control and Service Air System

Draw. No. M510-2	Rev. 42	Figure 9.3-1.2

NOTES:

1. FOR GENERAL NOTES AND LEGEND SEE DRAWING M510-1.
2. CAS VALVES REFLECTED IN TABLES ARE ROOT VALVES FOR SPV'S REFERENCED. TUBING TAKE-OFFS FOR EACH SPV ARE LOCATED WITHIN 12" OF CAS VALVES. EACH TAKE-OFF HAS A 3/8" SHUT-OFF VALVE INSTALLED (TYPICALLY) NEAR THE SPV FOR SINGULAR ISOLATION OF THE SPV AIR SUPPLY.



ACCUMULATOR	LINE NO "a"	LINE NO "b"	LINE NO "c"	LINE NO "d"
MS-TK-2A	1/2" CAS(5)-1-11	2" CAS(5)-1S-11	1/2" CAS(5)-1-15	2" CAS(5)-1S-19
MS-TK-2B	1/2" CAS(5)-1-12	2" CAS(5)-1S-12	1/2" CAS(5)-1-16	2" CAS(5)-1S-20
MS-TK-2C	1/2" CAS(5)-1-13	2" CAS(5)-1S-13	1/2" CAS(5)-1-17	2" CAS(5)-1S-21
MS-TK-2D	1/2" CAS(5)-1-14	2" CAS(5)-1S-14	1/2" CAS(5)-1-18	2" CAS(5)-1S-22

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/81	EDR-SPV-44 EDR-SPV-49 EDR-SPV-51 EDR-SPV-52 EDR-SPV-53 EDR-SPV-54 EDR-SPV-57 EDR-SPV-58 EDR-SPV-59

TABLE "A"
M510-2 (D/6)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/83	FDR-SPV-104 FDR-SPV-105 FDR-SPV-108 FDR-SPV-109 FDR-SPV-111 FDR-SPV-112 FDR-SPV-115 FDR-SPV-116 FDR-SPV-118

TABLE "B"
M510-2 (D/6)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/79	RWCU-SPV-206B RWCU-SPV-210B RWCU-SPV-214B RWCU-SPV-232B RWCU-SPV-234B RWCU-SPV-246B RWCU-SPV-247B

TABLE "C"
M510-2 (D/5)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/78	RWCU-SPV-207B RWCU-SPV-211B RWCU-SPV-212B RWCU-SPV-213B RWCU-SPV-231B RWCU-SPV-238B

TABLE "D"
M510-2 (D/5)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/76	RWCU-SPV-207A RWCU-SPV-211A RWCU-SPV-212A RWCU-SPV-213A RWCU-SPV-231A RWCU-SPV-238A

TABLE "E"
M510-2 (D/4)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/75	RWCU-SPV-206A RWCU-SPV-210A RWCU-SPV-214A RWCU-SPV-232A RWCU-SPV-234A RWCU-SPV-246A RWCU-SPV-247A

TABLE "F"
M510-2 (D/4)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-100/77	CF-SPV-616 CF-SPV-619 CF-SPV-620 COND-PCV-264 (CVI 220-01,905,1, THRU 4)

TABLE "G"
M510-2 (D/4)

(NOTE 2)

ISOLATION	SUPPLIES
CAS-V-98/40	CF-SPV-47 CF-SPV-89 COND-SPV-221 (CVI 220-01,905,1 THRU 4) COND-SPV-218 (CVI 220-01,905,1 THRU 4) RWCU-SPV-223 SA-SPV-50

TABLE "H"
M510-2 (D/6)

ISOLATION	SUPPLIES
CAS-V-98/48	FPC-SPV-8A FPC-SPV-8B MWR-SPV-509A MWR-SPV-509B MWR-SPV-525A MWR-SPV-525B MWR-SPV-576A MWR-SPV-576B MWR-SPV-620A MWR-SPV-620B RWCU-SPV-443 ← DEACTIVATED

TABLE "J"
M510-2 (D/4)

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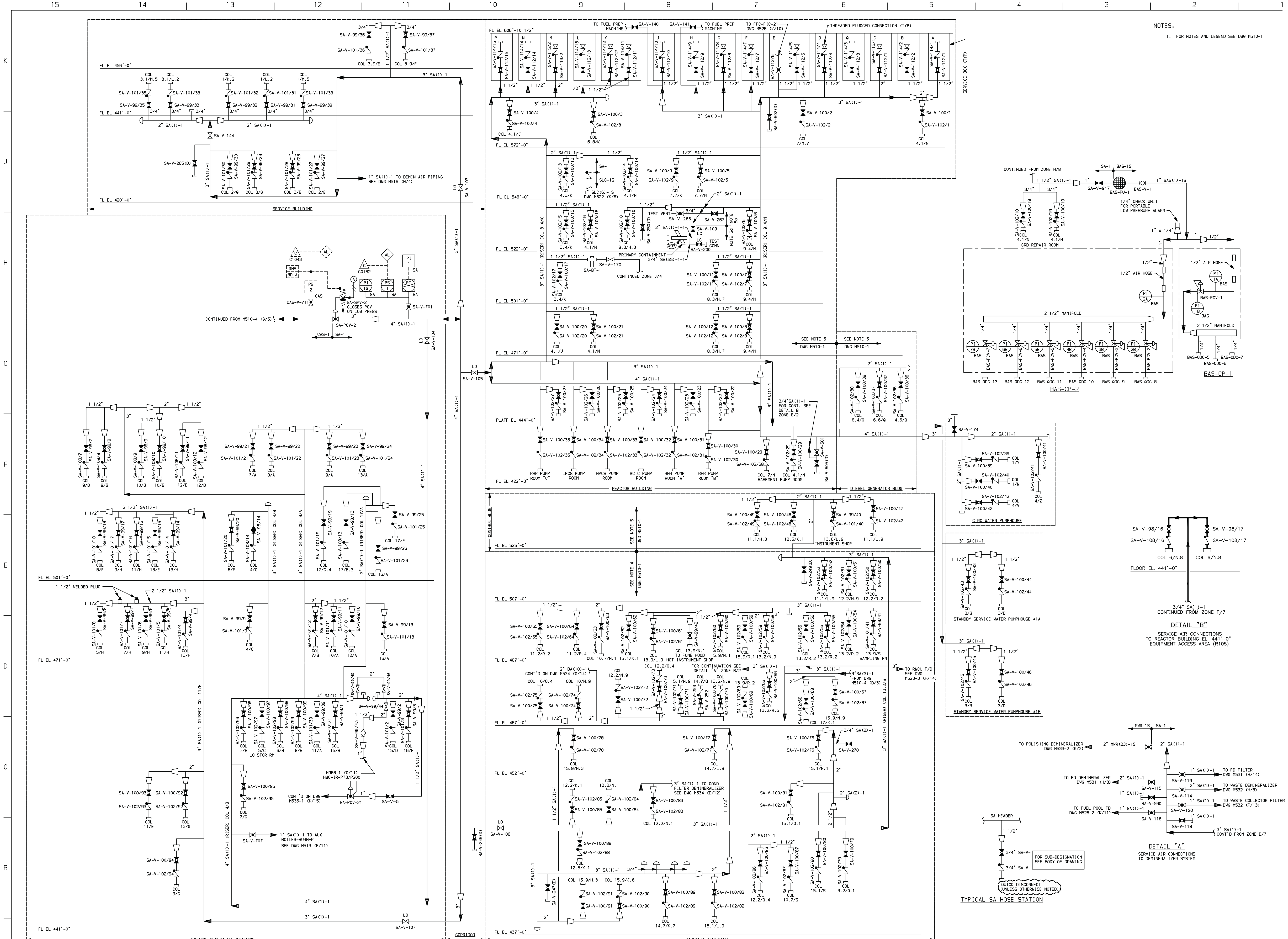
Draw. No. M510-2A | Rev. 16 | Figure 9.3-1.3

Form No. 960690ai

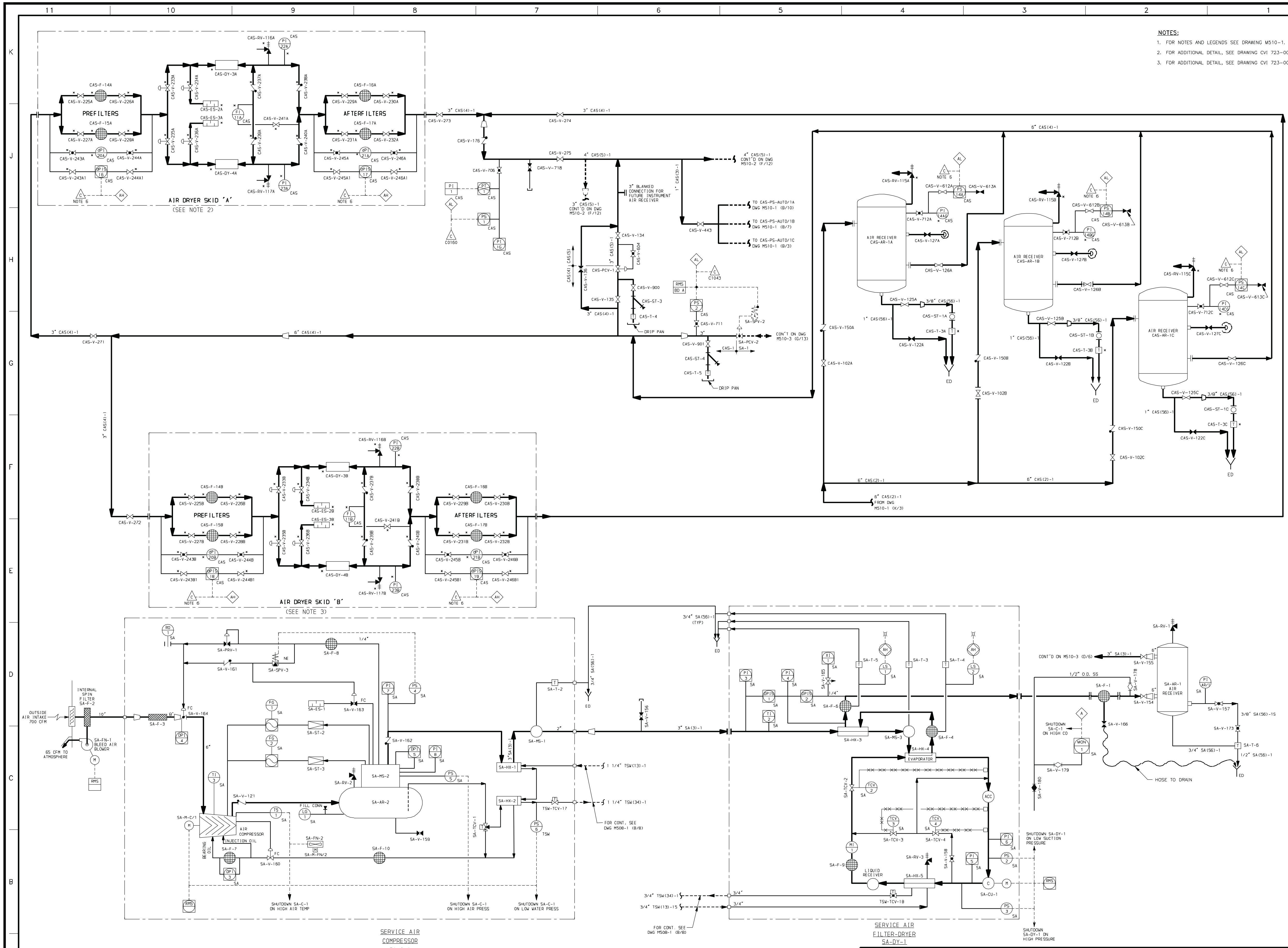


Columbia Generating Station
Final Safety Analysis Report

Control and Service Air System

Draw. No. M510-3 | Rev. 25 | Figure 9.3-1.4

NOTES:
1. FOR NOTES AND LEGENDS SEE DRAWING M510-1.
2. FOR ADDITIONAL DETAIL, SEE DRAWING CVI 723-00,1.
3. FOR ADDITIONAL DETAIL, SEE DRAWING CVI 723-00,2.

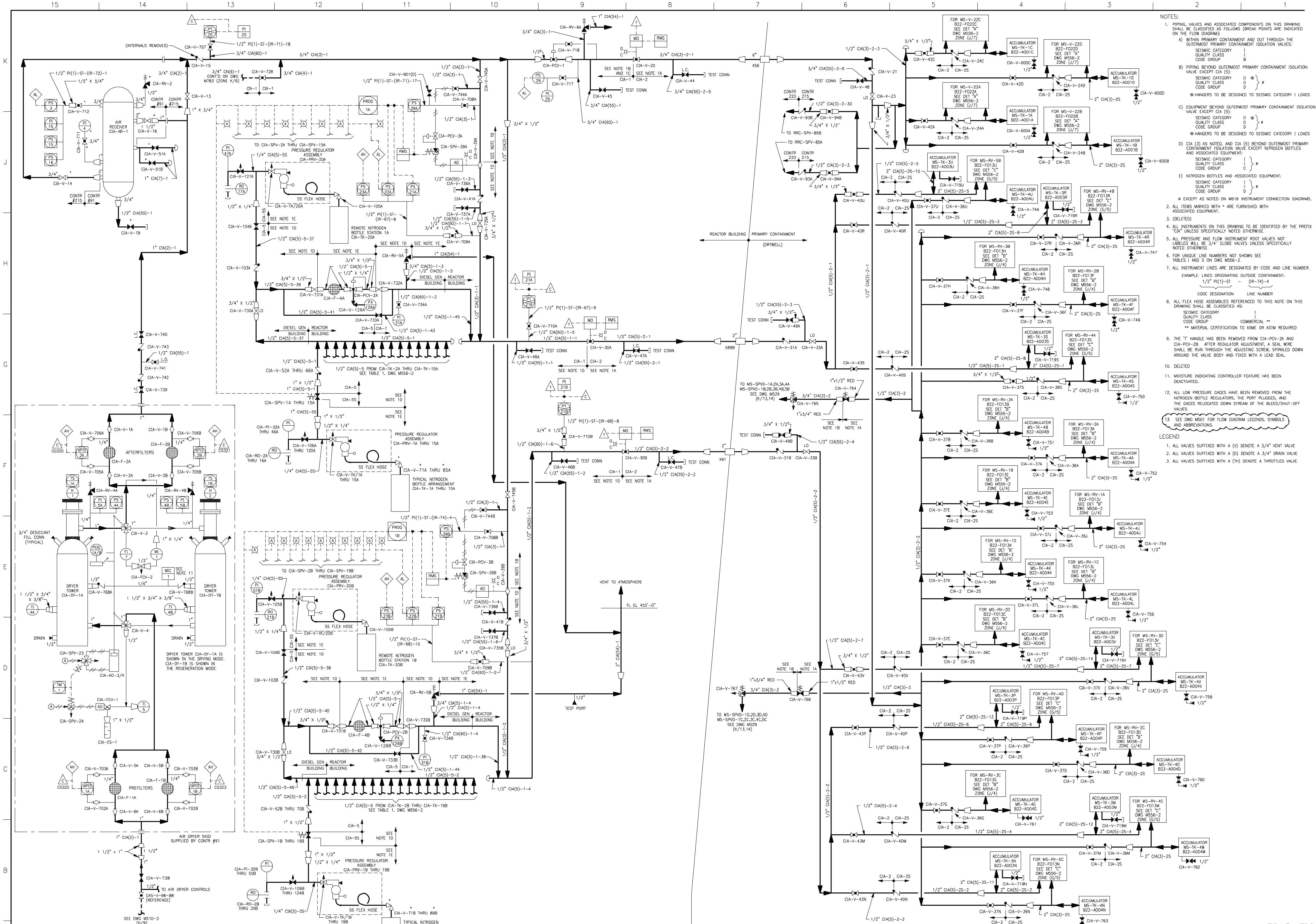


Columbia Generating Station
Final Safety Analysis Report

Control and Service Air System

Draw. No. M510-4 | Rev. 10 | Figure 9.3-1.5

Amendment 63
December 2015



FSAR FIG

Columbia Generating Station
Final Safety Analysis Report

Containment Instrument Air System

Draw. No. M556-1	Rev. 51	Figure 9.3-2.1

Form No. 960690ai

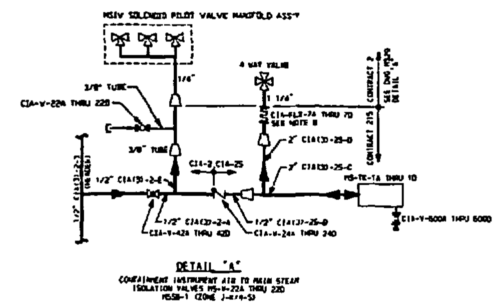
NOTE:
1. FOR GENERAL NOTES AND LEGEND SEE DRAWING M556-1.

TABLE I

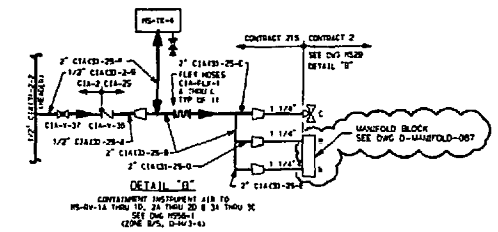
NITROGEN BOTTLE IDENTIFICATION	LINE NUMBER
C1A-TK-2A	1/2" C1A(5)-5-5
C1A-TK-2B	1/2" C1A(5)-5-6
C1A-TK-3A	1/2" C1A(5)-5-7
C1A-TK-3B	1/2" C1A(5)-5-8
C1A-TK-4A	1/2" C1A(5)-5-9
C1A-TK-4B	1/2" C1A(5)-5-10
C1A-TK-5A	1/2" C1A(5)-5-11
C1A-TK-5B	1/2" C1A(5)-5-12
C1A-TK-6A	1/2" C1A(5)-5-13
C1A-TK-6B	1/2" C1A(5)-5-14
C1A-TK-7A	1/2" C1A(5)-5-15
C1A-TK-7B	1/2" C1A(5)-5-16
C1A-TK-8A	1/2" C1A(5)-5-17
C1A-TK-8B	1/2" C1A(5)-5-18
C1A-TK-9A	1/2" C1A(5)-5-19
C1A-TK-9B	1/2" C1A(5)-5-20
C1A-TK-10A	1/2" C1A(5)-5-21
C1A-TK-10B	1/2" C1A(5)-5-22
C1A-TK-11A	1/2" C1A(5)-5-23
C1A-TK-11B	1/2" C1A(5)-5-24
C1A-TK-12A	1/2" C1A(5)-5-25
C1A-TK-12B	1/2" C1A(5)-5-26
C1A-TK-13A	1/2" C1A(5)-5-27
C1A-TK-13B	1/2" C1A(5)-5-28
C1A-TK-14A	1/2" C1A(5)-5-29
C1A-TK-14B	1/2" C1A(5)-5-30
C1A-TK-15A	1/2" C1A(5)-5-31
C1A-TK-15B	1/2" C1A(5)-5-32
C1A-TK-16B	1/2" C1A(5)-5-33
C1A-TK-17B	1/2" C1A(5)-5-34
C1A-TK-18B	1/2" C1A(5)-5-35
C1A-TK-19B	1/2" C1A(5)-5-36

TABLE II

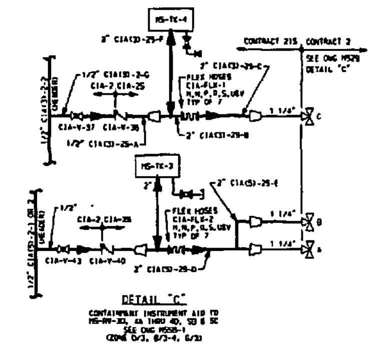
ACCUMULATOR IDENTIFICATION	LINE NUMBERS						
	A	B	C	D	E	F	G
MS-TK-4A	1/2" C1A(3)-25-13	2" C1A(3)-25-13	2" C1A(3)-25-13	2" C1A(3)-25-31	2" C1A(3)-25-42	2" C1A(3)-25-53	1/2" C1A(3)-2-13
MS-TK-4B	1/2" C1A(3)-25-14	2" C1A(3)-25-14	2" C1A(3)-25-14	2" C1A(3)-25-32	2" C1A(3)-25-43	2" C1A(3)-25-54	1/2" C1A(3)-2-14
MS-TK-4C	1/2" C1A(3)-25-15	2" C1A(3)-25-15	2" C1A(3)-25-15	2" C1A(3)-25-33	2" C1A(3)-25-44	2" C1A(3)-25-55	1/2" C1A(3)-2-15
MS-TK-4D	1/2" C1A(3)-25-16	2" C1A(3)-25-16	2" C1A(3)-25-16	2" C1A(3)-25-34	2" C1A(3)-25-45	2" C1A(3)-25-56	1/2" C1A(3)-2-16
MS-TK-4E	1/2" C1A(3)-25-17	2" C1A(3)-25-17	2" C1A(3)-25-17	2" C1A(3)-25-35	2" C1A(3)-25-46	2" C1A(3)-25-57	1/2" C1A(3)-2-17
MS-TK-4F	1/2" C1A(3)-25-18	2" C1A(3)-25-18	2" C1A(3)-25-18	2" C1A(3)-25-36	2" C1A(3)-25-47	2" C1A(3)-25-58	1/2" C1A(3)-2-18
MS-TK-4G	1/2" C1A(3)-25-19	2" C1A(3)-25-19	2" C1A(3)-25-19	2" C1A(3)-25-37	2" C1A(3)-25-48	2" C1A(3)-25-59	1/2" C1A(3)-2-19
MS-TK-4H	1/2" C1A(3)-25-20	2" C1A(3)-25-20	2" C1A(3)-25-20	2" C1A(3)-25-38	2" C1A(3)-25-49	2" C1A(3)-25-60	1/2" C1A(3)-2-20
MS-TK-4J	1/2" C1A(3)-25-21	2" C1A(3)-25-21	2" C1A(3)-25-21	2" C1A(3)-25-39	2" C1A(3)-25-50	2" C1A(3)-25-61	1/2" C1A(3)-2-21
MS-TK-4K	1/2" C1A(3)-25-22	2" C1A(3)-25-22	2" C1A(3)-25-22	2" C1A(3)-25-40	2" C1A(3)-25-51	2" C1A(3)-25-62	1/2" C1A(3)-2-22
MS-TK-4L	1/2" C1A(3)-25-23	2" C1A(3)-25-23	2" C1A(3)-25-23	2" C1A(3)-25-41	2" C1A(3)-25-52	2" C1A(3)-25-63	1/2" C1A(3)-2-23
MS-TK-4M	1/2" C1A(3)-25-24	2" C1A(3)-25-24	2" C1A(3)-25-24	2" C1A(5)-25-4	2" C1A(5)-25-15	2" C1A(3)-25-64	1/2" C1A(3)-2-24
MS-TK-4N	1/2" C1A(3)-25-9	2" C1A(3)-25-9	2" C1A(3)-25-9	2" C1A(5)-25-2	2" C1A(5)-25-16	2" C1A(3)-25-65	1/2" C1A(3)-2-2
MS-TK-4P	1/2" C1A(3)-25-25	2" C1A(3)-25-25	2" C1A(3)-25-25	2" C1A(5)-25-6	2" C1A(5)-25-17	2" C1A(3)-25-66	1/2" C1A(3)-2-25
MS-TK-4R	1/2" C1A(3)-25-26	2" C1A(3)-25-26	2" C1A(3)-25-26	2" C1A(5)-25-3	2" C1A(5)-25-18	2" C1A(3)-25-67	1/2" C1A(3)-2-26
MS-TK-4S	1/2" C1A(3)-25-27	2" C1A(3)-25-27	2" C1A(3)-25-27	2" C1A(5)-25-1	2" C1A(5)-25-19	2" C1A(3)-25-68	1/2" C1A(3)-2-27
MS-TK-4T	1/2" C1A(3)-25-28	2" C1A(3)-25-28	2" C1A(3)-25-28	2" C1A(5)-25-5	2" C1A(5)-25-20	2" C1A(3)-25-69	1/2" C1A(3)-2-28
MS-TK-4V	1/2" C1A(3)-25-29	2" C1A(3)-25-29	2" C1A(3)-25-29	2" C1A(5)-25-7	2" C1A(5)-25-21	2" C1A(3)-25-70	1/2" C1A(3)-2-29
MS-TK-1A	1/2" C1A(3)-2-5	1/2" C1A(3)-25-5	2" C1A(3)-25-5	2" C1A(3)-25-1	1/2" C1A(3)-2-9	—	—
MS-TK-1B	1/2" C1A(3)-2-6	1/2" C1A(3)-25-6	2" C1A(3)-25-6	2" C1A(3)-25-2	1/2" C1A(3)-2-10	—	—
MS-TK-1C	1/2" C1A(3)-2-7	1/2" C1A(3)-25-7	2" C1A(3)-25-7	2" C1A(3)-25-3	1/2" C1A(3)-2-11	—	—
MS-TK-1D	1/2" C1A(3)-2-8	1/2" C1A(3)-25-8	2" C1A(3)-25-8	2" C1A(3)-25-4	1/2" C1A(3)-2-12	—	—



DETAIL "A"



DETAIL "B"



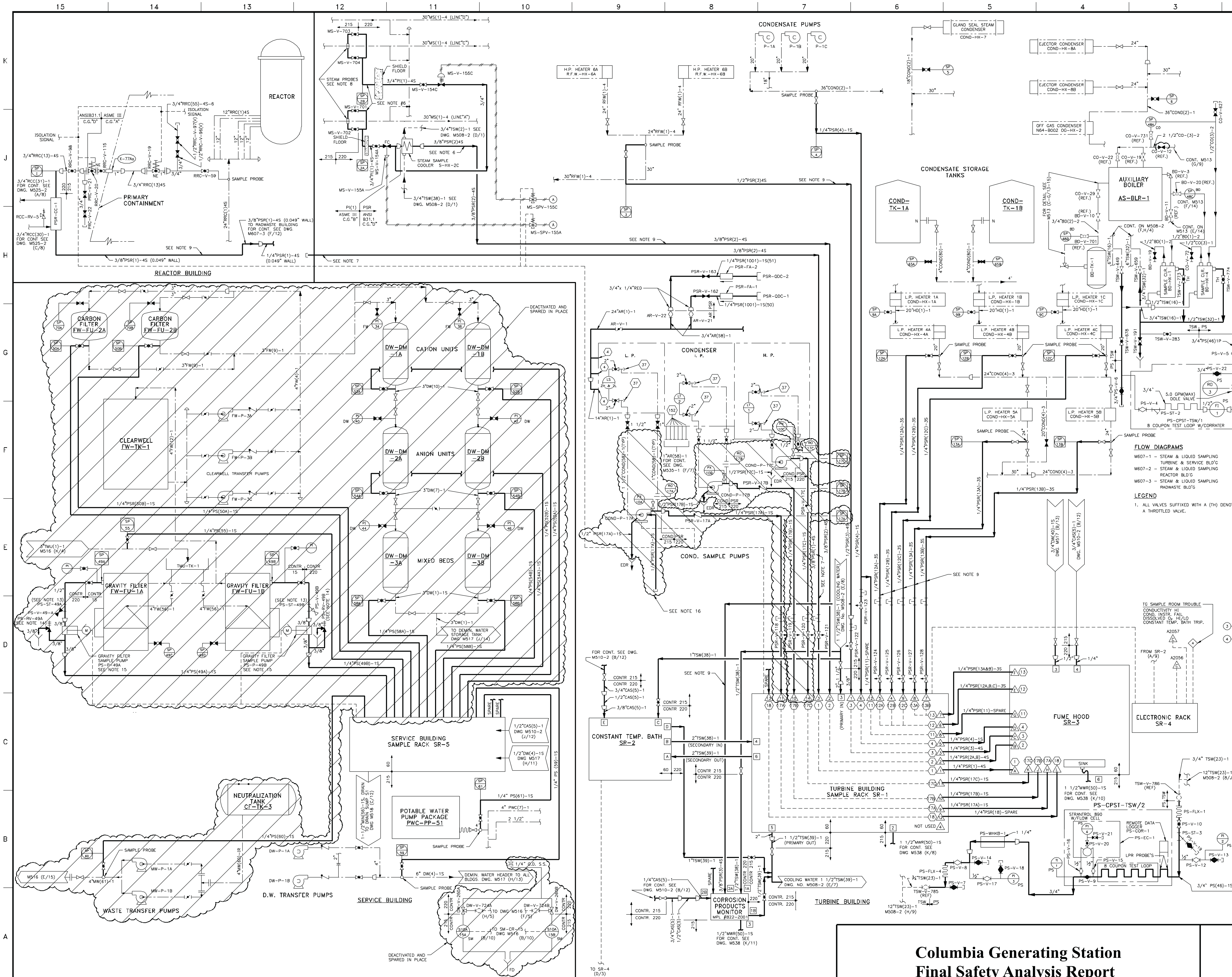
DETAIL "C"

Columbia Generating Station
Final Safety Analysis Report

Containment Instrument Air System

Draw. No. M556-2 | Rev. 8 | Figure 9.3-2.2

Form No. 960690



GENERAL NOTES

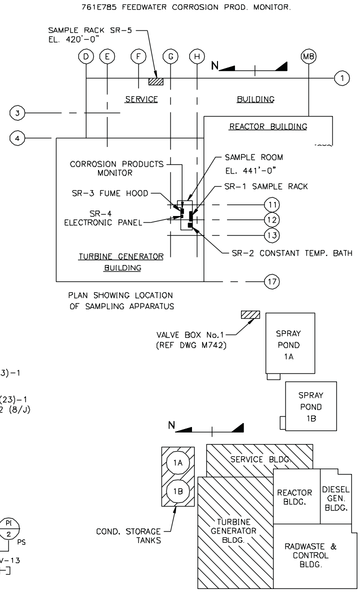
1. ALL PROCESS PIPING (EXCLUSIVE OF PS & PSR LINE DESIGNATION) IS BY CONTRACT 2808-215 ALL TUBING (PS & PSR DESIGNATION) IS BY CONTRACT 2808-220.
2. (DELETED)
3. ALL SAMPLE LINES TO BE 1/4" O.D. X 0.035" WALL S.S. TUBING, EXCEPT AS NOTED.
4. SAMPLE PROBES SHALL BE INSTALLED IN 4" AND ABOVE PIPING ONLY. FOR PIPING BELOW 4", A PRESSURE TAP SHALL BE USED.
5. TYPICAL CONTRACT MATCH LINE FOR SAMPLE CONN'S SHALL BE AS FOLLOWS:
6. ROUTE STEAM SAMPLE LINE FROM LINE TAP. FOR AT LEAST 14 FEET BEHIND SHIELD WALLS BEFORE SAMPLE LINE ENTERS AN ACCESSIBLE AREA.
7. 3/8" PSR(1)-4S TUBING RUN FROM PENETRATION X-77 TO SR-1 IS ABANDONED IN PLACE.
8. SEE DWG. M610 FOR STEAM PROBE INSTALLATION DETAILS.
9. INSULATE FOR PERSONNEL PROTECTION ONLY.
10. SAMPLE PIPING TO BE QUALITY CLASS II AND SEISMIC CATEGORY CLASS II (EXCEPT WHERE NOTED) HEREIN AND ON M619, INSTRUMENT CONNECTION DIAGRAMS.
11. ▭ DENOTES SAMPLE RACK SERVICE NOZZLE CONN.
12. △ DENOTES SEQUENTIAL ORDER OF SAMPLE RACK INLET AND OUTLET SAMPLE CONNECTIONS AS SHOWN ON CVI 60A-00,18 & 60A-00,27.
13. STRAINERS PS-ST-49A, & B ARE C.S. WYE TYPE, 1/2" NPT ENDS, 100 MESH SS STRAINER, 150 LB MINIMUM RATING.
14. RELIEF VALVES PS-RV-49A, B, CS BODY, 3/8 NPT ENDS, CORROSION RESISTANT INTERNALS, SOFT SEAT.
15. PUMPS PS-P-49A & B TO BE INSTALLED BY CONTR. 215
16. PUMPS COND-P-17A, B & C HAVE BEEN REMOVED. ASSOCIATED PIPING DEACTIVATED AND SPARED IN PLACE.
17. ⬡ DENOTES BULKHEAD NUMBER OF SAMPLE RACK INLET AND OUTLET SAMPLE CONNECTIONS AS SHOWN ON CVI 220-01,1422,8 & 220-01,1442,12.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

REFERENCE DRAWINGS

1.
2.
3. M610-INSTALLATION OF SAMPLE PROBES
4. M501-FLOW DIAGRAM LEGEND, SYMBOLS, NOTES AND ABBREVIATIONS.
5. GENERAL ELECTRIC CO. DWGS 106D4386 & 761E785 FEEDWATER CORROSION PROD. MONITOR.



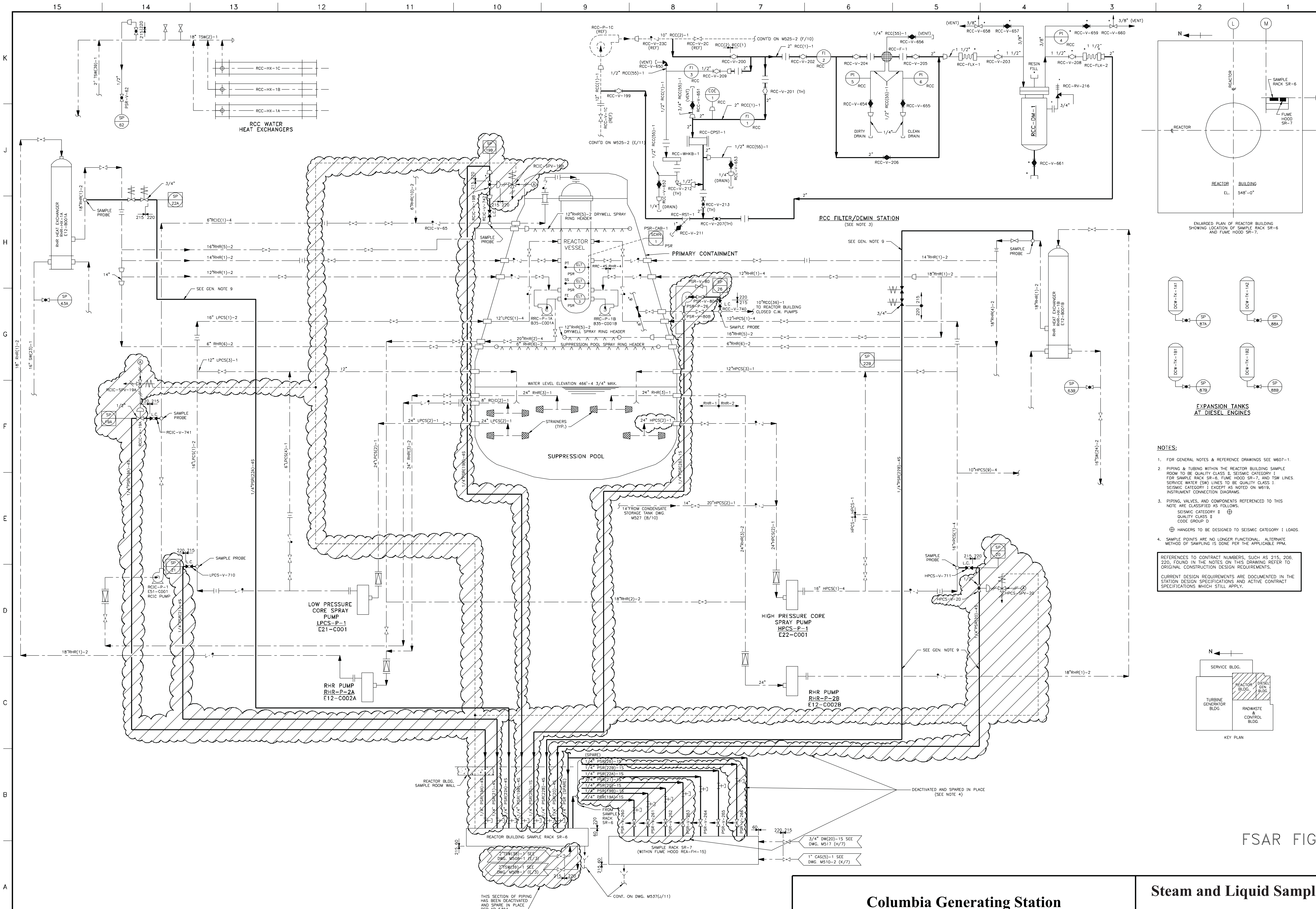
FSAR FIG.

**Columbia Generating Station
Final Safety Analysis Report**

**Steam and Liquid Sampling -
Turbine and Service Buildings**

Draw. No. M607-1 | Rev. 53 | Figure 9.3-3

Form No. 960690ai



NOTES:

1. FOR GENERAL NOTES & REFERENCE DRAWINGS SEE M607-1.
2. PIPING & TUBING WITHIN THE REACTOR BUILDING SAMPLE ROOM TO BE QUALITY CLASS II, SEISMIC CATEGORY I FOR SAMPLE RACK SR-6, FUME HOOD SR-7, AND TSW LINES. SERVICE WATER (SW) LINES TO BE QUALITY CLASS I. SEISMIC CATEGORY I EXCEPT AS NOTED ON M619, INSTRUMENT CONNECTION DIAGRAMS.
3. PIPING, VALVES, AND COMPONENTS REFERENCED TO THIS NOTE ARE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II ⊕
   QUALITY CLASS II
   CODE GROUP D
   ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
4. SAMPLE POINTS ARE NO LONGER FUNCTIONAL. ALTERNATE METHOD OF SAMPLING IS DONE PER THE APPLICABLE PPM.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

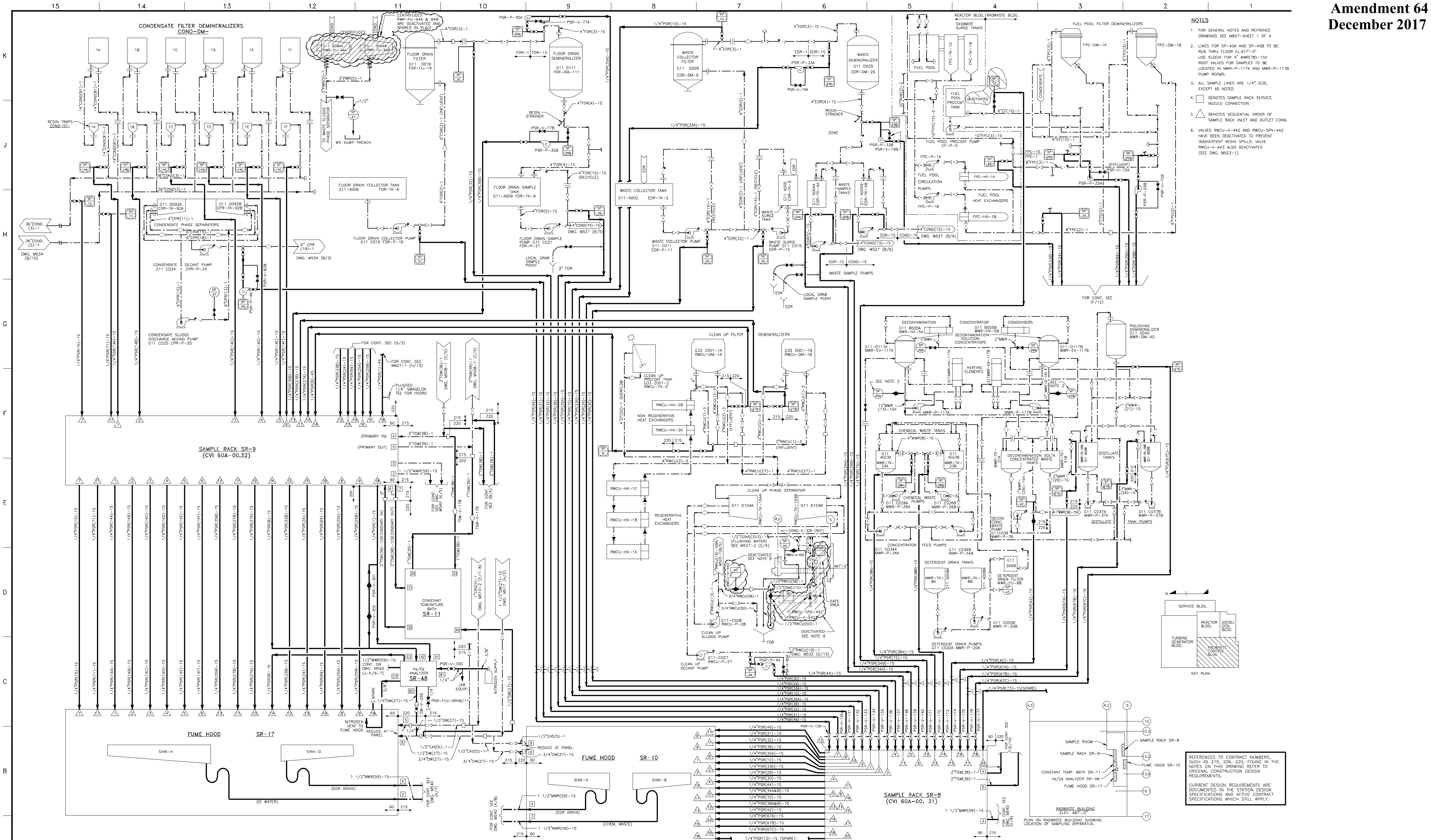
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Steam and Liquid Sampling - Reactor Building

Draw. No. M607-2 | Rev. 27 | Figure 09.3-04

Amendment 64
December 2017



Columbia Generating Station
Final Safety Analysis Report

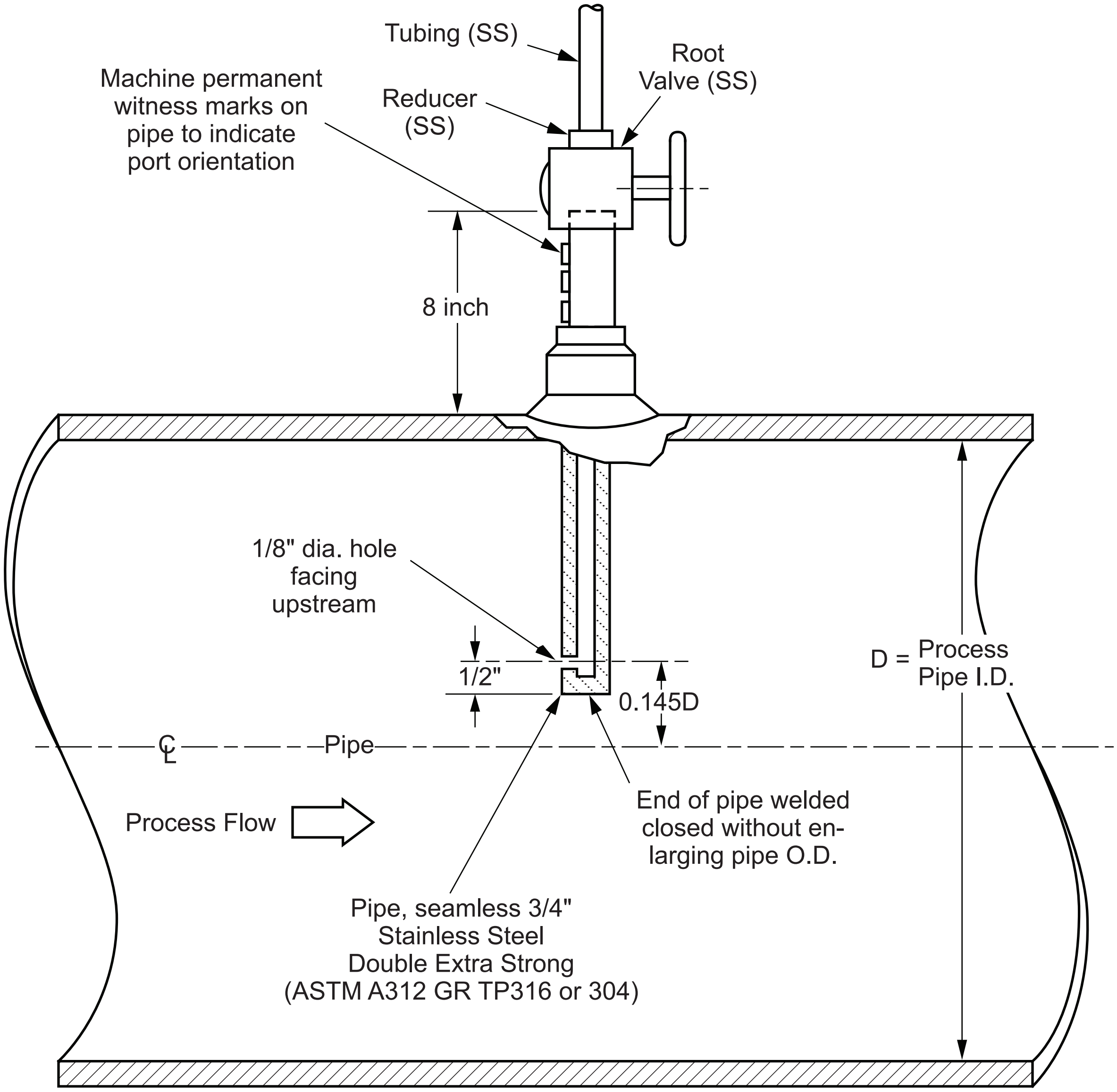
Steam and Liquid Sampling – Radwaste Building

Draw. No. M607-3	Rev. 29	Figure 9.3-5

Form No. 960690ai

22A2708, Rev 5
Reference Specification

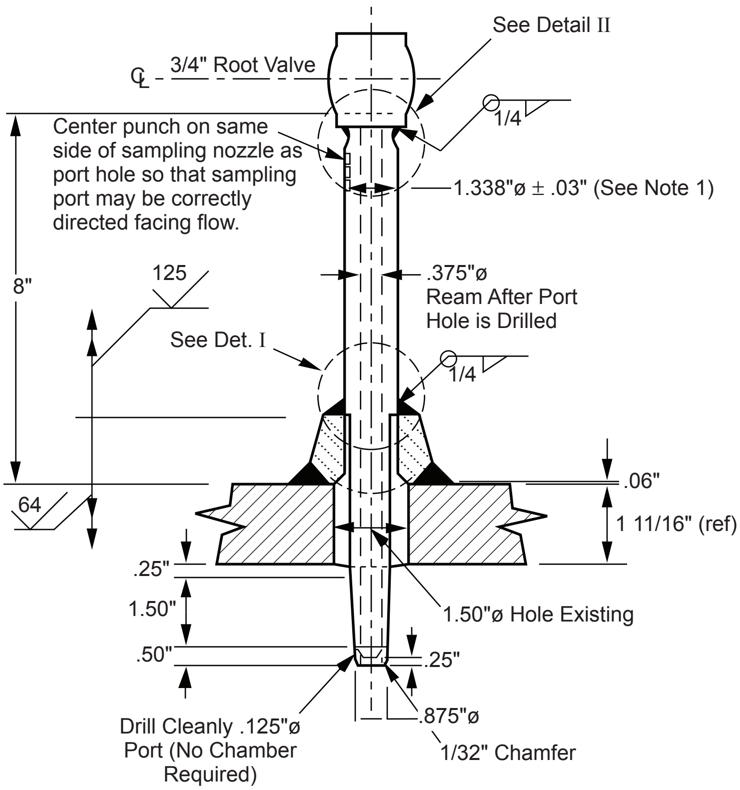
Sampling of Process Fluids



General Sample Probe

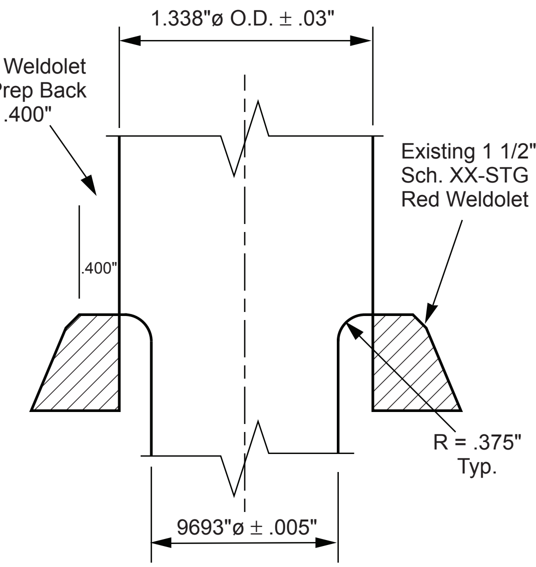
Columbia Generating Station
Final Safety Analysis Report

Draw. No. 960690.79 | Rev. | Figure 9.3-6



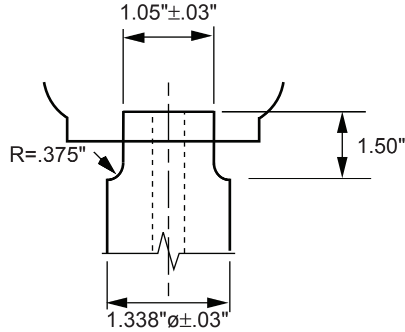
SAMPLE PROBE SP-3

Scale: Half Size



DETAIL I

Scale: 2X



DETAIL II

Scale: Full

Note 1: Sample Probe to Weldolet Weld Omitted for Clarity

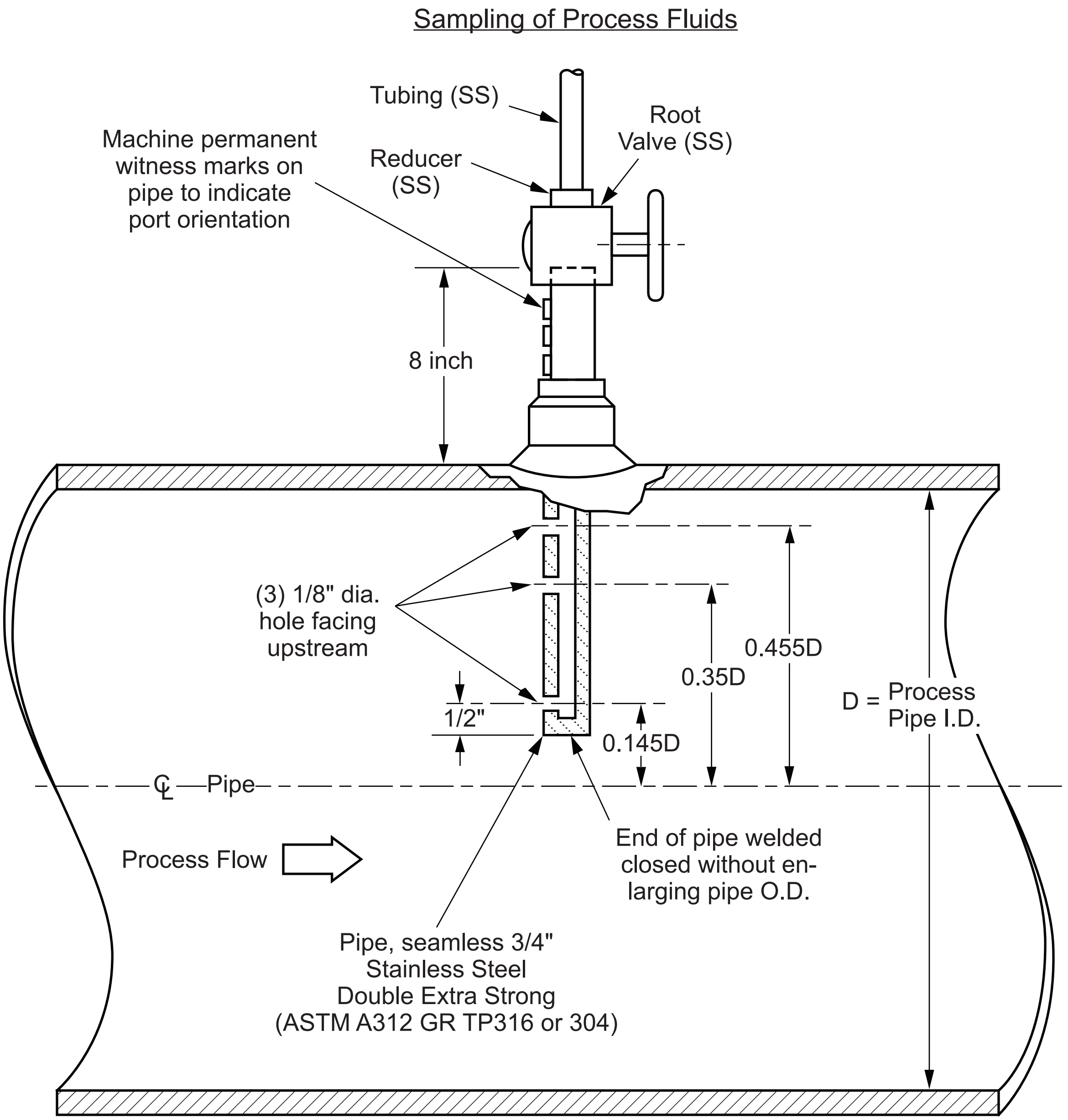
Columbia Generating Station
Final Safety Analysis Report

Sample Probe RFW-SP-3

Draw. No. 960690.94	Rev.	Figure 9.3-7

Form No. 960690

22A2708, Rev 5
Reference Specification

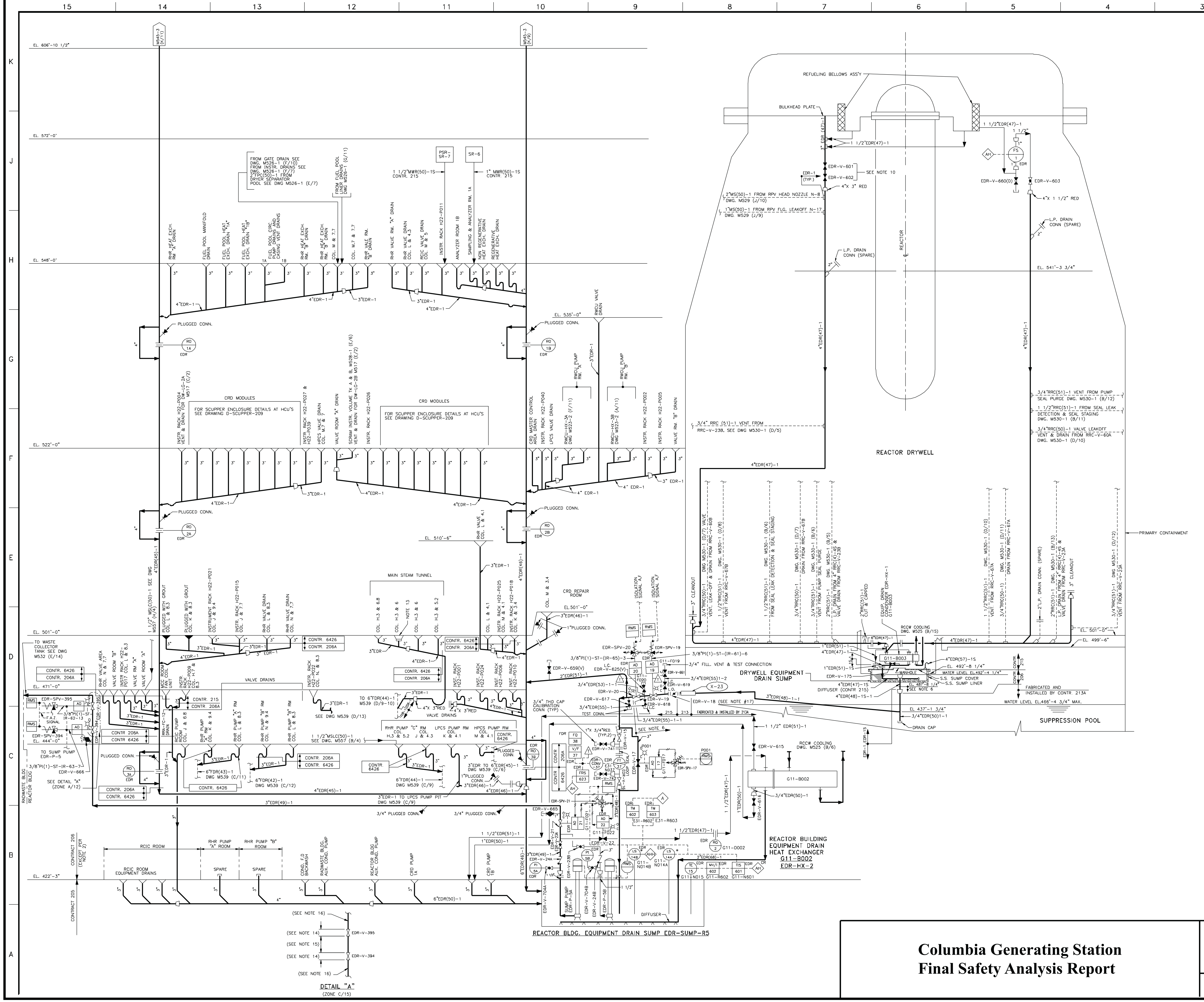


Columbia Generating Station
Final Safety Analysis Report

Feedwater Condensate Sample Probe

Draw. No. 960690.80 | Rev. | Figure 9.3-8

Form No. 960690



NOTES:

1. EXCEPT AS NOTED IN NOTES 6, 14 & 15;
ALL PIPING, VALVES, & ASSOCIATED COMPONENTS ON THIS DRAWING INCLUDED IN CONTRACTS 205, 206, & 215 ARE CLASSIFIED AS FOLLOWS:
QUALITY CLASS-II+
SEISMIC CATEGORY IM
CODE GROUP D
2. SUMP PUMP EDR-P-5 AND DISCHARGE PIPING FROM PUMP, REACTOR BUILDING EQUIPMENT DRAIN HEAT EXCHANGER, CONDENSER, AND ASSOCIATED PIPING ARE IN SCOPE OF CONTRACT 215.
3. ALL PIPING INSIDE PRIMARY CONTAINMENT, EXCEPT AS NOTED, IS IN CONTRACT 215.
4. ALL PIPING & ASSOCIATED COMPONENTS ON THIS DRAWING ARE INCLUDED IN CONTRACT 206 EXCEPT WHERE CONTRACT INTERFACES ARE DENOTED BY:
CONTRACT 206 (6426)
CONTRACT 205, 215 OR 216, 206A & 213A
5. (DELETED)
6. PIPING AND ASSOCIATED COMPONENTS IN SUBSYSTEM EDR(48) UPSTREAM OF VALVE EDR-V-20 ARE CLASSIFIED AS FOLLOWS:
QUALITY CLASS I
SEISMIC CATEGORY I
CODE GROUP B
7. (DELETED)
8. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
9. ALL WORK ON THIS DRAWING BY CONTRACT 206A IS SO NOTED. PERMANENT MATERIAL WILL BE FURNISHED TO CONTRACTOR, SEE SPECIFICATIONS.
10. VALVES EDR-V-601 & 602 ARE CLOSED AND TO BE OPENED ONLY WHEN ACCOMMODATING REFUELING OPERATIONS.
11. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
12. ALL INSTR. LINES ARE DESIGNATED BY CODE & LINE #
A. EXAMPLE: LINES ORIGINATING OUTSIDE CONTAINMENT.
1/2" PI(1)-ST (CODE DESIGNATION) – (H22-P021)-A6 (LINE NUMBER)
13. THIS EQUIP. DRAIN IS MODIFIED TO FUNCTION AS A FLOOR DRAIN. PIPING IS ROUTED TO 6" FDR(44)-1 TO FDR SUMP R4 IN RHR PUMP ROOM "C."
14. SECONDARY CONTAINMENT ISOLATION VALVES EDR-V-394 & EDR-V-395 ARE CLASSIFIED AS FOLLOWS (ALSO SEE NOTE 15 AND DETAIL "A" – ZONE A/12):
QUALITY CLASS-I
SEISMIC CATEGORY I
CODE GROUP C
15. 3" EDR (49)-1 PIPING BETWEEN EDR-V-394 & EDR-V-395 IS CLASSIFIED AS FOLLOWS (ALSO SEE NOTE 14 AND DETAIL "A" – ZONE A/12):
QUALITY CLASS-II+
SEISMIC CATEGORY I
CODE GROUP D
16. THE ATTACHED PIPING AND SUPPORTS HAVE BEEN ANALYZED TO SEISMIC CATEGORY I CRITERIA TO AN ANCHOR OR THROUGH AN OVERLAP REGION AS REQUIRED IN MES-3. (SEE DETAIL "A" – ZONE A/12).
17. EDR-V-18 AND ITS MATING FLANGES ARE STAINLESS STEEL.
18. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

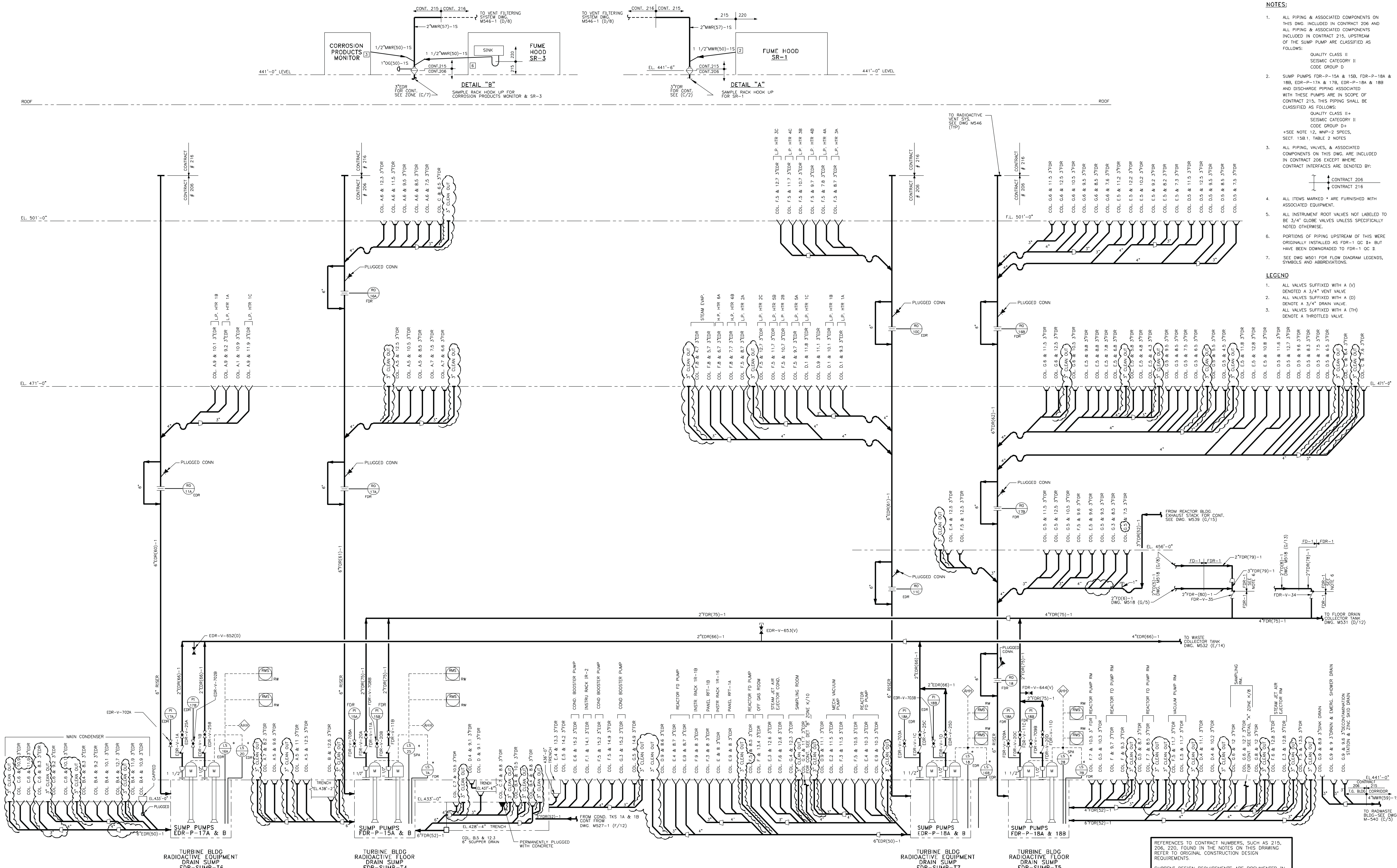
LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station
Final Safety Analysis Report

Equipment Drain System – Reactor Building

Draw. No. M537	Rev. 77	Figure 9.3-9



NOTES:

1. ALL PIPING & ASSOCIATED COMPONENTS ON THIS DWG. INCLUDED IN CONTRACT 206 AND ALL PIPING & ASSOCIATED COMPONENTS INCLUDED IN CONTRACT 215, UPSTREAM OF THE SUMP PUMP ARE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY II
   CODE GROUP D
2. SUMP PUMPS FDR-P-15A & 15B, FDR-P-18A & 18B, EDR-P-17A & 17B, EDR-P-18A & 18B AND DISCHARGE PIPING ASSOCIATED WITH THESE PUMPS ARE IN SCOPE OF CONTRACT 215, THIS PIPING SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II+
   SEISMIC CATEGORY II
   CODE GROUP D+
   +SEE NOTE 12, WNP-2 SPECS, SECT. 15B.1, TABLE 2 NOTES
3. ALL PIPING, VALVES, & ASSOCIATED COMPONENTS ON THIS DWG. ARE INCLUDED IN CONTRACT 206 EXCEPT WHERE CONTRACT INTERFACES ARE DENOTED BY:
   CONTRACT 206
   CONTRACT 216
4. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
5. ALL INSTRUMENT ROOT VALVES NOT LABELED TO BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
6. PORTIONS OF PIPING UPSTREAM OF THIS WERE ORIGINALLY INSTALLED AS FDR-1 QC II+ BUT HAVE BEEN DOWNGRADED TO FDR-1 QC II.
7. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTED A 3/4" VENT VALVE
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

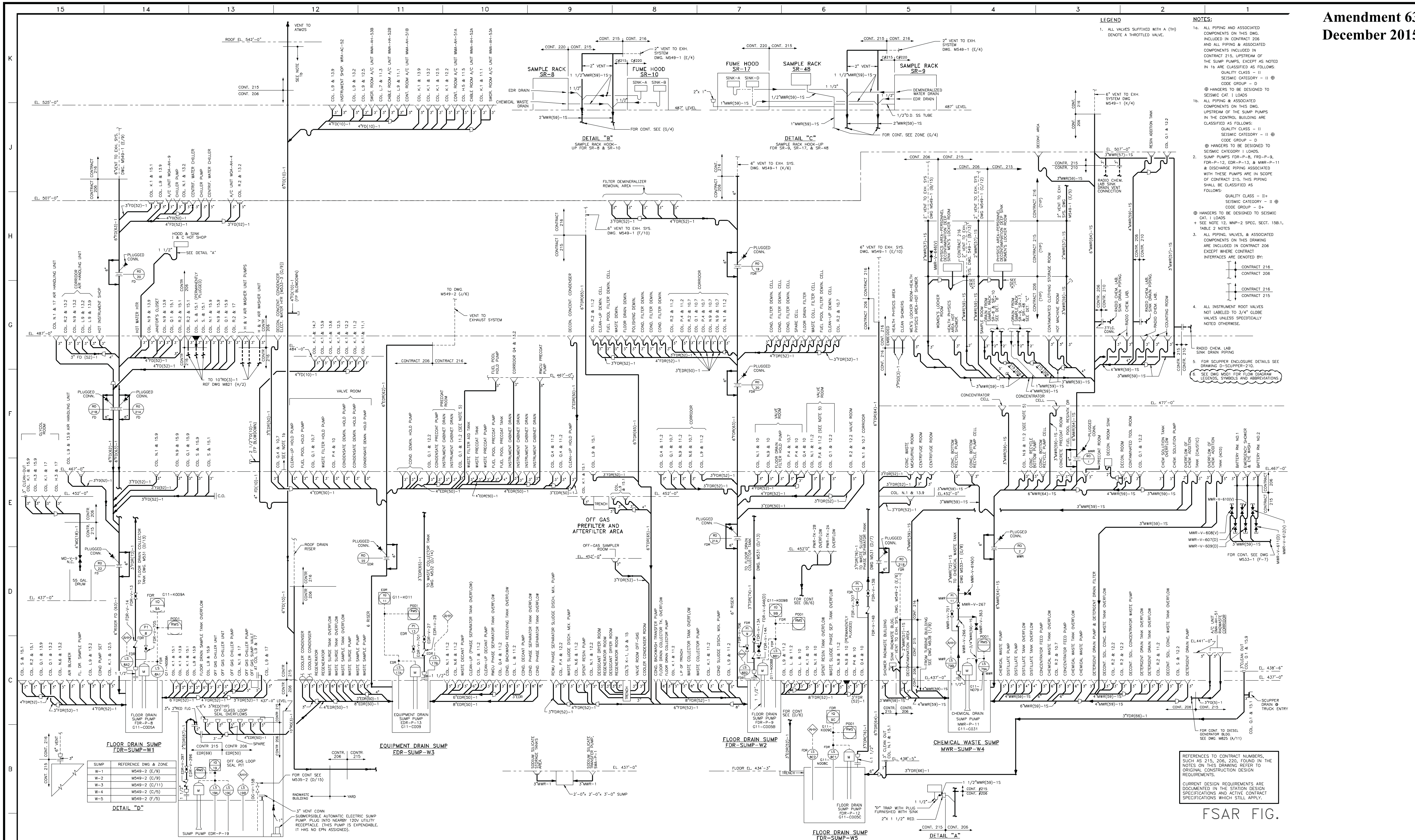
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Floor Drains - Turbine Building Equipment

Draw. No. M538 | Rev. 37 | Figure 9.3-10

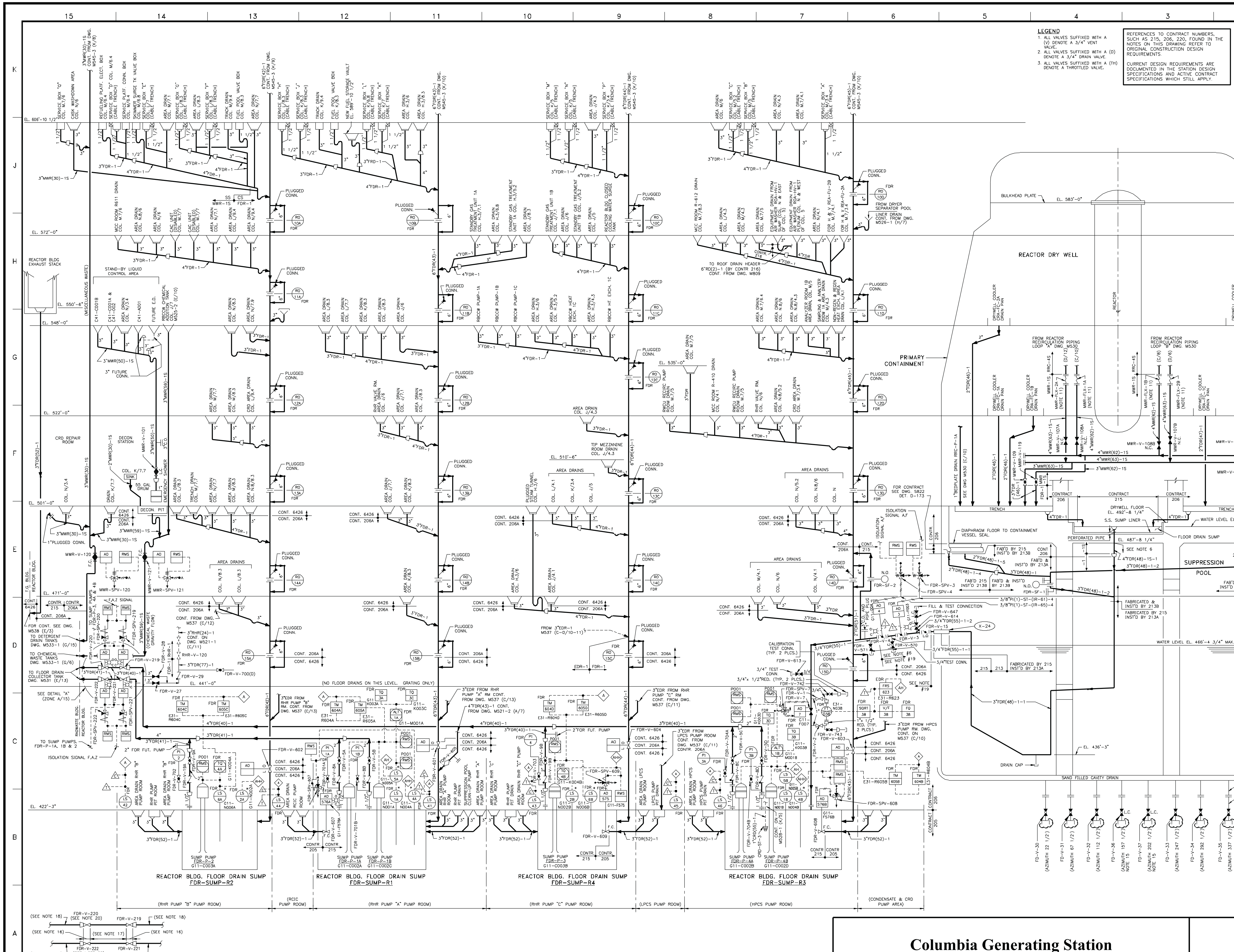
Amendment 63
December 2015



Columbia Generating Station
Final Safety Analysis Report

Radwaste Building Equipment and Floor Drains

Draw. No. M540	Rev. 53	Figure 9.3-11



LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

NOTES:

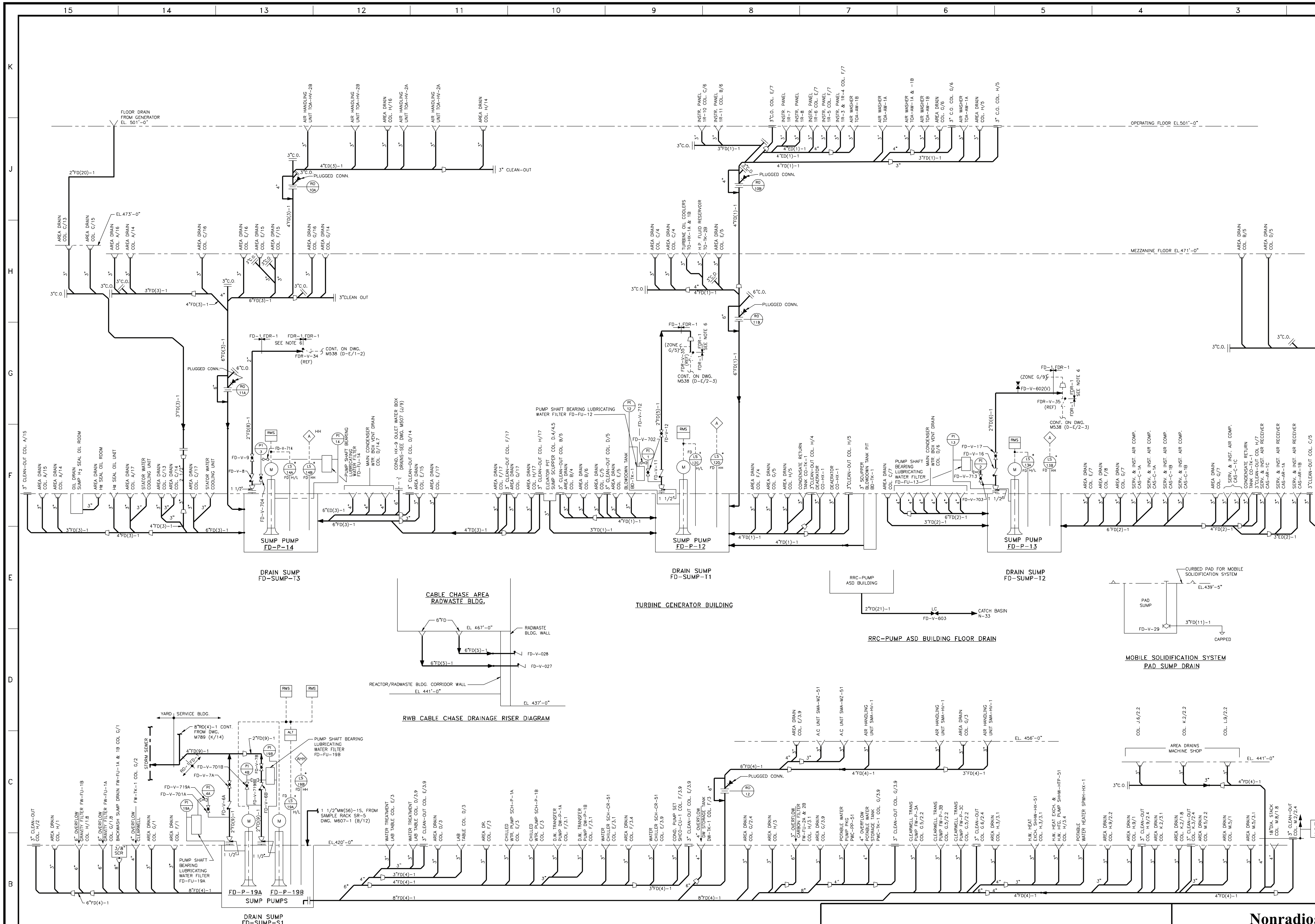
1. EXCEPT AS NOTED IN NOTES 6, 10, 16 & 17, ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING INCLUDED IN CONTRACT 205 & 206 ARE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II+
   SEISMIC CATEGORY IM
   CODE GROUP D
2. SUMP PUMPS FDR-P-1A; FDR-P-1B; FDR-P-2; FDR-P-3A; FDR-P-3B; FDR-P-4; AND ALL THE DISCHARGE PIPING FROM PUMPS ARE IN SCOPE OF CONTRACT 215.
3. ALL PIPING INSIDE PRIMARY CONTAINMENT, EXCEPT AS NOTED, IS IN CONTRACT 215.
4. ALL PIPING, VALVES, & ASSOCIATED COMPONENTS ON THIS DRAWING ARE INCLUDED IN CONTRACT 206 EXCEPT WHERE CONTRACT INTERFACES ARE DENOTED BY:
   CONTRACT 215, 205 OR 216, 206A, 213A | CONTRACT 206 (6426)
5. (DELETED)
6. PIPING & ASSOCIATED COMPONENTS IN SUBSYSTEM FDR(48) UPSTREAM OF VALVE FDR-V-4 (EXCEPT 3 FT OF 4"FDR(48)-1S-1 FROM DIAPHRAGM FLOOR SEAL WHICH DOES NOT REQUIRE HYDROTEST OR CODE STAMP) ARE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS I
   SEISMIC CATEGORY I
   CODE GROUP B
7. (DELETED)
8. * DENOTES INSTRUMENTS SUPPLIED WITH EQUIPMENT.
9. ALL INSTRUMENT ROOT VALVES NOT LABELED WILL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
10. FROM FIRST WELD INSIDE CONTAINMENT UP TO & INCLUDING TEST CONN. BOUNDARY OUTSIDE CONTAINMENT, PIPING MWR(62) & MWR(63) ARE CLASSIFIED AS FOLLOWS:
    QUALITY CLASS I
    SEISMIC CATEGORY I
    CODE GROUP B
11. FLEX CONN'S ARE INSTALLED ONLY DURING USE. LINE IS NORMALLY BLIND FLANGED
12. (DELETED)
13. (DELETED)
14. ALL INSTR. LINES ARE DESIG- -NATED BY CODE & LINE NUMBER
    A. EXAMPLE: LINES ORIGINATING OUTSIDE CONTAINMENT.
    1/2"PI(1)-ST – (H22-P021)-A6
    CODE DESIGNATION — LINE NUMBER
15. VALVES FD-V-36 & FD-V-37 PROVIDE A SECONDARY CONTAINMENT ISOLATION BOUNDARY WHEN THE REACTOR BUILDING RAILROAD BAY DOORS ARE OPEN ZONE (B/3)
16. SECONDARY CONTAINMENT ISOLATION VALVES FDR-V-219, FDR-V-220, FDR-V-221 & FDR-V-222 ARE CLASSIFIED AS FOLLOWS (ALSO SEE NOTE 17 AND DETAIL "A" - ZONE A/14):
    QUALITY CLASS I
    SEISMIC CATEGORY I
    CODE GROUP C
17. 3" FDR (40)-1 & 3" FDR (41)-1 BETWEEN VALVES FDR-V-219, FDR-V-220, FDR-V-221 & FDR-V-222 ARE CLASSIFIED AS FOLLOWS (ALSO SEE NOTE 16 AND DETAIL "A" - ZONE A/14):
    QUALITY CLASS II+
    SEISMIC CATEGORY I
    CODE GROUP D
18. THE ATTACHED PIPING AND SUPPORTS HAVE BEEN ANALYZED TO SEISMIC CATEGORY I CRITERIA TO AN ANCHOR OR THROUGH AN OVERLAP REGION AS REQUIRED IN MES-3. (SEE DETAIL A - ZONE A/14)
19. PIPING VALVES AND FITTINGS IN THIS AREA ARE STAINLESS STEEL.
20. VALVES FDR-V-220 & FDR-V-222 DO NOT FULLY OPEN DUE TO UNDERSIZED ACTUATORS FOR FDR-AO-220 AND FDR-AO-222 RESPECTIVELY. THIS CONDITION IS ACCEPTED AS-IS PER EC PDC 9989.
21. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

Floor Drains – Reactor Building

Draw. No. M539	Rev. 88	Figure 9.3-12



NOTES:

1. ALL PIPING, VALVES, & ASSOCIATED COMPONENTS ON THIS DWG ARE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY II
   CODE GROUP D
2. ALL PRESSURE AND FLOW INSTRUMENTS ROOT VALVES TO BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
3. CONTRACTS SCOPE:
   PIPING TO SUMPS BY CONTRACT 206, PUMPS DISCHARGE PIPING BY CONTRACT 215
4. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.
5. LIMIT OF CONTRACT 206A WORK IS AS NOTED ON DRAWING, PERMANENT MATERIAL WILL BE FURNISHED TO CONTRACTOR, SEE SPECIFICATIONS.
6. PORTIONS OF PIPING UPSTREAM OF THIS WERE ORIGINALLY INSTALLED AS FDR-1 QC II+ BUT HAVE BEEN DOWNGRADED TO FDR-1 QC II.
7. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

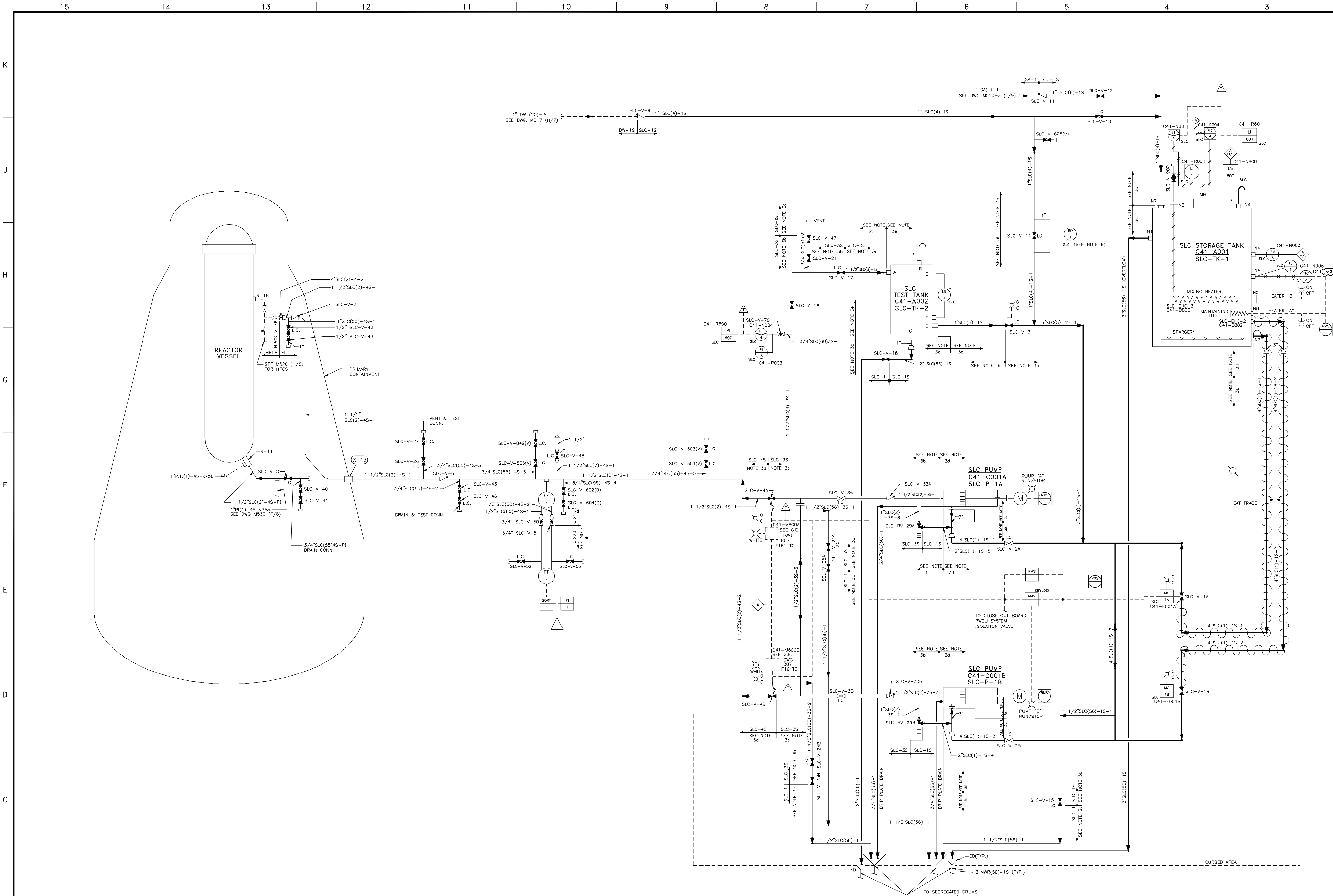
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

Nonradioactive Floor Drains

Draw. No. M518 | Rev. 37 | Figure 9.3-13



NOTES:

1. ALL INSTRUMENT ROOT VALVES NOT LABELED SHALL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.

2. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED EQUIPMENT.

3. PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DWG. SHALL BE CLASSIFIED AS FOLLOWS:
   a. ALL PIPING, VALVES, AND COMPONENTS DESIGNATED AS SLC-4S EXCEPT AS NOTED.
      SEISMIC CATEGORY – I
      QUALITY CLASS – I
      CODE GROUP – A
   b. ALL PIPING, VALVES, AND COMPONENTS DESIGNATED BY THE NOTE "SEE NOTE 3b."
      SEISMIC CATEGORY – I
      QUALITY CLASS – I
      CODE GROUP – B
   c. ALL PIPING, VALVES, AND COMPONENTS DESIGNATED BY THE NOTE "SEE NOTE 3c" OR THE SYSTEM DESIGNATION SLC (56) UNLESS NOTED.
      SEISMIC CATEGORY – II ⊕
      QUALITY CLASS – II
      CODE GROUP – D
      ⊕ HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.
   d. COMPONENTS DESIGNATED BY NOTE "SEE NOTE 3d"
      SEISMIC CATEGORY – I
      QUALITY CLASS – II +
   e. COMPONENTS DESIGNATED BY NOTE "SEE NOTE 3e"
      SEISMIC CATEGORY – II
      QUALITY CLASS – II

4. (DELETED)

5. ALL INSTRUMENT LINES ARE DESIGNATED BY CODE AND LINE NUMBER.

   A. EXAMPLE: LINES ORIGINATING INSIDE CONTAINMENT.

   1/2"PI(1)-4S – X 106
   (1/2"PI(1)-4S = CODE DESIGNATION; X 106 = LINE NUMBER)

6. SLC-RO-1 IS A BLANKING PLATE (AN ORIFICE PLATE WITH NO HOLE)

7. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

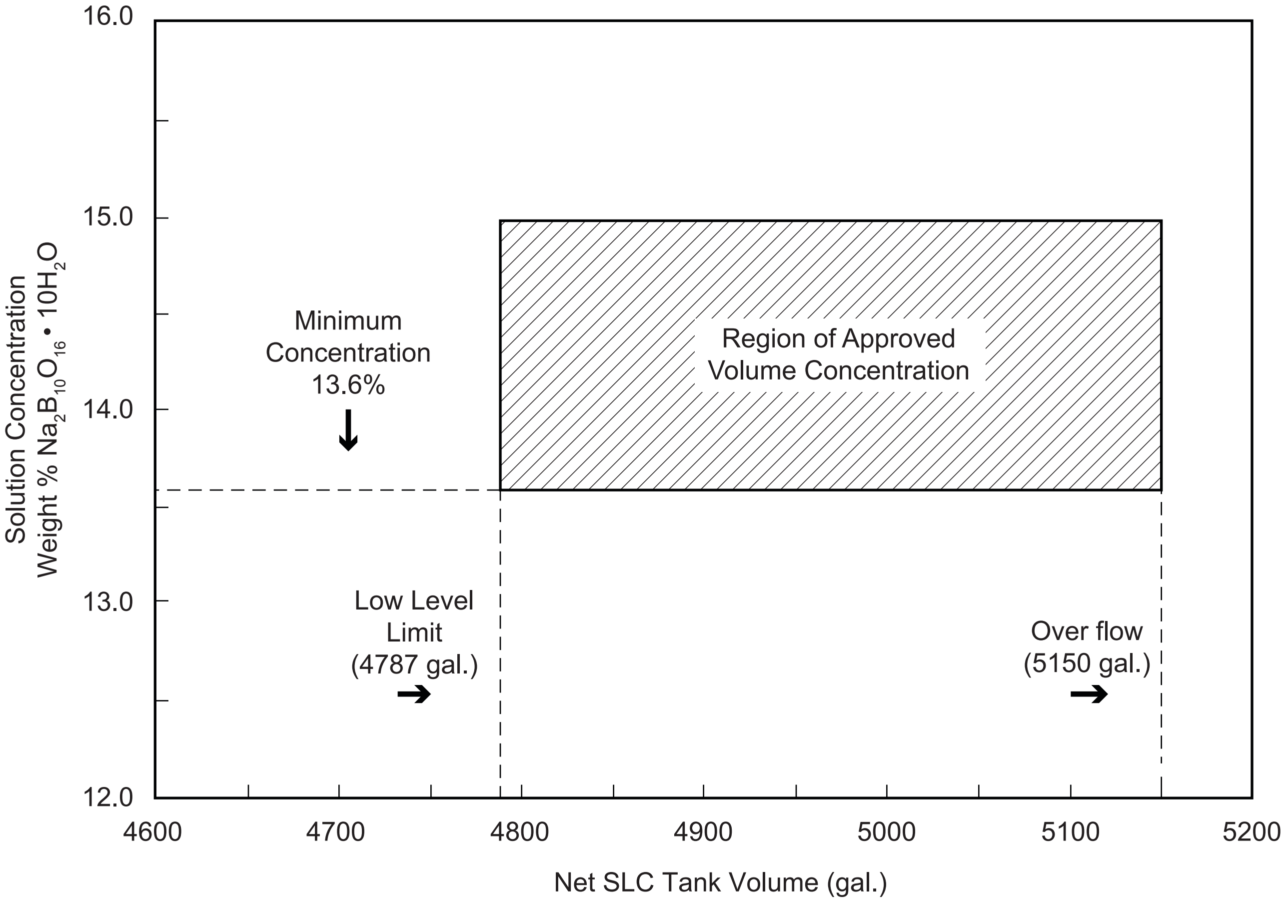
REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

LEGEND

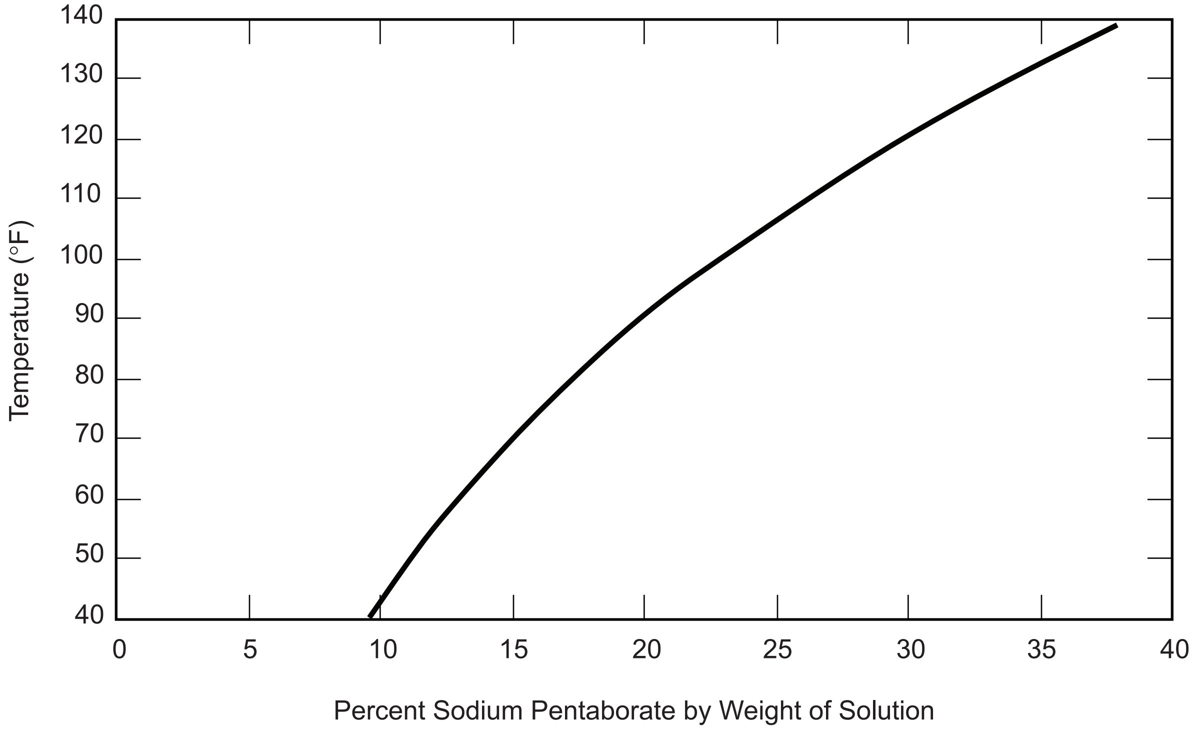
1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station **Final Safety Analysis Report**	**Standby Liquid Control System - Reactor Building**
	Draw. No. M522 | Rev. 39 | Figure 9.3-14



Sodium Pentaborate Decahydrate
($Na_2B_{10}O_{16} \cdot 10H_2O$)
Volume Concentration Requirements

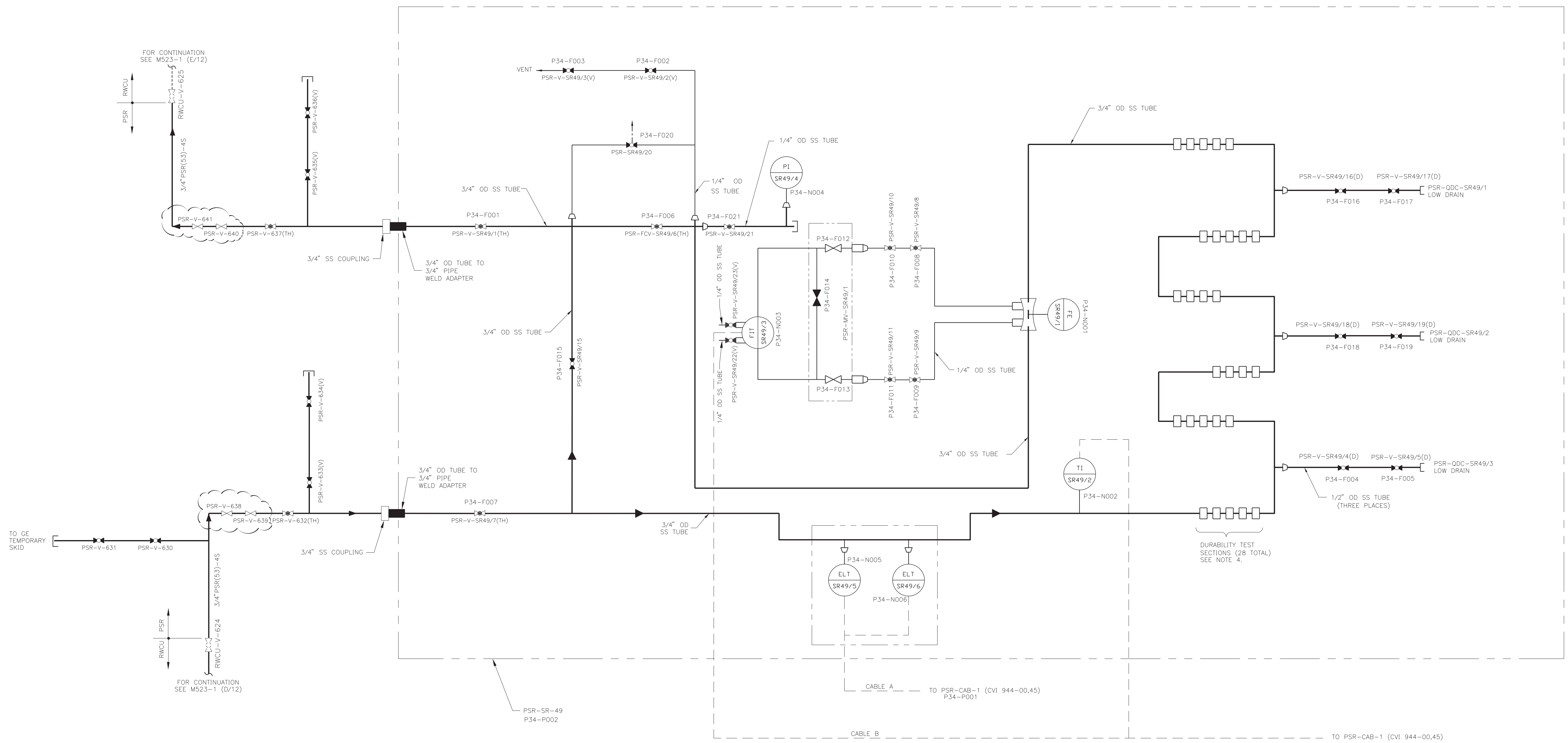
The minimum required volume to ensure reactor shutdown is 4587 gal. The Low Level Limit (4587 + 200 gal) includes 200 gal process margin to minimize air entrainment in the pumps. Operators may shutoff the pumps at 200 gal net SLC Tank Volume or less.



Saturation Temperature of
Sodium Pentaborate Solution

NOTES

1. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:
   QUALITY CLASS II
   SEISMIC CATEGORY IM
   CODE GROUP D
2. ALL PIPING COMPONENTS AND INSTRUMENTATION SHOWN IN THE CONFINES OF THE SKID PACKAGE, EXCEPT QUICK DISCONNECTS FOR LOW DRAIN, ARE SUPPLIED WITH THE ASSOCIATED EQUIPMENT.
3. FOR FLOW DIAGRAM LEGEND, SYMBOLS AND ABBREVIATIONS SEE DRAWING M501 AND CVI 02-02A42-04,2.
4. 28 DURABILITY TEST SECTIONS (COUPONS) WERE INITIALLY SUPPLIED WITH THE SAMPLE SKID. HOWEVER THESE COUPONS ARE PERIODICALLY REMOVED FOR SAMPLING, THEREFORE NUMBER OF COUPONS VARIES.



Columbia Generating Station Final Safety Analysis Report	Flow Diagram Steam and Liquid Sampling Reactor Building		
	Draw. No. M607-4	Rev. 2	Figure 9.3-17

Form No. 960690FH

9.4 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

The various heating, ventilating, and air conditioning (HVAC) systems serving the plant are designed to provide suitable environmental conditions throughout the plant for personnel comfort and/or equipment operation.

The following performance objectives are implemented in the design of the HVAC systems:

a. Maintain appropriate ambient temperature and humidity conditions for station operating personnel and equipment,

b. Control and monitor all potentially radioactive airborne releases from the plant so that releases are within the limits of 10 CFR Part 20,

c. Control and limit airborne radioactive contaminants within the plant structures by inducing air flow from areas of low contamination potential into areas of progressively higher contamination potential, and

d. Remove all potentially explosive gases, noxious fumes, or smoke from the plant.

In addition, a number of HVAC systems are required to ensure a safe shutdown of the reactor or to mitigate the results of the design basis accident. These systems are designed to continue operation in the event of any or all of the following events:

a. Safe shutdown earthquake (SSE),
b. Loss of offsite power,
c. Single failure of any active component, and
d. Design basis accident.

The effect of a loss of normal ventilation during a station blackout is discussed in Appendix 8A.

The following areas containing engineered safety features (ESF) equipment are serviced by critical HVAC systems:

a. Main control room/cable spreading room/critical switchgear area,
b. Diesel generator building,
c. Standby service water (SW) pump houses,
d. Reactor building emergency pump rooms,
e. Reactor building critical electrical equipment rooms, and
f. Diesel generator cable area corridor.

The balance of the plant structures are serviced by noncritical HVAC systems.

The following outdoor design conditions are used in the design of HVAC systems having ESF:

Summer:	105°F dry-bulb, 71°F wet-bulb
Winter:	0°F dry-bulb

The extreme outdoor conditions are:

Summer:	115°F dry-bulb
Winter:	-27°F

The effect of these extreme outdoor conditions on main control room/cable spreading room and critical switchgear area temperatures is negligible for the frequency and duration of these conditions since the rooms are interior rooms and the total load changes due to fresh air (maximum 5% of total air flow for control room and maximum 10% of total air flow for critical switchgear area) are within equipment capacity limits for maintaining inside design conditions. The mechanical equipment rooms housing these three systems are of extra heavy exterior wall and roof construction and the effect of extreme outside conditions is considered to be negligible for the frequency and duration of these extremes.

Extreme outside conditions have no effect on reactor building emergency pump rooms and reactor building critical electrical equipment rooms since these are interior rooms without any outdoor air supply during emergency. During normal operation the emergency pumps are not running and the critical electrical equipment is operating at a reduced load. The battery rooms are provided with room heaters to prevent excessive cooling from SW that could affect battery capacity.

The effect of extreme outdoor conditions on the diesel generator building ventilation system, diesel generator area cable cooling system, and SW pump house ventilation systems is discussed in Sections 9.4.7, 9.4.8, and 9.4.10 respectively.

9.4.1 MAIN CONTROL ROOM/CABLE SPREADING ROOM/CRITICAL SWITCHGEAR AREA

9.4.1.1 Design Bases

The critical switchgear area, cable spreading room, and main control room are located, one above the other, on three successive levels of the radwaste building, with the main control room on the top level. Each level is served by a separate HVAC system. Redundant HVAC systems are provided for the main control room and the cable spreading room. These three systems are ESF systems and all system components, except the radwaste building chilled water system (WCH) (see Section 9.4.4) to the control room, cable spreading room and critical switchgear area systems, and the plant service water (TSW) system to the switchgear area system, are designed to operate under all emergency modes. During an emergency condition, the SW system is used as the cooling medium for the cable spreading room and switchgear area systems. The control room chilled water (CCH) system or SW system is used as the cooling medium for the control room HVAC system during emergency conditions.

The three systems are designed to satisfy the following design criteria:

a. Main control room

During normal operation the main control room ambient conditions are normally maintained at 75°F ±3° dry-bulb temperature by the radwaste chillers. In the event both radwaste chillers are inoperative (emergency condition) the control room temperature will be maintained within the habitability limit (85°F) by control room chilled water. SW can maintain the control room temperature limit of 85°F during colder weather. SW will maintain the control room within the environmental qualification temperature limit for control room equipment (104°F). The ingress of smoke or combustion vapors (due to a fire within the plant but external to the control room), or of airborne radioactive contaminants released due to the design basis accident, is minimized by pressurizing the control room. During a loss-of-coolant accident (LOCA), the control room emergency pressurization mode through the emergency filter unit maintains a positive pressure with respect to its surroundings as measured in the cable spreading room.

Three air intakes are provided from which fresh air can be drawn. One local intake is provided for normal operation and two remote intakes are provided for normal and emergency operation. Fire external to the plant and any ingress of smoke or combustion vapors are detected by smoke detectors in the control room fresh air intake ducting, which will alarm in the control room.

Isolation of the control room fresh air intakes would place the control room HVAC in an unfiltered recirculation mode. In the event of a hazardous chemical release, the control room HVAC is manually isolated into the recirculation mode without filtration through the emergency filter units by closing the normal fresh air isolation damper.

b. Cable spreading room

The cable spreading room HVAC system is designed to maintain the cable spreading room and the remote shutdown room at approximately 80°F during normal operation and to limit the temperature below equipment operability limits during all emergency modes of operation. See Table 3.11-1.

c. Critical switchgear area

The critical switchgear area HVAC system is designed to maintain temperatures in the electrical rooms between 55°F and 104°F during normal operation and to limit the temperatures below equipment operability limits during all emergency modes of operation. See Table 3.11-1. The system is also designed to remove any combustible fumes generated by the emergency batteries.

9.4.1.2 System Description

The HVAC systems of the main control room, cable spreading room, and critical switchgear areas are shown in Figure 9.4-1. The HVAC systems for these three areas are located in equipment rooms above the main control room. These two equipment rooms are separated from each other by a missile barrier. Each equipment room houses three separate and independent systems serving the three areas. Equipment details are given in Table 9.4-1. Equipment seismic information is given in Table 3.2-1.

9.4.1.2.1 Main Control Room

Each of the main control room's 100%-capacity HVAC systems are composed of a primary air handling system and an emergency filter system. The two HVAC systems share a common outside air intake system and a common duct distribution system within the main control room. A single exhaust system, composed of a fan, shutoff damper, and ductwork, discharges air from the main control room toilet and kitchen. The exhaust fan operates continuously during normal operations.

Each primary air handling system consists of a centrifugal supply fan which blows through an air handling unit consisting of an air filter, two water cooling coils in series (one for radwaste chilled water and one for control room chilled water or SW), and an electric blast coil heater and associated ductwork and dampers.

Separate return air ductwork containing a sound absorber unit is provided from the main control room to each of the primary air handling systems.

During normal operation one air handling system operates, distributing air to the main control room. The temperature is controlled by electronic controllers located in the main control room which modulate the chilled water flow to the cooling coil.

Chilled water is normally supplied to the main control room air handling systems by the WCH. The WCH, which includes two 100%-capacity chillers and two 100%-capacity pumps is not an

ESF. During emergency condition, control room chilled water or SW is supplied to the air handling units for cooling. The control room can be maintained below 85°F by the control room chilled water, or SW can be used to maintain less than 104°F (shedding of nonessential loads may be required under some conditions). The control room temperature limit is 85 °F dry bulb for control room habitability. The environmental qualification temperature limit for control room equipment is 104°F

The two 1000-cfm capacity filter systems are normally in standby and operate in the event of an emergency (F, A, Z signal). Each of the emergency filter systems consists of an emergency filter unit, a 5-kW electric heater, bypass and recirculation control dampers, and associated ductwork. Each emergency filter unit consists of a medium efficiency prefilter, high efficiency particulate air (HEPA) filter, activated charcoal filters, and direct drive centrifugal fan, all enclosed in an all-welded sheet metal housing. A deluge water spray system is provided to soak the charcoal filters in the event of high temperatures in the charcoal beds. Check valves are provided on all drain connections from the filter unit, and the drain header is provided with a deep water seal trap to prevent inleakage of air during unit operation. The electric heater located in the fresh air duct to each emergency filter limits the relative humidity of the air entering the filter to 70%.

The medium efficiency prefilters are provided to protect and extend the life of the HEPA filters. They have an 80% to 85% dust spot efficiency by ASHRAE Standard 52.1 (MERV 13 rating by ASHRAE standard 52.2).

Regulatory Guide 1.52 compliance is described in Section 1.8.

Motor-operated outside air intake (bypass) dampers WMA-AD-51A-1 and 51B-1 are spring-loaded fail-closed type and are provided with limit switches to indicate full open and full closed positions on the main control room panel. Each damper is provided with a remote manual switch in the main control room. Dampers are automatically closed when deenergized by isolation signal or by the main control room panel-mounted switch. These dampers have a design leak rate of 0.5% of the rated flow. Main control room supply fan inlet pressure is higher than the emergency filter unit fan; therefore, when the emergency filter unit is operating, a negative pressure is developed on the inlet side of the bypass dampers preventing any contaminated air bypass of the emergency filter unit. In the event that either bypass damper does not close, an alarm will be activated in the main control room.

The three fresh air intakes (one normal and two remote) for the main control room are fitted with two butterfly isolation valves in series. The normal control room fresh air local intake valves are automatic isolation valves which isolate on an F, A, or Z signal. The normal fresh air intake valves have electrohydraulic operators which are powered from the Class 1E buses. All fresh air intakes are connected via ductwork to a common intake header from which both main control room air handling systems and both emergency filter systems draw fresh air. The isolation valves in the purge lines and the normal air intake and position indication on all fresh air intakes, the emergency filter units, and the bypass dampers that direct fresh air through the emergency filter units are division oriented electrically.

The remote air intake valves are manual, and the design is simple and reliable enough that the valve may be manually repositioned in a short period of time.

In the event of a LOCA, the main control room is protected from potential airborne radioactivity by pressurizing the control room with air supplied via the remote air intakes. The system operates in the following manner:

The isolation valves in the normal fresh air intake are closed by any of the F, A, or Z signals. These are the same signals provided for isolating the primary and secondary containments.

Both sets of remote air intake isolation valves are normally locked open. At least one air intake must be maintained open to ensure the control room is pressurized.

Each remote intake header is provided with a purge exhaust system to provide continuous radiation monitoring of the remote intakes while isolation valves are closed. The two purge exhaust systems each consists of two isolation valves in series. One purge valve is equipped with an electrohydraulic operator and is interlocked with its remote intake valve, and the other purge valve is maintained open.

Both purge exhaust systems utilize battery exhaust fans WEA-FN-53A and WEA-FN-53B (which are both ESF) to purge air from the remote intake headers.

Both battery exhaust fans provide the necessary redundancy through cross over ductwork between each set of purge exhaust valves.

The emergency filter units are energized by F, A, Z signals and all outdoor pressurizing air is automatically diverted through the filter units. The main control room kitchen exhaust fan and its isolation damper are also shut off by F, A, Z signals.

Operating in the above manner ensures that the main control room is continuously pressurized with filtered air. The details of the control room dose analysis are discussed in Sections 15.4.9, 15.6.4, 15.6.5 and 15.7.4.

9.4.1.2.2 Cable Spreading Room

The cable spreading room HVAC system consists of two 100%-capacity air-handling units, each with its own duct distribution system, common distribution system inside the cable spreading room, and one purge exhaust fan. The air handling units are similar to those servicing the main control room, i.e., filter, SW coil, chilled water coil, electric heater, and centrifugal fan in the sheet metal housing. Normally one air handling unit operates continuously on a 100% recirculation mode of operation maintaining the cable spreading room and remote shutdown room at approximately 80°F.

The cable spreading room purge exhaust fan does not normally operate. In the unlikely event of fire developing in the cable spreading room, the purge fan can be manually operated to remove any smoke from the cable spreading room prior to personnel access.

If the radwaste chilled water supply to the cable spreading room air handling units is lost, SW is supplied to the units for emergency cooling. Under this mode of operation the cable spreading room and remote shutdown room temperature is limited below equipment operability limits. See Table 3.11-1.

9.4.1.2.3 Critical Switchgear Area

The switchgear and batteries associated with the redundant emergency electric power systems are located in separate equipment rooms below the cable spreading room. A separate heating and ventilation system is provided for each set of equipment rooms. Ventilation of the emergency chiller area at the 525 ft level is also provided by this system. Each of the two heating and ventilating systems consists of an air handling unit, battery room exhaust fans and associated ductwork and controls. The air handling unit consists of a roughing filter, two water coils in series (one for WCH or plant service water, one for SW), an electric blast coil heater, and a centrifugal fan in a sheet metal housing. The two air handling units have different capacities due to heat load differences between the two sets of rooms. Electric heaters are provided in the ducts supplying air to the battery rooms to maintain temperature in those rooms above 60°F.

Both heating and ventilating systems normally operate continuously during all modes of operation. They are both partial recirculation systems with fresh air provided as makeup for the air exhausted from the battery rooms. The battery rooms are continuously exhausted (no recirculation) to prevent the possible buildup of combustible gases generated by the batteries. During normal operation, either WCH or plant service water is provided to the air handling units as the cooling medium.

Under all emergency modes of operation SW is provided to both units as the cooling medium. The critical switchgear area air handling units also provide the normal and emergency ventilation for the HVAC equipment rooms and the emergency chiller area at the 525 ft level. Temperatures in the HVAC equipment rooms are limited to a range of 55°F to 104°F during normal operation and below equipment operability limits during all emergency modes of operation. See Table 3.11-1.

9.4.1.3 Safety Evaluation

9.4.1.3.1 Main Control Room

The reliability of the HVAC system serving the main control room is achieved by providing two 100% redundant trains. Only one of the two redundant trains is required to operate to provide adequate dose mitigation. The two HVAC trains are physically separated to preclude simultaneous failure from any one incident. These HVAC trains are cooled normally by the non-safety related Radwaste Building Chilled Water (WCH) System. During an emergency, the HVAC trains can be cooled either directly by SW or indirectly by SW through the Control Room Chilled Water (CCH) system. All components of the two HVAC trains and the SW and CCH cooling systems are designed to withstand the effects of a SSE and are powered from emergency diesel buses. The emergency chillers are located in a general area. During initial licensing the emergency chillers were installed as directed in License Condition 2.c.(21) of the Operating License. The emergency chillers were required to be redundant, Seismic Category I, and environmentally qualified.

The CCH or SW system is used as the cooling medium in the event that WCH is unavailable, thus providing acceptable temperatures in the control room under all modes of operation. SW is capable of maintaining control room temperature within the environmental qualification temperature limit for control room equipment, but during the warmer months the capability of SW to maintain the control room within the habitability limit is limited. During those time periods, the redundant CCH trains ensure acceptable temperatures are maintained once the CCH system is started. Prior to start of the CCH system, which is a manually started system, the control room will temporarily exceed its steady state habitability limit, but remain below the National Institute for Occupational Safety and Health wet-bulb globe temperature for unlimited duration habitability.

The normal fresh air intake is provided with two division oriented valves (normally open, fail closed) in series to close in the event of an F, A, Z signal. The valves are a highly reliable butterfly-type with the disc keyed to the pivot shaft. If one of the remote air intake isolation valves should fail it may be easily repositioned or repaired. One remote intake will always remain open to ensure a pressurized control room and prevent infiltration.

The remote fresh air intakes are used to pressurize the main control room through emergency filter units. This limits infiltration of airborne radioactive contaminants and smoke due to a fire within the plant but external to the control room. Infiltration of airborne radioactivity in the main control room is discussed in Section 6.4.

The emergency filter unit starts operating in the event of a LOCA.

The main control room is maintained at 75 $\pm$3°F dry-bulb temperature under normal conditions. In the event of an emergency, the control room can be maintained below 85°F by the CCH. SW can be used to maintain less than 104°F. During colder ambient conditions, SW is capable of maintaining the control room less than 85°F dry bulb. The requirements of Licensee Controlled Specifications (LCS) 1.7.2 must be met when crediting SW for maintaining control room temperature within limits.

9.4.1.3.2 Cable Spreading Room

The cable spreading room is provided with two 100%-capacity HVAC systems which are physically separated. All components of the two systems, except the chilled water system, are designed to operate through the SSE and are powered from emergency diesel buses. As with the control room HVAC system, SW is used as the cooling water for the cable spreading room handling units to maintain an acceptable temperature in the cable spreading room for equipment operation in the event that the chilled water system is inoperable.

9.4.1.3.3 Critical Switchgear Area

The essential electric equipment for each of the redundant emergency diesel generators is serviced by separate heating and cooling systems. Each system is powered from a Class 1E bus which is supplied by the diesel generator it serves and is designed to operate through an SSE.

Standby service water is used as the system cooling medium whenever WCH or plant service water are not available, thus ensuring cooling during all modes of plant operation. The two systems are physically separated and arranged in such a manner that the failure of one system can affect only the diesel generator that it services.

9.4.1.4 Testing and Inspection Requirements

The performance of the HVAC systems servicing the main control room, cable spreading room, and critical switchgear areas can be verified while the systems are operating. The operability and performance of standby equipment is determined by alternating the duty of redundant systems.

The control room system ductwork was subject to leak tests during erection and was balanced for air flows in accordance with the procedures of the Associated Air Balance Control Council (AABC). All system components were subject to preoperational testing. All piping systems components were subject to hydrostatic tests during erection.

The emergency filter housings and filters were subject to both shop and field efficiency tests.

The HEPA and charcoal adsorber filters are periodically tested as required by the Technical Specifications. Charcoal samples laboratory test results are required within 31 days of removal.

9.4.1.5 Instrumentation Requirements

All essential controls for the control room, cable spreading room, and critical switchgear area HVAC systems are electric or electronic except the remote air intake isolation valves. Pneumatic controls are used only on nonessential components.

9.4.1.5.1 Main Control Room

The following controls are provided in the main control room in addition to those discussed in Section 9.4.1.2.1.

Both air handling systems serving the main control room can be started from separate selector switches located in the main control room. When an air handling unit fan is started, all controls associated with that system are energized via electrical interlocks initiating the following operations:

a. The fresh air intake damper is opened, and

b. The electronic thermostat in the main control room modulates the chilled water valve and energizes the two stages of electric heaters, as required, to satisfy the heating/cooling requirements of the main control room. (The heater breakers are normally locked open in modes 1, 2, and 3.)

In the emergency condition (loss of radwaste building chilled water during design basis accident), the cooling coil WMA-CC-51A1 serving air handling unit WMA-AH-51A is supplied with SW. When the Off-Auto control switch in the control room, which is normally in the Off position, is set to Auto, the cooling coil WMA-CC-51B1 will be automatically supplied with emergency chilled water. If necessary, cooling coil WMA-CC-51A1 can be supplied with CCH by manual opening or closing of valves in SW and CCH lines to chiller CCH-CR-1A. Also, if necessary, cooling coil WMA-CC-51B1 (which is normally lined up for CCH) can be supplied by SW by manually opening or closing of the appropriate valves in SW and CCH lines to chiller CCH-CR-1B.

Control switches are provided in the main control room for all fans, local air intake isolation valves, and dampers so that all components can be controlled manually as well as automatically. The remote air intake isolation valves are manual valves.

9.4.1.5.2 Cable Spreading Room

The air handling units serving the cable spreading room are started from separate selector switches located in the main control room. When an air handling unit fan is started, an associated solenoid valve is energized permitting the air handling unit pneumatic chilled water control valve and electric heating coils to receive a pneumatic control signal from a temperature controller sensing temperature in the air return duct from the cable spreading room (the heater breakers are normally locked open in modes 1, 2, and 3). The starting of the fan also energizes the air handling automatic roll filter control circuit permitting the filter drive motor to change media at selected preset timer intervals. Redundant temperature switches located in the cable spreading room will annunciate alarms in the main control room in the event of a temperature rise to 90°F thus alerting the operator of a possible equipment malfunction. A differential pressure switch across the air handling unit filter will alarm in the event of high differential pressure.

Smoke detectors in the cable spreading room return air ducts annunciate alarms in the main control room in the event of smoke so that the operator can activate the fire protection system (see Appendix F).

There are no control valves associated with the SW coils in the cable spreading room units. Whenever SW is on, there is full water flow through the coil. During normal operation any heat added to the space by the SW coil is compensated for by the air handling units chilled water coil.

9.4.1.5.3 Critical Switchgear Area

The two air handling units and the two battery room exhaust fans which service the critical switchgear area each have their own selector switch located in the main control room. When an air handling unit fan is started, an associated solenoid valve is energized permitting the air handling unit pneumatic plant service water valve and electric heating coils to receive a pneumatic control signal from a temperature controller sensing temperature in the supply air duct to the critical switchgear area. The temperature controller is set to maintain the temperature as described in Table 3.11-1. The starting of the fan also energizes the air handling unit automatic roll filter control circuit, permitting the filter drive motor to change media at selected preset timer intervals.

Temperature switches located in each of the electrical equipment rooms serviced by the critical switchgear system annunciate alarms in the main control room in the event of abnormally high temperatures thus alerting the operator of a possible malfunction of the cooling system. Smoke detectors in the main return air ducts to the air handling unit and in the battery room exhaust ducts will annunciate alarms in the main control room in the event of fire in the switchgear area. Differential pressure switches across each of the battery room exhaust fans and across the filter of the air handling units will annunciate alarms in the main control room in the event of low differential pressure across fan or high/low differential pressure across filter.

As with the cable spreading room air handling units, there are no control valves associated with the SW coils in the switchgear area units. Whenever SW is on, there is full water flow through the coil.

9.4.2 REACTOR BUILDING

9.4.2.1 Design Bases

The reactor building, or secondary containment, is provided with a HVAC system designed to meet the requirements for all general areas of the building, the spent fuel pool, potentially contaminated areas and the primary purge as follows.

a. To provide fresh, tempered, ventilating air to the various spaces in the reactor building in sufficient quantity to limit the temperature during all normal operating conditions and/or during loss of ac power as specified in Table 3.11-1, while providing at least one air change per hour in all areas;

b. To draw air across the surface of the spent fuel pool, reactor well, and dryer/separator pool by exhausting around their perimeters to control temperature and to maintain airborne radioactivity within acceptable levels in these spaces;

c. To provide for controlled air movement from areas of potentially low radiation to areas of potentially high radiation. This serves to isolate and segregate airborne radioactivity which may be released due to equipment failure or malfunction. The system is designed to preclude recirculation of reactor building air under normal operating conditions;

d. To maintain the reactor building during normal operation at a negative pressure of 0.25 in. w.g. with respect to atmosphere as indicated at the reactor building el. 572 ft to minimize release of airborne radioactive material. During emergency operation, the standby gas treatment (SGT) system (see Section 6.5) maintains the reactor building at a negative pressure;

e. Maintain the reactor building equipment drain sumps and headers at a negative pressure with respect to the rest of the reactor building, and provide means to filter the effluent before discharging it to the main reactor building exhaust header so that the release of radioactive contaminants is minimized;

f. Provide means to monitor all effluent from the reactor building prior to release for radioactive contamination and to isolate all ventilation openings in the building in the event that radiation levels so monitored exceed the limits defined in 10 CFR Part 20; and

g. In addition, the reactor building ventilation system is designed to provide for purging of the primary containment. Primary containment purge air is supplied and exhausted by the reactor building ventilation system.

Except for the emergency cooling system which is described in Section 9.4.9, the only portions of the reactor building heating and ventilating system which are designed as ESF are the isolation valves located in the outdoor air intake duct and the exhaust system discharge duct, and the isolation valves on the purge connections to the primary containment. The reactor building isolation valves are designed, manufactured, and N-stamped Class 3 in accordance with Section III of the ASME Boiler and Pressure Vessel (B&PV) Code. The primary containment purge isolation valves are N-stamped Class 2 in accordance with

Section III of the ASME B&PV Code. All isolation valves are Seismic Category I. The means of protecting the system vents and louvers from missiles is discussed in Section 3.5.

9.4.2.2 System Description

The reactor building heating and ventilating system is shown in Figure 9.4-2. The system is basically a "push-pull" heating and ventilation system providing once-through air flow with no recirculation and consists of the following systems:

a. Supply air,
b. Exhaust air,
c. Sump vent exhaust filter,
d. Emergency cooling (described in Section 9.4.9), and
e. Miscellaneous ventilation.

Equipment details are given in Table 9.4-2. Equipment seismic information is given in Table 3.2-1.

9.4.2.2.1 Supply Air System

The supply air consists of a heating and ventilation unit, air distribution ductwork, two isolation butterfly valves on the fresh air intake, and associated controls. The heating and ventilation unit is composed of the following elements in an insulated housing:

a. An automatic roll type prefilter,

b. Steam coils with face and bypass dampers,

c. A capillary type, evaporative cooling section with two 100%-capacity spray pumps, and

d. Two 100%-capacity vaneaxial fans with back draft dampers on the fan discharges.

During normal plant operation and shutdown, the supply air system isolation valves are open and the ventilation system operates continuously distributing tempered, 100% outdoor air throughout the building. One supply fan is normally operating with the second fan in standby. The standby fan starts automatically in the event the operating fan fails. During winter months, the steam coil in the ventilating unit heats the supply air. A second steam booster heater in the supply duct to the refueling floor heats the air to maintain the refueling floor area. (See Table 3.11-1 for temperature limitations.) During summer months, the capillary type air washer cools the incoming air by evaporative cooling. Water for this air washer is supplied from the potable water system (see Section 9.2.4).

The reactor building supply air system also provides makeup air to the primary containment during primary containment purge if needed. During purge, supply air is directed into the primary containment through the isolation valves. The purge supply air flow rate is controlled by an air operated directing damper in the supply system ductwork which is set manually from the main control room. A backdraft damper is provided in this purge line and is counterweighted so that the pressure drop across the backdraft damper in the open position, does not exceed 0.25 in. w.g.

9.4.2.2.2 Exhaust Air System

The reactor building exhaust system draws air from all areas with potential radiation contamination and discharges it to the elevated release point. There are two 100%-capacity vaneaxial fans in the system. One fan normally operates with the second fan in standby.

Approximately one-half of the reactor building exhaust air is drawn from the refueling level of the reactor building. Intake ducts to the exhaust system are embedded around the periphery of the spent fuel pool, dryer/separator pool, and reactor well to remove any potentially radioactive vapors generated in the pools. Volume control dampers in the ducts from each pool are controlled from a local panel in the reactor building to permit the operator to vary the flow over each pool during various fuel handling operations.

Primary containment purge can be performed by discharging the purge air through the reactor building exhaust system or through the SGT system (see Section 6.5). Ducts connect the primary containment drywell and suppression pool area with both systems. The reactor building exhaust system is normally used for purge after the SGT system is used for the first 24 hr. The SGT system is also used when an unacceptably high level of airborne radioactivity is present inside the primary containment.

Radiation monitors are located just outside of the air plenum on the intake side of the two reactor building exhaust fans. In the event that a preset high level limit of radioactivity is exceeded, the radiation monitors will annunciate an alarm in the main control room and transmit an isolation signal to the affected emergency safeguards systems. In the event of an F, A, or Z signal, the reactor building exhaust fans stop and the isolation valves close. All isolation signals which stop and isolate the reactor building exhaust system also start the SGT system (see Section 6.5.1).

9.4.2.2.3 Sump Vent Exhaust Filter System

All potentially radioactive leaks and/or spills in the reactor building are channeled to the equipment and/or floor drain systems. To minimize the release of radioactive contaminants from the building, the drain system sumps and drain headers are maintained at a negative pressure and vented through a filter system. The sump vent exhaust system is composed of two, full-capacity, filter units which draw air from the sumps and drain headers and pass it through filters, a moisture separator, and electric heater before discharge to the main reactor building exhaust system upstream of the radiation monitors.

Each filter unit consists of the following elements in a sheet metal housing:

a. A moisture separator to remove entrained moisture,

b. An electric blast coil heater to limit the relative humidity of the air entering the filter to 70%,

c. A medium efficiency particulate prefilter,

d. A HEPA filter,

e. A tray type, 2-in.-thick activated charcoal filter, and

f. A centrifugal fan.

All filters in the sump vent exhaust units are designed to satisfy the same efficiency requirements as those of the control room emergency filter units outlined in Section 9.4.1.2.1. One filter unit operates continuously during normal plant operation. The standby unit is started from the main control room in the event that the fan of the operating unit fails. Neither unit operates in the event of a reactor building isolation signal. Deluge fire protection is provided for each filter unit (see Appendix F).

9.4.2.2.4 Miscellaneous Area Ventilation Systems

The following miscellaneous HVAC systems are provided to service local areas in the reactor building:

a. The main steam tunnel is serviced by three fan coil units located within the tunnel. Three fan coil units are composed of a water cooling coil supplied by the plant service water system and a direct drive centrifugal fan in a sheet metal housing. Two fan coil units normally operate continuously in the recirculation mode to remove heat generated by the steam piping in the tunnel. Two fan coil units operating has sufficient capacity to limit the temperature in the tunnel to 130°F with one fan coil unit in standby.

b. The reactor water cleanup (RWCU) sample hood is provided with an exhaust filter unit which is operated whenever a sample is taken. The hood is of the air curtain type with supply air to the hood provided from the reactor building supply air system. An electric duct heater is provided in the supply air duct to temper the air into the hood to 70°F. The exhaust filter unit, which draws air from the hood, is composed of a medium efficiency prefilter, a HEPA filter, and a centrifugal fan in a sheet metal housing. The exhaust fan discharges air into the reactor building exhaust system upstream of the radiation monitors.

c. The vehicle air lock (railroad bay), on grade elevation, is heated and cooled by an air handling unit which operates in a 100% recirculation mode. The air handling unit is composed of a prefilter, water cooling coil, and centrifugal fan in a sheet metal housing. A 15-kW electric blast coil heater is provided in the unit discharge duct for heating. Plant service water is supplied to the water coil for cooling.

During periods when the large railroad lock door (R106) is open for operations associated with the Independent Spent Fuel Storage Installation (ISFSI), or other activities requiring the door to be open for an extended period, engineered features are available to maintain the railroad lock at temperate conditions. Eight thermostatically controlled heaters are installed near the door, and an air curtain is installed above the door. These supplemental heaters, used in conjunction with the air curtain, keep the railroad lock warm during winter conditions when the door is open.

9.4.2.3 Safety Evaluation

The following safety features are incorporated in the design of the reactor building ventilation system:

a. The air distribution within the building provides for controlled air movement from areas of potentially low radiation to areas of potentially high radiation. Under normal operating conditions, recirculation of contaminated air is precluded by system design.

b. There are only two penetrations of the reactor building associated with the building ventilation system. Two butterfly valves in series are provided in the duct connections to each of these ventilation openings. The four valves close, isolating the reactor building, and the ventilation system fans stop in the event of any of the F, A, Z isolation signals.

   The redundant, fail-closed valves on each ventilation opening ensure reactor building isolation in the event of failure of any one valve.

   Two fail-closed, air-operated isolation valves, in series, are also provided on all purge connections to the primary containment. These valves are open only during primary containment purge operations and close automatically in the event of any of the above isolation signals.

c. The reactor building is maintained at a negative pressure of 0.25 in. w.g. with respect to atmosphere by differential pressure controllers which position the blade settings of the exhaust fans. This atmospheric control limits the exfiltration of radioactive contaminants from secondary containment. See Section 6.5.1 for emergency operation of the SGT system which maintains the reactor building at a negative pressure under postulated accident conditions. Each set of main supply and exhaust fans are powered from different divisions of the Class 1E power supply.

d. Radiation monitors, located just outside of the exhaust air discharge plenum, monitor exhaust air discharged from the building and transmit an isolation signal in the event that the radiation level exceeds a preset level. See Chapter 11 for further discussion of radiation monitoring.

e. The equipment drain system sumps and headers are vented through two 100%-capacity filter units. This operation minimizes the release of radioactive material during normal plant operation. Two 100%-capacity redundant filter trains ensures continuous system operation in the event of any single component failure.

f. Each ventilation header with embedded exhaust duct connections around the spent fuel pool, reactor well and dryer/separator pool is equipped with a flow transmitter and flow indicator to ensure that the designed quantity of air is being exhausted for proper airborne contamination control. See Figure 9.4-2.

9.4.2.4 Testing and Inspection Requirements

The performance of the HVAC systems servicing the reactor building can be verified while the systems are operating. The operability of standby equipment is determined by rotating the duty of the redundant components.

The performance of those portions of the exhaust system which serves the fuel pool can be verified by measuring air flow in the fuel pool exhaust system exhaust header. A damper located in the fuel pool exhaust header controls this air flow. The flow indicator and damper controller are mounted on a local panel in the reactor building.

All system ductwork was balanced for air flows in accordance with procedures of the AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements. All piping systems and components were subject to hydrostatic and/or pressure tests during erection. Primary containment purge system isolation valves are normally closed and are leak tested in accordance with the Technical Specifications.

The sump vent exhaust system filter housings and filters were subject to both shop and field efficiency tests. The HEPA filters are given in-place DOP tests in accordance with ANSI N510-1980, "Testing of Nuclear Air Cleaning System." Filters are tested at rated flow with an acceptance limit of less than 0.05% penetration at rated flow. Charcoal adsorber filters are leak tested in accordance with ANSI N510-1980 to ensure that filter bypass is less than 0.05% of full flow.

9.4.2.5 Instrumentation Requirements

The following are the major instrumentation devices used for controlling the reactor building heating and ventilation system:

a. Isolation valve control

The isolation valves on the purge lines to the primary containment and the reactor building supply air intake and exhaust air discharge ducts are controlled by individual OPEN-AUTO-CLOSE selector switches located in the main control room. The switch springs back to AUTO from either the OPEN or CLOSE position. With the selector switch in the AUTO position, an isolation signal will deenergize the solenoid and close the isolation valve. The isolation valves are designed to fail in the closed position in the event of loss of control air.

b. Supply ventilation unit fan control

Selector switches, with indicating lights, are provided in the main control room for the two supply ventilation unit fans.

A differential pressure switch, with probes on either side of the fan/damper assembly, will automatically start the standby fan in the event of low differential pressure which is indicative of fan failure. The differential pressure switch will also annunciate an alarm in the main control room.

In the event of an isolation signal, both supply fans are stopped automatically via electric interlocks.

c. Main exhaust system fans

The two main exhaust fans are controlled by selector switches located in the main control room. When one fan is started, an associated solenoid valve is energized causing the pneumatic, fail-closed damper on the fan discharge to receive control air and open. A differential pressure switch, with probes on either side of the fan/damper assembly, will start the standby fan in the event of low differential pressure which is indicative of fan or damper failure.

The reactor building is maintained at a negative pressure of 0.25 in. w.g. with respect to atmosphere by automatically varying the pitch of the main exhaust fan blades, thereby changing fan capacity, via a pneumatic controller. There is an electronic differential pressure sensor across each of the reactor building's four exterior walls. The lowest of the four signals is transmitted to a differential pressure controller which transmits a signal, converted to a pneumatic signal, to the pneumatic fan blade controller to maintain the lowest differential pressure at the selected setpoint.

In the event of an isolation signal, both exhaust fans are stopped via electric interlocks.

d. Primary containment purge control

When the primary containment is purged to the reactor building exhaust system, the following operations are performed:

The primary containment purge exhaust isolation valves and the valve connecting the purge exhaust header to the reactor building exhaust system are opened via individual selector switches located in the main control room. A pneumatic volume damper in the purge line to the exhaust system is controlled by an adjustable differential pressure controller. The pressure is sensed between the ductwork connecting the primary containment and the reactor building. The differential pressure controller is located in the main control room. The primary containment is depressurized, if required, by slowly lowering the setpoint of the differential pressure controller thus gradually opening the damper. Flow indication of purge exhaust is provided in the main control room so that depressurization can be performed at a controlled rate.

Once the containment is depressurized, the isolation valves on the supply purge connection to the containment are opened via selector switches in the main control room. Pneumatic dampers in the supply system, which divert supply air into the purge supply header, are used for purge rate control. When the valve in the supply line to the supply purge header is opened, an associated solenoid valve is energized permitting the diverting damper to receive a control signal. The control signal is transmitted from an adjustable flow controller located in the main control room, which will modulate the damper as required to maintain the purge supply rate at the controller setpoint. Purge flow is adjustable up to 10,500 cfm.

Normally the primary containment drywell and suppression pool area are purged separately by opening the appropriate isolation valves. In the event of an isolation signal during purge, all isolation valves are automatically closed.

e. Sump vent exhaust system control

Selector switches with running lights are provided for each sump vent exhaust unit. When a unit fan is started, the control circuit for the unit is energized causing the electric blast coil heater to start and a damper control solenoid valve to energize. When energized, the solenoid valve permits the pneumatic volume damper on the unit fan discharge to receive a control signal from a differential pressure controller set to maintain a flow of 1000 cfm through the unit.

The drain system main exhaust header from which the filter unit draws is maintained at a negative pressure of approximately 1.0 in. w.g. with respect to the reactor building atmosphere. A volume control damper, located between the exhaust header and reactor building atmosphere, is modulated by a differential pressure controller set to maintain that pressure differential.

In the event that the operating sump exhaust unit fails, a differential pressure switch with probes set across the unit filters will annunciate an alarm in the main control room, thus alerting the operator to start the standby unit. The differential pressure switch also deenergizes the units electric heater.

A thermocouple on the charcoal filter will annunciate an alarm in the main control room on a temperature rise to 250°F.

f. Heating control

Supply air is heated in the supply ventilation unit by a steam coil with pneumatic face and bypass dampers. The source of the heating steam (HS) is from the gland steam evaporator during turbine generator operation and from the auxiliary boiler during shutdown. The dampers are controlled by a temperature controller which senses supply air temperature downstream of the fans. The setpoint of the temperature controller is adjustable. A temperature switch with a sensor in the outdoor air intake energizes a solenoid valve, thus causing the steam shutoff valve in the feed line to the steam coil to open whenever the outdoor temperature drops below the setpoint.

The steam booster heater in the supply duct to the refueling floor is controlled in a similar manner to that of the main ventilation unit and is supplied HS from the same sources that supply the main unit. Face and bypass dampers on the booster heater are modulated by an adjustable, area mounted, temperature controller.

g. Evaporative cooler control

The supply ventilation unit evaporative cooler (air washer) section is controlled by temperature switches with sensors located in the outdoor air intake.

9.4.3 RADWASTE BUILDING

9.4.3.1 Design Bases

The radwaste building houses the solid, liquid, and gaseous radwaste treatment systems. The HVAC systems serving the radwaste building are designed to satisfy the following requirements:

a. To provide fresh tempered ventilation air to the various spaces in the radwaste building in sufficient quantity to limit the temperature as specified in Table 3.11-1, while providing at least three air changes per hour in potentially contaminated areas. Additionally, areas in which personnel will spend extended periods of time performing sensitive operations are air conditioned for personnel comfort;

b. The air distribution within the building provides for controlled air movement from areas of low radiation contamination potential to areas of progressively higher radiation contamination potential;

c. To filter the exhaust air from the building before discharging it to the atmosphere to limit the release of airborne radioactive particulates;

d. To heat the supply air as required during the winter season to maintain minimum temperatures as specified in Table 3.11-1; and

e. To maintain the lower level of the radwaste building at a negative pressure with respect to atmosphere to minimize the release of radioactivity.

9.4.3.2 System Description

The radwaste building HVAC system is shown in Figure 9.4-3. The main system is a push-pull heating and ventilating system providing once-through air flow with no recirculation.

In addition, individual air conditioning units are provided for all rooms which personnel will normally occupy for extended periods of time. Equipment details are given in Table 9.4-3. Equipment seismic information is given in Table 3.2-1.

The main radwaste building supply air system consists of a supply ventilation unit and distribution ductwork. The supply ventilation unit consists of an insulated steel cabinet housing a prefilter, steam coil with face and bypass dampers, an evaporative cooling section, and two 100%-capacity centrifugal fans. The prefilter is of the renewable roll type, automatically progressed to maintain uniform pressure drop. The steam coil is of the nonfreeze type with automatic face and bypass dampers for temperature control. The evaporative cooling section is of the capillary type with two full-capacity pumps with common suction from the washer basin and common discharge into the spray header system. Makeup water to the evaporative cooler is supplied from the plant potable water system.

During normal plant operation the supply unit operates continuously, providing tempered air throughout the building via the supply duct distribution system. The radwaste building supply system has no safety functions and will be inoperative in the event of loss of offsite power.

The radwaste building exhaust system is composed of three 50%-capacity exhaust filter units. Each exhaust unit consists of medium efficiency prefilters, HEPA filters, and a centrifugal fan in a sheet metal housing. The prefilters are of the cartridge type with a minimum Dust Spot Efficiency of 80%-85% by ASHRAE standard 52.1 (MERV 13 rating by ASHRAE standard 52.2). The HEPA filters are designed for removal of fine airborne particulates. These filters are of water repellent and fire-resistant construction for operation at temperatures up to 300°F. The HEPA filter has a minimum efficiency of 99.97% on a 0.3 m DOP test. The HEPA filters are fabricated in accordance with MIL-F-51068C, MIL-STD-282, and carry a UL label certifying compliance with UL586.

Each exhaust unit fan is provided with an automatic air-operated inlet vane for flow control. The inlet vanes are controlled by differential pressure controllers set to maintain the tank enclosures in the lower level of the radwaste building at a negative pressure with respect to atmosphere.

During normal plant operation two exhaust units operate, with the third unit in standby, drawing air from a common exhaust duct system and discharging the air above the radwaste building roof. All radwaste building exhaust air is processed by the exhaust units and monitored by radiation detectors prior to discharge. Radioactive releases to the environment are discussed in Section 11.3.3. The radiation monitoring system is discussed in Section 11.5.2.2.1.7 with arrangement details shown in Figure 11.5-7. The exhaust duct system is arranged in such a manner that all exhaust is drawn from areas with the highest radioactive contamination potential thus inducing air flow from clean areas into the potentially contaminated zones. Where applicable, automatic volume dampers are provided in ventilation openings in walls between clean and potentially contaminated areas. The volume dampers are controlled by differential pressure controllers, with probes on either side of the vent opening, to maintain "hot zones" at a negative pressure with respect to "clean zones."

The radwaste control room, instrument shop, radiochemical laboratory, sample room, counting room, and health physics area are provided with air conditioning systems to maintain suitable conditions for personnel comfort. All areas except the radwaste control room are serviced by once-through air conditioning systems. The radwaste control room, which has no contamination potential, has a partial recirculation air conditioning system.

The air conditioning for each area is provided by air handling units which draw air from the radwaste building supply air system, pass it through filters, chilled water coils, and electric heaters, and discharge it into the rooms being conditioned. Chilled water is supplied to the coils from the WCH.

The conditioned air leaves the rooms by exfiltration to the rest of the building or, as in case of radiochemistry laboratory, hot instrument shop and sample room, through exhaust hoods which discharge into the main exhaust system. The exhaust hoods in the radiochemistry laboratory, hot instrument shop and sample room are provided with local filter units composed of prefilters, HEPA filters, and fans to remove radioactive particulates at the hoods prior to discharge into the exhaust system. These HEPA filters are similar to those in the main exhaust filter units.

Effluent from the radwaste building ventilation is continuously monitored for gaseous activity and continuously sampled for laboratory analysis of particulate radioactivity. The sampling and monitoring system is described in Section 11.5.2.2.3.

9.4.3.3 Safety Evaluation

The radwaste building HVAC system is not required for a safe shutdown of the plant; however, the following features are incorporated in its design to ensure system reliability and to minimize the uncontrolled release of airborne radioactive contaminants during normal plant operation:

a. The 50% standby capacity of the exhaust filter system ensures full system capacity with any unit inoperative due to equipment failure or maintenance outage,

b. Redundant supply fans ensure supply system operation in the event of single fan failure,

c. All exhaust air is passed through HEPA filters prior to discharge thus minimizing the release of radioactive contaminants, and

d. The potentially contaminated area is maintained at a negative pressure and all air is monitored by radiation detectors prior to discharge to ensure against release of radioactive contaminants.

9.4.3.4 Testing and Inspection Requirements

The performance of the HVAC systems servicing the radwaste building can be verified while the systems are operating. The operability and performance of standby equipment is determined by rotating the duty of redundant components. Pressure, temperature, and flow instrumentation is provided as shown in Figure 9.4-3.

The HEPA filters in the radwaste building exhaust filter units are subject to both shop and field efficiency tests. On installation, and periodically thereafter, HEPA filters are given in-place DOP tests in accordance with ANSI N510-1980, "Testing of Nuclear Air Cleaning System." Filters are field tested at rated flow with an acceptance limit of less than 0.05% penetration.

All system ductwork was balanced for air flows in accordance with the procedures of the AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements.

9.4.4 RADWASTE BUILDING CHILLED WATER SYSTEM

9.4.4.1 Design Bases

The WCH is designed to provide a reliable source of chilled water to the main control room air handling units, the cable spreading room air handling units, the switchgear area air handling units, and the air handling units serving the conditioned areas of the radwaste building (see Sections 9.4.1 and 9.4.3).

The temperature of the chilled water supplied to the air handling units is maintained between 44°F and 55°.

9.4.4.2 System Description

The WCH is shown in Figure 9.4-4. It is a closed loop system incorporating two 100%-capacity pumps and two 100%-capacity centrifugal water chillers. The chillers are arranged to operate independently with bypass and shutoff valves provided for ease of maintenance. During normal operation, either chiller (or both) operates to maintain the chilled water supplied to the air handling units between 44°F and 55°F. The two chilled water pumps are arranged in parallel with one normally operating and one in standby. The liquid chillers are each rated at 150 tons refrigeration capacity. Each consists of a hermetic centrifugal compressor with linear capacity control from 10% to 100% of rated unit capacity, and evaporator, water-cooled condenser, purge system, and automatic control center. Condenser cooling water is supplied to the chillers from the plant service water system (see Section 9.2.1).

An air separator, expansion tank, chemical feed tank, and appropriate valves and piping connections are provided at the common suction to the two pumps for system control. Makeup water to the system is supplied from the plant potable water system (see Section 9.2.4).

9.4.4.3 Safety Evaluation

The WCH has no safety function; however, redundant circulating pumps and liquid chillers are incorporated in the design to ensure uninterrupted system operation during normal plant operation.

All components of the chilled water system are designed to Seismic Category II requirements.

9.4.4.4 Testing and Inspection Requirements

The performance of the WCH can be verified while the system is operating. The operability of standby equipment is determined by rotating the duty of redundant components. Pressure, temperature, and flow instrumentation is provided as shown in Figure 9.4-4.

Chillers, pumps, tanks, and piping were subject to hydrostatic tests in the field after erection.

9.4.4.5 Instrumentation Requirements

Each of the two chilled water pumps is controlled by a locally mounted selector switch. When either pump is energized, the chiller control circuit is energized via electrical interlocks. If the operating chilled water pump fails, a pressure switch on the pump discharge will start the standby pump after a delay and an alarm will be actuated in the main control room.

Each chiller has a temperature sensing element in the chilled water supply line which controls the chiller capacity by modulating the guide vane position to maintain the required temperature.

A single trouble alarm is actuated in the control room to alert operators upon chilled water low temperature, high condenser temperature, or high motor temperature.

9.4.5 OFFGAS CHARCOAL ADSORBER VAULT REFRIGERATION SYSTEM

The offgas charcoal adsorber vault refrigeration system has been permanently deactivated in-place.

9.4.6 TURBINE GENERATOR BUILDING

9.4.6.1 Design Bases

The turbine generator building is provided with HVAC systems designed to satisfy the following requirements.

a. Provide fresh, tempered, filtered ventilating air to the various spaces within the turbine generator building in sufficient quantity to limit the temperatures as specified in Table 3.11-1;

b. Provide for controlled air movement from areas of potentially lower airborne radiation contamination to areas of progressively higher airborne radiation contamination potential. This distribution serves to limit airborne contaminants from migrating from potentially contaminated areas into clean areas. The ventilation systems operate on a once-through basis without recirculation;

c. Monitor exhaust air from the building for radioactive contaminants, prior to discharge, to ensure that the release of contaminants does not exceed the concentration limits defined in 10 CFR 20;

d. Maintain the turbine generator building potentially radioactive areas at a negative pressure with respect to atmosphere to minimize the release of radioactive contaminants;

e. Automatically provide combustion air for the auxiliary boiler in the turbine generator building;

f. Provide ventilation air to the makeup water pump transformers in the turbine building, this portion of the ventilation system is to remain operable through a design basis tornado; and

g. Provide the sample room exhaust hood with a supply and exhaust filtration system and to provide tempered ventilation air to the sample room.

The components of the turbine generator building ventilation systems are classified Seismic Category II. The system fans are constructed and rated in accordance with the applicable AMCA standards.

9.4.6.2 System Description

The HVAC systems of the turbine generator building are shown in Figure 9.4-6. The primary system is a "push-pull" heating and ventilating system consisting of the following systems:

a. Main supply,
b. Main exhaust,
c. Auxiliary boiler room ventilation,
d. Transformer vault ventilation, and
e. Sample room air conditioning.

Equipment details are given in Table 9.4-4. Equipment seismic information is given in Table 3.2-1.

9.4.6.2.1 Main Supply System

The turbine generator building supply air system consists of four supply ventilation units and associated distribution ductwork. The units are operated in pairs, with one pair discharging into a common supply duct system servicing the west side of the building and the other pair discharging into a common supply duct system servicing the east side of the building.

Each of the four ventilation units consists of a prefilter, a steam coil with face and bypass dampers, an evaporative cooling section, and a centrifugal fan enclosed in an insulated housing. The prefilters are of the renewable roll type, automatically progressed to maintain uniform pressure drop. The steam coil is of the nonfreeze type with automatic face and bypass dampers used for temperature control. The evaporative cooling section is of the capillary air washer type with two full capacity pumps which have a common suction line from the washer basin and common discharge line into the washer spray healer system. Makeup water to the air washer is supplied from the plant potable water system.

The centrifugal fans of each ventilation unit have automatic inlet vanes for fan capacity control and are used to vary supply air flow to maintain the turbine building at a set pressure with respect to outdoors. The fan intake ducts of each pair of ventilation units are joined by means of a manual damper so that a single fan can draw air through both ventilation units in the event of failure of one fan. Automatic dampers are provided on the intake of each supply fan which can be controlled from the local panel.

9.4.6.2.2 Main Exhaust System

The main exhaust system consists of four roof-mounted centrifugal fans which draw air from a central exhaust plenum. Three of the exhaust fans normally operate continuously with one fan in standby. During the winter, if the temperature in the turbine generator building can be maintained within the design limit, two of the exhaust fans can be operated.

Almost all exhaust air is drawn from the shielded areas of the turbine building, where the potential for airborne radioactive contamination is highest, thus inducing flow from the less contaminated areas through the shielded areas. The air in the exhaust duct is monitored for radioactive contaminants by a recorder in the main control room. Radioactive releases to the environment are discussed in Section 11.3.3.

In the event that supply air to the turbine generator building is reduced, as during a plant outage, only one or two exhaust fans may be operated. Motor-operated shutoff dampers are provided in the main branches of the exhaust duct system so that exhaust can be stopped on an area-by-area basis. Automatic volume dampers are provided in the exhaust system so that full exhaust flow can be drawn from the shielded equipment vaults on the lower level of the turbine building when the exhaust system is operating at reduced capacity. These vaults house equipment with higher contamination potential such as the air ejectors and the offgas system hydrogen recombiners.

9.4.6.2.3 Auxiliary Boiler Room Ventilation System

The auxiliary boiler room, which is located in the lower level of the turbine generator building, is normally ventilated from the turbine generator building supply air system. This ventilation rate is sufficient when the boiler is not operating. However, when the boiler is operating and drawing combustion air from the room, additional ventilation is supplied to the boiler room by a separate air handling unit. This air handling unit starts automatically, via electrical interlocks, when the boiler is started and draws 100% outdoor air through a weather louver, heats it as required, and discharges it into the room. Part of this air is drawn by the boiler as combustion air, with the balance of the air leaving the boiler room via relief dampers in the exterior wall of the boiler room.

9.4.6.2.4 Transformer Vault Ventilation System

Two transformers, located in adjacent equipment vaults in the lower level of the turbine generator building, must remain operational in the event of a design basis tornado. The power feeds of the makeup water pumps, which are the source of makeup water to the emergency spray ponds, are drawn from these transformers which can be fed from the emergency diesel generator buses. Two tube-axial fans are provided for the ventilation of the vaults in the event of a tornado. The two fans exhaust air from the vaults with makeup air provided through ventilation openings in the vaults walls. Either fan has sufficient capacity to remove the heat generated by the transformers and both are powered from the emergency diesel generator buses. During normal plant operation, makeup air to the vaults is provided by the main turbine generator building supply air system with one vault ventilation fan operating and other in standby.

9.4.6.2.5 Sample Room Air Conditioning System

The turbine building sample room located on the lower level of the turbine generator building is provided with a sample hood exhaust filter system and a self-contained air conditioning system. The sample room hood is of the air curtain type with air supplied to the hood by a centrifugal fan which draws air from the corridor outside the sample room and from the room itself. Air is exhausted from the hood by a filter unit. This unit is composed of a medium efficiency prefilter, a HEPA filter, and an exhaust fan in a sheet metal housing. The filter unit discharges into the main turbine building exhaust system.

9.4.6.3 Safety Evaluation

The transformer vault ventilation system is designed to operate in the event of a design basis tornado. Two full-capacity fans powered from the emergency diesel buses are provided to ensure system operation in the event of a single active component failure. The vaults, which house the ventilation fans as well as the transformers, are designed to withstand the effects of the design basis tornado.

The following features are incorporated in the design of the turbine generator building HVAC system to ensure system reliability and to control air movement from the potentially contaminated areas:

a. Standby exhaust fan capacity is provided (three of four fans operating) to ensure full system capacity in the event of a single fan failure,

b. The supply system ventilation units are designed with cross ties between fans to minimize the effect of a fan failure on system capacity,

c. The building air is monitored by radiation monitoring system sampling from the exhaust ductwork, and

d. Exhaust air is drawn from within the shielded areas of the turbine generator building thus inducing air flow from “clean” areas to areas of potential airborne contamination.

The radiological considerations of normal system operation are evaluated in Chapters 11 and 12.

9.4.6.4 Testing and Inspection Requirements

The performance of the HVAC systems serving the turbine generator building can be verified while the systems are operating. The operability and performance of standby equipment is determined by rotating the duty of redundant components. Pressure, temperature, and flow instrumentation is provided, as shown in Figure 9.4-6, to monitor system performance.

All system ductwork was balanced for air flows in accordance with the procedures of the AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements.

9.4.6.5 Instrumentation Requirements

Control devices for the turbine generator building HVAC system are mounted on racks in unshielded areas of the building. The following major instrumentation devices are used for the turbine generator building HVAC system:

a. Main supply system: The inlet vortex damper on each supply fan is automatically controlled by a differential pressure controller and transmitter, which sense the pressure inside the turbine building relative to outside the building. The differential pressure controller can maintain a differential pressure from approximately -0.25-in. w.g. to +0.25-in. w.g.

b. Auxiliary boiler room ventilation system: The unit is automatically started, via electrical interlocks, when the boiler is started.

c. Transformer vault ventilation system: The two transformer vault fans are controlled by locally mounted selector switches. One unit normally operates continuously with the second unit in standby. In the event of operating fan failure, a pressure switch on the fan discharge will annunciate an alarm and start the standby fan.

9.4.7 EMERGENCY DIESEL GENERATOR BUILDING

9.4.7.1 Design Bases

Each of the three diesel generator rooms is serviced by a separate HVAC system. With the exception of the fuel oil day tank room and the oil pump room exhaust fans, the function of the three systems is to maintain suitable temperatures within the rooms for equipment operation. The exhaust fans provided in each of the three oil pump rooms and in the three day tank rooms prevent the buildup of oil fumes.

All three HVAC systems operate automatically to maintain ambient temperature below equipment operability limits during all emergency modes of operation (see Table 3.11-1) for the various locations in the diesel generator building. Electric heaters are designed to maintain diesel generator rooms above the minimum required for reliable equipment operation (down to the design low of 0°F) and may be supplemented as necessary by other means (down to the extreme low of -27°F). The high-pressure core spray (HPCS) diesel generator batteries will be maintained at a temperature of 60°F or greater by the HVAC system and supplemented as necessary by portable heaters or other means.

Since an independent and separate diesel generator HVAC system serves each diesel generator, a failure in one system will not effect the operational function of the other systems. The HVAC systems are housed in separate rooms in the Seismic Category I diesel generator building. The means of protecting system vents and louvers from missiles is discussed in Section 3.5.

All system components (except the electric unit heaters, the intake filters, the day tank room exhaust fans, and the fuel oil pump room exhaust fans) are Seismic Category I. The system fans are constructed and rated in accordance with applicable AMCA standards.

9.4.7.2 System Description

The three similar heating and ventilating systems serving the diesel generator rooms are shown in Figure 9.4-7.

Each room has a main "push-pull" ventilation system and an exhaust system for each oil day tank room. Each diesel fuel pump room is served by its own independent ventilation system. Equipment details are given in Table 9.4-5. Equipment seismic information is given in Table 3.2-1.

Each "push-pull" ventilation system is composed of two air handling units, an exhaust fan, associated ductwork, and controls. The two air handling units share a fresh air intake plenum and a common intake air filter bank. Each air handling unit has a water cooling coil (with a bypass damper) and a centrifugal fan in a sheet metal housing. The exhaust fan is a direct drive, vaneaxial fan.

Normally, the smaller of the two air handling units operates continuously to maintain proper temperatures in the diesel generator room. Heating is provided by an electric blast coil heater located in the air handling unit discharge duct. Ambient temperature control is provided by temperature regulated proportional dampers on the air handling unit intake which mix outside air and recirculated room air.

When a diesel generator is started, the larger air handling unit and the main exhaust fan automatically start, and SW is supplied to the water cooling coils in both air handling units. The exhaust fan ductwork is arranged such that the exhaust air can be discharged outside (via the pipe area) or recirculated through the two air handling units in any proportion from 0% to 100% to control supply air temperature. The water cooling coils provide additional cooling during high outdoor air temperatures.

The fuel oil day tank exhaust fans and the fuel oil pump room exhaust fans operate to purge oil fumes from the rooms. An outside air intake louver is provided in each oil pump room. The oil pump exhaust fan discharges to the atmosphere. The explosion-proof electric unit heaters in the pump rooms will maintain the temperature above 50°F.

9.4.7.3 Safety Evaluation

Components of the three emergency diesel generators are serviced by separate and independent HVAC systems. Each HVAC system is powered from a Class 1E bus which is supplied by the diesel generator it serves. All components of each system are located within the equipment room it serves and are therefore protected from all external missiles. All HVAC components required to ensure emergency diesel generator operation are Seismic Category I and Quality Class I.

The HVAC system is started automatically, via electric interlocks, whenever the associated diesel generator is started. Failure of part of any of the three systems will only effect the diesel served and will not impair the operational function of the remaining two systems. These systems are designed to operate in the event of a LOCA coincident with loss of offsite power.

9.4.7.4 Testing and Inspection Requirements

The diesel generators are normally on standby with the ventilation system equipment accessible for out-of-service inspection. All system ductwork was balanced for air flows in accordance with the procedures of AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements. All piping system components were subject to hydrostatic tests during erection.

The performance of the heating and ventilation system components are verified while the system is in operation. The performance of standby components are verified during Technical Specifications required testing of the diesel generators. Temperature and pressure instrumentation are provided as shown in Figure 9.4-7.

9.4.7.5 Instrumentation Requirements

The following is a discussion of the instrumentation provided for each of the three emergency diesel generator room HVAC systems.

The smaller air handling unit in each room is controlled by a local rack-mounted ON-OFF switch. In the ON position, the fan operates and the control circuits of all associated equipment are energized causing the following:

a. Electric duct heater control circuit is energized permitting the heater to operate, to satisfy the electric heating thermostat. (Heaters can only operate when the differential pressure switch across the air handling unit fan indicates air flow);

b. Fresh air/recirculation air damper control circuit permitting the electronic temperature controller to proportion air to maintain a proper supply air temperature (100% outdoor air supplied when outdoor temperature is above the damper motor controller setpoint). A sensor located in the supply air duct upstream of the heating unit signals the temperature of the supply air to the damper control; and

c. A motor-operated face and bypass damper on the air handling unit water cooling coil is controlled by a temperature switch located in the fresh air intake. When the fresh air temperature falls below the damper motor controller setpoint, the air is bypassed over the cooling coil to prevent the supply air temperature from dropping below the setpoint temperature.

The larger air handling unit fan and the main exhaust fan are controlled by separate local rack-mounted ON-OFF-AUTO switches. Both unit switches are normally in the AUTO position and are started automatically, via electric interlocks, whenever the associated diesel generator is started. The control circuits for the dampers associated with the larger air handling unit are energized when the fan is started and operated in the same manner as those of the smaller air handling unit.

The oil day tank room and fuel oil pump room exhaust fans are all controlled by local rack mounted ON-OFF switches. The explosion proof electric unit heaters are controlled by local ON-OFF switches. In the ON position, the heaters are cycled on and off by electric room thermostats.

Differential pressure switches are installed across all fans serving the diesel generator rooms. In the event of low differential pressure, an alarm is annunciated in the main control room and/or on local panels. Temperature sensors in the diesel generator rooms and in the exhaust ducts also annunciate alarms in the event of abnormally high or low temperatures (see Figure 9.4-7).

9.4.8 DIESEL GENERATOR AREA CABLE COOLING SYSTEM

9.4.8.1 Design Bases

The critical electric cabling which runs between the emergency diesel generators and the main control room and critical switchgear room is routed in corridors adjacent to the diesel generator building and in corridors between the reactor building and radwaste building. These corridors are normally ventilated by the turbine building and radwaste building ventilation systems with normal ambient temperatures below 115°F (except for corridor C-121 below 104°F); however, an emergency cable cooling ventilation system is provided to ensure that ambient temperatures in the corridors do not exceed the ambient environmental temperatures for which the cables are rated, in the event of loss of offsite power. During an extreme winter outside temperature of -27°F, the incoming air is heated to a minimum temperature of 35°F.

The ventilation system is comprised of two independent and separate systems which cool Division 1 and Division 2 cable areas. A failure in one system will not effect the operational functions of the other cooling system.

The fresh air intake opening is located in the south exterior wall and is shielded by a concrete barrier which would preclude entry by a missile such as generated by a tornado. Division 1 exhaust fan discharges air into a cable chase which is not open to the atmosphere. The air is removed by the radwaste building exhaust system.

All components in the system are Seismic Category I, Quality Class I. The system fans are constructed and rated in accordance with AMCA standards.

9.4.8.2 System Description

The cable cooling system is shown in Figure 9.4-7. The system is composed of one exhaust fan powered from the Division 1 emergency power bus and one supply air handling unit powered from the Division 2 emergency power bus.

The exhaust fan, which is normally in standby, is started automatically when the Division 1 diesel generator is started. The operation of this standby exhaust fan opens the outdoor air bypass damper when outdoor air temperature is above 40°F and when the Division 2 supply fan is not running.

The Division 2 air handling unit is composed of a 30-kW electric blast coil heater and a centrifugal fan in a sheet metal housing. It is normally in standby. When the Division 2 diesel generator is started, this air handling unit is automatically started through interlocks. When this air handling unit is started, a damper in the supply air duct from the turbine building HVAC system (which is used for normal ventilation of the corridors) is automatically closed. This air handling unit then supplies tempered air to the corridors in which Division 2 cable is routed.

9.4.8.3 Safety Evaluation

All components of the cable cooling system are powered from their respective emergency diesel buses. All HVAC components in this system are Seismic Category I, Quality Class I.

The capacity of the Division 1 and Division 2 components of the HVAC system is sufficient to maintain safe ambient conditions in the event of failure of either power division. The components powered from the two divisions are independent and physically separated to preclude the possibility of any single failure damaging both systems.

9.4.8.4 Inspection and Testing Requirements

All components of the cable cooling system which are normally in standby are accessible for out-of-service inspection. All system ductwork was balanced for air flows in accordance with the procedures of AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements.

The performance of the ventilation system components are verified while the system is in operation. Temperature and pressure instrumentation is provided, as shown in Figure 9.4-7, to monitor system performance.

9.4.8.5 Instrumentation Requirements

The Division 1 standby exhaust fan and the Division 2 air handling unit are controlled by separate, local, ON-AUTO-OFF switches (spring back from OFF to AUTO). With the control switches in the AUTO position, the Division 1 standby exhaust fan starts automatically, via electric interlocks, when the Division 1 diesel generator is started.

The Division 2 air handling unit control switch is normally in the AUTO position. It automatically starts and its control circuit energizes, via electric interlocks, when the Division 2 diesel generator is started. When energized, the air handling unit's control circuits perform the following function:

The inlet mixing damper and electric blast coil heaters are controlled by electric thermostats located in the corridor. When corridor temperature is above 70°F, the damper is positioned for 100% outdoor air. When the temperature drops below a nominal 70°F, the damper is positioned for minimum outdoor air. When the temperature drops below a nominal 62°F and 54°F, respectively, the two stages of electric heater are energized.

Failure of air flow through the air handling unit fan after the fan motor is energized will trip a differential pressure switch that deenergizes the air handling unit control circuits and activates an alarm. Also, the filter bank in the air handling units is provided with a differential pressure switch which activates an alarm on high differential pressure.

The operation of the Division 1 standby exhaust fan opens the outdoor air bypass damper when outdoor air temperature is above 40°F and when the Division 2 supply fan is not running.

9.4.9 REACTOR BUILDING EMERGENCY COOLING SYSTEMS

9.4.9.1 Design Bases

All equipment located within the Seismic Category I reactor building which requires a controlled environment to operate, and which must operate in the event of a LOCA, is enclosed in individual equipment rooms. These rooms are normally heated and ventilated by the reactor building HVAC system (see Section 9.4.2); however, under emergency conditions, the rooms are automatically cooled by recirculation of room air through their respective reactor building emergency cooling system. Ambient temperatures of the following rooms are maintained below equipment operability limits during all emergency modes of operation. See Table 3.11-1.

HPCS pump room
Division 1 Low-pressure core spray (LPCS) pump room
Division 2 Reactor core isolation cooling (RCIC) pump room
Division 1 Residual heat removal (RHR) pump room
Division 2 RHR pump rooms (2 pump rooms)
Division 1 Motor control center (MCC) room (el. 522)
Division 2 MCC room (el. 522)
Division 1 dc MCC room (el. 471)
Division 1 H2 recombiner MCC room (el. 572)
Division 2 H2 recombiner MCC room (el. 572)
Fuel pool cooling (FPC) pump room

The critical MCC and FPC pump rooms emergency cooling fans auto start and the rooms are isolated from the reactor building HVAC system on an F, A, or Z signal. Although the FPC pump room is isolated from the reactor building HVAC system, the room temperature can be maintained below equipment operability limits with the reactor building HVAC dampers open. The ECCS and RCIC pump rooms emergency cooling fans auto start when their respective pump starts. SW is provided to the emergency cooling coils as described in Section 9.4.9.5.

All components of the reactor building emergency cooling system are designed Quality Class I, Seismic Category I and are powered from the same diesel generator bus as the equipment being served. Since each separate cooling system services redundant emergency equipment systems, a failure of one cooling system will not effect the operational function of the other cooling systems or the safe shutdown of the reactor. The means of protecting the system vents and louvers from missiles is discussed in Section 3.5.

All ductwork connected to the fan coil units in this system is designed to Seismic Category I requirements. The system fans are constructed and rated in accordance with the applicable AMCA standards. The water cooling coils are designed and code stamped in accordance with the requirements of the ASME Code Section III, Class 3.

9.4.9.2 System Description

The reactor building emergency cooling system is shown in Figure 9.4-2. Each of the rooms housing critical equipment is provided with an individual air handling unit (two units in the FPC pump room) which is fully enclosed within the room. Each air handling unit is comprised of a direct drive centrifugal or vane axial fan and a water cooling coil in a sheet metal housing. Water is supplied to the water coils by the SW system (see Section 9.2.7). During normal operation, these air handling units are in standby.

All units recirculate the air within the room they serve, removing the heat generated in the room via the water coil, to maintain temperatures below the design limits. Equipment details are on Table 9.4-2. Equipment seismic information is given in Table 3.2-1.

9.4.9.3 Safety Evaluation

Each of the emergency equipment rooms in the reactor building is provided with a separate, independent cooling system, all components of which are located within the room serviced. Each cooling system is powered from a Class 1E bus of the same division as the equipment it serves and is designed to withstand the effects of an SSE. A failure of one cooling system will not affect the operational function of any other system or the safe shutdown of the reactor.

With the exception of the FPC pump room the air handling units serving the pump rooms are interlocked electrically with the pumps they serve in such a manner that they start when the pump is started. The air handling units serving the FPC pump room and critical MCC rooms are started by any of the F, A, or Z isolation signals.

The FPC pump room air handling units also start on loss of offsite power.

9.4.9.4 Testing and Inspection Requirements

All components of the reactor building emergency cooling system are normally in standby and are accessible for out-of-service inspection. All piping systems were subject to hydrostatic tests during manufacture and erection.

The cooling system was subject to preoperational testing to verify that the system functions in accordance with the design requirements, and performance is verified periodically by testing during unit operation.

9.4.9.5 Instrumentation Requirements

With the exception of the FPC pump room units, the air handling units serving the pump rooms are controlled identically. Each is electrically interlocked with the pump it serves to operate when the pump operates. Running lights for the fans are located on the MCCs. The SW system supplies the air handling unit water coil when the pump is started. A local manual switch is provided in each pump room for testing the air handling unit fan.

The controls for each of the air handling units serving the FPC pump room and the critical MCC rooms are identical. An ON-AUTO-OFF switch (spring back from OFF to AUTO) is provided for each fan unit in the main control room. Normally all switches are in the AUTO position and the fan units are in standby. In the AUTO mode, any of the three isolation signals (F, A, Z) will cause the following operations, via electric interlocks.

a. Air handling unit fans start,

b. Solenoid valves associated with the air-operated dampers in the reactor building ventilation system supply air ducts to the critical MCC and FPC pump rooms are deenergized, thus isolating these rooms from the balance of the reactor building.

For the F isolation signal, the Division 1 and 2 SW systems are auto started as described in Section 7.3.1.1.6 and provide cooling water to these unit cooling coils. For the A isolation signal, the Division 2 SW system is auto started via RCIC as described in Section 7.3.1.1.6 and the Division 1 SW system can be manually started as needed from the control room. For the Z isolation signal, the Division 1 and 2 SW systems can be manually started as needed from the control room.

In addition, the FPC pump room fan units will start on loss of offsite power when the control switch is in the AUTO position.

Room temperature indicators, alarms and/or HVAC related alarms are provided in the main control room for each of the equipment rooms as shown on Figure 9.4-2 or 9.2-12, as applicable. The alarms will annunciate in the event that temperatures exceed the design limit.

In addition, the leak detection system provides temperature indication and alarms in the main control room for Division 1 RHR A pump room, Division 2 RHR B pump room and the RCIC pump room as shown on Figure 7.6-1.

9.4.10 STANDBY SERVICE WATER PUMP HOUSE

9.4.10.1 Design Bases

The SW pump house HVAC systems are designed to remove the heat generated by operation of the SW pumps and the HPCS service water pump and to limit the temperature in the two pump houses as specified in Table 3.11-1. The ventilation systems are designed as ESF systems and are powered from a Class 1E bus of the same division as the pumps being served.

Since each HVAC system associated with the redundant SW pumps is separate and independent, a failure in one system will not affect the operational function of the other system. The means of protecting the system vents and louvers from missiles is discussed in Section 3.5.

Heating of the pump houses is provided by electric unit heaters (four in each building) sized to heat the building spaces to maintain temperatures as specified in Table 3.11-1. The unit heaters are powered from the emergency diesel-generator buses, but are classified Seismic Category II. If the pumps are required to operate following a seismic event, the heat generated from the pump motor is sufficient to maintain the building above freezing. The SW pumphouse outside air supply fans and motors are classified Seismic Category IM. These fans and motors are not required to operate to cool the safety related equipment in the pump houses under accident conditions. The remaining components, ductwork, and piping in the SW pump house ventilation systems are classified Seismic Category I.

The fan coil units and the supply fans are constructed and rated in accordance with the applicable AMCA standards. The water cooling coils are designed and code stamped in accordance with the requirements of ASME Code Section III, Class 3.

9.4.10.2 System Description

The SW pumps are located in pump houses adjacent to the emergency spray ponds. The loop A SW pump and the HPCS service water pump share one pump house and the loop B SW pump is in a second pump house. The HVAC systems serving the two pump houses are depicted in Figure 9.4-7. Each system consists of a fan coil unit composed of a sheet metal cabinet containing a direct-drive centrifugal fan and a water cooling coil, and a separate centrifugal supply fan with inlet mixing dampers.

Each fan coil unit is interlocked electrically with the associated SW pump it serves in such a manner that the unit fan starts and recirculates room air over the water cooling coil when the pump starts. Water is supplied to the unit coil from the main supply header of the SW pump. The fan coil units are normally in standby and operate only when the pump is started.

The supply ventilation fans in both pump rooms operate automatically when required. A room thermostat in the pump house starts the fan on a temperature rise to 80°F or above and stops the fan on a temperature drop to 60°F or below. When the outdoor temperature is above 40°F, 100% outdoor air is supplied to the room. When the outdoor temperature falls below 40°F, a temperature indicating switch, with its sensor in the outdoor air intake duct, positions the motor-operated intake mixing damper to a position for 4400 cfm recirculation air and 600 cfm outdoor air. Air is exhausted from the pump houses through relief dampers at a rate between 600 cfm and 5000 cfm depending on the intake of outside air.

There are four 10-kW electric unit heaters in each pump house. Each heater is controlled by a separate wall-mounted thermostat which starts the heater on a drop in room temperature to below 40°F. Equipment details are given in Table 9.4-6. Equipment seismic information is given in Table 3.2-1.

9.4.10.3 Safety Evaluation

The following safety features are incorporated in the design of the heating and ventilating systems serving the SW pump houses:

a. Each of SW pump rooms 1A and 1B is serviced by a separate 100%-capacity fan coil unit powered from the same Class 1E bus as the pump room being serviced,

b. The HPCS service water pump is located in SW pump house 1A,

c. Both fan coil units and the HPCS supply fan start when the pump serviced starts,

d. In the event of loss of offsite power, the ventilation equipment is powered from the emergency diesel generator buses, and

e. All ESF components of the system are designed to operate in the event of an SSE.

Since each HVAC system associated with the redundant SW pumps is separate and independent, a failure in one system will not effect the operational function of the other system.

9.4.10.4 Testing and Inspection Requirements

The performance of normally operating components of the SW pump house ventilating systems can be verified while operating. All standby equipment is accessible for out-of-service inspection. All system ductwork was balanced for air flows in accordance with the procedures of AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements. All piping systems and components were subject to hydrostatic tests during erection.

9.4.10.5 Instrumentation Requirements

In addition to the instrumentation described in Section 9.4.10.3 the following devices are provided:

a. Each fan coil unit fan is provided with a local rack-mounted ON-AUTO-OFF switch (spring back to AUTO) which is used to test fan operation,

b. Each supply air fan is provided with a local rack-mounted ON-AUTO-OFF switch (spring back from OFF to AUTO) which is used to test fan operation,

c. Differential pressure switches are provided across each fan coil unit fan and each supply fan which annunciate an alarm in the main control room in the event of low differential pressure when the fan is given a start signal, and

d. Temperature switches in each pump room annunciate alarms in the main control room in the event of high or low temperatures.

9.4.11 PRIMARY CONTAINMENT

9.4.11.1 Design Bases

The primary containment is divided into two separate volumes: the drywell which houses the reactor vessel and auxiliaries, and the wetwell which housed the suppression pool. There is no heat producing equipment in the wetwell; therefore, a wetwell air cooling system is not required. The drywell, which has a high internal heat load, is provided with recirculation cooling system designed to meet the following requirements:

a. To limit during normal plant operation, the average air temperature within the primary containment drywell to Table 3.11-1 limits,

b. To provide suitable working temperatures inside the primary containment for personnel during shutdown and refueling operations, and

c. To remove the additional heat released in the event of a reactor scram, and to limit temperatures in the neutron monitoring cable area beneath the reactor to Table 3.11-1 limits.

The primary containment cooling system is not required for safe shutdown of the reactor. Essential equipment located in primary containment that is required for safe shutdown of the reactor is designed to function without the containment cooling system in operation.

All components of the primary containment cooling system are classified Seismic Category I. System fans are constructed and rated in accordance with applicable AMCA codes. The water cooling coils are designed and code stamped in accordance with the requirements of the ASME Code Section III, Class 3.

9.4.11.2 System Description

Equipment seismic information is given in Table 3.2-1. The equipment details are described in Table 9.4-2. The primary containment cooling system is shown in Figure 9.4-8. Cooling of the drywell is provided by five fan coil units which recirculate containment air through water cooling coils for heat removal. Seven recirculation fans and two head area return fans are also provided at various locations in the drywell to provide additional air turbulence to prevent pockets of hot air from developing. Each of the five fan coil units consists of two vaneaxial fans, both of which operate at the same time, and a water cooling coil in a sheet metal housing. Provisions have been made to install filters in the units, for coil protection, while the units are operated during plant construction; however, no filters are required during normal plant operation. Water is supplied to the unit cooling coils from the reactor building closed cooling water system as described in Section 9.2.2.

Three of the fan coil units are located low in the drywell and two of the units are located at a higher level.

Each of the three lower level fan coil units are provided with two vaneaxial fans one of which discharges directly into the general drywell volume, and the other discharges, via ductwork, into the neutron monitoring cable area beneath the reactor and general drywell volume.

The two upper level fan coil units are each provided with one 30,000-cfm capacity fan and one 10,000-cfm capacity fan. The larger fans discharge directly into the upper volume area. The smaller fans discharge into the containment head area above the refueling bellows. Two vaneaxial head area return fans draw air from the containment head area and discharge it below the refueling bellows. Return air to the upper fan coil units is drawn from immediately below the refueling bellows. During normal operation, one or both of the head area return fans will be running.

Three recirculating fans are located at lower level and four fans are located at upper level in the drywell to provide air circulation. During normal operation, up to three lower level fans and up to four upper level fans are operating.

In the event of a reactor scram, both of the head area return fans are started (unless already operating).

9.4.11.3 Safety Evaluation

The primary containment cooling system does not have to operate, in the event of LOCA, to ensure the safe shutdown of the reactor. Head area return fans (CRA-FN-4A and CRA-FN-4B) will operate post-LOCA to help ensure hydrogen mixing. Design of the system incorporates the following features to ensure safe operation.

a. All fan coil units, recirculation fans, and head area return fans are designed to withstand the effects of an SSE and are powered from the emergency diesel buses;

b. All containment fans have been evaluated for the normal environmental conditions in containment to ensure long term reliable operation; and

c. Those fans used for hydrogen mixing following a LOCA are identified and qualified to Class 1E requirements. Additionally, these fans are powered from Class 1E sources.

9.4.11.4 Testing and Inspection Requirements

All components of the primary containment cooling system were subject to shop and field tests prior to plant operation. System performance is verified during reactor operation when the equipment is operating at design conditions.

All system ductwork was balanced for air flows in accordance with the procedures of the AABC. All system components were subject to preoperational testing to verify that the system functions in accordance with the design requirements.

9.4.11.5 Instrumentation Requirements

The primary containment fan coil units, recirculation fans, and cooling water isolation valves are each controlled by individual selector switches with indication lights, mounted in the main control room.

Temperature sensors are located throughout the primary containment as indicated in Figure 9.4-8. These sensors continuously monitor ambient conditions inside the containment and the performance of the cooling system.

9.4.12 MAKEUP WATER PUMP HOUSE

9.4.12.1 Design Bases

The heating and ventilating system provided in the makeup water pump house is designed to maintain temperatures within the structure between 50°F and 104°F to ensure suitable conditions for equipment operation. In the event of the hypothesized dewatering of the SW spray ponds due to a tornado, the makeup water pumps may be operated to refill the spray ponds (see Sections 9.2.7 and 10.4.5).

Since the ventilation system must be operated to ensure an acceptable environment for the makeup pump motors, the system is designed with redundant equipment to ensure that a single component failure will not interfere with the operation function of the system. In the event a tornado causes the loss of offsite power, the system is powered from the emergency diesel generator buses. The fresh air intake and exhaust air openings are located in the east exterior wall and are shielded by a concrete barrier wall which precludes entry of a missile such as a tornado-generated missile.

The makeup water pumps and auxiliaries are not required to operate in the event of an SSE; therefore, all components of the heating and ventilating system serving the pump house are designed to Seismic Category II requirements as defined in Section 3.2. The system fans are constructed and rated in accordance with applicable AMCA standards.

9.4.12.2 System Description

The makeup water pump house heating and ventilating system is shown in Figure 9.4-7. It consists of two full-capacity air handling units and two battery hood exhaust fans which service the electric equipment area, and two full-capacity fan coil units and two electric space heaters which service the pump area. Equipment details are given in Table 9.4-7. Equipment seismic information is given in Table 3.2-1.

The two air handling units serving the electric equipment area consist of an insulated sheet metal cabinet housing a replaceable roughing filter, a two-stage electric blast coil heater, a water cooling coil, and a centrifugal fan. One of the two air handling units operates at all times to maintain design temperatures in the electric equipment area. The second unit is in standby and starts in the event that the operating unit fails.

The air handling units draw air from the outside atmosphere through intake louvers. The air is discharged, via ductwork, into the electric equipment area from which it flows into the pump room. It is then released either to the outside atmosphere, via relief dampers, or is partially recirculated back through the unit. Motor-operated dampers on the unit intake ducts are so arranged that the unit can draw 100% outdoor air or recirculate air drawn from the pump area back through the unit. The damper motor is controlled by a temperature switch which senses outdoor temperature. The damper will be positioned for 100% outdoor air when the outside temperature is between 50°F and 70°F.

The fan coil units servicing the pump area consist of a centrifugal fan, a water cooling coil, and a roughing filter in a sheet metal housing. The units recirculate air in the pump room only and are interlocked electrically with the makeup water pumps to start when the pumps start. Each unit has sufficient capacity to maintain design conditions with two of the makeup water pumps operating. In the event all three pumps are operating, the second fan coil is automatically started.

Water is supplied to the electrical area air handling units and the pump area fan coil units from the discharge header of the makeup water pumps. A fail-closed, motor-operated valve is provided in the water supply line to each unit. The valve control circuit is energized when its respective fan is energized. With the control circuit energized, the valve is controlled by a thermostat, located in the area serviced, which opens the valve on a temperature rise to 90°F or above.

The electric blast coil heaters in the electrical equipment area air handling units are controlled by separate two-stage room thermostats. Two electric unit heaters provide supplementary heating to the pump area. A temperature switch starts the heaters at the desired temperature setpoint.

Two spark resistant, battery hood exhaust fans both operate continuously to exhaust any combustible gases generated from the batteries to the atmosphere.

9.4.12.3 Safety Evaluation

The makeup water pumps are required to supply water to the SW spray ponds in the event a design basis tornado empties the ponds of their coolant (see Section 9.2.7). The pump house HVAC system is required to ensure that the operation of the makeup pumps is not diminished by extremes in temperature. The HVAC system provided in the makeup water pump house incorporates the following safety features to ensure that a single component failure will not prevent the system from performing its operational function:

a. Two full-capacity air handling units are provided for the electrical equipment area and two full-capacity fan coil units are provided for the makeup pump area; therefore, failure of any one unit will not effect system operation,

b. The redundant HVAC equipment is powered from different divisions of the emergency diesel generator buses; therefore, failure of any one bus will affect only one train of ventilating equipment, and

c. All heating and ventilating equipment is located within the pump house where it is protected from tornado missiles.

9.4.12.4 Testing and Inspection Requirements

The performance of the heating and ventilating system servicing the makeup water pump house can be verified while the systems are operating. The operability of standby equipment is determined by rotating the duty of redundant systems.

All systems ductwork was balanced for air flows in accordance with the procedures of AABC and all piping systems and components were subject to hydrostatic tests during erection.

9.4.12.5 Instrumentation Requirements

The following major instrumentation devices are used in the control and monitoring of the makeup water pump house heating and ventilating system in addition to those described in Section 9.4.12.2:

a. Three position selector switches (ON-OFF-AUTO) are provided locally for each of the two pump area fan coil units and are normally in the AUTO position. In this position, the starting of the makeup pump, powered from the same bus as the fan coil unit, will start the fan coil unit and energize its control circuit via an electric interlock. The second makeup pump start will not start the second fan coil unit. Both fan coil units operate only when all three pumps are operating. Differential pressure switches across the fan of each unit will annunciate an alarm and start the standby unit in the event of a low differential pressure;

b. Three position selector switches (ON-OFF-STANDBY) are provided locally for each of the two electrical equipment area air handling units. One unit is normally operating with the second unit in standby. Differential pressure switches across each fan, annunciate an alarm and start the standby unit in the event of low differential pressure across the operating fan;

c. Each of the two battery hood exhaust fans are provided with local selector switches and a differential pressure switch across the fan which annunciates a local alarm in the event of fan failure; and

d. Temperature switches located in the electrical equipment and pump areas annunciate alarms in the main control room on high or low ambient temperature conditions.

9.4.13 SERVICE BUILDING

9.4.13.1 Design Bases

The service building HVAC system is designed to provide a controlled environment for personnel comfort within the building. The heating and air conditioning system is of a conventional design.

9.4.13.2 System Description

The service building HVAC system is a "push-pull," multizone system using chilled water for cooling and hot water for heating.

9.4.13.3 Safety Evaluation

The service building HVAC system has no safety function. Malfunction or failure of the HVAC system will not impair normal or emergency plant operations.

There are no potential sources of radioactive contaminants, with the exception of tritium (see Section 9.4.16.3), nor safety related equipment in the service building.

9.4.14 WATER TREATMENT AREA AND MACHINE SHOP

9.4.14.1 Design Bases

The HVAC system serving the water treatment area and machine shop, both of which are in the service building, is designed to remove noxious fumes generated in the area served and to provide tempered air for personnel comfort. The HVAC system is of a conventional design. The system is sized to provide three air changes per hour in the areas served.

9.4.14.2 System Description

The system is basically a once-through system with the facility for partial recirculation of air from the machine shop to reduce heating requirements during the winter months.

Air is supplied to the machine shop and water treatment area by a central supply air system composed of a ventilation unit and distribution ductwork.

Exhaust fans are provided to exhaust air from the machine shop and water treatment area.

9.4.14.3 Safety Evaluation

The heating and ventilating system serving the water treatment area and machine shop has no safety function. Malfunction or failure of the system will not effect reactor operation nor cause the release of radioactive materials.

There are no potential sources of radioactive contaminants, with the exception of tritium (see Section 9.4.16.3) nor safety-related equipment in the areas serviced.

9.4.15 CIRCULATING WATER PUMP HOUSE

9.4.15.1 Design Bases

The HVAC system serving the circulating pump house is designed to satisfy the following criteria:

a. Limit the maximum temperature in the circulating pump area to within 10°F of the ambient temperature when the pumps are operating,

b. Maintain the pump area at a minimum temperature of 50°F when the pumps are not operating,

c. Maintain the electrical equipment room and control room pressurized, with respect to the adjacent rooms, to prevent the ingress of noxious fumes, and maintain the room temperature between 65°F and 85°F,

d. Exhaust air from the halogen storage tank room, halogen injection pump room, and acid pump room to prevent the potential buildup of noxious fumes, and heat the halogen injection pump room to 65°F for personnel comfort during room occupancy, and

e. Continuously exhaust air to atmosphere from the diesel oil storage room to prevent the potential buildup of combustible fumes.

9.4.15.2 System Description

The HVAC systems serving the circulating water pump house are shown in Figure 9.4-7.

The pump area is ventilated by six 33,000-cfm capacity roof exhaust fans, each of which is controlled by a manual switch.

When the exhaust fans are on, air is induced into the pump area through weather louvers in the exterior walls of the structure. Heat is provided in the pump area by twelve electric unit heaters, each controlled by separate room thermostats.

The electrical equipment room and control room are serviced by an air-cooled, roof-mounted air conditioning unit. The unit has a built-in, electric blast coil heater, a roughing filter bank, an integral air-cooled condenser, and a centrifugal fan. The unit supplies air to the two rooms, drawing outdoor air to pressurize the rooms and recirculating air from the electric equipment room. The pressurizing outside air supplied to the rooms is relieved to the pump area via relief dampers in the partition wall between the rooms and the pump area.

A fiberglass roof ventilator continuously exhausts air from the halogen injection pump room, and the acid pump room. The halogen storage tank room is served by a heat pump unit, which recirculates air from this area. If needed, the fiberglass roof ventilator can be used to exhaust air from the halogen storage tank room by opening a volume damper in the exhaust duct. Makeup air is induced into the halogen injection pump room and the acid pump room through relief dampers from the pump area. An electric unit heater is provided in the halogen injection pump room for personnel comfort when the area is occupied. A motor-operated damper in the branch exhaust duct from the halogen injection pump room is controlled by a thermostat located in the halogen storage tank room in such a manner that air exhaust from the halogen injection pump room can be reduced when the outdoor temperature (as sensed in the halogen storage tank room) falls below a predetermined setpoint to minimize the halogen injection pump room heating requirements.

An explosion proof wall fan continuously exhausts air from the diesel oil tank storage room to the atmosphere to prevent the buildup of combustible gases. Air is introduced into the room from the pump area through a vent opening protected by a 3-hr rated fire damper. Air exhausted from the room is also vented through a 3-hr rated fire damper. Equipment details are given in Table 9.4-8. Equipment seismic information is given in Table 3.2-1.

9.4.15.3 Safety Evaluation

The HVAC system serving the circulating water pump house has no safety function. Malfunction or failure of the system will not impair normal or emergency operation.

9.4.15.4 Testing and Inspection Requirements

All system ductwork was balanced for air flows in accordance with the procedures of AABC. All system components were subjected to preoperational testing to verify that the system functions in accordance with the design requirements.

9.4.15.5 Instrumentation Requirements

Each electric unit heater is put in service by a local hand switch and is controlled by its own thermostat.

Each fan is put in service by an OFF-ON switch.

The electrical equipment room air conditioning unit is put in service by a local ON-OFF switch. When ON, the fan runs continuously and the unit control circuit is energized permitting a one-stage cooling, two-stage heating thermostat to cycle the unit compressor or the two-stage electric blast coil heater, as required.

Pressure switches with sensors in the exhaust duct of the chlorine exhaust fan and the supply duct of the air conditioning unit fan will annunciate alarms in the event of a fan failure.

9.4.16 PLANT HEATING STEAM SYSTEM

9.4.16.1 Design Basis

The plant HS system, in conjunction with heating coils, humidifiers, and steam unit heaters in the plant HVAC systems, discussed previously in this section, is designed to:

a. Maintain a minimum temperature of 50°F in the reactor, radwaste, and turbine generator buildings during cold weather conditions,

b. Maintain a minimum temperature of 65°F on the refueling floor of the reactor building and in the service building machine shop and water treatment areas,

c. Provide humidified air to the radwaste control room, radiochemistry laboratory, counting room, and hot instrument shop, and

d. Generate, through a hot water heat exchanger, 180°F water for perimeter heating of service building offices and laboratories.

The plant HS system is designed for 50 psig service. The source of the HS is the gland steam evaporator during turbine generator operation and the auxiliary boiler during plant shutdown. The heating condensate (HCO) system is designed as a gravity return to the auxiliary boiler condensate return tank (CO-TK-1) in the turbine generator building.

9.4.16.2 System Description

The plant HS system is depicted in Figure 9.4-9. The system originates from four pressure reducing stations (two in the turbine generator building and one each in the reactor and radwaste buildings). Steam at 200 psig pressure is supplied to these pressure reducing stations from either the auxiliary boiler or the gland steam evaporator. At the pressure reducing stations, the steam pressure is reduced to 50 psig and this steam is fed to the heating coils, humidifiers, steam unit heaters, and hot water heat exchanger.

The condensate from the HS system is returned to the auxiliary boiler condensate return tank located in the auxiliary boiler room of the turbine generator building. Condensate from the reactor building, turbine generator building, and upper level of the service building is returned to the auxiliary condensate return tank by gravity.

In the radwaste building and lower level of the service building, the condensate returns are below the level of the auxiliary condensate return tank. A condensate pump-set is, therefore, provided in each of these areas to pump the condensate to the return tank. Equipment details are given in Table 9.4-9. Equipment seismic information is given in Table 3.2-1.

9.4.16.3 Safety Evaluation

The auxiliary boiler and associated steam systems were originally intended to be free from radiological contamination. During operation, however, the system has become contaminated with tritium. Possible sources of the tritium activity are tube leaks in the feedwater heaters or the steam evaporator. As is discussed in Section 11.1.3, all tritium produced in the reactor is eventually released to the environs. Tritium may be released from the heating system in vapor and gaseous form or in auxiliary boiler water blowdown. The boiler blowdown tank drains to a turbine building sump (see Section 9.3.3.2.3.1) which is directed to radwaste processing. The tritium contamination in the auxiliary boiler and associated steam systems is monitored and efforts are made to minimize the levels of activity. The tritium does not necessitate changes in system design or operation and will not cause significant radiological impacts.

The plant HS system has no safety function. Any rupture in HS or HCO piping does not impair safe reactor shutdown as discussed in Sections 3.6.1.15.3 and 3.6.1.18.3.6. All system piping except that in the reactor building is Seismic Category II. All system piping in the reactor building is analyzed and supported to Seismic Category I loading requirements.

9.4.16.4 Testing and Inspection Requirements

The performance of plant HS system was verified by tests prior to startup and is verified during system operation. All components in the system were tested and inspected at the manufacturers plant for conformance with specifications. After installation, the major components were checked and the system hydrostatically tested to ensure leaktightness.

9.4.16.5 Instrumentation Requirements

Adequate instrumentation is provided to monitor and control operation of the system.

Table 9.4-1

Main Control Room/Cable Spreading Room/Critical Switchgear Area Major Components of HVAC Systems

a. Exhaust fans

1. Tag number	WEA-FN-51	WEA-FN-52	WEA-FN-53A	WEA-FN-53B
2. Number of fans	1	1	1	1
3. Area served	Main control room	Cable spreading room	Battery room 1	Battery room 2
4. Fan type and style	Centrifugal SWSI	Centrifugal SWSI	Centrifugal SWSI	Centrifugal SWSI
5. Drive	Direct	Direct	Direct	Direct
6. Capacity	750 acfm	1000 scfm	2400 scfm	900 scfm
7. Total static pressure (in., w.g.)	1.4	1.75	1.64	1.5
8. Motor type	Open drip-proof self-ventilated with Class B insulation with a maximum temperature rise of 50° C above a 50°C ambient			
9. Motor (hp)	1	1	2	1

b. Air handling units

1. Tag number	WMA-AH-51A WMA-AH-51B	WMA-AH-52A WMA-AH-52B	WMA-AH-53A WMA-AH-53B
2. Number of units	2 (1 standby)	2 (1 standby)	2
3. Area served	Main control room	Cable spreading room	Critical switchgear
4. Air flow per unit (acfm)	21,000	9500	28,100 (22,800 for WMA-AH-53B)
5. Total static pressure (in., w.g.)	5.50	4.27	6.13
6. Sensible cooling capacity (Btu/hr) per unit			
a) Normal operation	600,000	235,000	370,000 (320,000 for WMA-AH-53B)
b) Emergency operation	285,000	160,000	370,000 (320,000 for WMA-AH-53B)
7. Water supply source			
a) Normal operation	Chilled water	Chilled water	Chilled water or Plant service water
b) Emergency operation	CCH or standby service water	Standby service water	Standby service water

Table 9.4-1

Main Control Room/Cable Spreading Room/Critical Switchgear Area
Major Components of HVAC Systems (Continued)

c. Main control room emergency filter units	
1. Tag number	WMA-FU-54A, WMA-FU-54B
2. Number of units	2
3. Capacity (scfm)	1000
4. Fan	Centrifugal direct drive
5. Total static press (in., w.g.)	9.6
6. Prefilters	
a) Type	Replaceable media
b) Efficiency	80-85%
c) Initial pressure drop	0.5 in. maximum
7. HEPA filters	
a) Type	High efficiency
b) Media	Glass media, water repellent and fire resistant
c) Efficiency (DOP 0.3 μ particle size)	99.97%
d) Initial pressure drop (in., w.g.)	1.0 maximum
8. Charcoal adsorber	
a) Media	Activated carbon
b) Test efficiency @ 70% RH	97.5% (methyl iodide)
d. Emergency chiller units	
1. Tag number	CCH-CR-1A, CCH-CR-1B
2. Number of units	2 (1 each division)
3. Peak operating load	50 tons
4. Motor (kW)	126
5. Chilled water (gpm)	145
6. Chilled water supply temperature	44°F
7. Condenser cooling source	Standby service water
e. Emergency chiller pumps	
1. Tag number	CCH-P-1A, CCH-P-1B
2. Number of units	2 (1 each division)
3. Capacity	145 gpm at 56 ft total head
4. Motor (hp)	7.5
5. Units served	CCH-CR-1A, CCH-CR-1B

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems

a. Heating and ventilating unit (evaporative air washer)

1. Tag number	ROA-HV-1
2. Number of units	1
3. Air flow (scfm)	80,000
4. Steam flow (lb/hr)	6800
5. Supply air temperature	
a) Summer	72°F DB (evaporative cooling)
b) Winter	50°F
6. Fan type	Vaneaxial V-belt drive (200 hp motor)
7. Number of fans	2 (1 standby)
8. Fan total pressure (in., w.g.)	9.3

b. Reactor building exhaust fans

1. Tag number	REA-FN-1A REA-FN-1B
2. Number of fans	2 (1 standby)
3. Fan type	Vaneaxial
4. Drive	Direct (200 hp motor)
5. Capacity	80,000 - 105,000
6. Total (scfm) pressure (in., w.g.)	9.43 @ 105,000 scfm
7. Motor type	TEAO with Class "RH" insulation

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems (Continued)

c. Reactor building emergency fan coil units (part 1 of 2)

1. Tag number	RRA-FC-1 RRA-FC-2 RRA-FC-3	RRA-FC-19 RRA-FC-20	RRA-FC-4	RRA-FC-5	RRA-FC-6
2. Number of units	3	2	1	1	1
3. Air flow per unit (acfm)	5208	10,000	15,625	9375	3125
4. Sensible cooling capacity (Btu/hr) per unit	165,000	134,000	500,000	280,000	60,000
5. Total static pressure (in.,w.g.)	1.34	0.5	1.64	1.46	1.53
6. Area served	RHR pump rooms	FPC pump room	HPCS pump room	LPCS pump room	RCIC pump room
7. Water supply service	Standby service water	Standby service water	Standby service water	Standby service water	Standby service water

c. Reactor building emergency fan coil units (part 2 of 2)

1. Tag number	RRA-FC-10 RRA-FC-11	RRA-FC-12	RRA-FC-13 RRA-FC-14
2. Number of units	2	1	2
3. Air flow per unit (acfm)	5730	6500	4100
4. Sensible cooling capacity (Btu/hr) per unit	71,280	85,000	53,900
5. Total static pressure (in.,w.g.)	0.5	1.41	1.39
6. Area served	MCC rooms	Division 1, dc-MCC-room	H_2 recombiner rooms
7. Water supply service	Standby service water	Standby service water	Standby service water

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems (Continued)

d. Reactor building steam tunnel fan coil units

1. Tag number	RRA-FC-8 RRA-FC-9 RRA-FC-21
2. Number of units	3
3. Air flow per unit (scfm)	4250 (RRA-FC-8) 4000 (RRA-FC-9) 3000 (RRA-FC-21)
4. Sensible cooling capacity (Btuh) per unit	97,200
5. Total static pressure (in., w.g.)	1.53
6. Area served	Steam tunnel
7. Water supply source	Plant service water

e. Vehicle air lock (railroad bay) HVAC

1. Tag number	RRA-AH-7	RRA-AH-8	RRA-EUH-1 RRA-EUH-2 RRA-EUH-3 RRA-EUH-4 RRA-EUH-5 RRA-EUH-6 RRA-EUH-7 RRA-EUH-8
2. Number of units	1	1	8
3. Fan type	Centrifugal DWDI	Centrifugal	Axial
4. Drive (per unit)	V-belt (3 hp motor)	Belts (20 hp motor)	Direct drive (1/3 hp motor)
5. Nominal air flow	5000 scfm	32,500 cfm	1635 cfm
6. Sensible cooling capacity at nominal air flow (MBtu/hr)	42.5	None	None
7. Electric heating capacity per unit (kw)	15	None	38.4
8. Total static pressure (in., w.g.)	1.68	N/A	N/A
9. Area served	Vehicle air lock (railroad bay)	Vehicle air lock (railroad bay) R106 Door	Vehicle air lock (railroad bay)

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems (Continued)

f. Sump vent filter units

1. Tag number	REA-FU-2A REA-FU-2B
2. Number of units	2 (1 standby)
3. Capacity (scfm)	1000
4. Fan	Centrifugal direct drive
5. Total static pressure (in., w.g.)	9.6
6. Prefilters	
a) Type	Replaceable media
b) Efficiency	80-85%
c) Initial pressure drop (in., w.g.)	0.5
7. Heater	
a) Type	Electric resistance (3 stage)
b) Quantity	1
c) Capacity	21 kW total
8. HEPA filters	
a) Type	High efficiency
b) Media	Glass media, water repellent and fire resistant
c) Efficiency (DOP 0.3 μ particle size)	99.97%
d) Initial pressure drop (in., w.g.)	Maximum 1.0
9. Charcoal adsorber	
a) Media	Activated carbon
b) Test efficiency @ 70% RH	99.9% elemental iodine 99% methyl iodide
10. Moisture separator	
a) Type	Impingement
b) Initial pressure drop (in., w.g.)	Maximum 1.0

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems (Continued)

g. Sample room fume hood exhaust filter unit

1. Tag number	REA-FU-15
2. Number of units	1
3. Capacity (scfm)	850
4. Type of fan	Centrifugal direct drive (3 hp motor)
5. Prefilter	Replaceable viscous impingement type
6. HEPA filter	Glass media, water repellent and fire resistant
7. HEPA filter efficiency (DOP 0.3 μ particle size)	99.97%
8. Total static pressure (in., w.g.)	4.5

h. Primary containment fan coil units

1. Tag number	CRA-FC-1A CRA-FC-1B CRA-FC-1C	CRA-FC-2A CRA-FC-2B
2. Number of units	3 (1 standby)	2 (1 standby)
3. Fan type	Vaneaxial (2 per unit)	Vaneaxial (2 per unit)
4. Fan motor type	TEAO with Class RN insulation	TEAO with Class RN insulation
5. Nominal air flow (scfm)	40,000	40,000
6. Cooling capacity (sensible) at nominal air flow (Btu/hr)	1,140,000	1,140,000
7. Water supply source	Reactor building closed cooling system	Reactor building closed cooling system

Table 9.4-2

Reactor Building and Primary Containment Areas
Major Components of HVAC Systems (Continued)

i. Primary containment head area return fans

1.	Tag number	CRA-FN-4A CRA-FN-4B
2.	Number of fans	2 (1 standby)
3.	Fan type	Vaneaxial
4.	Drive	Direct
5.	Capacity (acfm)	5000
6.	Total pressure (in., w.g.)	1.68 (normal condition) 5.23 (accident condition)
7.	Motor type	TEAO with Class RN insulation

j. Primary containment recirculating fans

1.	Tag number	CRA-FN-3A, CRA-FN-3B, CRA-FN-3C, CRA-FN-5A, CRA-FN-5B, CRA-FN-5C, CRA-FN-5D
2.	Number of fans	7 (2 standby)
3.	Fan type	Vaneaxial
4.	Drive	Direct
5.	Capacity (acfm)	20,000
6.	Total pressure (in., w.g.)	0.83
7.	Motor type	TEAO with Class RN insulation

Table 9.4-3

Radwaste Building Area Major Components of HVAC Systems

a. Heating and ventilating unit (evaporative air washer)

1. Tag number	WOA-HV-1
2. Number of units	1
3. Maximum air flow (acfm)	91,304 (82,430 cfm normal)
4. Steam flow (lb/hr)	6980
5. Supply air temperature	
a) Summer	72°F DB (evaporative cooling)
b) Winter	50°F (minimum)
6. Fan type	Centrifugal SWSI V-belt drive (150 hp motor)
7. Number of fans	2 (1 standby)
8. Total static pressure (in., w.g.)	5.43

b. Air handling units

1. Tag number	WOA-AH-3	WOA-AH-4	WOA-AH-5	WMA-AH-6	WOA-AH-9
2. Number of units	1	1	1	1	1
3. Drive	V-belt (1 hp motor)	V-belt (5 hp motor)	V- belt (2 hp motor)	V-belt (5 hp motor)	V-belt (1.5 hp motor)
4. Nominal air flow (scfm)	1475	6900	3000	7000	2000
5. Cooling capacity (sensible and latent) at nominal air flow (MBtu/hr)	57	255	155	204	76
6. Total static pressure (in., w.g.)	1.9	1.9	1.77	1.9	1.7
7. Area served	Health physics area	Radio chem lab	Hot instrument shop	Radwaste control room	Counting room
8. Cooling water supply source	Chilled water	Chilled water	Chilled water	Chilled water	Chilled water

Table 9.4-3

Radwaste Building Area Major Components of HVAC Systems (Continued)

c. Exhaust filter units	
1. Tag number	WEA-FU-1A, WEA-FU-1B, WEA-FU-1C
2. Number of units	3
3. Maximum capacity (scfm)	42,000
4. Fan type	Centrifugal direct drive (75 hp motor)
5. Total static pressure (in., w.g.)	7.6
6. Prefilters	
a) Type	Replaceable media
b) Efficiency	80-85%
c) Initial pressure drop (in., w.g.)	0.5 maximum
7. HEPA filters	
a) Type	High efficiency
b) Media	Glass media, water repellent and fire resistant
c) Efficiency (DOP 0.3 μ particle size)	99.97%
d) Initial pressure drop (in., w.g.)	Maximum 1.0

Table 9.4-3

Radwaste Building Area Major Components of HVAC Systems (Continued)

d. Fume hood filter units

1. Tag number	WEA-FU-2A WEA-FU-2B WEA-FU-2C	WEA-FU-4 WEA-FU-5	WEA-FU-6
2. Number of units	3	2	1
3. Capacity (scfm)	1850	1850	3700
4. Fan type	Centrifugal direct drive	Centrifugal direct drive	Centrifugal direct drive
5. Prefilter	Replaceable viscous impingement type	Replaceable viscous impingement type	Replaceable viscous impingement type
6. HEPA filter	Glass media, water repellent and fire resistant	Glass media, water repellent and fire resistant	Glass media, water repellent and fire resistant
7. HEPA filter efficiency (DOP 0.3 µ particle size)	99.97%	99.97%	99.97%
8. Total static pressure (in., w.g.)	4.5	4.5	4.5
9. Area served	Fume hood radio chem labs	Fume hood instrument shop	Fume hood sample room

e. Water chillers

1. Tag number	WCH-CR-51A, WCH-CR-51B
2. Number of units	2 (1 standby)
3. Nominal capacity	150 tons (145 kW compressor motor)
4. Chilled water (gpm)	360
5. Chilled water supply temperature	44°F
6. Condenser cooling water source	Plant service water
7. Area served	Main control room, cable spreading room, health physics area, radwaste control, radio chem lab, counting room, and hot instrument shop

Table 9.4-3

Radwaste Building Area Major Components of HVAC Systems (Continued)

f. Offgas charcoal adsorber vault air handling units (spared in place)

1. Tag number	WRA-AH-7A, WRA-AH-8A, WRA-AH-7B, WRA-AH-8B
2. Number of units	4 (2 standby)
3. Drive	V-belt (15 hp motor)
4. Nominal air flow (acfm)	15,000
5. Total cooling capacity at -55°F brine (R-11) temp (MBtu/hr)	155
6. Nominal brine flow (gpm)	150
7. External static pressure (in., w.g.)	1.5

g. Brine chillers (spared in place)

1. Tag number	WRE-CR-7A, WRE-CR-7B
2. Number of units	2 (1 standby)
3. Brine	R-11
4. Brine flow range (gpm)	265
5. Brine inlet and outlet temperature	-51°F and -55°F
6. Nominal capacity (MBtu/hr)	175
7. Condenser cooling water source	Plant service water or chilled water (both physically disconnected from brine chillers)
8. Area served	Offgas charcoal adsorber vault

Table 9.4-4

Turbine Generator Building Major Components of HVAC Systems

a. Heating and ventilating unit (evaporative air washer)

1.	Tag number	TOA-HV-1A TOA-HV-1B	TOA-HV-2A TOA-HV-2B
2.	Number of units	2	2
3.	Nominal air flow (scfm)	80,000	97,000
4.	Steam flow (lb/hr)	4530	5570
5.	Supply air temperature		
	a) Summer	72°F DB (evaporative cooling)	72°F DB (evaporative cooling)
	b) Winter	50°F	50°F
6.	Fan type	Centrifugal V-belt (125 hp motor)	Centrifugal V-belt (125 hp motor)
7.	Number of fans	2 (1 for each unit)	2 (1 for each unit)
8.	Total static pressure (in., w.g.)	5.8	4.8

b. Exhaust fans

1.	Tag number	TEA-FN-1A, TEA-FN-1B, TEA-FN-1C, TEA-FN-1D
2.	Number of fans	4 (one standby)
3.	Fan type	Centrifugal SWSI
4.	Drive	Direct (200 hp motor)
5.	Capacity (acfm)	117,000
6.	Total static pressure (in., w.g.)	7.0

Table 9.4-4

Turbine Generator Building Major Components of HVAC Systems (Continued)

c. Boiler room air handling unit

1.	Tag number	TOA-AH-51
2.	Number of units	1
3.	Drive	V-belt (15 hp motor)
4.	Nominal air flow (scfm)	15,000
5.	Steam flow (lb/hr)	980
6.	Total static pressure (in., w.g.)	2.1
7.	Area served	Boiler room

d. Local exhaust fans

1.	Tag number	TEA-FN-52	TEA-FN-53	TEA-FN-2	TEA-FN-3A TEA-FN-3B
2.	Number of units	1	1	1	2
3.	Drive	Direct (2 hp motor)	Direct (3/4 hp motor)	Direct (1/4 hp motor)	Direct (2 hp motor)
4.	Nominal air flow (scfm)	1350	810	400	9000
5.	Total static pressure (in., w.g.)	4 1/2	5/8	3/4	1/4
6.	Area served	Fume hood sample room	Sample room	Toilet	Transformer room

Table 9.4-5

Diesel Generator Building Areas Major Components of HVAC Systems

a. Diesel generator building air handling units

1. Tag number	DMA-AH-11 DMA-AH-21 DMA-AH-31	DMA-AH-12 DMA-AH-22 DMA-AH-32	DMA-AH-51
2. Number of units	3	3	1
3. Design air flow per unit (scfm)	36,000	15,000[a]	6000
4. Sensible cooling capacity (Btu/hr)	506,000	210,000	
5. Total static pressure (in., w.g.)	3.57	4.37	2.57
6. Water supply source	Standby service water	Standby service water	
7. Area served	Electrical equipment and generator area (normally standby)	Electrical equipment and generator area (normally standby)	Corridor area

Table 9.4-5

Diesel Generator Building Areas Major Components of HVAC Systems (Continued)

b. Diesel generator building exhaust fans

1. Tag number	DEA-FN-11 DEA-FN-21 DEA-FN-31	DEA-FN-52	DEA-FN-12 DEA-FN-22 DEA-FN-32	DEA-FN-13 DEA-FN-23 DEA-FN-33
2. Number of fans	3	1	3	3
3. Fan type	Vaneaxial	Propeller	Centrifugal SWSI	Centrifugal SWSI
4. Drive	Direct (50 hp motor)	Direct (1.0 hp motor)	Direct (0.5 hp motor)	Direct (1.5 hp motor)
5. Design air flow (scfm)	51,000[a]	2,000	350	300
6. Total pressure (in., w.g.)	4.03	1.07	1.25	0.5
7. Motor type	Totally enclosed air over (TEAO) class F insulated windings, rated for a 50°C ambient temperature		Open drip proof self ventilated type class B insulated windings with a maximum temperature rise of 50°C above ambient	Explosion proof type with class B insulated windings
8. Area served	Diesel generator area	Corridor area	Day tank rooms	Oil pump rooms

[a] Actual air flow of the units is higher and is shown in Figure 9.4-7.

Table 9.4-6

Standby Service Water Pump House Areas
Major Components of HVAC Systems

a. Standby service water pump house supply fans

1.	Tag number	POA-FN-2A POA-FN-2B
2.	Number of fans	2
3.	Fan type and style	Centrifugal SWSI
4.	Drive	Direct (2 hp motor)
5.	Capacity (scfm)	5000
6.	Total static pressure (in., w.g.)	1.0

b. Standby service water pump house fan coil units

1.	Tag number	PRA-FC-1A PRA-FC-1B
2.	Number of units	2
3.	Nominal air flow (scfm) per unit	17,000
4.	Sensible cooling capacity (Btu/hr) per unit	404,000
5.	Total static pressure (in., w.g.)	1.71
6.	Water supply source	Standby service water

Table 9.4-7

Makeup Water Pump House Major Components of HVAC Systems

a. Air handling and fan coil units

1.	Tag number	PMA-AH-81A PMA-AH-81B	PRA-FC-91A PRA-FC-91B
2.	Number of units	2	2
3.	Air flow per unit (acfm)	8000	16,500
4.	Sensible cooling capacity per unit (Btu/hr)	221,000	474,000
5.	Total static pressure (in., w.g.)	2.57	2.19
6.	Fan motor (hp)	7 1/2	10
7.	Area served	Electrical equipment area	Pump area
8.	Water supply service	Cooling tower makeup water	Cooling tower makeup water

b. Exhaust fans

1.	Tag number	PEA-FN-81A PEA-FN-81B	PEA-FN-82
2.	Number of units	2	1
3.	Air flow per unit (scfm)	150	100
4.	Total static pressure (in., w.g.)	0.625	0.375
5.	Area served	Battery hood exhaust	Toilet room
6.	Motor (hp)	1/6	1/8

Table 9.4-8

Circulating Water Pump House
Major Components of HVAC Systems

a. Ventilators

1. Tag number	PEA-FN-51	PEA-FN-52	PEA-RVT-11 PEA-RVT-12 PEA-RVT-13 PEA-RVT-14 PEA-RVT-15 PEA-RVT-16
2. Number of units	1	1	6
3. Rated air flow, (scfm)	4800	250	33,000
4. Total static pressure (in., w.g.)	0.5	1/8	1/8
5. Fan (hp)	2	1/12	7-1/2

b. Air conditioning unit

1. Tag number	PMA-AC-51
2. Number of units	1
3. Rated air flow (scfm)	2000
4. Cooling capacity (Btu/hr)	52,000
5. Heating capacity (Btu/hr)	66,000

LDCN-09-028

Table 9.4-9

Plant Heating Steam System

a. Unit heaters

1. Tag number	TRA-SUH-1	TRA-SUH-2	SRA-SUH-1	WRA-SUH-1	WRA-SUH-3 WRA-SUH-4 WRA-SUH-5
2. Number of units	1	1	1	1	3
3. Heating capacity (mbh)	1410	708	915	1265	204
4. Entering air temperature (°F)	50	50	65	65	65
5. Nominal flow (cfm)	25,000	12,000	15,400	25,000	2250
6. Steam flow (lb/hr)	1540	775	1000	1490	224
7. Area served	Turbine building railroad door	Turbine building truck door	Machine shop truck door	Radwaste building truck door	Radwaste building mechanical equipment room and demineralizer removal area

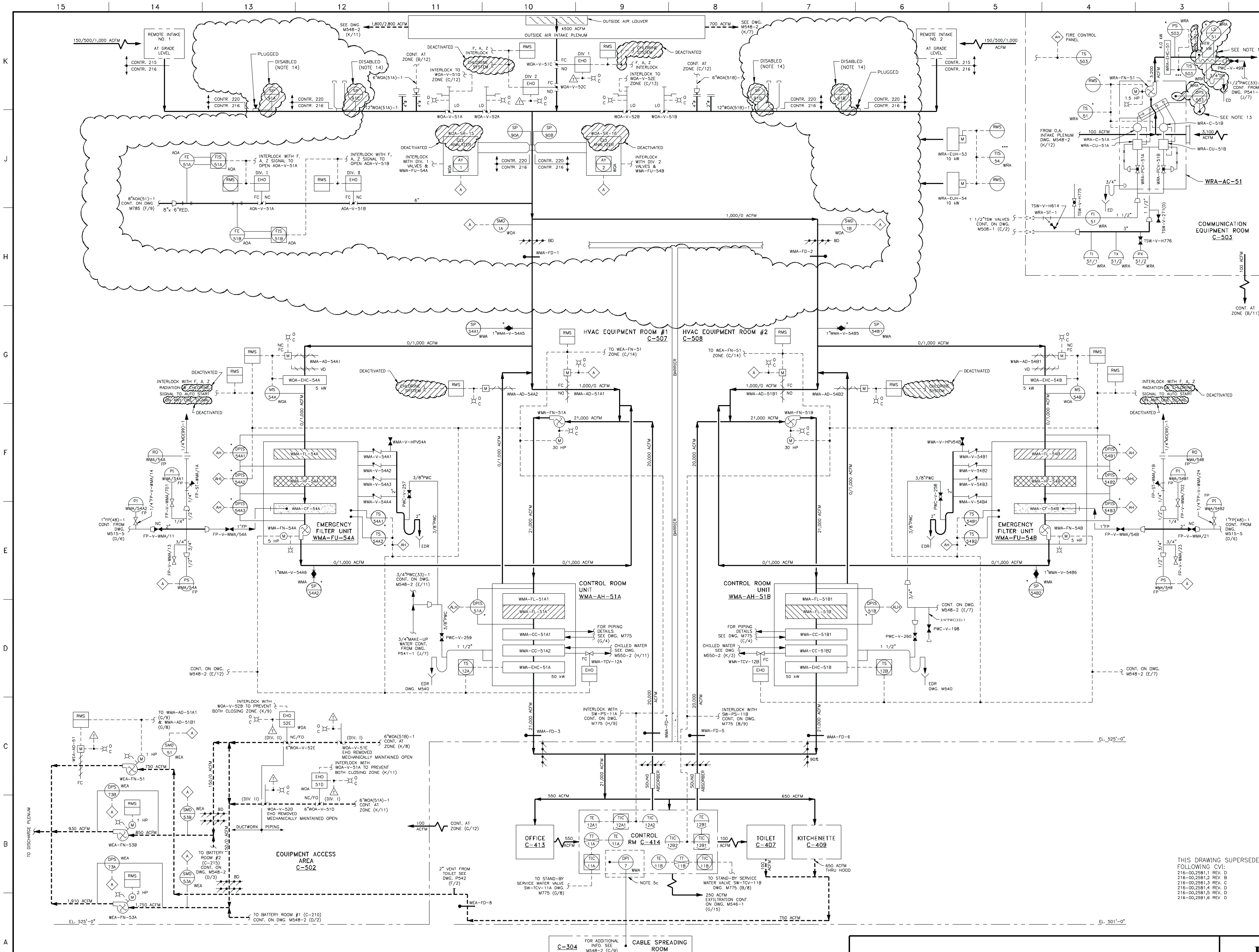
b. Steam humidifiers

1. Tag number	WOA-HU-4	WOA-HU-5	WMA-HU-6	WOA-HU-9
2. Capacity (lb/hr)	200	95	35	75
3. Area served	Radio chem lab	Hot instrument shop	Radwaste control room	Counting room

Table 9.4-9

Plant Heating Steam System (Continued)

c. Condensate pumps		
1. Tag number	SHCO-CU-1	WHCO-CU-1
2. Unit capacity	15,000	80,000
3. Pumpset capacity (gpm)	22.5	120
4. Discharge pressure (psig)	20	25
5. Area served	Service building	Radwaste building
d. Heat transfer package		
1. Tag number	SHHW-HX-51	
2. Heating capacity (mbh)	1800	
3. Steam flow (lb/hr)	1980	
4. Water flow (gpm)	190	
5. Inlet water temperature	161°F	
6. Outlet water temperature	180°F	
7. Area served	Service building	
e. Reheat Coil		
1. Tag number	ROA-HC-2	
2. Air flow (cfm)	33,200	
3. Steam flow (lb/hr)	2560	
4. Air temperature in	50°F	
5. Air temperature out	115°F	
6. Area served	Reactor building	



NOTES:

1. ALL INSTRUMENTS ON THIS DRAWING SHALL BE IDENTIFIED BY PREFIX "WMA" UNLESS OTHERWISE NOTED. (EXAMPLE: WMA-TIC-51A)

2. ALL INSTRUMENTATION SHALL BE PROVIDED BY HVAC CONTRACTOR (CONTR. NO. 216), UNLESS SHOWN AS MOUNTED ON MAIN CONTROL ROOM PANEL OR AS LISTED BELOW.

   OR

   WMA-RE-10A, 10B

3. ALL ITEMS MARKED WITH AN ASTERISK (*) ARE PROVIDED WITH ASSOCIATED EQUIPMENT.

4. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DWG. M501.

5. a) ALL DUCTWORK, EQUIPMENT, INSTRUMENTS, AND ASSOCIATED COMPONENTS SHOWN ON THIS DWG. SHALL BE CLASSIFIED AS FOLLOWS, UNLESS OTHERWISE NOTED:

   SEISMIC CATEGORY I
   QUALITY CLASS I

   b) UNITS WRA-AC-51 AND WRA-AC-52 ALONG WITH ALL ASSOCIATED COMPONENTS, DUCTWORK, HANGERS, AND INSTRUMENTATION SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY II
   QUALITY CLASS II

   c) ALL UNIT HEATERS, ASSOCIATED COMPONENTS, AND INSTRUMENT WMA-DPI-7 SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY II
   QUALITY CLASS II

   ALL SUPPORTS FOR UNIT HEATERS, ASSOCIATED COMPONENTS, INSTRUMENT WMA-DPI-7, AND ITS ASSOCIATED TUBING SHALL BE CLASSIFIED:

   SEISMIC CATEGORY I
   QUALITY CLASS II

   d) ALL CHILLED WATER SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY:

   PIPING SUPPORTS I
   PIPING, VALVES, & ASSOCIATED COMP. II

   QUALITY CLASS:

   PIPING SUPPORTS II
   PIPING, VALVES, & ASSOCIATED COMP. II

   e) ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING IN THE TSW SYSTEM IN THE REACTOR BLDG. AND CONTROL BLDG. SHALL BE CLASSIFIED AS FOLLOWS:

   QUALITY CLASS II+
   SEISMIC CATEGORY II/1M*
   CODE GROUP D
   *HANGERS TO BE DESIGNED TO SEISMIC CATEGORY I LOADS.

6. AIR QUANTITIES INDICATED AS CFM ARE (STANDARD) SCFM. WHERE ACTUAL CFM IS INDICATED AT FAN AS ACFM, CONTRACTOR SHALL BALANCE SYSTEM TO SUIT ACFM CONDITIONS.

7. ALL TAGS FOR INSTRUMENT ROOT VALVES WILL BE FURNISHED AND INSTALLED BY OWNER.

8. INTERFACE WITH OTHER CONTRACTORS:

   a) ALL STANDBY SERVICE WATER SYSTEM, PLANT SERVICE WATER, AND FIRE PROTECTION SYSTEM PIPING (UPSTREAM OF DELUGE VALVE STATIONS) SHOWN ON THIS DRAWING SHALL BE SUPPLIED AND INSTALLED BY MECH. CONTRACTOR (NO. 215).

   b) ALL CHILLED WATER SYSTEMS, MAKE-UP WATER (POTABLE WATER SYSTEM), FIRE PROTECTION SYSTEM (FP) FROM DELUGE VALVE STATIONS TO FILTER UNITS, AND EQUIPMENT DRAIN (FROM EQUIPMENT TO EXISTING EQUIPMENT DRAINS) PIPING AND VALVES SHALL BE SUPPLIED AND INSTALLED BY HVAC CONTRACTOR (NO. 216).

9. ALL FIRE PROTECTION PIPING ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:

   a) PIPING & VALVES:

   SIESMIC CATEGORY II
   QUALITY CLASS II
   CODE GROUP D

   b) PIPING SUPPORTS:

   SEISMIC CATEGORY I
   QUALITY CLASS II

10. TEMPERATURE CONTROL INSTRUMENTS AND CONTROL AIR SUPPLY FOR ELECTRIC HEATING COILS WMA-EHC-51A, 52A, 53A, 51B, 52B, AND 53B ARE SEISMIC CATEGORY II, QUALITY CLASS II. THE POWER SUPPLY FEEDERS TO THESE HEATERS ARE LOCKED "OFF" DURING PLANT OPERATION. THEY MAY BE TURNED ON WHEN THE PLANT IS SHUT DOWN IF DESIRED. SEE NOTE 4 ON DRAWING E503-11.

11. THE POWER SUPPLY FEEDERS FOR UNIT HEATERS WRA-EUH-51 THRU 56 ARE LOCKED "OFF" DURING TIMES OF THE YEAR WHEN CONTROL FAILURE COULD CAUSE EXCESSIVE AMBIENT TEMPERATURE TO CLASS 1E EQUIPMENT. SEE NOTE 3 ON DRAWING E503-5.

12. THIS EQUIPMENT IS NORMALLY CONTROLLED FROM THE MAIN CONTROL ROOM. IF THE MAIN CONTROL ROOM MUST BE VACATED, THIS CONTROL POINT MAY BE ISOLATED AND CONTROL TRANSFERRED TO THE ALTERNATE REMOTE SHUTDOWN PANEL E-CP-ARS.

13. PER EC 5397 PWC-V-499 HAS BEEN CLOSED. WRA-DPS-503, WRA-LS-51, WRA-HU-51 AND ALL PIPING DOWNSTREAM OF PWC-V-499 INCLUDING THE 3/4" DRAIN LINE HAS BEEN DEACTIVATED/DISABLED.

14. SAMPLE POINTS WOA-SP-91A, WOA-SP-91B, WOA-SP-91C AND WOA-SP-91D HAVE BEEN DISABLED. SAMPLE TUBING HAS BEEN REMOVED OR CAPPED. WOA-SR-18A, WOA-SR-18B, WOA-SR-19A AND WOA-SR-19B HAVE BEEN REMOVED FROM FROM THE PLANT PER EC 11373.

LEGEND:

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

2. ALL VALVES SUFFIXED WITH A (DV) DENOTE A DELUGE VALVE.

3. ALL VALVES SUFFIXED WITH A (BWV) DENOTE A BACKWATER VALVE

** DENOTES FURNISHED & INSTALLED BY CONTR. 218
*** DENOTES FURNISHED BY CONTR. 216, & INSTALLED BY CONTR. 218.

THIS DRAWING SUPERSEDES THE FOLLOWING CVI:
216-00,2581,1 REV. D
216-00,2581,2 REV. B
216-00,2581,3 REV. C
216-00,2581,4 REV. D
216-00,2581,5 REV. D
216-00,2581,6 REV. D

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

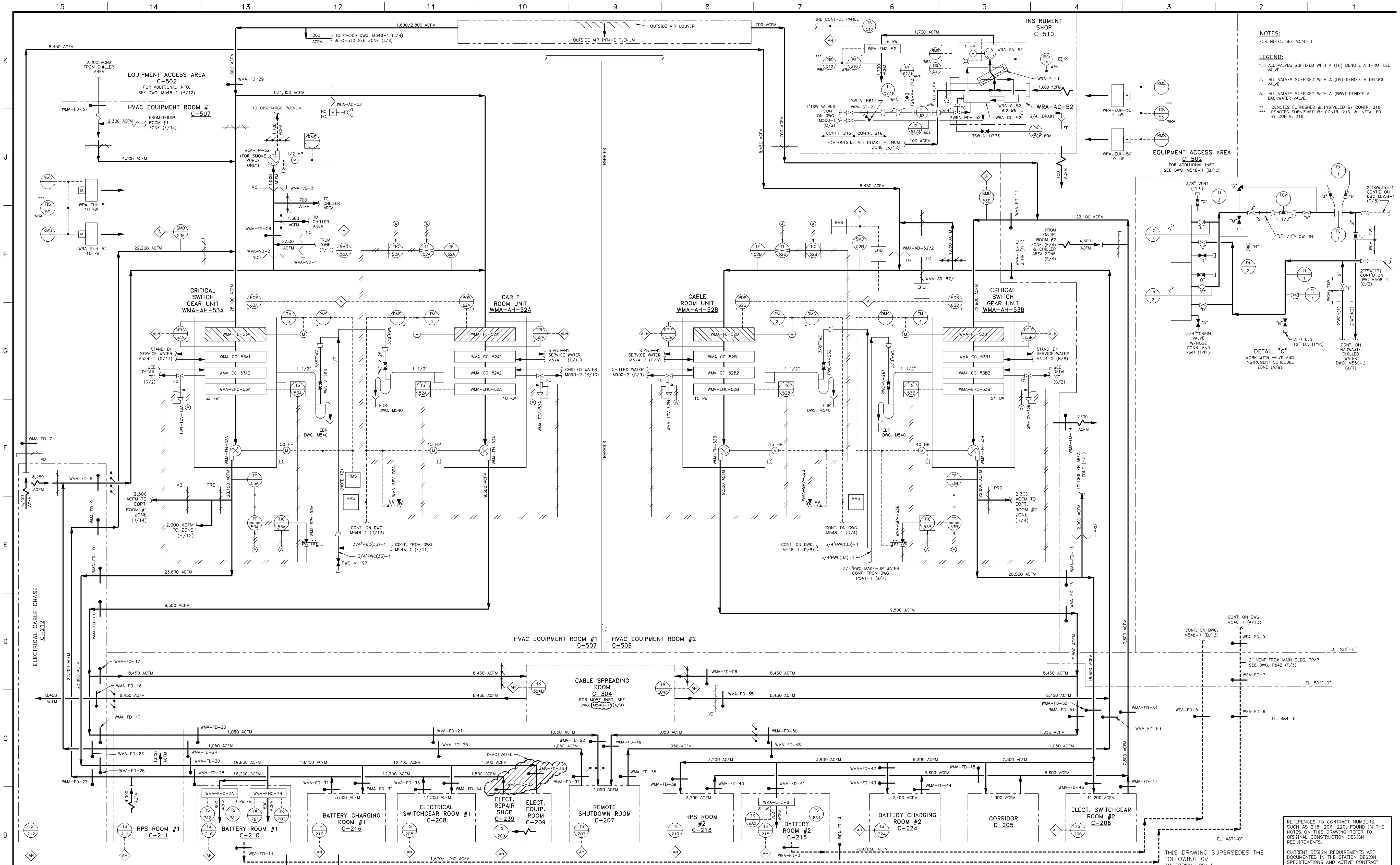
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

HVAC for Control and Switchgear Rooms Radwaste Building

Draw. No. M548–1 | Rev. 102 | Figure 9.4–1.1



NOTES:

FOR NOTES SEE M548-1

LEGEND:

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.
2. ALL VALVES SUFFIXED WITH A (DV) DENOTE A DELUGE VALVE.
3. ALL VALVES SUFFIXED WITH A (BWV) DENOTE A BACKWATER VALVE.

** DENOTES FURNISHED & INSTALLED BY CONTR. 218
*** DENOTES FURNISHED BY CONTR. 216, & INSTALLED BY CONTR. 218.

DRAIN VALVE "R"	VENT VALVE "O"	ISOLATION VALVE "U"	ISOLATION VALVE "T"	STRAINER "S"	DRAIN VALVE "Q"	VENT VALVE "P"	DRAIN VALVE "N"	DRAIN VALVE "M"	BLOWDOWN VALVE "L"	ROOT VALVE "K"	ROOT VALVE "J"	UNIT NUMBER	TCV	SHUT-OFF VALVES "A" - "B" - "C" - "D"	BALANCING VALVES "E" - "F"	BYPASS VALVE "G"	TI 1 - 2	TX 1 - 2	PI 1 - 2	FE-1	FX-1	ROOT VALVE "H"	ROOT VALVE "I"
TSW-V-H615AL	TSW-V-H779AL	TSW-V-276A	TSW-V-275A	TSW-ST-53A	TSW-V-H615A	TSW-V-H779A	TSW-V-H612A	TSW-V-H611A	TSW-V-H610A	TSW-V-H762A	TSW-V-H761A	WMA-AH-53A	TSW-TCV-16A	2"TSW-V-H53AA, AB, AC, AD	2"TSW-V-H53AE(TH), AF	1 1/2"TSW-V-H53AG	TSW-TI-53A1, A2	TSW-TX-53A1, A2	TSW-PI-53A1, A2	TSW-FE-53A1	TSW-FX-53A1	TSW-V-H753A	TSW-V-H754A
TSW-V-H615BL	TSW-V-H779BL	TSW-V-276B	TSW-V-275B	TSW-ST-53B	TSW-V-H615B	TSW-V-H779B	TSW-V-H612B	TSW-V-H611B	TSW-V-H610B	TSW-V-H762B	TSW-V-H761B	WMA-AH-53B	TSW-TCV-16B	2"TSW-V-H53BA, BB, BC, BD	2"TSW-V-H53BE, BF	1 1/2"TSW-V-H53BG	TSW-TI-53B1, B2	TSW-TX-53B1, B2	TSW-PI-53B1, B2	TSW-FE-53B1	TSW-FX-53B1	TSW-V-H753B	TSW-V-H754B

THIS DRAWING SUPERSEDES THE FOLLOWING CVI:
216-00,2581,1 REV. D
216-00,2581,2 REV. B
216-00,2581,3 REV. C
216-00,2581,4 REV. D
216-00,2581,5 REV. D
216-00,2581,6 REV. D

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

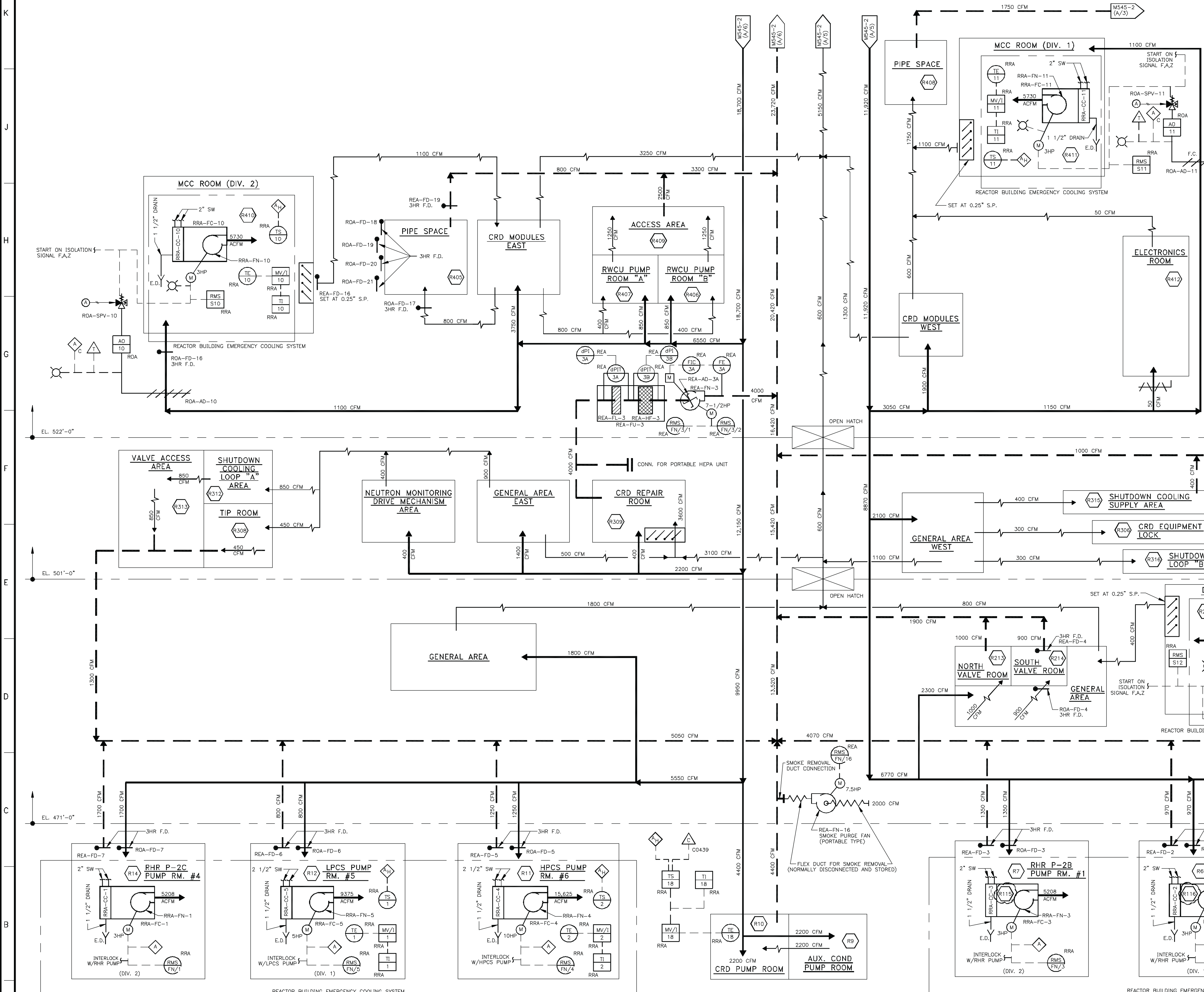
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

HVAC for Control and Switchgear Rooms
Radwaste Building

Draw. No. M548-2	Rev. 9	Figure 9.4-1.2



NOTES

1. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS, SEE DRAWING M501.
2. INSTRUMENTS ARE TAGGED WITH FULL IDENTIFICATION AS FOLLOWS: e.g.
   ROA TS 2 IS TAGGED ROA-TS-2; REA dPT 1A IS TAGGED REA-DPT-1A
3. ISOLATION SIGNAL CODES
   - A - REACTOR VESSEL LOW WATER LEVEL
   - F - HIGH DRYWELL PRESSURE
   - Z - HIGH RADIATION REACTOR BUILDING VENTILATION SYSTEM
4. ASTERISK (*) INDICATES INSTRUMENT SUPPLIED WITH ASSOCIATED EQUIPMENT.
5. ALL PRESSURE AND INSTRUMENT ROOT VALVES ARE 3/4"GLOBE VALVES UNLESS NOTED OTHERWISE. ROOT VALVES FOR FLOW ELEMENTS ARE 1/4" SIZE.
6. a. ALL DUCTWORK BETWEEN OUTERMOST ISOLATION VALVES AND REACTOR BUILDING PENETRATION AND ALL DUCTWORK DIRECTLY CONNECTED TO FAN COIL UNITS RRA-FC-1 THRU -6,-10,-11 THRU -14 ARE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY I
   QUALITY CLASS I
   b. ALL DUCTWORK DIRECTLY CONNECTED TO AIR HANDLING UNIT RRA-AH-7 IS CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II
   QUALITY CLASS II
   c. ALL DUCTWORK HANGERS IN REACTOR BUILDING (UNLESS OTHERWISE NOTED) ARE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY I
   QUALITY CLASS II
   ALL NON-ESSENTIAL HVAC PIPE SUPPORTS IN THE REACTOR BUILDING (UNLESS OTHERWISE NOTED) ARE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY I
   QUALITY CLASS II
   d. ALL DUCTWORK IN REACTOR BUILDING (UNLESS OTHERWISE NOTED) IS CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY - MODIFIED SEISMIC II
   QUALITY CLASS II (SEE WNP-2 SPECS., SECTION 15A.4)
   ALL NON-ESSENTIAL HVAC PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING (UNLESS OTHERWISE NOTED) SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY: MODIFIED SEISMIC II
   QUALITY CLASS II
7. THESE VALVES SHALL BE CLASSIFIED AS FOLLOWED:
   SEISMIC CATEGORY I
   QUALITY CLASS I
   CODE GROUP C
   AIR SUPPLY PIPING & TUBING TO THESE VALVES SHALL BE:
   SEISMIC CATEGORY I
   QUALITY CLASS I
   CODE GROUP D

LEGEND

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

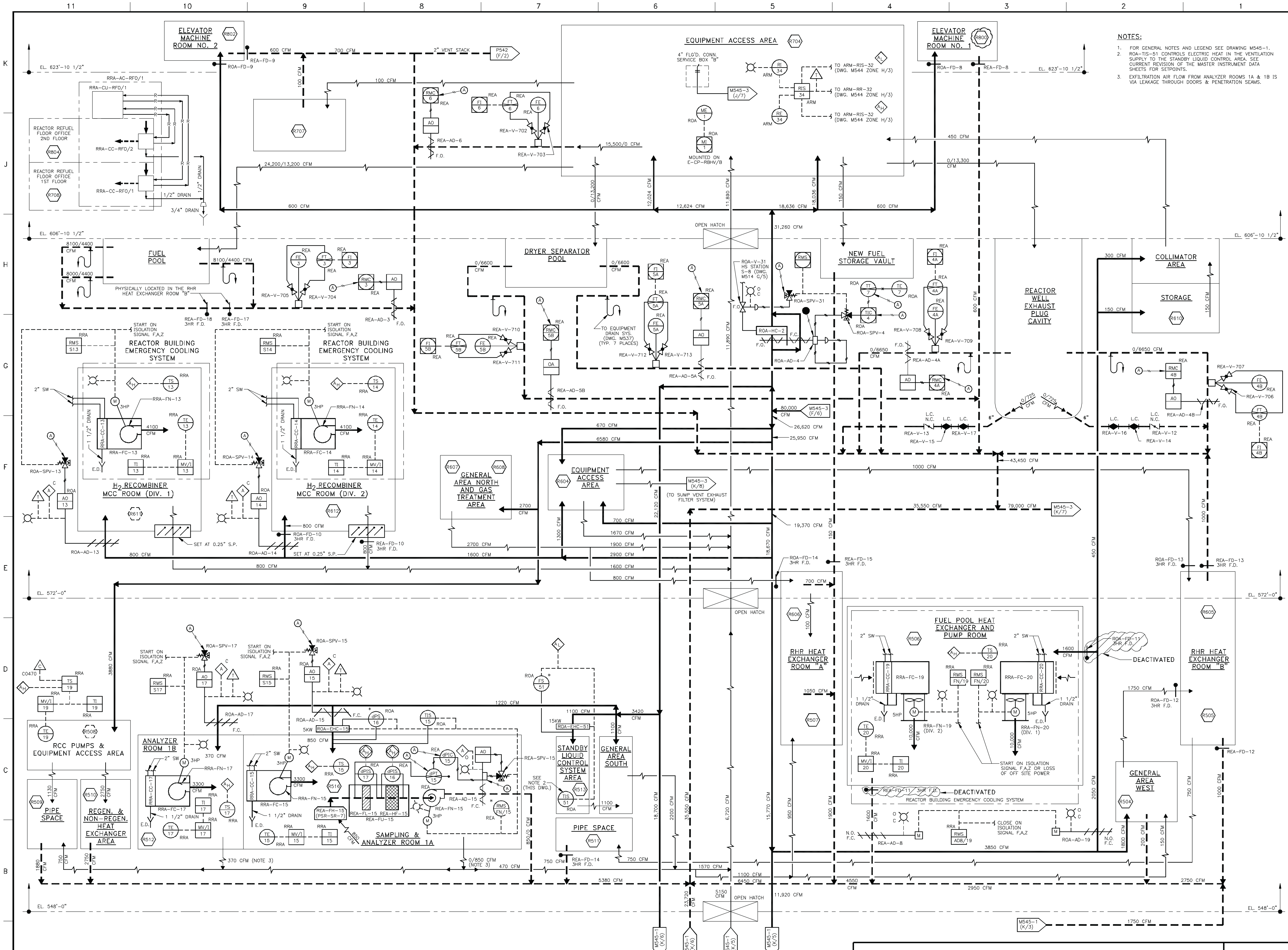
FSAR FIG.

Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Reactor Building

Draw. No. M545-1 | Rev. 72 | Figure 9.4-2.1

Form No. 960690ai

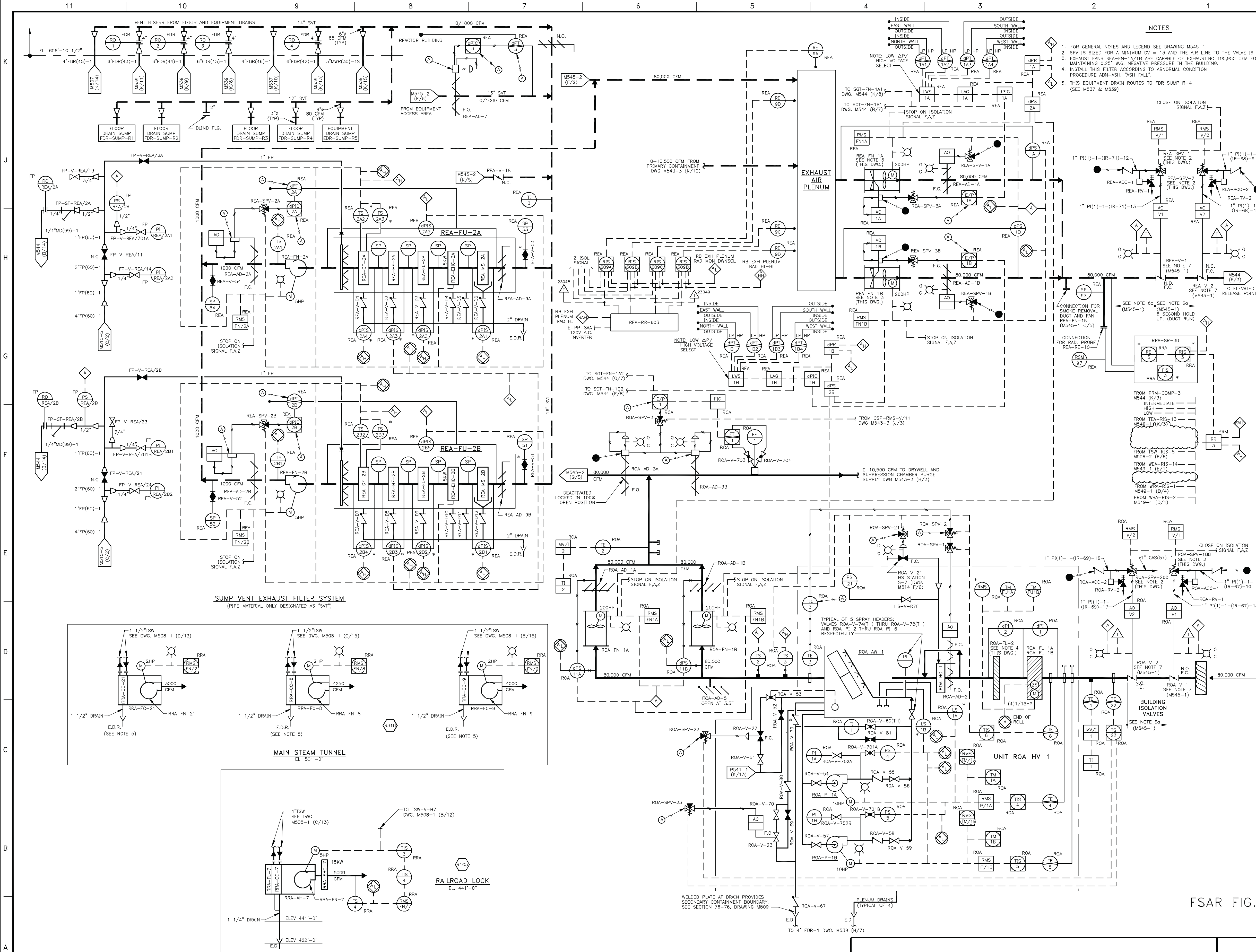


Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Reactor Building

Draw. No. M545-2 | Rev. 13 | Figure 9.4-2.2

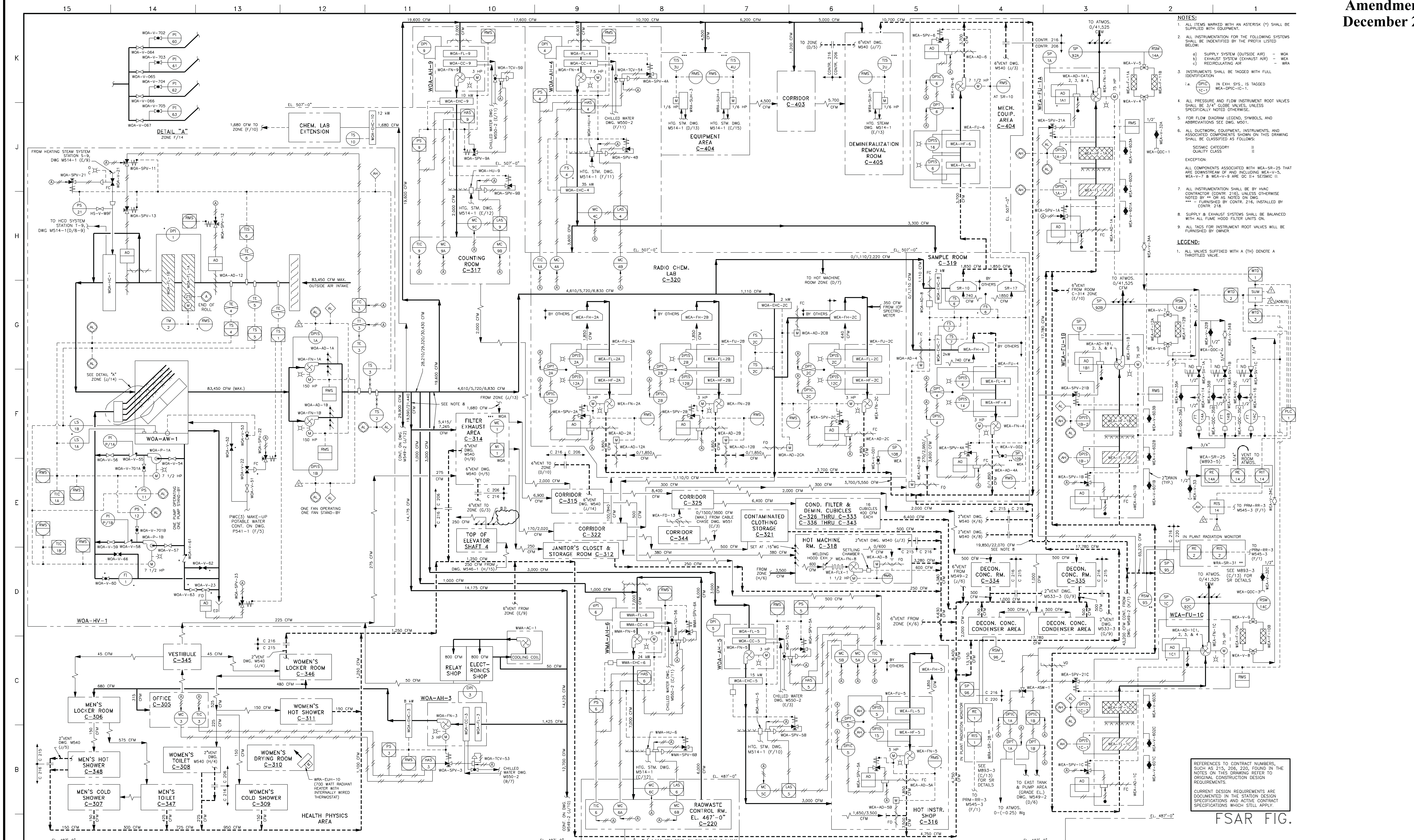
Form No. 960690ai



Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Reactor Building

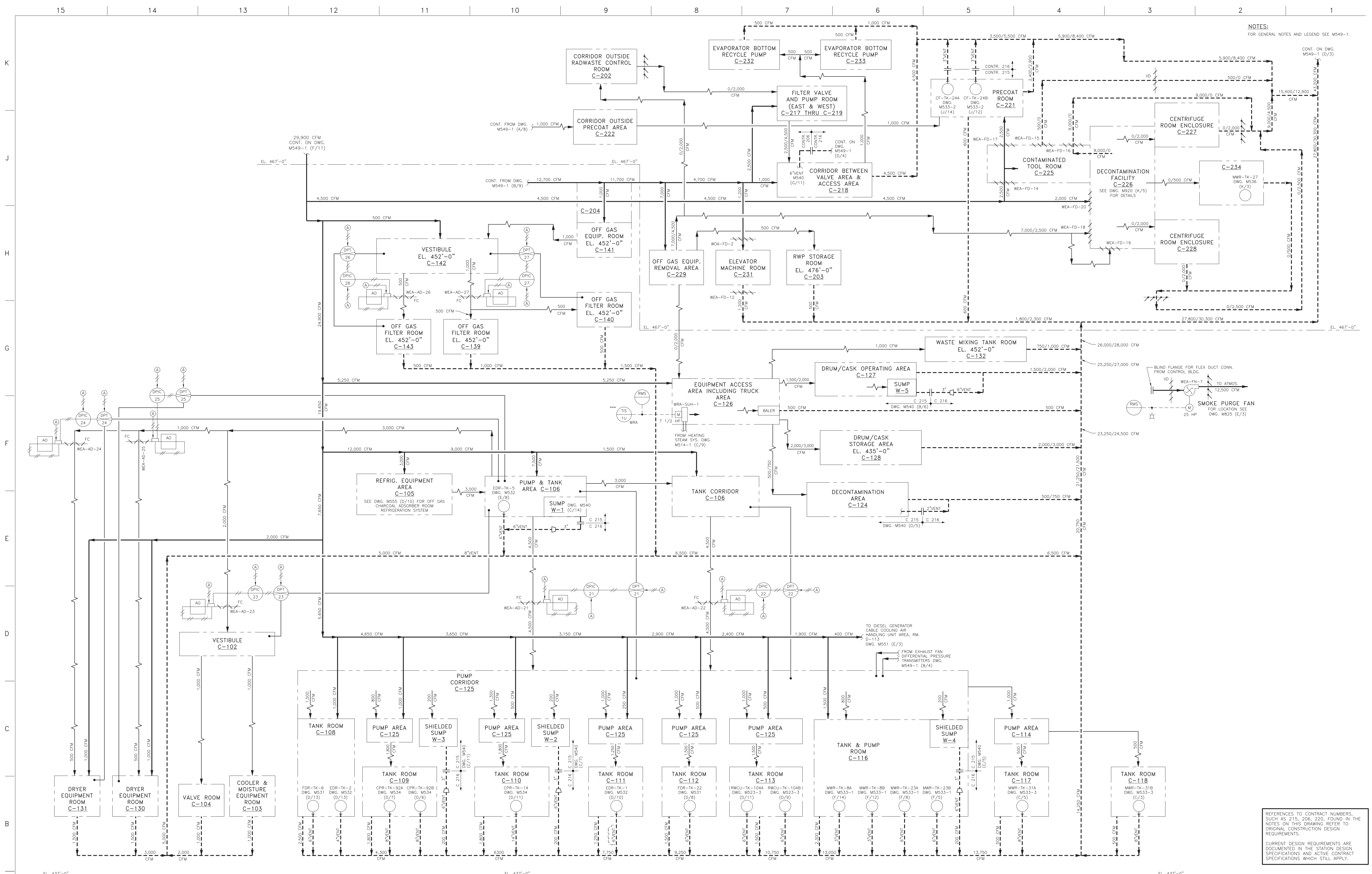
Draw. No. M545-3	Rev. 26	Figure 9.4-2.3



Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Radwaste Building

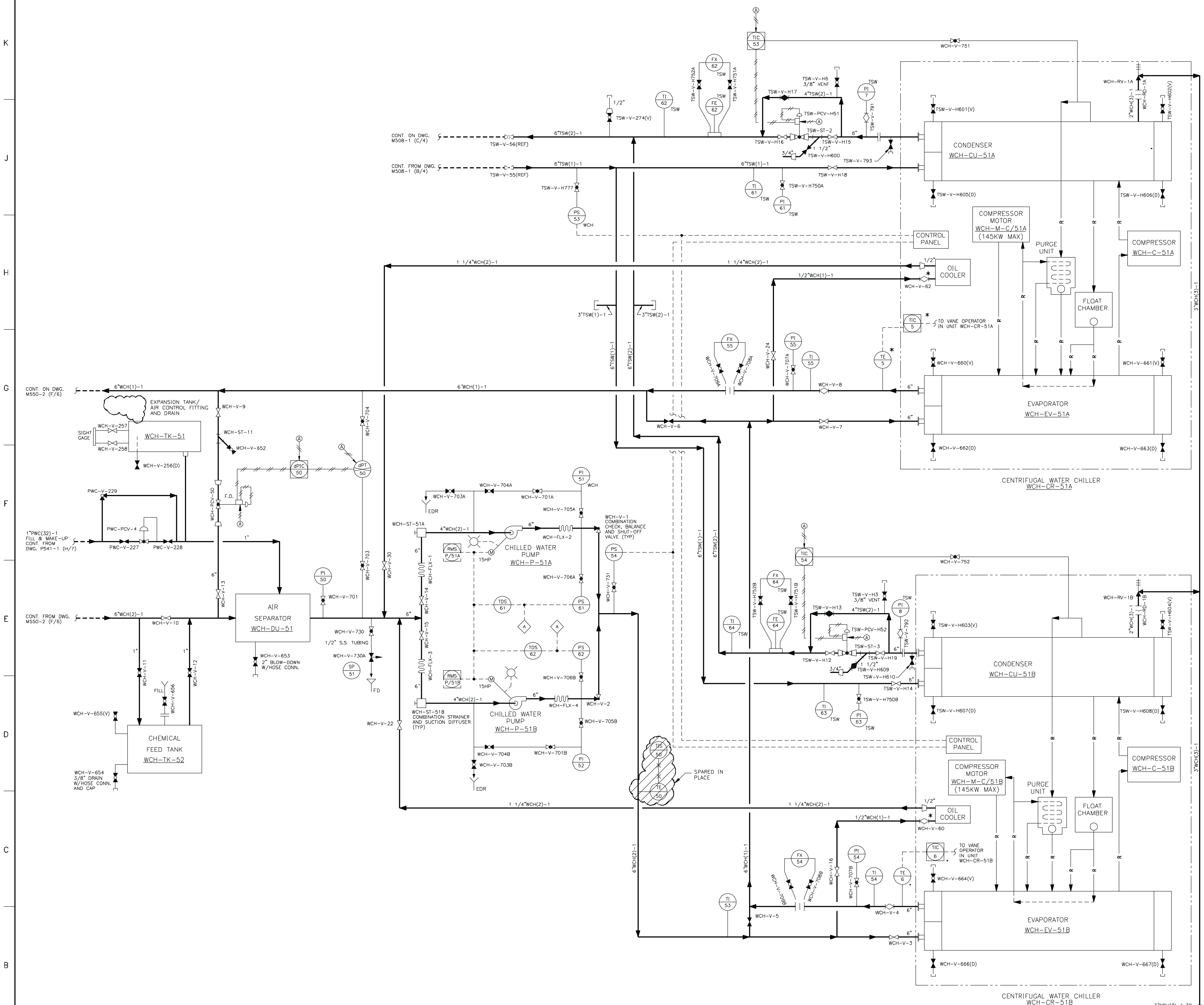
Draw. No. M549-1 | Rev. 62 | Figure 9.4-3.1



Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Radwaste Building

Draw. No. M549-2 | Rev. 2 | Figure 9.4-3.2

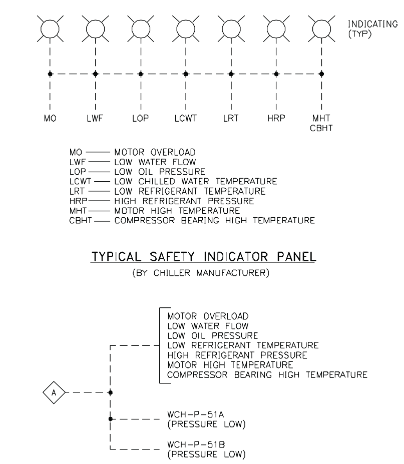


GENERAL NOTES

1. FOR FLOW DIAGRAM LEGEND, SYMBOLS AND ABBREVIATIONS SEE DWG. M501.
2. ALL INSTRUMENTATION AND CONTROLS ON THIS DRAWING SHALL BE IDENTIFIED BY PREFIX "WCH" UNLESS OTHERWISE NOTED.
   EXAMPLE: PI 55 IS WCH-PI-55
   PI 61 TSW IS TSW-PI-61
3. ALL ITEMS MARKED WITH AN ASTERISK (*) INDICATES SUPPLIED WITH ASSOCIATED EQUIPMENT.
4. ALL PIPING, PIPING SUPPORTS, VALVES AND ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:

   SEISMIC CATEGORY:
   PIPING SUPPORTS INSIDE CONTROL BLDG. -I
   PIPING SUPPORTS OUTSIDE CONTROL BLDG. -II
   PIPING, VALVES AND ASSOCIATED COMPONENTS -II

   QUALITY CLASS:
   PIPING SUPPORTS INSIDE CONTROL BLDG. -II
   PIPING SUPPORTS OUTSIDE CONTROL BLDG. -II
   PIPING, VALVES AND ASSOCIATED COMPONENTS -II
5. LINES SHOWN (—— R ——) ARE INTERCONNECTING REFRIGERANT LINES PROVIDED BY THE CHILLER MANUFACTURER.
6. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES UNLESS OTHERWISE NOTED.



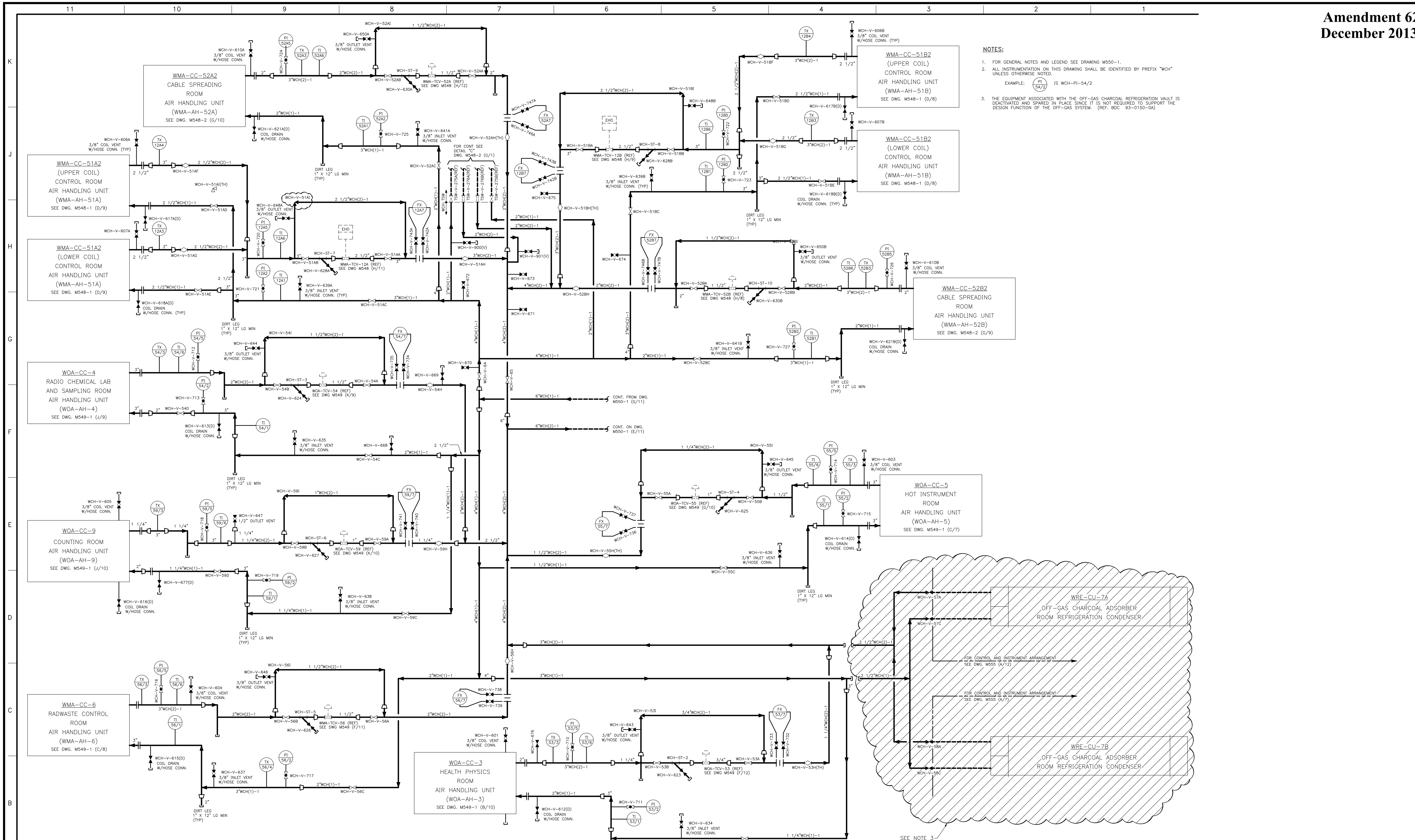
LEGEND

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station
Final Safety Analysis Report

HVAC Chilled Water System – Radwaste Building

Draw. No. M550-1	Rev. 37	Figure 9.4-4.1

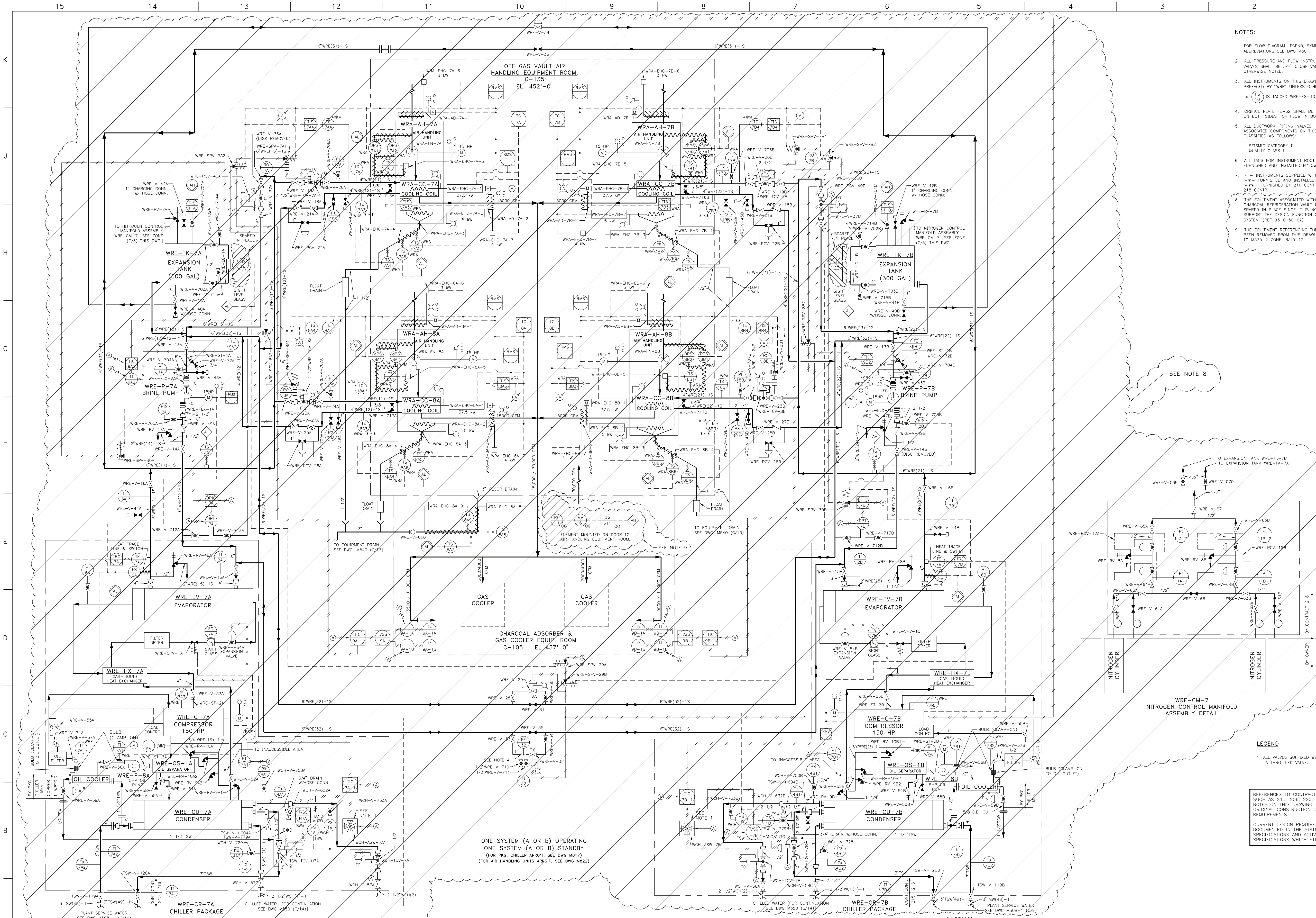


Columbia Generating Station
Final Safety Analysis Report

HVAC Chilled Water System - Radwaste Building

Draw. No. M550-2	Rev. 5	Figure 9.4-4-2

Amendment 58
December 2005



NOTES:

1. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DWG M501.
2. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES UNLESS OTHERWISE NOTED.
3. ALL INSTRUMENTS ON THIS DRAWING TO BE PREFACED BY "WRE" UNLESS OTHERWISE NOTED.
   i.e. (FS/10) IS TAGGED WRE-FS-10.
4. ORIFICE PLATE FE-32 SHALL BE SQUARE-EDGED ON BOTH SIDES FOR FLOW IN BOTH DIRECTIONS.
5. ALL DUCTWORK, PIPING, VALVES, EQUIPMENT, AND ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY II
   QUALITY CLASS II
6. ALL TAGS FOR INSTRUMENT ROOT VALVES WILL BE FURNISHED AND INSTALLED BY OWNER.
7. * - INSTRUMENTS SUPPLIED WITH EQUIPMENT.
   ** - FURNISHED AND INSTALLED BY 218 CONTR.
   *** - FURNISHED BY 216 CONTR., INSTALLED BY 218 CONTR.
8. THE EQUIPMENT ASSOCIATED WITH THE OFF-GAS CHARCOAL REFRIGERATION VAULT IS DEACTIVATED AND SPARED IN PLACE SINCE IT IS NOT REQUIRED TO SUPPORT THE DESIGN FUNCTION OF THE OFF-GAS SYSTEM. (REF 93-0150-0A)
9. THE EQUIPMENT REFERENCING THIS NOTE HAS BEEN REMOVED FROM THIS DRAWING AND MOVED TO M535-2 ZONE: B/10-12.

LEGEND

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

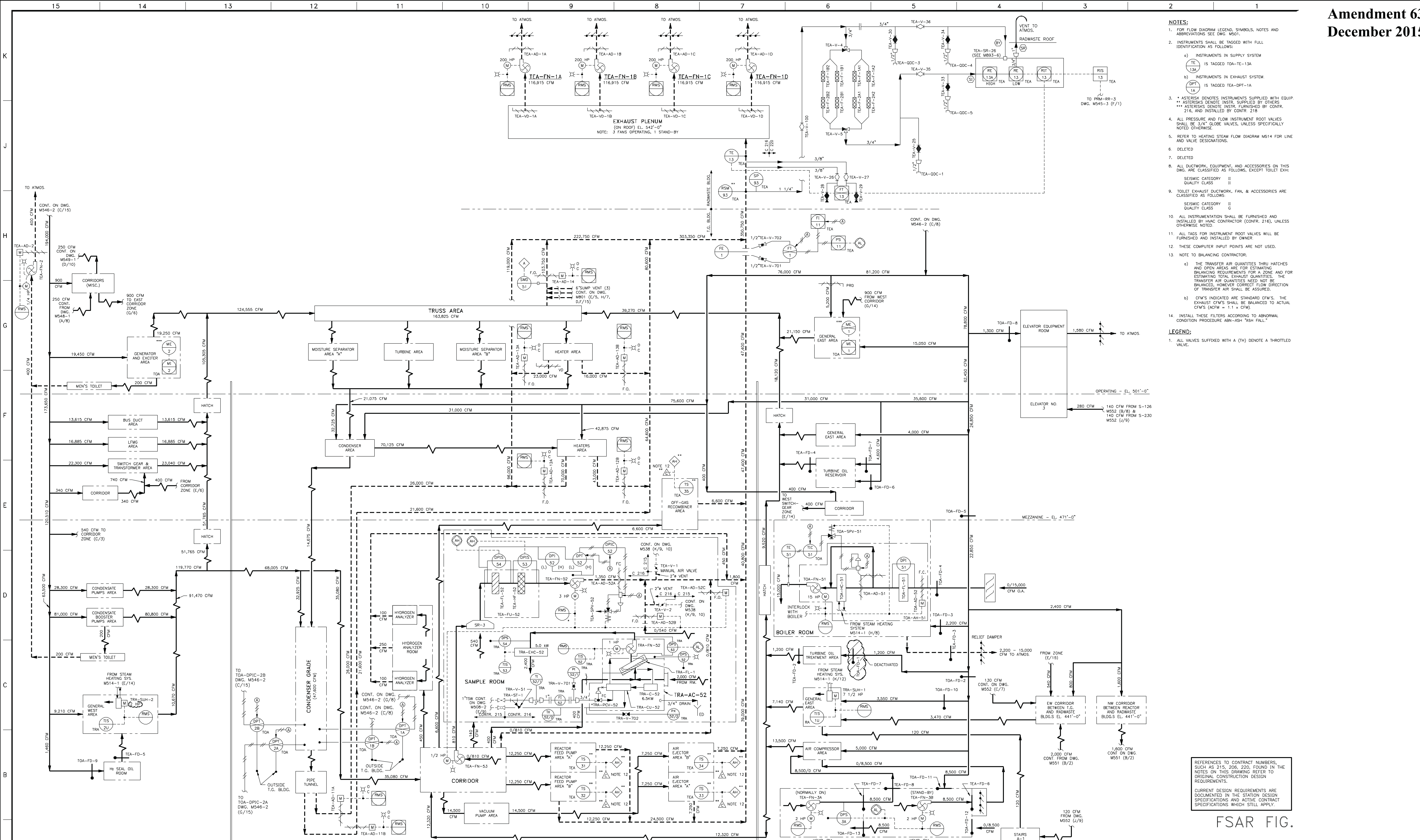
CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

HVAC Offgas Charcoal Adsorber Vault - Radwaste Building

Draw. No. M555 | Rev. 41 | Figure 9.4-5

Form No. 960690FH

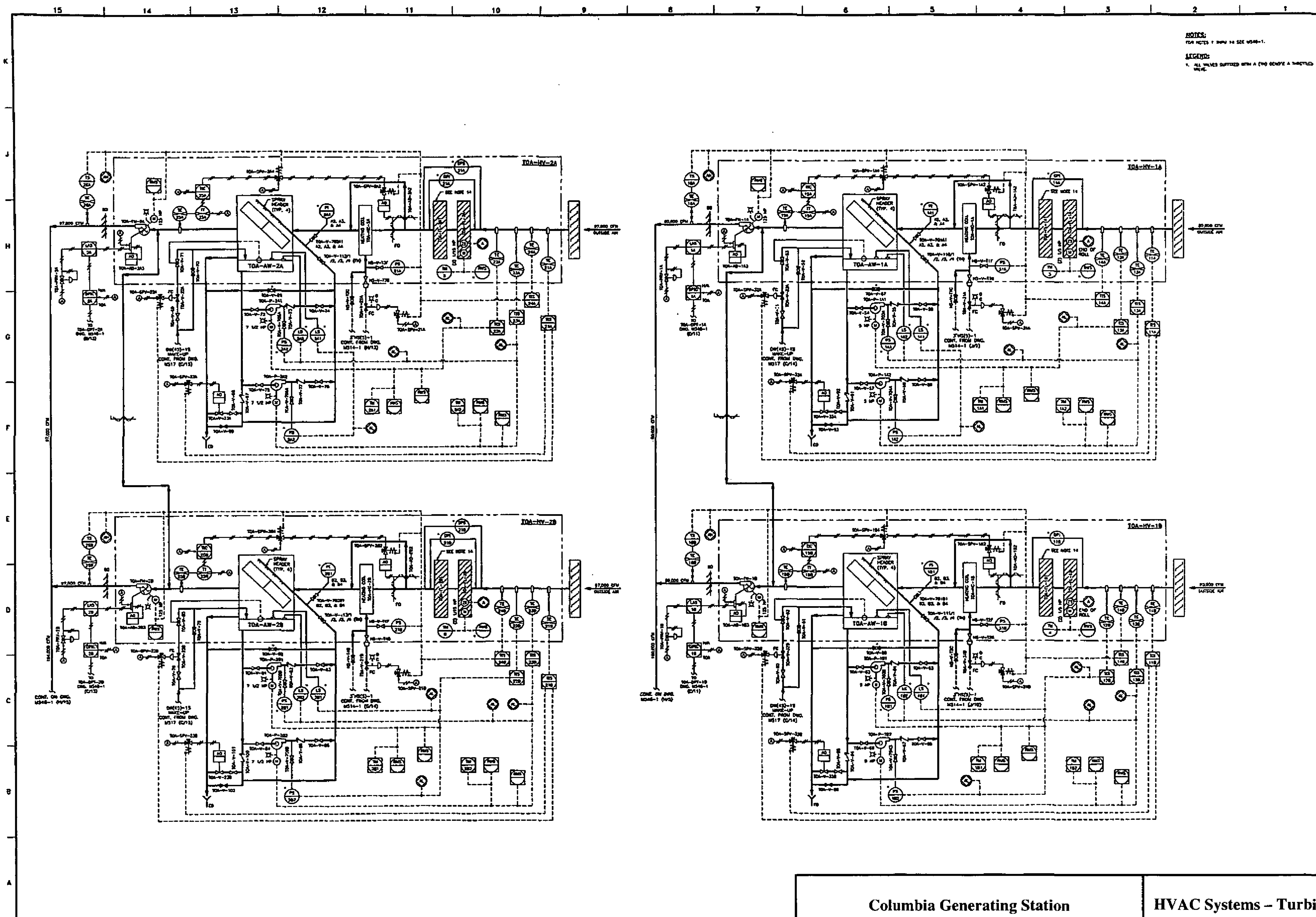


Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Turbine Generator Building

Draw. No. M546-1 | Rev. 56 | Figure 9.4-6.1

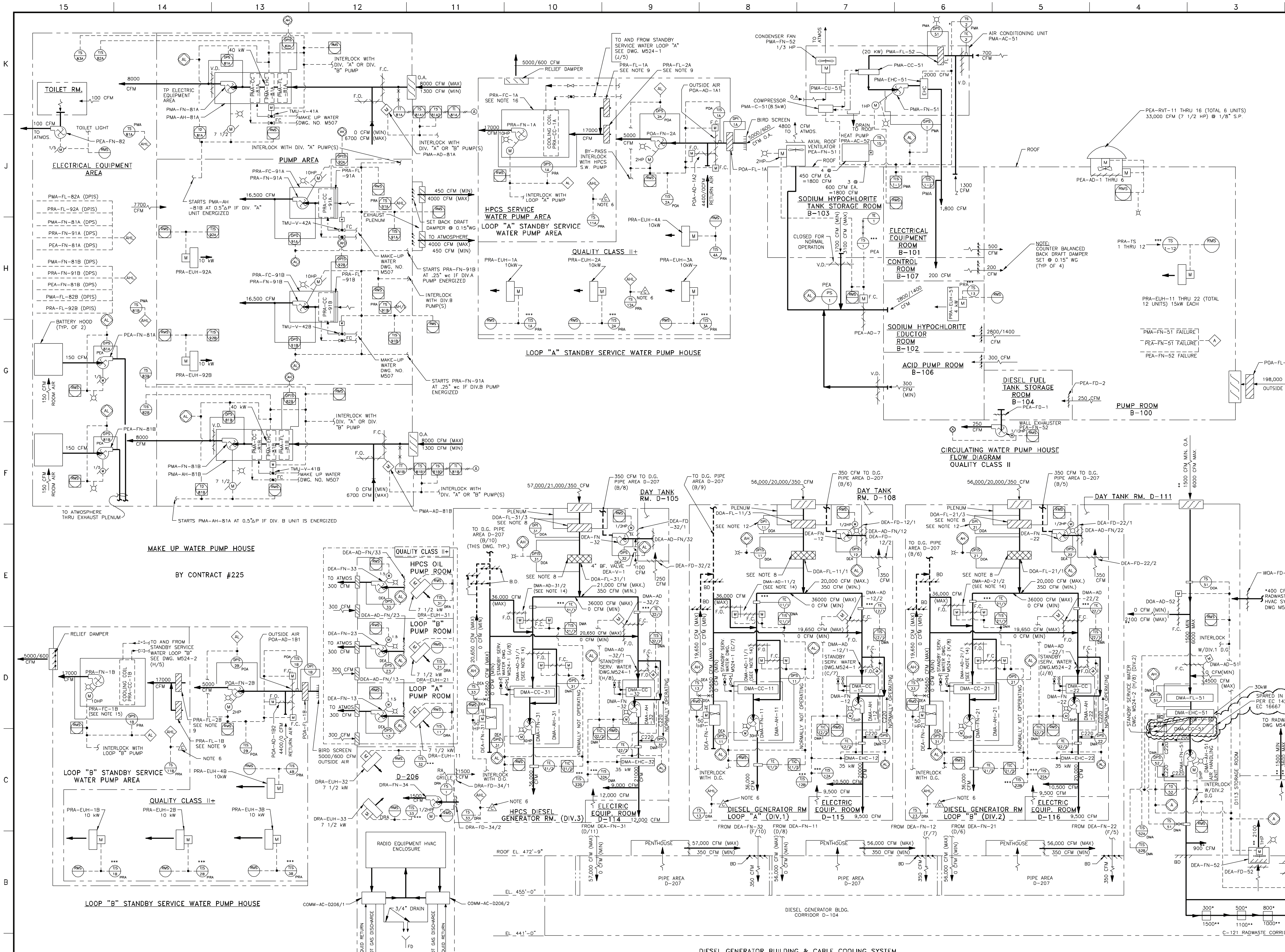
Amendment 57
December 2003



Columbia Generating Station
Final Safety Analysis Report

HVAC Systems – Turbine Generator Building

Draw. No. M546-2	Rev. 0	Figure 9.4-6.2



NOTES:

1. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DWG. M501
2. INSTRUMENTS SHALL BE TAGGED WITH FULL INDENTIFICATION AS FOLLOWS:
   TIS 1A POA IS TAGGED POA-TIS-IA
3. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE
4. ALL SYSTEM COMPONENTS, INCLUDING SUPPORTS, DUCTWORK, PIPING, AND EQUIPMENT SHOWN ON THIS DWG. SHALL BE CLASSIFIED AS FOLLOWS (UNLESS OTHERWISE NOTED):
   A. DIESEL GENERATOR BLDG., CABLE COOLING SYSTEM, AND STANDBY SERVICE WATER PUMP HOUSE.
      SEISMIC CATEGORY I
      QUALITY CLASS I
   B. CIRCULATING WATER PUMP HOUSE, ELECTRIC UNIT HTR'S & FAN DRA-FN-34.
      SEISMIC CATEGORY II
      QUALITY CLASS II
   C. FUEL OIL PUMP ROOM EXHAUST FANS DEA-FN-13, DEA-FN-23 & DEA-FN-33.
      SEISMIC CATEGORY IM
      QUALITY CLASS II+
   D. SEE NOTE 8, 12 & 13 BELOW
5. INTERFACE WITH OTHER CONTRACTORS:
   A. ALL STANDBY SERVICE WATER SYSTEM PIPING AND VALVES SHOWN ON THIS DRAWING SHALL BE SUPPLIED AND INSTALLED BY MECHANICAL CONTRACTOR (CONTRACT NO. 215)
   B. MAKE UP WATER PUMP HOUSE HVAC SYSTEM INCLUDING PIPING AND VALVES SHALL BE SUPPLIED AND INSTALLED UNDER CONTRACT NO. 225
6. THESE COMPUTER INPUT POINTS ARE NOT USED
7. * NORMAL CONDITION CFM
   ** EMERGENCY CONDITION CFM
   *** FURNISHED BY CONTRACT 216 INSTALLED BY OTHERS (CONTR. 218)
8. THE FOLLOWING INTAKE FILTERS SHALL BE CLASSIFIED AS SEISMIC CATEGORY IM, QUALITY CLASS II;
   - DOA-FL-11/1;
   - DOA-FL-21/1;
   - DOA-FL-31/1; DOA-FL-31/3
9. INSTALL THESE FILTERS ACCORDING TO ABNORMAL CONDITIONS PROCEDURE ABN-ASH, "ASH FALL".
10. DELETED
11. DELETED
12. THE FOLLOWING EQUIPMENT SHALL BE CLASSIFIED AS SEISMIC CATEGORY IM, QUALITY CLASS II+:
   - POA-FN-2A(B)
   - ELECTRIC UNIT HEATERS IN THE STANDBY SERVICE WATER PUMP HOUSES AND DIESEL FUEL OIL TRANSFER PUMP ROOMS
     PRA-EUH-1A, 2A, 3A, 4A
     PRA-EUH-1B, 2B, 3B, 4B
     DRA-EUH-11, 21, 31
   - DEA-FN-12, 22, 32
   - DOA-DPI-11, 21
13. THE FOLLOWING EQUIPMENT SHALL BE CLASSIFIED AS SEISMIC CATEGORY II, QUALITY CLASS II;
   - ELECTRIC UNIT HEATERS IN THE DIESEL GENERATOR BUILDINGS FIRE DELUGE EQUIPMENT ROOM DRA-EUH-32 & 33
14. FACE/BYPASS DAMPERS DMA-AD-11/1, DMA-AD-21/1, DMA-AD-31/1 AND OUTSIDE AIR/RECIRCULATION DAMPERS DMA-AD-11/2, DMA-AD-21/2, DMA-AD-31/2 IN THE DIESEL GENERATOR BUILDING ARE OPERATED BY TWO MOTORS WITH LINKAGE ARMS CONNECTING THE TWO SETS OF DAMPERS.
15. FOR PERIODIC THERMAL PERFORMANCE TESTING OF PRA-FC-1B, TEN THERMOCOUPLES ARE INSTALLED IN THE RETURN DUCT OF PRA-FC-1B AND FOUR THERMOCOUPLES ARE INSTALLED ON THE PRA-FN-1B DUCT SCREEN. THESE ARE MOUNTED QC II+ SC 1M.
16. FOR PERIODIC THERMAL PERFORMANCE TESTING OF PRA-FC-1A, TEN THERMOCOUPLES ARE INSTALLED IN THE RETURN DUCT OF PRA-FC-1A AND FOUR THERMOCOUPLES ARE INSTALLED ON THE PRA-FN-1A DUCT SCREEN. THESE ARE MOUNTED QC II+ SC 1M.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

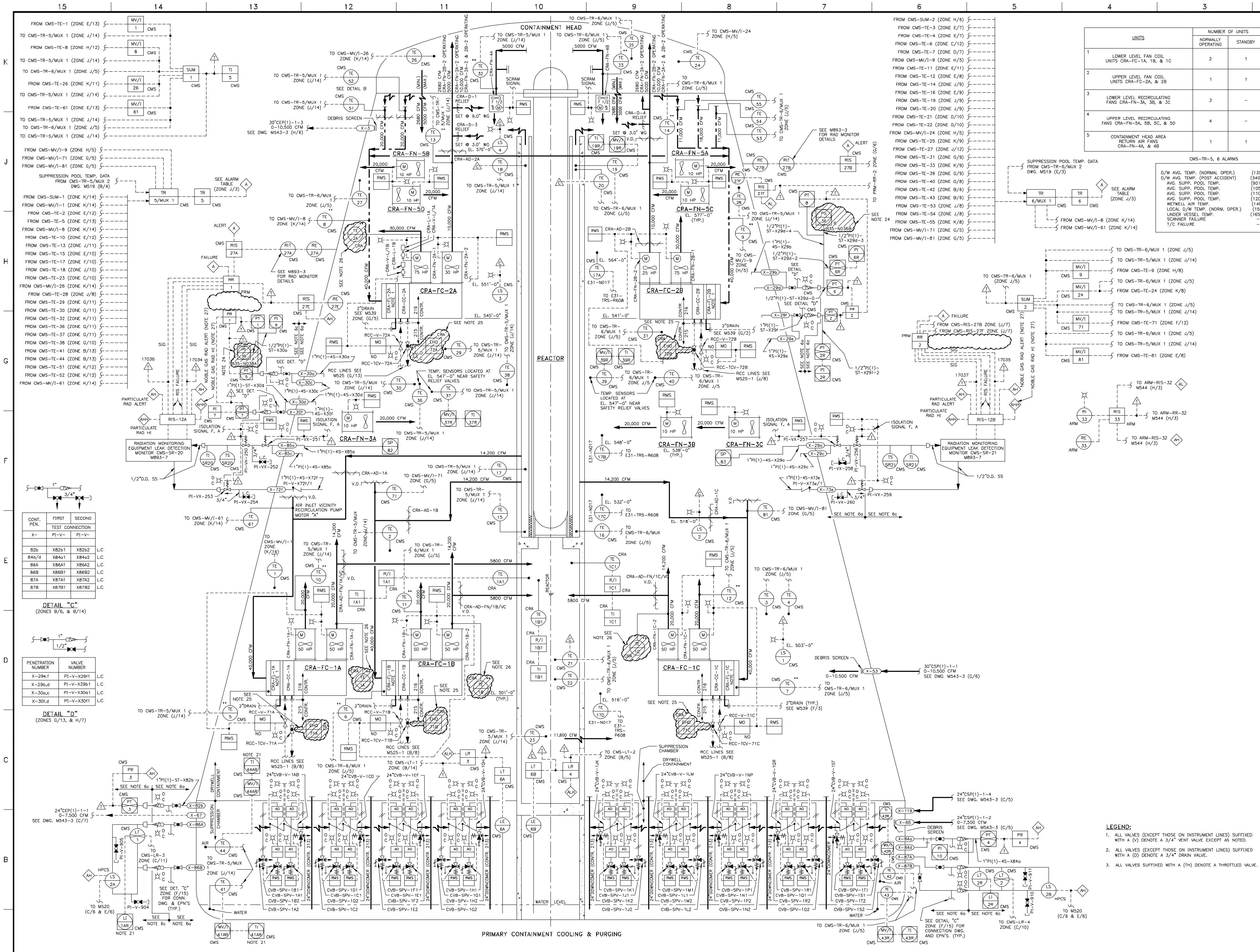
LEGEND

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station
Final Safety Analysis Report

HVAC – CW, SW, and MUW Pump Houses and Diesel Generator Building

Draw. No. M551	Rev. 70	Figure 9.4-7



UNITS	NUMBER OF UNITS	
	NORMALLY OPERATING	STANDBY
1 LOWER LEVEL FAN COIL UNITS CRA-FC-1A, 1B, & 1C	2	1
2 UPPER LEVEL FAN COIL UNITS CRA-FC-2A, & 2B	1	1
3 LOWER LEVEL RECIRCULATING FANS CRA-FN-3A, 3B, & 3C	3	–
4 UPPER LEVEL RECIRCULATING FANS CRA-FN-5A, 5B, 5C, & 5D	4	–
5 CONTAINMENT HEAD AREA RETURN AIR FANS CRA-FN-4A, & 4B	1	1

CMS-TR-5, 6 ALARMS

D/W AVG. TEMP. (NORMAL OPER.)	(135°F)
D/W AVG. TEMP. (POST ACCIDENT)	(340°F)
AVG. SUPP. POOL TEMP.	(90°F)
AVG. SUPP. POOL TEMP.	(105°F)
AVG. SUPP. POOL TEMP.	(110°F)
AVG. SUPP. POOL TEMP.	(120°F)
WETWELL AIR TEMP.	(140°F)
LOCAL D/W TEMP. (NORM. OPER.)	(150°F)
UNDER VESSEL TEMP.	(165°F)
SCANNER FAILURE	–
T/C FAILURE	–

LEGEND:

1. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (V) DENOTE A 3/4" VENT VALVE EXCEPT AS NOTED.
2. ALL VALVES (EXCEPT THOSE ON INSTRUMENT LINES) SUFFIXED WITH A (D) DENOTE A 3/4" DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

NOTES:

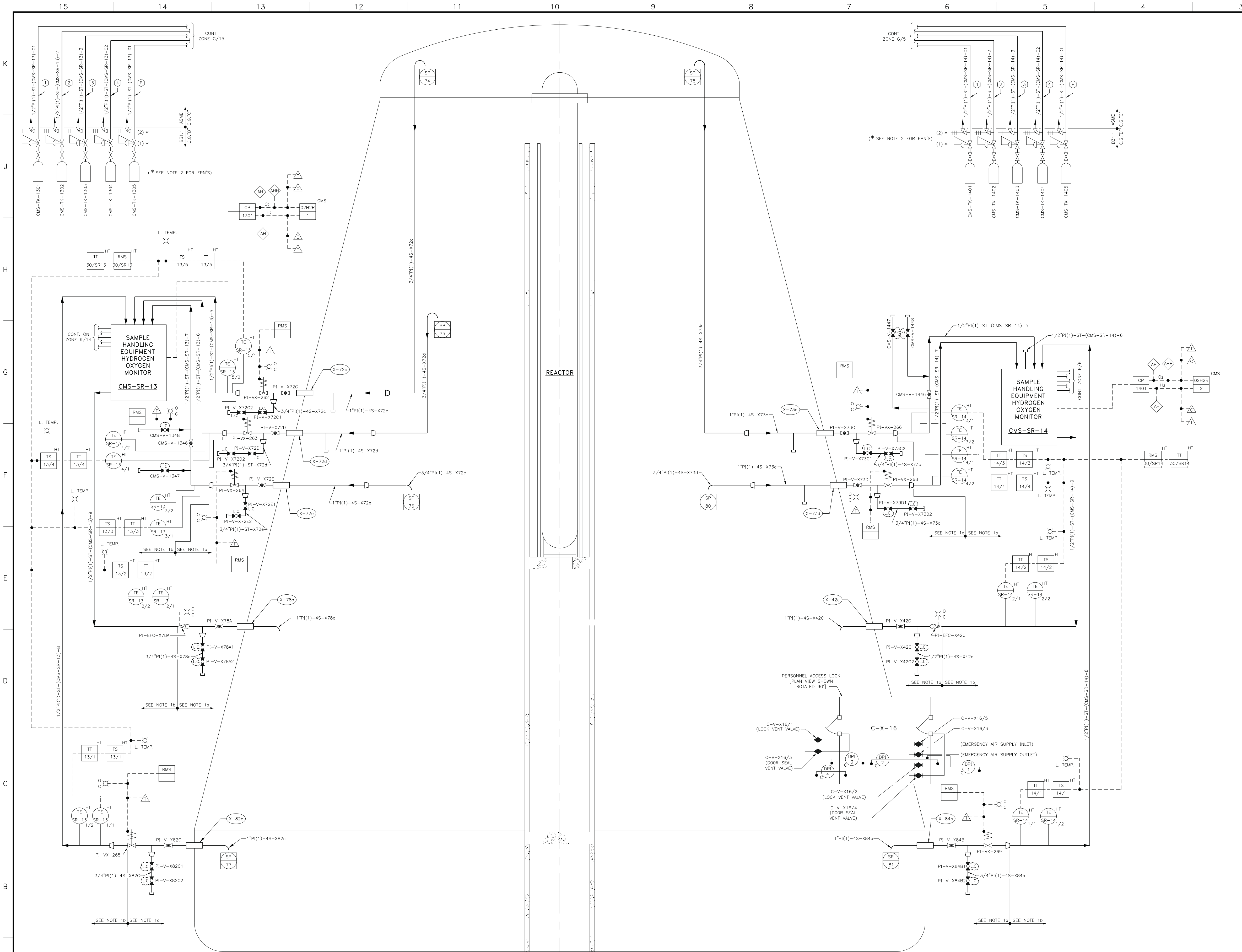
1. FOR ALL FAN COIL UNITS (FC), THE FILTERS ARE USED ONLY DURING CONSTRUCTION PERIOD.
2. ISOLATION SIGNAL CODES:
   A – REACTOR VESSEL LOW WATER LEVEL
   F – HIGH DRYWELL PRESSURE
   Z – HIGH RADIATION, REACTOR BUILDING VENTILATION SYSTEM
3. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DRAWING M501.
4. ALL INSTRUMENTS ON THIS DRAWING TO BE PREFIXED BY "CRA" UNLESS SPECIFICALLY NOTED OTHERWISE.
   EX. FI 2 IS IDENTIFIED AS CRA-FI-2
5. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES UNLESS SPECIFICALLY NOTED OTHERWISE.
6. PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING SHALL BE CLASSIFIED AS FOLLOWS:
   a. PIPING AND VALVES WITHIN PRIMARY CONTAINMENT AND UP TO THE OUTERMOST ISOLATION VALVE OR AS OTHERWISE REFERENCED TO THIS NOTE:
      SEISMIC CATEGORY I
      QUALITY CLASS I
      CODE GROUP B
   b. PIPING AND VALVES BEYOND OUTERMOST ISOLATION VALVES (EXCEPT AS NOTED):
      SEISMIC CATEGORY II
      QUALITY CLASS II } Ø
      CODE GROUP D
      SUPPORTED SEISMIC CATEGORY I IN THE REACTOR BUILDING.
   c. INSTRUMENT LINES AS NOTED
      SEISMIC CATEGORY I
      QUALITY CLASS I } Ø
      CODE GROUP C
   Ø EXCEPT AS NOTED ON M619 INSTRUMENT CONNECTION DIAGRAMS
7. DUCTWORK WITHIN THE PRIMARY CONTAINMENT SHALL BE CLASSIFIED AS FOLLOWS:
   a. HEAD AREA:
      SEISMIC CATEGORY I
      QUALITY CLASS I
   b. ALL OTHER AREAS (EXCEPT 10 GAUGE DUCT SUPPORTING CRA-D-1, -3 & -4 WHICH IS SEISMIC CATEGORY I, QUALITY CLASS II):
      SEISMIC CATEGORY II *
      QUALITY CLASS II
      * SUPPORTED SEISMIC CLASS I
8. CRA-FN-3A, B, C, 4A, B, 5A, B, C, AND D SHALL BE CLASSIFIED AS FOLLOWS:
   SEISMIC CATEGORY I
   QUALITY CLASS I
9. ALL PIPING SYSTEMS IDENTIFIED BY THE PREFIX "PI" SHALL BE SUPPLIED AND INSTALLED BY CONTRACT #220.
10. ALL VALVE TEST CONNECTIONS FOR LINES PENETRATING PRIMARY CONTAINMENT SHALL CONSIST OF 3/4" GLOBE VALVES, WHICH SHALL BE TAGGED AS FOLLOWS:
    CSP-V-800-(NUMBER)
    CEP-V-800-(NUMBER)
11. RADIATION MONITORING AND SAMPLE HANDLING SYSTEMS (CONTRACT 220). VALVES SHALL BE TAGGED AS FOLLOWS:
    a. BLOCK VALVE (*)-V-X(PENETRATION NO.)
    b. EXCESS FLOW CHECK VALVE (*)-EFC-X(PEN. NO.)
    c. CHECK VALVE (*)-CV-X(PENETRATION NO.)
    * USE PI FOR INSTRUMENT LINES AND PSR FOR SAMPLING LINES.
12. ALL TAGS FOR INSTRUMENT ROOT VALVES WILL BE FURNISHED AND INSTALLED BY OWNER.
13. ALL AIR QUANITITES INDICATED ARE ACTUAL CFM.
14. SEE M619-161 FOR THE CONSTRUCTION DETAILS OF THE QUALITY CLASS I INSTRUMENT AIR SYSTEM.
15. **FURNISHED BY CONTRACT 216, INSTALLED BY OTHERS (CONTRACT 218).
16. ALL INSTRUMENT LINES ARE DESIGNATED BY CODE AND LINE NUMBER:
    a. EXAMPLE: LINES ORIGINATING OUTSIDE CONTAINMENT.
       1/2"PI(1)-ST – (H22-P021)-A6
       CODE DESIGNATION LINE NUMBER
    b. EXAMPLE: LINES ORIGINATING INSIDE CONTAINMENT.
       1/2"PI(1)-4S – X106
       CODE DESIGNATION LINE NUMBER
    c. EXAMPLE: CONTINUATION OF THE ABOVE LINE OUTSIDE CONTAINMENT IS DESIGNATED AS FOLLOWS, WITH LINE NUMBERS NOT SHOWN.
       1/2"PI(1)-ST-X106 – (H22-P021)-
       CODE DESIGNATION LINE NUMBER
17. DELETED.
18. THE BLADE SETTING OF THE FANS SHALL BE AS NOTED BELOW:
    a) CRA-FN-1A1, 1B1, 1C1 ----- #4.0
    b) CRA-FN-1A2, 1B2, 1C2 ----- #3.0
    c) CRA-FN-2A1, 2B1 ---------- #1.25
    d) CRA-FN-2A2, 2B2 ---------- #9.0
19. DAMPERS ARE PROVIDED IN (6)RFW, (1)LPCS, AND (1)HPCS OPENINGS THROUGH THE SAC. SHIELD WALL AT APPROXIMATE ELEVATION 560'-1" TO CONTROL COOLING AIR FLOW. THESE DAMPERS DO NOT PREVENT VENTING OF THE ANNULUS DURING AP.
20. AN ACCEPTABLE OPTION TO ONE OR BOTH 1/2" VALVES IS INSTALLATION OF A SOCKET WELDED CAP OR COUPLING/PLUG ONTO THE UNTERMINATED 1/2" TUBE STUB. COMPLY WITH THE FOLLOWING IF THIS OPTION IS USED:
    a) BAR STOCK MATERIAL: SA 479, TYPE 304 (FOR CAP OR PLUG).
    b) COUPLING: 316 STAINLESS STEEL, CAJON #SS-8-TSW-6 OR EQUIVALENT.
    c) INCREASE STUB LENGTH 4" TO 6" MORE THAN WHAT IS NECESSARY FOR INSTALLATION OF VALVE(S).
21. THESE INSTRUMENTS ARE LOCATED ON THE ALTERNATE REMOTE SHUTDOWN PANEL E-CP-ARS.
22. VALVES CSP-V-93, CSP-V-96, CSP-V-97, & CSP-V-98 ARE INSTALLED IN THE REVERSE DIRECTION. ACCIDENT FLOW TO THESE VALVES IS FROM PRIMARY CONTAINMENT.
23. VACUUM RELIEF FROM SECONDARY CONTAINMENT AT 0.5 PSID WITH THE SUPPRESSION CHAMBER PRESSURE.
24. EQUIPMENT SHOWN IN CROSSHATCH IS SPARED IN PLACE.
25. VALVE OPERATOR HAS BEEN DEACTIVATED AND SPARED IN PLACE. VALVE IS IN THE OPEN POSITION AND FLUID DRAINED FROM OPERATOR.
26. TEMPERATURE ELEMENT HAS BEEN DEACTIVATED AND SPARED IN PLACE.
27. THE NEW TERMINOLOGY FOR EXIST HI, HI-HI ALARMS IS NOW ALERT & HI RESPECTIVELY FOR GA-ESI EQUIPMENT.

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Flow Diagram - Reactor Building Primary Containment Cooling and Purging System

Draw. No. M543-1 | Rev. 90 | Figure 9.4-8.1



NOTES:

1. ALL PIPING AND VALVES AND ASSOCIATED COMPONENTS ON THIS DRAWIING SHALL BE CLASSIFIED AS FOLLOWS: (BREAK POINTS INDICATED ON FLOW DIAGRAM)

   a. PIPING AND VALVES WITHIN PRIMARY CONTAINMENT AND UP TO THE OUTERMOST ISOLATION VALVES:

      SEISMIC CATEGORY I
      QUALITY CLASS I
      CODE GROUP B

   b. PIPING AND VALVES BEYOND THE OUTERMOST ISOLATION VALVES (INSTRUMENT LINES):

      SEISMIC CATEGORY I
      QUALITY CLASS I
      CODE GROUP C

2. CMS EPN'S FOR CALIBRATION GAS:

TANK #	(1)REGULATOR#	(2)RELIEF VALVES#	TANK VALVE
CMS-TK-1301	CMS-PRV-1301	CMS-RV-1301	CMS-V-1351
CMS-TK-1302	CMS-PRV-1302	CMS-RV-1302	CMS-V-1352
CMS-TK-1303	CMS-PRV-1303	CMS-RV-1303	CMS-V-1353
CMS-TK-1304	CMS-PRV-1304	CMS-RV-1304	CMS-V-1354
CMS-TK-1305	CMS-PRV-1305	CMS-RV-1305	CMS-V-1355
CMS-TK-1401	CMS-PRV-1401	CMS-RV-1401	CMS-V-1451
CMS-TK-1402	CMS-PRV-1402	CMS-RV-1402	CMS-V-1452
CMS-TK-1403	CMS-PRV-1403	CMS-RV-1403	CMS-V-1453
CMS-TK-1404	CMS-PRV-1404	CMS-RV-1404	CMS-V-1454
CMS-TK-1405	CMS-PRV-1405	CMS-RV-1405	CMS-V-1455

3. ⬡ REPRESENTS RACK CONNECTION BULKHEAD NUMBER.

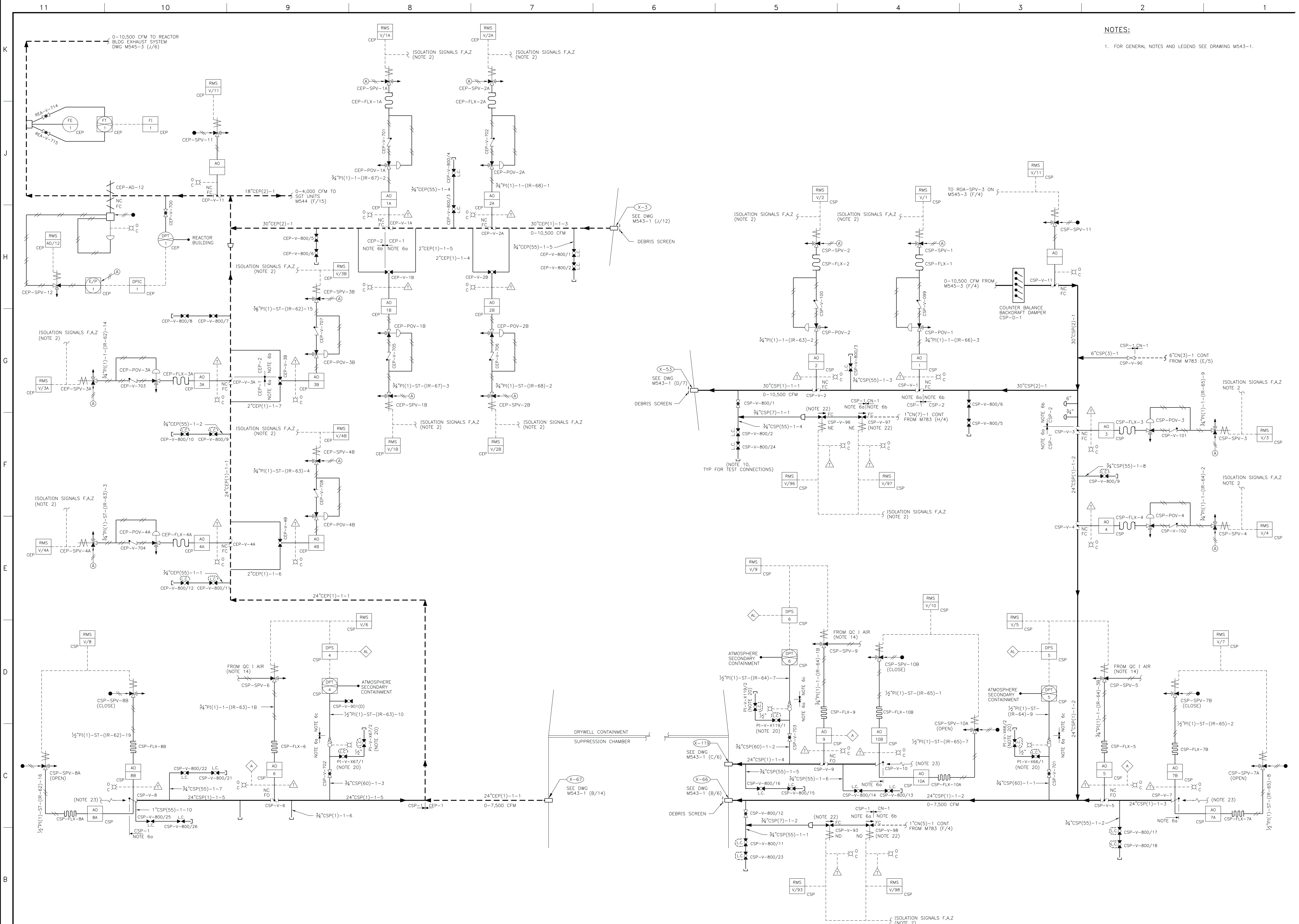
REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station
Final Safety Analysis Report

Flow Diagram - Reactor Building Primary Containment Cooling and Purging System

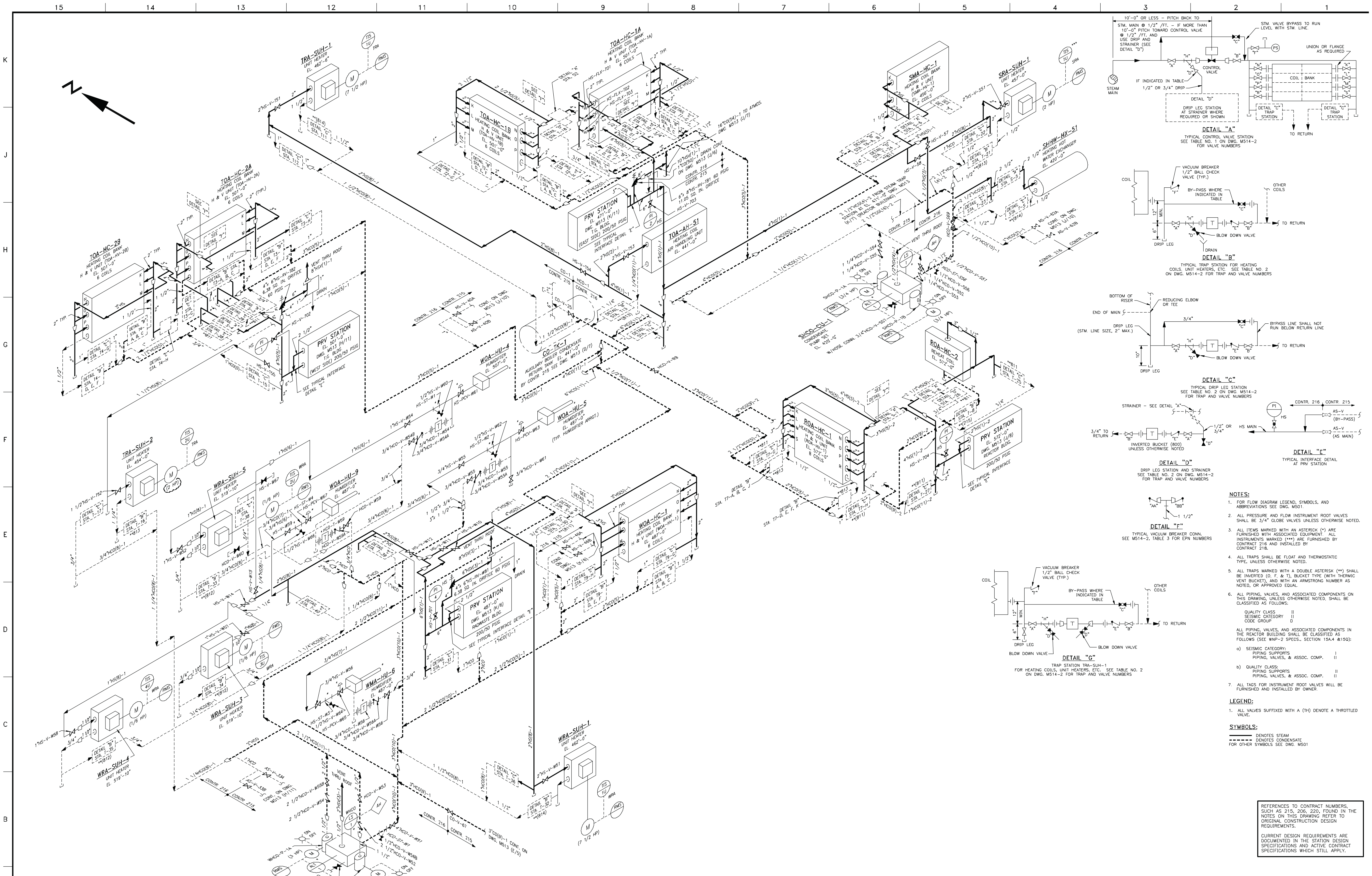
Draw. No. M543-2 | Rev. 11 | Figure 9.4-8.2



Columbia Generating Station
Final Safety Analysis Report

Flow Diagram - Reactor Building Primary Containment Cooling and Purging System

Draw. No. M543-3 | Rev. 4 | Figure 9.4-8.3



NOTES:

1. FOR FLOW DIAGRAM LEGEND, SYMBOLS, AND ABBREVIATIONS SEE DWG. M501.
2. ALL PRESSURE AND FLOW INSTRUMENT ROOT VALVES SHALL BE 3/4" GLOBE VALVES UNLESS OTHERWISE NOTED.
3. ALL ITEMS MARKED WITH AN ASTERICK (*) ARE FURNISHED WITH ASSOCIATED EQUIPMENT. ALL INSTRUMENTS MARKED (***) ARE FURNISHED BY CONTRACT 216 AND INSTALLED BY CONTRACT 218.
4. ALL TRAPS SHALL BE FLOAT AND THERMOSTATIC TYPE, UNLESS OTHERWISE NOTED.
5. ALL TRAPS MARKED WITH A DOUBLE ASTERISK (**) SHALL BE INVERTED (O. F. & T), BUCKET TYPE (WITH THERMIC VENT BUCKET), AND WITH AN ARMSTRONG NUMBER AS NOTED, OR APPROVED EQUAL.
6. ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS ON THIS DRAWING, UNLESS OTHERWISE NOTED, SHALL BE CLASSIFIED AS FOLLOWS:

   QUALITY CLASS II
   SEISMIC CATEGORY II
   CODE GROUP D

   ALL PIPING, VALVES, AND ASSOCIATED COMPONENTS IN THE REACTOR BUILDING SHALL BE CLASSIFIED AS FOLLOWS (SEE WNP-2 SPECS., SECTION 15A.4 &15Q):

   a) SEISMIC CATEGORY:
      PIPING SUPPORTS I
      PIPING, VALVES, & ASSOC. COMP. II

   b) QUALITY CLASS:
      PIPING SUPPORTS II
      PIPING, VALVES, & ASSOC. COMP. II

7. ALL TAGS FOR INSTRUMENT ROOT VALVES WILL BE FURNISHED AND INSTALLED BY OWNER.

LEGEND:

1. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

SYMBOLS:

—— DENOTES STEAM
- - - DENOTES CONDENSATE
FOR OTHER SYMBOLS SEE DWG. M501

REFERENCES TO CONTRACT NUMBERS, SUCH AS 215, 206, 220, FOUND IN THE NOTES ON THIS DRAWING REFER TO ORIGINAL CONSTRUCTION DESIGN REQUIREMENTS.

CURRENT DESIGN REQUIREMENTS ARE DOCUMENTED IN THE STATION DESIGN SPECIFICATIONS AND ACTIVE CONTRACT SPECIFICATIONS WHICH STILL APPLY.

Columbia Generating Station Final Safety Analysis Report	Heating Steam System – All Buildings		
	Draw. No. M514-1	Rev. 41	Figure 9.4-9.1

NOTES

1. FOR GENERAL NOTES SEE DRAWING M514-1.

TABLE NO. 1 – VALVE NUMBERS FOR CONTROL STATIONS

HS STATION NUMBER	CONTROL VALVE	SHUT OFF VALVES "A" & "B"	SHUT OFF VALVES "F"	BY-PASS VALVE "C"	BLOW DOWN VALVE "D"	Y STRAINERS "H"	SHUT OFF VALVES "K THRU S"
S-1	3"TOA-V-31A	4"HS-V-T1A & T1B	1/2"HS-V-T1F	3"HS-V-T1C		4"HCO-ST-S1	2"HS-V-T1K THRU T1P
S-2	3"TOA-V-31B	4"HS-V-T2A & T2B	1/2"HS-V-T2F	3"HS-V-T2C		4"HCO-ST-S2	2"HS-V-T2K THRU T2P
S-3	3"TOA-V-21A	4"HS-V-T3A & T3B	1/2"HS-V-T3F	3"HS-V-T3C	1/2"HS-V-T3D	4"HCO-ST-S3	2"HS-V-T3K THRU T3P
S-4	3"TOA-V-21B	4"HS-V-T4A & T4B	1/2"HS-V-T4F	3"HS-V-T4C	1/2"HS-V-T4D	4"HCO-ST-S4	2"HS-V-T4K THRU T4P
S-5	2"HS-TCV-S5	2 1/2"HS-V-S5A & S5B		2"HS-V-S5C	3/4"HS-V-S5D	2"HCO-ST-S5	2 1/2"HS-V-S5K
S-6	3"SMA-V-21	3"HS-V-S6A & S6B	1/2"HS-V-S6F	2 1/2"HS-V-S6C		3"HCO-ST-S6	2"HS-V-S6K & S6L
S-7	3"ROA-V-21	4"HS-V-R7A & R7B	1/2"HS-V-R7F	3"HS-V-R7C	1/2"HS-V-R7D	4"HCO-ST-S7	2"HS-V-R7K THRU R7S
S-8	2"ROA-V-31	2 1/2"HS-V-R8A & R8B		2"HS-V-R8C		2 1/2"HCO-ST-S8	
S-9	3"WOA-V-21	4"HS-V-W9A & W9B	1/2"HS-V-W9F	3"HS-V-W9C	3/4"HS-V-W9D	4"HCO-ST-S9	2"HS-V-W9K THRU W9P

TABLE NO.3–VACUUM BREAKER EPN NO'S.

HS STATION NO.	"AA"	"BB"
S-1	1" HS-V-709A	1" HS-V-709B
S-2	1" HS-V-710A	1" HS-V-710B
S-3	1" HS-V-711A	1" HS-V-711B
S-4	1" HS-V-712A	1" HS-V-712B
S-5	–	–
S-6	1" HS-V-713A	1" HS-V-713B
S-7	1" HS-V-714A	1" HS-V-714B
S-8	–	–
S-9	1" HS-V-715A	1" HS-V-715B

TABLE NO. 2 – VALVE NUMBERS FOR TRAP STATIONS

HCO STATION NUMBER	ORIFICE SIZE	TRAP NUMBER	SHUT OFF VALVES "A" & "B"	BY PASS VALVE "C"	BLOW DOWN VALVE "D"	CHECK VALVE "E"	CHECK VALVE "F"	Y STRAINER "H"	HEATING COIL INLET VALVE OR DRIP LEG (STATION #)
T-1A	19/64"	1 1/2"HCO-T-T1A	1 1/2"HCO-V-T1AA & T1AB		1/2"HCO-V-T1AD	1 1/2"HCO-V-T1AE	HCO-V-T1AF	1 1/2"HCO-ST-T1A	HS-V-T1K EAST SIDE TOA-HC-1A (S-1)
T-1B	19/64"	1 1/2"HCO-T-T1B	1 1/2"HCO-V-T1BA & T1BB		1/2"HCO-V-T1BD	1 1/2"HCO-V-T1BE	HCO-V-T1BF	1 1/2"HCO-ST-T1B	HS-V-T1L EAST SIDE TOA-HC-1A (S-1)
T-1C	19/64"	1 1/2"HCO-T-T1C	1 1/2"HCO-V-T1CA & T1CB		1/2"HCO-V-T1CD	1 1/2"HCO-V-T1CE	HCO-V-T1CF	1 1/2"HCO-ST-T1C	HS-V-T1M EAST SIDE TOA-HC-1A (S-1)
T-1D	19/64"	1 1/2"HCO-T-T1D	1 1/2"HCO-V-T1DA & T1DB		1/2"HCO-V-T1DD	1 1/2"HCO-V-T1DE	HCO-V-T1DF	1 1/2"HCO-ST-T1D	HS-V-T1N WEST SIDE/ TOA-HC-1A (S-1)
T-1E	19/64"	1 1/2"HCO-T-T1E	1 1/2"HCO-V-T1EA & T1EB		1/2"HCO-V-T1ED	1 1/2"HCO-V-T1EE	HCO-V-T1EF	1 1/2"HCO-ST-T1E	HS-V-T1O WEST SIDE TOA-HC-1A (S-1)
T-1F	19/64"	1 1/2"HCO-T-T1F	1 1/2"HCO-V-T1FA & T1FB		1/2"HCO-V-T1FD	1 1/2"HCO-V-T1FE	HCO-V-T1FF	1 1/2"HCO-ST-T1F	HS-V-T1P WEST SIDE TOA-HC-1A (S-1)
T-1G	11/64"	1"HCO-T-T1G	1"HCO-V-T1GA & T1GB	3/4"HCO-V-T1GC	1/2"HCO-V-T1GD	1"HCO-V-T1GE		1"HCO-ST-T1G	DRIP LEG EAST SIDE TOA-HC-1A (S-1)
T-1H	11/64"	1"HCO-T-T1H	1"HCO-V-T1HA & T1HB	3/4"HCO-V-T1HC	1/2"HCO-V-T1HD	1"HCO-V-T1HE		1"HCO-ST-T1H	DRIP LEG WEST SIDE TOA-HC-1A (S-1)
T-2A	19/64"	1 1/2"HCO-T-T2A	1 1/2"HCO-V-T2AA & T2AB		1/2"HCO-V-T2AD	1 1/2"HCO-V-T2AE	HCO-V-T2AF	1 1/2"HCO-ST-T2A	HS-V-T2N SOUTH SIDE TOA-HC-1B (S-2)
T-2B	19/64"	1 1/2"HCO-T-T2B	1 1/2"HCO-V-T2BA & T2BB		1/2"HCO-V-T2BD	1 1/2"HCO-V-T2BE	HCO-V-T2BF	1 1/2"HCO-ST-T2B	HS-V-T2O SOUTH SIDE TOA-HC-1B (S-2)
T-2C	19/64"	1 1/2"HCO-T-T2C	1 1/2"HCO-V-T2CA & T2CB		1/2"HCO-V-T2CD	1 1/2"HCO-V-T2CE	HCO-V-T2CF	1 1/2"HCO-ST-T2C	HS-V-T2P SOUTH SIDE TOA-HC-1B (S-2)
T-2D	19/64"	1 1/2"HCO-T-T2D	1 1/2"HCO-V-T2DA & T2DB		1/2"HCO-V-T2DD	1 1/2"HCO-V-T2DE	HCO-V-T2DF	1 1/2"HCO-ST-T2D	HS-V-T2K NORTH SIDE TOA-HC-1B (S-2)
T-2E	19/64"	1 1/2"HCO-T-T2E	1 1/2"HCO-V-T2EA & T2EB		1/2"HCO-V-T2ED	1 1/2"HCO-V-T2EE	HCO-V-T2EF	1 1/2"HCO-ST-T2E	HS-V-T2L NORTH SIDE TOA-HC-1B (S-2)
T-2F	19/64"	1 1/2"HCO-T-T2F	1 1/2"HCO-V-T2FA & T2FB		1/2"HCO-V-T2FD	1 1/2"HCO-V-T2FE	HCO-V-T2FF	1 1/2"HCO-ST-T2F	HS-V-T2M NORTH SIDE TOA-HC-1B (S-2)
T-2G	11/64"	1"HCO-T-T2G	1"HCO-V-T2GA & T2GB	3/4"HCO-V-T2GC	1/2"HCO-V-T2GD	1"HCO-V-T2GE		1"HCO-ST-T2G	DRIP LEG NORTH SIDE TOA-HC-1B (S-2)
T-2H	11/64"	1"HCO-T-T2H	1"HCO-V-T2HA & T2HB	3/4"HCO-V-T2HC	1/2"HCO-V-T2HD	1"HCO-V-T2HE		1"HCO-ST-T2H	DRIP LEG SOUTH SIDE TOA-HC-1B (S-2)
T-3A	19/64"	1 1/2"HCO-T-T3A	1 1/2"HCO-V-T3AA & T3AB		1/2"HCO-V-T3AD	1 1/2"HCO-V-T3AE	HCO-V-T3AF	1 1/2"HCO-ST-T3A	HS-V-T3N WEST SIDE TOA-HC-2A (S-3)
T-3B	19/64"	1 1/2"HCO-T-T3B	1 1/2"HCO-V-T3BA & T3BB		1/2"HCO-V-T3BD	1 1/2"HCO-V-T3BE	HCO-V-T3BF	1 1/2"HCO-ST-T3B	HS-V-T3O WEST SIDE TOA-HC-2A (S-3)
T-3C	19/64"	1 1/2"HCO-T-T3C	1 1/2"HCO-V-T3CA & T3CB		1/2"HCO-V-T3CD	1 1/2"HCO-V-T3CE	HCO-V-T3CF	1 1/2"HCO-ST-T3C	HS-V-T3P WEST SIDE TOA-HC-2A (S-3)
T-3D	19/64"	1 1/2"HCO-T-T3D	1 1/2"HCO-V-T3DA & T3DB		1/2"HCO-V-T3DD	1 1/2"HCO-V-T3DE	HCO-V-T3DF	1 1/2"HCO-ST-T3D	HS-V-T3K EAST SIDE TOA-HC-2A (S-3)
T-3E	19/64"	1 1/2"HCO-T-T3E	1 1/2"HCO-V-T3EA & T3EB		1/2"HCO-V-T3ED	1 1/2"HCO-V-T3EE	HCO-V-T3EF	1 1/2"HCO-ST-T3E	HS-V-T3L EAST SIDE TOA-HC-2A (S-3)
T-3F	19/64"	1 1/2"HCO-T-T3F	1 1/2"HCO-V-T3FA & T3FB		1/2"HCO-V-T3FD	1 1/2"HCO-V-T3FE	HCO-V-T3FF	1 1/2"HCO-ST-T3F	HS-V-T3M EAST SIDE TOA-HC-2A (S-3)
T-3G	11/64"	1"HCO-T-T3G	1"HCO-V-T3GA & T3GB	3/4"HCO-V-T3GC	1/2"HCO-V-T3GD	1"HCO-V-T3GE		1"HCO-ST-T3G	DRIP LEG WEST SIDE TOA-HC-2A (S-3)
T-3H	11/64"	1"HCO-T-T3H	1"HCO-V-T3HA & T3HB	3/4"HCO-V-T3HC	1/2"HCO-V-T3HD	1"HCO-V-T3HE		1"HCO-ST-T3H	DRIP LEG EAST SIDE TOA-HC-2A (S-3)
T-4A	19/64"	1 1/2"HCO-T-T4A	1 1/2"HCO-V-T4AA & T4AB		1/2"HCO-V-T4AD	1 1/2"HCO-V-T4AE	HCO-V-T4AF	1 1/2"HCO-ST-T4A	HS-V-T4K EAST SIDE TOA-HC-2B (S-4)
T-4B	19/64"	1 1/2"HCO-T-T4B	1 1/2"HCO-V-T4BA & T4BB		1/2"HCO-V-T4BD	1 1/2"HCO-V-T4BE	HCO-V-T4BF	1 1/2"HCO-ST-T4B	HS-V-T4L EAST SIDE TOA-HC-2B (S-4)
T-4C	19/64"	1 1/2"HCO-T-T4C	1 1/2"HCO-V-T4CA & T4CB		1/2"HCO-V-T4CD	1 1/2"HCO-V-T4CE	HCO-V-T4CF	1 1/2"HCO-ST-T4C	HS-V-T4M EAST SIDE TOA-HC-2B (S-4)
T-4D	19/64"	1 1/2"HCO-T-T4D	1 1/2"HCO-V-T4DA & T4DB		1/2"HCO-V-T4DD	1 1/2"HCO-V-T4DE	HCO-V-T4DF	1 1/2"HCO-ST-T4D	HS-V-T4N WEST SIDE TOA-HC-2B (S-4)
T-4E	19/64"	1 1/2"HCO-T-T4E	1 1/2"HCO-V-T4EA & T4EB		1/2"HCO-V-T4ED	1 1/2"HCO-V-T4EE	HCO-V-T4EF	1 1/2"HCO-ST-T4E	HS-V-T4O WEST SIDE TOA-HC-2B (S-4)
T-4F	19/64"	1 1/2"HCO-T-T4F	1 1/2"HCO-V-T4FA & T4FB		1/2"HCO-V-T4FD	1 1/2"HCO-V-T4FE	HCO-V-T4FF	1 1/2"HCO-ST-T4F	HS-V-T4P WEST SIDE TOA-HC-2B (S-4)
T-4G	11/64"	1"HCO-T-T4G	1"HCO-V-T4GA & T4GB	3/4"HCO-V-T4GC	1/2"HCO-V-T4GD	1"HCO-V-T4GE		1"HCO-ST-T4G	DRIP LEG WEST SIDE TOA-HC-2B (S-4)
T-4H	11/64"	1"HCO-T-T4H	1"HCO-V-T4HA & T4HB	3/4"HCO-V-T4HC	1/2"HCO-V-T4HD	1"HCO-V-T4HE		1"HCO-ST-T4H	DRIP LEG EAST SIDE TOA-HC-2B (S-4)
T-5	3/8"	1"HCO-T-S5	1 1/2"HCO-V-S5A & S5B	1"HCO-V-S5C	1 1/2"HCO-V-S5D	1 1/2"HCO-V-S5E		1 1/2"HCO-ST-S5C	-----
T-6A	19/64"	1 1/2"HCO-T-S6A	1 1/2"HCO-V-S6AA & S6AB	1 1/2"HCO-V-S6AC	1/2"HCO-V-S6AD	1 1/2"HCO-V-S6AE	HCO-V-S6AF	1 1/2"HCO-ST-S6A	HS-V-S6K WEST SIDE SMA-HC-1 (S-6)
T-6B	19/64"	1 1/2"HCO-T-S6B	1 1/2"HCO-V-S6BA & S6BB	1 1/2"HCO-V-S6BC	1/2"HCO-V-S6BD	1 1/2"HCO-V-S6BE	HCO-V-S6BF	1 1/2"HCO-ST-S6B	HS-V-S6L WEST SIDE SMA-HC-1 (S-6)
T-7A	5/16"	1"HCO-T-R7A	1 1/4"HCO-V-R7AA & R7AB		1/2"HCO-V-R7AD	1 1/4"HCO-V-R7AE	HCO-V-R7AF	1 1/4"HCO-ST-R7A	HS-V-R7K NORTH SIDE ROA-HC-1 (S-7)
T-7B	5/16"	1"HCO-T-R7B	1 1/4"HCO-V-R7BA & R7BB		1/2"HCO-V-R7BD	1 1/4"HCO-V-R7BE	HCO-V-R7BF	1 1/4"HCO-ST-R7B	HS-V-R7L NORTH SIDE ROA-HC-1 (S-7)
T-7C	5/16"	1"HCO-T-R7C	1 1/4"HCO-V-R7CA & R7CB		1/2"HCO-V-R7CD	1 1/4"HCO-V-R7CE	HCO-V-R7CF	1 1/4"HCO-ST-R7C	HS-V-R7M NORTH SIDE ROA-HC-1 (S-7)
T-7D	5/16"	1"HCO-T-R7D	1 1/4"HCO-V-R7DA & R7DB		1/2"HCO-V-R7DD	1 1/4"HCO-V-R7DE	HCO-V-R7DF	1 1/4"HCO-ST-R7D	HS-V-R7N SOUTH SIDE ROA-HC-1 (S-7)
T-7E	5/16"	1"HCO-T-R7E	1 1/4"HCO-V-R7EA & R7EB		1/2"HCO-V-R7ED	1 1/4"HCO-V-R7EE	HCO-V-R7EF	1 1/4"HCO-ST-R7E	HS-V-R7O SOUTH SIDE ROA-HC-1 (S-7)
T-7F	5/16"	1"HCO-T-R7F	1 1/4"HCO-V-R7FA & R7FB		1/2"HCO-V-R7FD	1 1/4"HCO-V-R7FE	HCO-V-R7FF	1 1/4"HCO-ST-R7F	HS-V-R7P SOUTH SIDE ROA-HC-1 (S-7)
T-7G	5/32"	3/4"HCO-T-R7G	1"HCO-V-R7GA & R7GB	3/4"HCO-V-R7GC	1/2"HCO-V-R7GD	1"HCO-V-R7GE		1"HCO-ST-R7G	DRIP LEG NORTH SIDE ROA-HC-1 (S-7)
T-7H	5/32"	3/4"HCO-T-R7H	1"HCO-V-R7HA & R7HB	3/4"HCO-V-R7HC	1/2"HCO-V-R7HD	1"HCO-V-R7HE		1"HCO-ST-R7H	DRIP LEG SOUTH SIDE ROA-HC-1 (S-7)
T-7J	5/16"	1"HCO-T-R7J	1 1/4"HCO-V-R7JA & R7JB		1/2"HCO-V-R7JD	1 1/4"HCO-V-R7JE	HCO-V-R7JF	1 1/4"HCO-ST-R7J	HS-V-R7S NORTH SIDE ROA-HC-1 (S-7)
T-7K	5/16"	1"HCO-T-R7K	1 1/4"HCO-V-R7KA & R7KB		1/2"HCO-V-R7KD	1 1/4"HCO-V-R7KE	HCO-V-R7KF	1 1/4"HCO-ST-R7K	HS-V-R7R SOUTH SIDE ROA-HC-1 (S-7)
T-8	7/16"	1 1/2"HCO-T-R8	2"HCO-V-R8A & R8B	1"HCO-V-R8C	1/2"HCO-V-R8D	2"HCO-V-R8E	HCO-V-R8F	2"HCO-ST-R8	-----
T-9A	19/64"	1 1/2"HCO-T-W9A	1 1/2"HCO-V-W9AA & W9AB		1/2"HCO-V-W9AD	1 1/2"HCO-V-W9AE	HCO-V-W9AF	1 1/2"HCO-ST-W9A	HS-V-W9N EAST SIDE WOA-HC-1 (S-9)
T-9B	19/64"	1 1/2"HCO-T-W9B	1 1/2"HCO-V-W9BA & W9BB		1/2"HCO-V-W9BD	1 1/2"HCO-V-W9BE	HCO-V-W9BF	1 1/2"HCO-ST-W9B	HS-V-W9O EAST SIDE WOA-HC-1 (S-9)
T-9C	19/64"	1 1/2"HCO-T-W9C	1 1/2"HCO-V-W9CA & W9CB		1/2"HCO-V-W9CD	1 1/2"HCO-V-W9CE	HCO-V-W9CF	1 1/2"HCO-ST-W9C	HS-V-W9P EAST SIDE WOA-HC-1 (S-9)
T-9D	19/64"	1 1/2"HCO-T-W9D	1 1/2"HCO-V-W9DA & W9DB		1/2"HCO-V-W9DD	1 1/2"HCO-V-W9DE	HCO-V-W9DF	1 1/2"HCO-ST-W9D	HS-V-W9K WEST SIDE WOA-HC-1 (S-9)
T-9E	19/64"	1 1/2"HCO-T-W9E	1 1/2"HCO-V-W9EA & W9EB		1/2"HCO-V-W9ED	1 1/2"HCO-V-W9EE	HCO-V-W9EF	1 1/2"HCO-ST-W9E	HS-V-W9L WEST SIDE WOA-HC-1 (S-9)
T-9F	19/64"	1 1/2"HCO-T-W9F	1 1/2"HCO-V-W9FA & W9FB		1/2"HCO-V-W9FD	1 1/2"HCO-V-W9FE	HCO-V-W9FF	1 1/2"HCO-ST-W9F	HS-V-W9M WEST SIDE WOA-HC-1 (S-9)
T-9G	11/64"	1"HCO-T-W9G	1"HCO-V-W9GA & W9GB	3/4"HCO-V-W9GC	1/2"HCO-V-W9GD	1"HCO-V-W9GE		1"HCO-ST-W9G	DRIP LEG EAST SIDE WOA-HC-1 (S-9)
T-9H	11/64"	1"HCO-T-W9H	1"HCO-V-W9HA & W9HB	3/4"HCO-V-W9HC	1/2"HCO-V-W9HD	1"HCO-V-W9HE		1"HCO-ST-W9H	DRIP LEG WEST SIDE WOA-HC-1 (S-9)
T-10	1/8"	3/4"HCO-T-T10	3/4"HCO-V-T10A & T10B		3/4"HCO-V-T10D	3/4"HCO-V-T10E			------
T-11	3/8"	1"HCO-T-T11	1 1/2"HCO-V-T11A & T11B	3/4"HCO-V-T11C	1/2"HCO-V-T11D	1 1/2"HCO-V-T11E	HCO-V-T11F	1 1/2"HCO-ST-T11	DRIP LEG HCO-V-T11G SOUTH OF TRA-SUH-1
					1 1/2"HCO-V-T11H				
T-12	11/64"	1"HCO-T-T12	1"HCO-V-T12A & T12B	3/4"HCO-V-T12C	1/2"HCO-V-T12D	1"HCO-V-T12E		1"HCO-ST-T12	------
T-13	5/16"	1"HCO-T-T13	1 1/4"HCO-V-T13A & T13B	3/4"HCO-V-T13C	1/2"HCO-V-T13D	1 1/4"HCO-V-T13E	HCO-V-T13F	1 1/4"HCO-ST-T13	------
T-14	11/64"	1"HCO-T-T14	1"HCO-V-T14A & T14B	3/4"HCO-V-T14C	1/2"HCO-V-T14D	1"HCO-V-T14E		1"HCO-ST-T14	------
T-15	11/64"	1"HCO-T-T15	1"HCO-V-T15A & T15B	3/4"HCO-V-T15C	1/2"HCO-V-T15D	1"HCO-V-T15E		1"HCO-ST-T15	------
T-16	5/16"	1"HCO-T-T16	1 1/4"HCO-V-T16A & T16B	1"HCO-V-T16C	1/2"HCO-V-T16D	1 1/4"HCO-V-T16E	HCO-V-T16F	1 1/4"HCO-ST-T16	------
T-17	11/64"	3/4"HCO-T-T17	3/4"HCO-V-T17A & T17B	3/4"HCO-V-T17C	1/2"HCO-V-T17D	3/4"HCO-V-T17E		3/4"HCO-ST-T17	------
T-18	1/8"	3/4"HCO-T-T18	3/4"HCO-V-T18A & T18B		3/4"HCO-V-T18D	3/4"HCO-V-T18E			------
T-21	9/32"	1"HCO-T-S21	1 1/2"HCO-V-S21A & S21B	1"HCO-V-S21C	1/2"HCO-V-S21D	1 1/2"HCO-V-S21E	HCO-V-S21F	1 1/2"HCO-ST-S21	------
T-22	11/64"	1"HCO-T-S22	1"HCO-V-S22A & S22B	3/4"HCO-V-S22C	1/2"HCO-V-S22D	1"HCO-V-S22E		1"HCO-ST-S22	------
T-23	11/64"	1"HCO-T-S23	1"HCO-V-S23A & S23B	3/4"HCO-V-S23C	1/2"HCO-V-S23D	1"HCO-V-S23E		1"HCO-ST-S23	------
T-24	5/32"	3/4"HCO-T-S24	3/4"HCO-V-S24A & S24B		3/4"HCO-V-S24D	3/4"HCO-V-S24E		3/4"HCO-ST-S24	------
T-25	#38	3/4"HCO-T-R25	3/4"HCO-V-R25A & R25B	3/4"HCO-V-R25C	1/2"HCO-V-R25D	3/4"HCO-V-R25E		3/4"HCO-ST-R25	------
T-26	5/32"	3/4"HCO-T-R26	3/4"HCO-V-R26A & R26B			3/4"HCO-V-R26E			------
T-27	5/32"	3/4"HCO-T-R27	1"HCO-V-R27A & R27B	3/4"HCO-V-R27C	1/2"HCO-V-R27D	1"HCO-V-R27E		1"HCO-ST-R27	------
T-28	#38	3/4"HCO-T-R28	3/4"HCO-V-R28A & R28B	3/4"HCO-V-R28C	1/2"HCO-V-R28D	3/4"HCO-V-R28E		3/4"HCO-ST-T28	------
T-29	#38	3/4"HCO-T-R29	3/4"HCO-V-R29A & R29B	3/4"HCO-V-R29C	1/2"HCO-V-R29D	3/4"HCO-V-R29E		3/4"HCO-ST-T29	------
T-30	5/32"	3/4"HCO-T-W30	3/4"HCO-V-W30A & W30B		3/4"HCO-V-W30D	3/4"HCO-V-W30E			------
T-31	11/64"	1"HCO-T-W31	1"HCO-V-W31A & W31B	3/4"HCO-V-W31C	1/2"HCO-V-W31D	1"HCO-V-W31E		1"HCO-ST-W31	------
T-32	3/8"	1"HCO-T-W32	1 1/2"HCO-V-W32A & W32B	1"HCO-V-W32C	1/2"HCO-V-W32D	1 1/2"HCO-V-W32E	HCO-V-W32F	1 1/2"HCO-ST-W32	------
T-33	3/16"	3/4"HCO-T-W33	3/4"HCO-V-W33A & W33B	3/4"HCO-V-W33C	1/2"HCO-V-W33D	3/4"HCO-V-W33E	HCO-V-W33F	3/4"HCO-ST-W33	------
T-34	3/16"	3/4"HCO-T-W34	3/4"HCO-V-W34A & W34B	3/4"HCO-V-W34C	1/2"HCO-V-W34D	3/4"HCO-V-W34E	HCO-V-W34F	3/4"HCO-ST-W34	------
T-35	3/16"	3/4"HCO-T-W35	3/4"HCO-V-W35A & W35B	3/4"HCO-V-W35C	1/2"HCO-V-W35D	3/4"HCO-V-W35E	HCO-V-W35F	3/4"HCO-ST-W35	------
T-36	11/64"	3/4"HCO-T-W36	1"HCO-V-W36A & W36B	3/4"HCO-V-W36C	1/2"HCO-V-W36D	1"HCO-V-W36E		1"HCO-ST-W36	------
T-37									------
T-38	11/64"	3/4"HCO-T-W38	3/4"HCO-V-W38A & W38B	3/4"HCO-V-W38C	1/2"HCO-V-W38D	3/4"HCO-V-W38E		3/4"HCO-ST-W38	------
T-39	11/64"	1"HCO-T-W39	1"HCO-V-W39A & W39B	3/4"HCO-V-W39C	1/2"HCO-V-W39D	1"HCO-V-W39E		1"HCO-ST-W39	------
T-40	11/64"	1"HCO-T-W40	1"HCO-V-W40A & W40B	3/4"HCO-V-W40C	1/2"HCO-V-W40D	1"HCO-V-W40E		1"HCO-ST-W40	------

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Draw. No. M514-2 | Rev. 6 | Figure 9.4-9.2

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 FIRE PROTECTION SYSTEM

Appendix F, Fire Protection Evaluation, contains information on the plant fire protection systems.

9.5.2 COMMUNICATIONS SYSTEMS

9.5.2.1 Design Basis

Columbia Generating Station is provided with the following communication systems:

a. Public telephone access,

b. Private branch exchange (PBX),

c. Sound-powered telephone system,

d. Public address and building-wide alarm system,

e. Radio communication systems, and

f. Telephone link to Bonneville Power Administration (BPA) Dittmer Control Center.

The public telephone network provides for connection of PBX phones to outside lines.

The PBX provides intraplant communications, communication to BPA, and access to the public address and radio paging systems.

The sound-powered telephone system provides a backup to the PBX and can be used as a supplementary communications circuit to aid in the testing and maintenance of plant process systems.

The public address system provides a way of contacting personnel in the various buildings of the plant and locations of the site that might be inaccessible using other means of communication. The building-wide alarm system alerts (via the public address system speakers) operating personnel to fire hazards and other trouble conditions for which plant management finds it necessary to alert plant personnel.

The radio communications system provides a communications link for security and emergency communications to local law enforcement agencies and emergency control centers. In addition, the radio communications system is used for communications with personnel involved in maintenance and security in and around the plant complex by means of hand-held portable radio units, mobile radio units, and paging receivers. The telephone link to BPA provides a direct communication link to the BPA Dittmer Control Center.

Post-fire safe shutdown operator actions that require emergency communication with the control room or remote shutdown room rely on the PBX phone system. The post-fire safe shutdown communication system must remain operational during a loss of offsite power. Fire brigade activities use radio communication and may communicate with the control room or remote shutdown room using a PBX phone.

All equipment, components, raceways, and support systems located in the main control room are designed and anchored such that they will not cause loss of function of nearby safety-related equipment as a result of the safe shutdown earthquake. The same criteria is followed wherever such equipment is located close to safety-related equipment.

9.5.2.2 System Description

9.5.2.2.1 Public Telephone Access

This system consists of interconnections to the public telephone network as described in the following:

a. Individual direct lines with inward and outward dialing access to several plant locations:

    1. Plant Manager's office,
    2. Main control room,
    3. Security central alarm station (CAS),
    4. Remote shutdown room, and
    5. Security secondary alarm station (SAS).

b. Provisions for extension of individual lines with direct inward and outward dialing access to other plant locations:

    1. Shift Manager's office and
    2. Radwaste control room.

c. Trunks to the PBX provide inward and outward dialing access to various plant locations.

9.5.2.2.2 Private Branch Exchange

This system consists of an all electronic, stored program, computer controlled telephone switching system with integral redundant computers. Telephones are strategically located throughout the plant complex. The system receives power from an uninterruptible power supply (UPS) system for reliable operation, consisting of a battery E-B0-PBX and battery chargers E-C0-PBX/1 and E-C0-PBX/2, located in building 25 (PAAP).

The PBX provides complete intercommunication at all times between any two telephones. Connections are established by means of a dial on each telephone. Automatic dial tone, busy tone, and ringing current are provided.

Telephone communications boxes (CBs) are provided throughout the plant. The CBs in offices have a jack for plugging in a desk-type telephone. These CBs are extensions of the PBX exchange.

Most CBs in the operating and work areas have a PBX telephone jack and a sound-powered telephone jack. Instrument and control panels in the control room have PBX and sound-powered telephone jacks installed in the panels. Operating and work areas use portable telephones plugged into the jacks. A telephone number is assigned to one CB or jack of a compatible group and the others in the group are wired in parallel to it.

Head sets may be plugged into telephones in the operating and work areas when hands-free communication is required. Approved wireless communication devices, such as cordless handsets, may be used in the plant main control room and radwaste control room. To support outage activities approved wireless communication devices can be used in the drywell and approved reactor building elevations. Administrative control of wireless devices based on the location, operating frequency, field strength, minimum distance of an exclusion zone, visual postings, and end user training are established to preclude the effects of EMI.

Dedicated communication links provide access to BPA. The PBX provides the following special features:

a. Conference - up to eight telephones can be connected into a conference network to facilitate maintenance, testing, and management activities.

b. Paging - the Public Address System can be accessed from any PBX telephone extension.

c. Ringdown - the PBX can be programmed to provide ringdown (hotline) service for selected telephones. The service provides automatic ringing without dialing.

9.5.2.2.3 Sound-Powered Telephone System

The sound-powered telephone system consists of jack access in the communications boxes and panels and connecting wiring. The system is divided into eight circuits. Each circuit serves a different area of the plant. All wiring is routed to a terminal box located in the communications equipment room. The terminal box is equipped with jumpers for interconnecting the circuits. During normal operation the jumpers are connected to form a single bus so that all sound-powered jacks are connected in parallel. Each circuit can be isolated at the terminal box if shorts or grounds occur.

Portable sound-powered telephones are plugged into the jacks to complete a communications link.

9.5.2.2.4 Public Address and Building-Wide Alarm Systems

9.5.2.2.4.1 Public Address System. The public address system is designed to provide area-wide announcements throughout the plant by means of loudspeakers located in various areas. Audio power to the speakers is provided by electronics located in equipment racks in the communications equipment room, which is located in the radwaste and control building. Power to the electronics is provided from the UPS bus.

The speakers in each of the buildings or zones are connected in two separate circuit loops. This provides an alternative path for partial communications should one loop be damaged. Paging microphones are located in various areas and are used for “all zone” pages and have priority over telephone-accessed paging.

Most telephone instruments in the PBX can access the paging system by dialing the appropriate access number. Telephone pages can be directed to a specific building/zone or to all zones. The connection between the PBX and the paging system is provided through special paging adapters which interface the two systems.

Critical electronic equipment is redundant and is automatically switched on line as required. Failure of the amplifier systems is alarmed in the control room as well as locally at the public address racks.

9.5.2.2.4.2 Building/Zone-Audio Alarm System. The audio alarm system consists of a multitone generator with redundant backup which is located within the public address (PA) system racks. The audio generators are capable of producing five distinct audio tones which are amplified by the PA system. The redundant generator is automatically switched online should the primary unit fail and an alarm is activated. The units are fed from the UPS system along with the PA system. One tone is used to alert personnel, followed by specific announcements. The audio alarm system has priority over PBX paging and “microphone actuated paging,” and will override either of these functions. The main control room is capable of activating all tones that are used. The alert tone may be activated from either the Plant Manager's office or the remote shutdown room or the TSC.

9.5.2.2.5 Radio Communications System

The radio communications system for Columbia Generating Station is integrated into the Energy Northwest radio network, which provides communications for all Energy Northwest facilities in the Hanford area.

The system is comprised of the following:

a. P25 L2 Core
b. Fiber-Optic Distributed Antenna System
c. In-Plant Repeaters
d. Area Wide Repeaters
e. Base Radio Stations
f. Radio System Desk Sets
g. Radio Dispatch Consoles
h. Portable Handheld Radios, and
i. Mobile Radios installed in vehicles.

P25 L2 Core

The P25 L2 Core zone controller system is the core of the radio communicaitons system and is run using the ASTRO 25 "L" Core platform. The system architecture is designed with inherent fault distribution to ensure that a single point failure will not cause a complete loss of radio communications. The fault distribution includes the ability to reroute IP voice and data packets among the various redundant router configurations. Faults within the network will provide notification on the fault management terminal.

Fiber-Optic Distributed Antenna Systems (FODAS)

The FODAS consist of the ION-M master unit, ION-M4 remote unit transceivers, antennas, and rediax cables used as antennas. The master unit transmits and receives radio frequency signals to/from the base radio stations while controlling the entire ION-M system, including provisioning of the backhaul connectivity. The remote units are connected to the master unit via fiber optic cable. Up to four antennas can be connected to a transceiver using a single fiber back to the master unit.

In-Plant Repeaters

In-plant repeaters are used to provide radio communications within the plant using a fiber optic distributed antenna system. In-plant repeaters provide in-plant radio communications for

Operations, Security, Emergency Preparedness, Fire Brigade, and Maintenance. The in-plant system consists of six repeaters. One repeater is designated as a “control channel” while the other five repeaters provide the audio communications. In a trunked system the control channel notifies the zone controller when a radio user initiates or ends a call using the push-to-to-talk button on the radio, console, or desk set. The zone controller then designates an audio repeater to start or end the call. The in-plant repeaters are located in the Diesel Generator Building and are separated from other communication systems. Six traffic channels support the in-plant radio communications.

Area Wide Repeaters

Area wide repeaters provide area wide radio communications for Operations, Security, and Emergency Preparedness talkgroups. Mobile radios have been programmed to operate using area wide talkgroups. Area wide repeaters are located in the Consolidated Community Communications Facility (CCCF) on Rattlesnake Mountain.

Base Radio Stations

Base radios are programmed with talkgroups to support the in-plant and area wide radio communications. Base radios are connected to radio system desk sets and allow the desk set to talk to any talkgroup programmed within the base radio.

Radio System Desk Sets

Desk sets enable managers, superviosrs, and team leaders the ability to communicate with plant and field teams through the in-plant and area wide radio communication systems to provide directional instructions.

Radio Dispatch Consoles

Dispatch consoles have access to all RF resources available to the L2 Core Trunked Digital Radio System. Offsite agencies using conventional radio channels will only be available to the dispatch consoles. Dispatch consoles serve as the mutual aid for interoperability and have the ability to patch offsite agencies into talkgroups for communications with radio users.

All equipment other than mobile radios or handheld portable radios are powered by a UPS bus for reliable operation.

9.5.2.2.6 Telephone Link for Connection to the BPA Dittmer Control Center

This circuit consists of telephones located in the main control and remote shutdown rooms of the radwaste and control building, which are directly connected to the Columbia Generating Station/BPA communications equipment. These phones automatically ring to the Dittmer Control Center of BPA when they are used.

9.5.2.3 Inspection and Testing Requirements

All communication cable conductors are tested for continuity and insulation resistance before connection to the various communication apparatus. Fiber optic cables are tested using an Optical Time Domain Reflector (OTDR) to measure continuity. A functional test on all communications systems is made after installation.

The functional test on the total installed radio communications system included a complete test of all system functions such as operation from dispatch consoles, base radios, desk sets, and two-way communication between offsite and onsite stations. Tests were made using both the maintenance and security system frequencies. Tests were performed to ensure that no harmful interference results between this equipment, the repeater station on Rattlesnake Mountain, and control room equipment. During preoperational and postoperational surveillance testing, solid state electronics in some areas exhibited spurious response to radio transmission. These areas have been flagged by signs showing “Prohibited Area For Use of Radios” and are put under administrative control.

9.5.2.4 Capability During Postulated Accident and Anticipated Transients

Table 9.5-1 shows the strategic work areas and the type of communications available between these locations and the control room, remote shutdown room, and outside Columbia Generating Station.

9.5.2.4.1 Protective Measures

The plant communications system provides assurance that a reliable communications link is available from the strategic plant work stations to the control room. The following design factors contribute toward this goal:

a. The PBX is built with plug-in modular circuit boards so that defective boards can be quickly replaced,

b. The PBX has redundant processing units with automatic switching from a failed computer to the redundant computer,

c. The sound-powered telephone system backs up the PBX system in case of a major failure of the PBX,

d. Several telephones are connected directly to the public telephone network to operate independently of the PBX. These include telephones in the main control room, remote shutdown room, building 62, and the Plant General Manager's office, and

e. During a loss of offsite power, the PEC/PAAP diesel generator ensures the PBX system operation beyond the 8-hr capacity of the PBX communication system battery, E-B0-PBX.

9.5.2.4.2 Severing of Lines or Trunks

The failure of a single line or trunk cannot prevent communications from critical plant locations. Alternate facilities are available as follows:

a. Radios do not require offsite lines and can be used in lieu of telephones if telephone lines are not available,

b. Portable radios can be used if the antenna leads to fixed stations are inoperable, and

c. Tie lines connect the PBX to the BPA communications system. The lines provides telephone communications from Columbia Generating Station to telephones in BPA facilities. These communications are independent of the public telephone network.

9.5.2.4.3 High Noise

The communication system design addresses high noise area problems as follows:

a. Telephones may be installed in sound dampening booths with either or both noise-canceling handsets and amplified receivers, and

b. Public address system speakers have volume controls which are adjusted according to the ambient noise level.

9.5.2.4.4 Post-Fire Safe Shutdown

Fire induced failures of the PBX communication system are evaluated for the various fire areas as part of the post-fire safe shutdown analysis. See F.2.6.2 for more detail.

9.5.3 PLANT LIGHTING SYSTEM

9.5.3.1 Design Bases

a. Lighting intensities are designed to provide indoor and outdoor illumination consistent with the Illumination Engineering Society recommendations (July 1974), and to meet or exceed OSHA requirements,

b. Light sources are selected with consideration for environmental conditions and ease of maintenance,

c. Fluorescent or high-intensity discharge (HID) sources are not used inside primary containment. Only incandescent sources are used inside primary containment,

d. The normal lighting supplied from either the main generator or offsite power is designed to provide adequate lighting for normal plant operation and associated plant access routes, and for control and maintenance of equipment, and

e. The emergency lighting supplied from onsite power is designed to provide adequate lighting for safe shutdown of the plant and for associated plant access routes during the full spectrum of accidents, transients and special events.

9.5.3.2 System Description

The plant lighting system consists of four systems: normal ac lighting, normal-emergency ac lighting, emergency dc lighting, and battery-pack emergency lighting. For the location of various fixed emergency lighting systems that support safe shutdown of the plant, see Table 9.5-2. See Figures F.6-18, F.6-19 and F.6-20 for locations of portable lantern use.

9.5.3.2.1 Normal Alternating Current (ac) Lighting Systems

This system consists of two systems (A and B) which are energized from the plant non-safety-related 480-V ac auxiliary system motor control centers directly from three-phase 480-V ac, or through 208/120-V ac dry type lighting transformers and local area lighting panels.

9.5.3.2.2 Normal-Emergency ac Lighting Systems

Normal-emergency ac lighting is provided for safe and orderly shutdown during the loss of normal ac power. This system is energized from the safety-related 480-V ac motor-control centers through isolation devices to non-Class 1E three-phase, four-wire 208/120-V ac dry type lighting transformers that feed lighting panels.

This lighting system consists of two systems (Divisions 1 and 2). Each system has ac lighting energized from critical buses that are connected both to and backed by their associated diesel generators (DG1 & 2).

This ac lighting comprises approximately 15% of the normal plant lighting load. The ac lighting fixtures in the main control room are designed and supported as Seismic Category I.

Some of the ac lighting system within the main control room can be manually transferred from its critical bus to an inverter supplied source if the associated battery charger is in service.

9.5.3.2.3 Emergency Direct Current (dc) Lighting Systems

Emergency dc lighting is provided in the main control room, the access route to the remote shutdown room, and in the remote shutdown room. The emergency dc lighting system is necessary for conducting shutdown operations during the coping period of a Station Blackout event.

This lighting consists of two systems (Divisions 1 and 2). Each system is energized from a 125-V dc plant emergency battery system. The remote shutdown room and access route lighting is continuously lit, and the control room dc lighting is energized on a loss of power to the normal-emergency lighting in the main control room. This dc lighting load consists of incandescent light sources.

9.5.3.2.4 Battery-Pack Emergency Lighting Systems

Battery-pack emergency lighting consists of 1.5-hr and Appendix R lighting units. The lamps automatically energize on loss of the respective normal and/or normal-emergency ac lighting. Emergency battery units in Seismic Category I areas of the radwaste building are Seismic Category I mounted and supported.

The 1.5-hr lighting consists of Emergency Battery Units (EBUs) and Emergency Reserve Ballast (ERB) units in areas without EBUs, installed for the safety of operating personnel to provide lighting for egress routes.

Appendix R 8-hr emergency battery packs and portable 8-hr lanterns are available for use to ensure operators can perform post-fire safe shutdown manual actions outside the control room, for a fire in specific plant areas, concurrent with a LOOP. At a minimum, 8-hr emergency battery pack lighting is installed at locations where operators perform long-term plant control and shutdown actions. The portable 8-hr lanterns are used for short-duration operator actions. There are four stations provided in various plant locations with five portable lanterns available at each location.

9.5.3.3 Safety Evaluation

Normal and normal-emergency lighting is located throughout the plant to provide necessary lighting during normal plant operation and during a power system failure. In the Reactor Building, during accident conditions, the normal lighting is tripped by an accident signal (FAZ) to reduce building heat load.

In areas that are serviced by HID lighting sources, 10% of the fixtures are provided with tungsten halogen standby lamps. These standby lamps will be immediately energized after an interruption of the power source and will provide partial illumination until the HID lamps restrike.

The normal and normal-emergency lighting provide no safety-related function and thus are non-safety related.

9.5.4 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

9.5.4.1 Design Bases

a. The onsite storage capacity of each subsystem provides for continuous operation of each diesel generator for at least 7 days while satisfying post-LOCA maximum load demands;

b. The design of the system conforms to Regulatory Guide 1.137. The equipment within the system conforms to the applicable codes and standards of ASME, ASTM, ANSI, DEMA, IEEE, API, and NFPA;

c. The system piping off of the engine skid is constructed to ASME Section III, Class 3 and Seismic Category I requirements except for the portions of the piping associated with the filter/polisher system. Except for the diesel oil storage tanks and portions of the filter/polisher system, all portions of the system, including the fuel oil day tanks, are protected from tornado missiles by enclosure in tornado-hardened, Seismic Category I structures. The diesel oil storage tanks and associated piping (except for exposed fill, vent, and filter/polisher piping as described in Section 3.5) are buried for tornado protection and to maximize containment of postulated oil spills. The system is not subject to flooding since the site is not subject to flooding. The piping on the engine is constructed using ANSI B31.1 as a guide and is Seismic Category I;

d. The diesel fuel storage system is augmented by the installation of a filter/polisher unit located in a separate filter/polisher building east of the storage tanks. This unit is non-safety-related. It is used to clean bulk fuel of contaminants and fuel degradation products formed due to long storage. It is also used to polish fuel oil delivered by fuel supply tankers, if necessary, prior to delivery to the storage tanks. The filter vessels are constructed to ASME Section VIII, Division I, and the piping components to ANSI B31.1 Power Piping Code.

e. The Quality Class II Auxiliary boiler storage tank is used as an additional storage tank for the emergency diesel generator fuel oil. This tank was cleaned before putting it into diesel fuel storage service and is maintained to the same cleanliness requirements as the other Class I fuel oil tanks. The diesel fuel oil stored in this tank is surveyed to the same requirements as the other diesel storage tank's fuel oil. This storage tank and its connective piping are not required to be Seismic Category I, since this additional qualified fuel oil is non-safety-related.

9.5.4.2 System Description

The fuel oil storage and transfer system consists of separate, independent diesel oil supply systems serving each of the two tandem diesel generators (DG 1 and DG 2) and the high-pressure core spray (HPCS) diesel engine generator (DG 3). Each of these systems consists of a fuel oil storage tank, a transfer pump, a day tank, interconnecting piping and valves, and associated instruments and controls. The system diagram is shown in Figure 9.5-1.

In each supply system, a transfer pump powered from a safety-related motor control center (MCC) takes suction from the diesel oil storage tank and discharges to an associated diesel generator fuel oil day tank to maintain the fuel oil level within the day tank. The transfer pump is sized to provide a flow several times the maximum engine consumption rate (of 110% load) and is automatically controlled by level switches activated by day tank fuel level. The fuel stored in each diesel generator 60,000-gal storage tank (50,000 gal for the HPCS diesel generator) plus the fuel maintained in each 3000-gal day tank is adequate for 7 days of operation.

Each transfer pump supplies a separate day tank for each diesel generator. There is a pipe interconnecting the diesel generator 1 and 2 transfer lines with normally locked closed valves. If a rupture occurs in the interconnecting cross line when in use, this line will be manually isolated and thereby the fuel oil supply will not be interrupted between any storage tank and its associated day tank.

The volume of the day tanks permits 8.5 hr of engine operation of the associated diesel generator without resupply to the day tank. This arrangement allows the transfer pump start signal to occur prior to the day tank low level alarm. In the event the transfer pump does not start, there remains at least 3.5 more hours of operation after low level alarms are actuated to take required corrective action. These operating times are for Division 1 and Division 2 with the diesel generators operating at 100% of the continuous rated load of 4400 kW. The maximum operating time for Division 3 (HPCS) will be substantially longer since the day tanks are the same size. The single HPCS engine carrying 2600 kW will use substantially less fuel than two engines carrying a load of 4400 kW.

At normal high oil level a switch will shut off the pump. If the fuel oil level goes above the normal high level, a high level switch is activated and sends an alarm signal. If the pump does not shut off, the day tank overflow line will return all pump flow to the storage tank of the same diesel generator.

The fuel oil storage system has provisions to fill the storage tanks, transfer fuel from one tank to another, and filter/polish the fuel in the tanks or fuel being delivered to the tanks. The fill header is designed to allow delivery of fuel directly to a storage tank or run through the filter/polisher unit prior to delivering it to the tank from the fuel tanker. The piping boundary between the ASME III fill lines and header and the Quality Class II filter/polisher are at ASME III, 3 normally closed butterfly valves.

The filter/polisher, when used to polish the fuel stored in the tanks, removes oil from the bottom of the tank through a suction sparger that extends along the length of the tank. This oil is filtered and polished removing water and particulates. Then the filter/polisher returns the oil to the tank through the fill line.

The filter/polisher can be used to transfer fuel from one tank to another with or without filtering and polishing. The filter/polisher is equipped with a recording flow meter so the operator knows the quantity of fuel that has passed through the filter/polisher.

The filter/polisher suction line from the storage tank flanged nozzle to the filter/polisher suction header isolation valves is ANSI B31.1 Quality Class 2, Seismic Category I. The sparger in the tank is ANSI B31.1, Quality Class 2, Seismic Category I, and the fill line returning oil to the tank is ANSI B31.1, Quality Class 2, Seismic Category II. The suction and fill line for the auxiliary boiler storage tank is ANSI B31.1, Quality Class 2, Seismic Category II.

Operation of the fuel storage tank transfer pump is controlled manually when fuel is being transferred through the interconnecting line from storage tank A to day tank B or from storage tank B to day tank A. High level annunciation of the day tank fuel level will provide a warning of overfilling the day tank.

The fuel oil supply from the day tanks to each diesel engine consists of two systems. Either system is capable of supplying fuel oil to the engine. For diesel generator 1 and 2 each system contains a fuel supply line strainer, fuel oil pump, duplex filter, pressure gauge, relief and check valves, and separate fuel return lines to the day tanks. The HPCS diesel generator fuel oil system is slightly different, see Section 8.3.1.1.7.2.6 for a description of the HPCS diesel generator fuel oil system.

One of the fuel supply pumps is mechanically driven by the engine and is normally used during engine operation. The other supply pump is driven by a 120-V dc motor and is used to fill the fuel oil system and fuel header prior to initial operation and after maintenance has been performed on system piping and components. The dc-motor-driven pump is running during engine operation in the event fuel supply through the engine-driven pump system fails.

The fuel pumps are located 2.3 ft higher than the suction pipes inside the day tank. The fuel pumps are designed to operate at this negative suction pressure. The fuel oil supply and return piping is not exposed to ignition sources such as open flames or hot surfaces. The transfer lines between the storage and day tanks are buried.

The fuel oil day tank is located in a separate ventilated room which is sized to contain the full contents of the tank should a leak develop. For discussion of fire protection see Section 9.5.1.

The tanks are filled through individual lines from a common fill header that has a strainer and locked fill connection. Each tank also has an individual vent with a flame arrestor.

The fill and vent lines terminate at 2.33 ft and 8.0 ft, respectively, above plant grade, which prevents direct seepage of any ground water into the storage tanks.

In the event of fill line damage due to a missile, the pump-out connection which is protected by a metal enclosure, located at ground level, may be used for the fuel oil filling operation.

Prior to filling the storage tanks, the day tank will be confirmed to be full. This will allow sufficient time for sediment to settle before oil from the storage tanks is transferred to the day tank.

Diesel fuel oil conforming with the requirements of the Technical Specifications is provided for operation of the diesel generators. This grade of diesel fuel complies with the engine manufacturer's requirements and is available from local distribution sources as discussed in Section 9.5.4.3.

Equipment design characteristics for the fuel oil supply system are shown in Table 9.5-3.

9.5.4.3 Safety Evaluation

The entire diesel oil supply system is located within the confines of a Seismic Category I building except for the buried storage tank and the fill, vent, and filter/polisher piping. Each system oil storage tank transfer pump, day tank, and diesel generator set is physically separated within separate concrete enclosures designed to protect against missiles, in compliance with Section 3.5, and to provide fire protection. No high- or moderate-energy piping is present in the diesel generator building which could present a potential hazard to the operational function of these systems. The oil storage tanks are buried for protection so that storage tank failure is completely contained within the soil at a level below any building penetration or access opening. Each storage and day tank is provided with a vent directly to the outside atmosphere. In addition, the enclosures are provided with exhaust ventilation to the outside atmosphere to ensure that diesel fuel vapors are maintained well below the combustible limit. The enclosures are automatically monitored by temperature detectors which initiate the preaction sprinkler system in the event of fire (Appendix F). All storage and day tank vents are equipped with flame arrestor devices.

Although a single failure may result in loss of fuel to one diesel generator, the other diesel generator can provide sufficient capacity for emergency conditions, including safe shutdown of the reactor (see Section 8.3) coincident with loss of offsite power.

The fuel level in each storage tank is maintained above the level at which the fuel in the storage tank plus the fuel in the corresponding day tank is adequate for 7 days of continuous operation at 4400 kW for diesel generators 1 and 2, and 2630 kW for diesel generator 3 (HPCS).

The minimum site storage of 7 days is considered adequate time for obtaining additional fuel oil, if required. The auxiliary boiler storage tank is available as an additional source for qualified diesel fuel oil. On an expedited basis fuel can also be available at the site from a remote source within 12 to 24 hr.

Materials for the fuel oil supply system are provided in Table 9.5-3.

For corrosion protection, the exterior surfaces of the buried piping and components are coated with coal tar enamel. Application of coatings are in strict accordance with AWWA Standard C203.

The buried components of the fuel oil system are all at a relatively uniform temperature and not subject to condensation phenomena. The periodic sampling of the diesel fuel storage tank bottom below the transfer pump will be performed to determine if any water has accumulated and if so corrective action will be taken.

A fuel oil filter and strainer is provided on each fuel line to each engine to eliminate passage of particles, 12 μ or larger in size to the engine injectors.

The overflow lines from the day tank to the storage tank run underground south of the diesel generator building. Diesel oil pipe lines extending under the diesel generator building do not receive full protection from the exterior rectifier-anode system because of the electrical shielding effect of the ground grid and foundation reinforcing and structural steel. Since the earth area under the diesel generator building is sheltered and hence relatively much drier than the earth exterior to this building, no additional cathodic protection system is provided or required.

9.5.4.4 Testing and Inspection Requirements

System components are inspected and cleaned prior to installation. Instruments are calibrated during testing and automatic controls are tested for actuation at the proper setpoints. Alarm functions are checked for operability and limits during plant preoperational testing. Automatic actuation of system components is tested periodically in accordance with the Technical Specifications and plant procedures. The system is operated and tested initially with regard to flow paths, flow capacity, and mechanical operability (see Chapter 14).

Operability of the diesel fuel oil system is ensured by

a. At least once per 10 years: Draining each fuel oil storage tank, removing the accumulated sediment, and cleaning the tank using a sodium hypochlorite or equivalent solution, and

b. At least once per 10 years: Performing a pressure test of those portions of the diesel fuel oil system designed to Section III, Subsection ND of the ASME Code in accordance with ASME Code Section XI, Article IWD-5000.

New and stored fuel oil is sampled and tested in accordance with the Technical Specifications.

9.5.4.5 Instrumentation Requirements

Each diesel oil storage tank is provided with local level indicators and high and low level switches which actuate alarm annunciators in the main control room. In addition, there are system fault annunciators in the main control room for each diesel oil storage tank that will alert the operator of a malfunction of the level instrumentation for a given storage tank. Each day tank is provided with two level switches and a float switch which perform the following functions:

a. Start and stop the transfer pump to maintain level in the day tank,
b. Actuate an alarm in the main control room on low level, and

c. Actuate an alarm in the main control room on high level.

The fuel oil filter/polisher is equipped with a flow totalizer to aid in maintaining minimum fuel quantity in each storage tank when transferring from tank to tank. The filter/polisher is equipped with instrumentation and a level switch in a sump to alarm in the main control room if a malfunction occurs or fuel oil leakage occurs in the filter/polisher building. The filter/polisher control panel contains a bargraph/digital level indicator for each diesel oil storage tank. Each bargraph drives a visual and audible annunciator that alerts the operator of a high level condition in that tank. An outside alarm is provided at the filter/polisher facility to alert the operator if any storage tank has a high level condition. A remote shutdown switch is provided in the control room for the operator to shut down the filter/polisher. An emergency shutdown switch is also located just outside of the door of the filter/polisher building.

Each transfer pump discharge line is provided with local pressure indicators. The system maintains the proper supply of diesel oil in each day tank by means of the level switches in the day tanks which signal the corresponding pump motor starters to automatically start and stop the transfer pumps.

Each diesel generator local control panel is provided with a control switch for control of its respective transfer pump.

Local indication of differential pressure is provided across the duplex filters of the fuel oil supply lines to the diesel engines of diesel generators 1 and 2.

9.5.5 DIESEL GENERATOR COOLING WATER SYSTEM

9.5.5.1 Design Bases

a. The diesel generator cooling water system is designed to provide full load cooling for the diesel generator engines while they are operating and to maintain each engine at an acceptable starting temperature under standby conditions;

b. The piping system associated with the diesel cooling water system was constructed to the guidelines of ANSI B31.1. Seismic classification of the system is Seismic Category I as discussed in Section 3.2.4. The diesel cooling water heat exchangers for diesel generators 1A and 1B are designed and built in accordance with ASME Section III, Class 3 and TEMA Standards, Class C; diesel generator 1C (HPCS) cooling water heat exchanger is designed and built in accordance with ASME Section VIII, TEMA Standards, Class C; and

c. The reliability of the diesel cooling water system is achieved by providing separate cooling water systems for each diesel generator. Thus, failure of a single component in one cooling water system would not effect the operation of the other diesel generator. In addition the systems are housed separately in a Seismic Category I structure containing no high- or moderate-energy piping which could present a potential hazard to the operational function of these systems.

9.5.5.2 System Description

Each diesel generator is serviced by an independent cooling system. These systems are located in separate rooms associated with their respective diesel generator. Each engine cooling water system is a closed water circuit which recirculates treated water (see Section 9.2.3) for engine cooling (see Figures 9.5-1 and 9.5-3). The treated water is circulated through the water-jacketed components of the engine to remove heat from the engine parts. This jacket water heat is rejected through a shell and tube heat exchanger to the standby service water (SW) system (see Section 9.2.7). Location of the system is shown in Figure 9.5-2.

The forced circulation of cooling water through the engine, lube oil cooler, heat exchanger, and heat exchanger bypass circuit is maintained by two engine-driven pumps. The separate bypass piping flow paths are provided to bypass the heat exchanger at low engine outlet temperatures and to heat the jacket water system during standby. The heat exchanger bypass flow and temperature is automatically regulated by a three-way self-contained thermostatic valve. This valve is set to maintain the engine outlet water temperature at about 180°F. This thermostatic valve outlet opens to the heat exchanger when the engine jacket water temperature reaches 165°F and is full open to the heat exchanger at 180°F. A high temperature alarm annunciates at 200°F (195°F for HPCS diesel engine). A high temperature shutdown switch is provided to shut down the engine when coolant temperature reaches 208°F (205°F for HPCS diesel engine) during test conditions.

The heat exchangers are designed for 110% continuous rating of each diesel generator using 95°F service water to the heat exchanger. The maximum service water temperature is always well below 95°F. This provides a 10% margin in the size of the heat exchangers.

The only time the diesel generators are run at 110% of their continuous rating is during required surveillance testing. This is usually for 2 hr once a year, and always less than 10 hr/year, compared to the 2 hr/day as allowed by the engine manufacturer's rating.

The diesel generator heat exchangers are designed to perform as given in Table 9.5-4.

An expansion tank is mounted on the diesel engine skid, located above the cooling water circulating pump suction. The expansion tank is provided with a pressure cap that maintains pressure on the cooling water system (7 psi) and prevents loss of water due to evaporation.

The expansion tank is provided with a level sight glass which is mounted on the front with instructions that indicate minimum water level. An alarm is provided in the control room to annunciate in case of low water level. Makeup water is normally supplied by the demineralized water system, but a Seismic Category I, Safety Class 3, makeup water line from the SW system is provided as an alternate supply to the expansion tank.

Diesel generator unit reliability, including the functions required of the circulating water pump and expansion tank were demonstrated prior to installation (qualification and shop performance tests). Periodic testing and maintenance ensure continued reliability.

During shutdown periods, an electric immersion heater is provided for standby heating. The engine can thus be kept in constant readiness for an immediate start. The heating unit is mounted at the bottom of the accessory rack to heat the engine cooling water which circulates by thermosyphon action to the lube oil cooler, engine, and turbocharger after coolers. A thermostat sensing water temperature controls the heating elements. The water temperature is controlled to maintain a lube oil temperature of approximately 120°F as described in Section 9.5.7. The auxiliary motor-driven oil pump circulates lube oil through the lube oil cooler to pick up heat during standby conditions and then returns the warmed oil to the engine sump (see Section 9.5.7). Low oil temperature alarm is provided to ensure that the immersion heater is operating properly (see Sections 9.5.7.2 and 8.3.1.1.7.2.3).

To ensure that all components and piping are initially filled with water, a demineralized water supply is temporarily connected to the 1.25-in. fill-drain connection located on the engine base at the cooling water pump end. Filling the cooling water system from the bottom up allows entrapped air to be vented to the expansion tank. (The HPCS engine has a permanent connection.)

The engine cooling water return pipe (between engine block and temperature regulating valve) is slightly higher than the top of the expansion tank. However, as may be seen from Figures 9.5-1 and 9.5-3, during system operation any entrapped air will be properly relieved to the expansion tank through the provided vent lines due to the differential pressures involved.

A 500-gal reservoir tank is provided in the cooling water system of each diesel engine associated with diesel generators 1 and 2 to permit operation of the engine for the time required to receive SW cooling. The HPCS diesel engine is designed to permit operation without cooling for a time equivalent to that required to bring the cooling equipment into service with energy from the HPCS diesel generator.

In accordance with the manufacturer's maintenance instructions, a corrosion inhibitor is added to the demineralized fill water to preclude corrosion and organic fouling in the diesel engine cooling water system. Since the entire system is enclosed in the diesel generator building and maintained in a warm condition with immersion heaters, antifreeze compounds are not needed.

Cooling system materials of construction include cast irons, carbon steel, rubber, and bronze. Corrosion inhibitors can be used effectively with these materials.

Demineralized water and a corrosion inhibitor are in conformance with the engine manufacturer's recommendations.

9.5.5.3 Safety Evaluation

The diesel generator cooling water system meets the single failure criterion in that if a failure in the system prevents the operation of its associated diesel generator, the remaining diesel generators will not be affected.

This redundancy is accomplished by segregating the power supplies to engineered safety features into three mutually exclusive divisions, each provided with a diesel generator and associated cooling water system. The cooling water systems associated with a particular diesel generator are cooled from an independent SW system.

In the event of the loss of offsite power, the SW pumps which supply cooling water to the heat exchangers begin operation within a safe margin of the point at which the diesel generators 1 or 2 would require the cooling capability of the heat exchangers. See Section 9.2.7 for evaluation of this system.

The high temperature shutdown switches are locked out of the safety circuit during the automatic (emergency) operational mode of the diesel generators to ensure the availability of the emergency power from each generator.

Evaluation of the diesel generator operation under light load conditions is presented in Sections 8.3.1.1.7.1.11 and 8.3.1.1.7.2.11.

9.5.5.4 Testing and Inspection Requirements

The system is operated and tested initially with regard to flow path, flow capacity, and mechanical operability (see Section 14.2).

To ensure continued integrity of the diesel generator cooling water system, scheduled testing of equipment is performed as part of the overall engine performance checks at regular intervals in accordance with the Technical Specifications. Periodic inspections are conducted no less than once every 30 months in accordance with plant procedures prepared in conjunction with the manufacturer's recommendations.

Instrumentation is provided to monitor cooling water temperature and pressure, expansion tank level, and to alarm high water jacket temperature. These instruments receive periodic calibration and inspection to verify their accuracy.

The water in the cooling water system is periodically analyzed and treated, as necessary, to maintain the desired quality.

9.5.6 STARTING AIR SYSTEM

9.5.6.1 Design Bases

a. Each emergency diesel generator, including the HPCS diesel generator, is provided with separate, independent starting air systems;

b. Each starting air system on diesel generator 1 or 2 has sufficient air receivers to provide for five diesel generator starts. The starting air system on each diesel generator consists of two completely redundant systems including two banks of air receivers, separate piping and valves, and one pair of air motors per engine which are both actuated on a start signal. The starting system on HPCS diesel generator 3 consists of two separate systems from separate air receivers through separate piping and control valves to a pair of air motors on each side of the engine. The air receivers have sufficient air capacity for three starts; and

c. The starting air piping off the engine skid is designed, fabricated, inspected, and erected in accordance with ANSI B31.1. The piping on the engine skid is constructed using ANSI B31.1 as a guide. The system is designed to Seismic Category I requirements. The air receivers associated with diesel generators 1 or 2 are designed and constructed in accordance with the requirements of ASME Section VIII (1973 Edition). The HPCS diesel generator air receivers were designed and constructed in accordance with the 1971 Edition of the same code.

9.5.6.2 System Description

The starting air system is shown schematically in Figure 9.5-1. The starting air systems for diesel generators 1 and 2 consist of two electric-motor-driven air compressors, eight air receivers, and associated piping and controls.

Control switches for the electric-motor-driven operation of the air compressors on diesel generators 1 and 2 are on the local diesel engine control board. These control switches permit on-auto-off operation. A selector switch permits selection of either compressor function as the primary pressurization compressor.

Pressure switches in either air receiver bank automatically start the selected compressor when the receiver pressure decays to 241 psig. If the selected compressor fails to operate or cannot hold system pressure, a separate low pressure alarm switch is provided for each bank of air receivers and is set to alarm at 238 psig on a local panel and in the main control room. When the receiver pressure decays to a lower pressure, the back-up air compressor starts.

The HPCS starting air system has two separate air supply trains: one supplied by a diesel-driven compressor and the other by an electric-motor-driven compressor.

The compressor discharge piping is cross connected. Both air receivers charge if either compressor operates. A check valve on each receiver inlet isolates one train from the other.

The compressors are controlled automatically by pressure switches on their associated air receiver. The compressor's low pressure setpoint ensures that the compressor starts to maintain the air receiver pressure at a sufficient amount to start the engine the required number of times.

The HPCS diesel-driven compressor may shut down prior to clearing the low pressure alarm on the receiver in the electric-motor-driven compressor train.

The air receivers are equipped with safety/relief valves set at the receiver design pressure.

The major system components are located adjacent to the diesel generator skid.

For each diesel generator (1 and 2), two separate air-cooled compressors discharge through common piping to two banks of four 32 ft^3 air receivers which are connected in parallel. Each bank of air receivers has the capability of a minimum of five engine starts. Each bank is connected through separate piping to a pair of air start motors on each engine.

The flow path is from the air receiver manifold, through an isolation valve, a pressure reducing valve, through piping to the engine, then a strainer, an air relay valve, and a lubricator to each pair of air starter motors. The starting air system on each engine consists of four air start motors. These air start motors drive a flywheel ring gear which turns the engine. When a start signal is given, an air start solenoid valve in each redundant system admits air to engage a pair of the air start motor pinions on each engine to the flywheel ring gear. When the pinions are engaged, air is admitted through an air control valve to a pair of air start motors. The other pair of start motors on the engine are simultaneously engaged by the redundant start solenoid valves. Engine cranking time is approximately 2 sec.

The starting air system is designed to provide a reliable method for automatically starting each diesel generator unit. The system design is such as to preclude fouling of its components. Downstream of the air compressors, dryers are installed to ensure the dewpoint of the air will be below the minimum room temperature if the system is filled during the worst ambient air conditions. The air dryers are drained periodically to remove oil and moisture. A filter is provided downstream of the dryer to ensure no desiccant or debris can enter the system. In addition, "Y" type strainers are provided upstream of the starting air valves and motors. These strainers are cleaned periodically to ensure that they are kept free from contaminants.

The air starting system of the HPCS diesel generator is similar to that of diesel generators 1 and 2 described above except (a) the number of air receivers: two, of approximately 36 ft^3 each, (b) the number of engine starts: three from the air receivers with the compressors locked out, (c) the redundant starting air compressor is diesel driven and automatically operates without manual actions, and (d) there are two parallel systems that each simultaneously operate a pair of air motors on the diesel generator for a start. The parallel systems provide the ability to produce a start even if one system sustains a pressure boundary failure or a failure of one starting air solenoid valve to open.

See Section 8.3.1.1.7.2.5 for additional discussion of the HPCS diesel engine starting air system.

9.5.6.3 Safety Evaluation

Each diesel generator starting air system is capable of supplying a sufficient quantity of air from its associated air receivers to ensure a successful starting operation of the diesel generator independent of normal plant power sources.

The starting air systems for each diesel generator unit are physically and electrically separated to ensure that no single failure can cause malfunction of both divisions of standby ac power. The single failure criterion is satisfied and significantly enhanced by having redundant piping systems and mechanical equipment for diesel generators 1A and 1B and duplicate (but not functionally redundant) piping systems and mechanical components for the HPCS diesel generator. All three diesel generators also have redundant starting solenoid valves.

9.5.6.4 Testing and Inspection Requirements

Preoperational testing was performed as described in Section 14.2. To ensure continued integrity of the diesel generator starting air system, scheduled testing of equipment is performed as part of the overall engine performance checks at regular intervals in accordance with the Technical Specifications. Periodic inspections are conducted no less than once every 30 months in accordance with plant procedures prepared in conjunction with the manufacturer's recommendations.

9.5.7 DIESEL GENERATOR LUBRICATION SYSTEM

9.5.7.1 Design Bases

a. The diesel generator lubrication system is designed to provide sufficient lubrication for proper operation of its associated diesel generator under all loading conditions. The system is required to circulate the lube oil to the diesel engine working surfaces and to remove excess heat generated by friction during operation. The system provides oil at the engine surfaces at approximately

120°F during the anticipated long periods of standby duty by use of an electric immersion heater in the cooling water system; and

b. The piping system was constructed to the guidelines of ANSI B31.1 and Seismic Category I requirements.

9.5.7.2 System Description

The lubrication system for each diesel generator is shown in Figure 9.5-1. The lubrication system for each diesel engine is mounted on its diesel generator skid (see Figure 9.5-4) and is a combination of three separate systems. These are the main lubricating oil systems, the piston cooling system, and the scavenging oil system. Each system has its own pump. The main lube oil pump and the piston cooling oil pump are in tandem housings and share a common drive shaft. All three pumps are positive displacement, helical gear type, mounted externally at the front of the engine, and are gear-driven from the engine.

The main lubricating pump supplies oil under pressure to the various moving parts of the engine. The piston cooling pump supplies oil for the cooling of the pistons and lubrication of the piston pin bearing surfaces. After circulation through the engine parts, the lubricating oil flows back to the engine oil sump. The scavenging oil pump takes suction from the engine oil sump and pumps this oil through a filter and lube oil cooler to the strainer sump which supplies the main and piston lubricating pumps. The lube oil cooler is a shell and tube, water-cooled type capable of adequately cooling the engine lube oil when operating at any load point within the engine generation load range. The diesel cooling water acts as the lube oil cooler heat sink.

The engine lubrication system including the lube oil cooler is furnished by the engine manufacturer, Electromotive Diesel, a division of General Motors. The diesel cooling water system, also furnished with the engine, removes the heat from the lube oil coolers. Heat from the diesel cooling water system is removed in the diesel generator cooling water heat exchangers. The characteristics of these heat exchangers are described in Section 9.5.5.

The lubrication system on each engine also has three small lube oil pumps to circulate oil through the engine main bearings and the turbocharger bearings to minimize wear when the engine starts.

The circulating lube oil pump continuously circulates lube oil through the main lube oil system filter, the lube oil cooler (where it is warmed to approximately 120°F) and then through the engine main bearings. This maintains the oil level in the engine just below the camshaft so the oil pressure will increase rapidly when the engine starts from a normal standby condition or on a hot restart.

An ac-driven soak back pump continuously circulates lube oil through the turbocharger bearings to minimize wear when the engine starts and to remove heat from the turbocharger following engine shutdown. A dc-driven soak back pump is arranged in parallel with the ac soak back pump and will automatically start on loss of pressure downstream of the ac and dc pumps.

Instrumentation is provided that alarms locally and activates a "DG Trouble Alarm" in the control room on loss of pressure downstream of any of the pumps.

Abnormal lube oil pressures, temperatures, low sump level, and loss of pressure on the lube oil circulating pump discharge are annunciated.

In the event of a high crankcase pressure, annunciator and computer alarms are provided to alert the operator. A manual shutdown will then be made for diesel generators 1 and 2. For diesel generator 3 (HPCS) an automatic shutdown will occur unless an auto initiation signal is present. The hand-hole or top deck covers, following a high crankcase pressure condition, will not be opened until the engine has been allowed to cool off. This will prevent ignition of oil vapors due to air admittance.

Suitable screens and/or filters in the engine lubrication oil fill pipes prevent entry of foreign material into the engine crankcase. Procedural control, operator training, and careful labeling of fill ports to identify the standard and grade of lubricant to be used ensures that the proper lubricant is used. Lubricant storage containers are similarly labeled to identify contents. Sampling and testing of the lubricating oil to verify conformance to ASTM Standard 0975-74, Grade 2-D, is performed periodically.

The manufacturers recommendations on measures to be taken to maintain the required quality of the lubricating oil provided in the engine instruction manual are followed.

The following sensors and alarms are provided as described below (diesel generator 3 values are in parentheses):

Sensor	Alarm Point	Purpose
Engine lube oil temperature low	115°F (100°F)	To warn of loss of warm-up immersion heater
Engine lube oil temperature high	240°F (230°F)	To warn of loss of cooling water system
Engine lube oil pressure low (alarm)	26 psig (25 psig)	To warn of low oil pressure prior to engine damage

Sensor	Alarm Point	Purpose
Engine lube oil pressure low (shut down)	21 psig (23 psig)	Shut down engine only during test mode to prevent damage
Shutdown engine lube oil pressure low (alarm)	7 psig (7 psig)	Warns of inadequate lube oil pressure in standby mode.

Operator actions to be taken to resolve alarm conditions are provided in appropriate plant procedures.

See Sections 8.3.1.1.7.1.4 and 8.3.1.1.7.2.4 for additional discussion of the diesel generator lubrication system.

9.5.7.3 Safety Evaluation

The diesel generator lubrication system is capable of providing sufficient lubrication under all loading conditions. Each engine oil sump is of adequate size to contain a supply of oil to support 7 days of continuous operation.

The provision for a physically separate lubrication system for each diesel engine satisfies the requirements of the single failure criterion for complete independence and redundance of the onsite power system by avoiding any commonality between diesel generator units. All system equipment is housed inside a Seismic Category I structure containing no high- or moderate-energy piping.

The lubrication system has a low level alarm in the sump to warn of low oil level. The engines are periodically visually inspected for oil leaks to guard against excessive oil leakage.

9.5.7.4 Testing and Inspection Requirements

Preoperational testing was performed as described in Section 14.2. To ensure continued integrity of the diesel generator lubrication system, scheduled testing of equipment and lubrication oil quality is performed as part of the overall engine performance checks at regular intervals in accordance with the Technical Specifications. Periodic inspections are conducted no less than once every 30 months in accordance with plant procedures prepared in conjunction with the manufacturer's recommendations.

9.5.8 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

9.5.8.1 Design Bases

a. The diesel generator combustion air intake and exhaust system is designed to supply clean combustion air to each diesel engine and to exhaust combustion gases in a manner that will not effect the operational function of the diesel engines;

b. Each diesel engine is provided with an independent combustion air intake train which filters and directs air from the exterior of the diesel generator building (south side) to the engine turbocharger, and an independent exhaust train which silences and directs engine exhaust gases to the exterior of the diesel generator building (north side). Since each diesel generator unit has its own independent and separate intake and exhaust train, the single failure criterion is satisfied;

c. The air intake trains are designed to eliminate contaminating substances, such as dust and larger foreign objects, by filtering the air supply through a screened air intake louver, a prefilter, and then through an oil bath air cleaner for the HPCS engine and a cartridge type air cleaner for the engines associated with diesel generators 1 and 2; and

d. The combustion air intake and exhaust system is protected from externally generated missiles (i.e., tornado missiles) by enclosure in a Seismic Category I structure. The piping for the diesel engine intake and exhaust systems is Seismic Category I and is in accordance with the requirements of ANSI B31.1. The exhaust silencers, however, are not ANSI B31.1 material but are ASTM A569 which is suitable for the service. The seismic and quality group classification of components in this system is provided in Section 3.2.

   Nondestructive examination in accordance with ASME Section III, ND-5000 requirements, was performed on the welds in the combustion air intake and exhaust systems piping.

9.5.8.2 System Description

The combustion air intake and exhaust system is shown in Figure 9.5-1 and the location within the diesel generator building is shown in Figure 9.5-2.

The air intake trains associated with each diesel generator are housed in separate rooms and each is supplied air from the exterior of the diesel generator building (south side) through a screened air intake louver. Each engine air intake system consists of prefilters, an oil bath type air cleaner for the HPCS engine and cartridge type for the engines associated with diesel generators 1 and 2, air turning box, the necessary piping, ductwork, and flexible connections to the inlet of the engine turbocharger and aftercooler. An in-line air intake silencer is also provided in the HPCS diesel engine air intake system.

Intake air is cooled in the aftercooler by the engine cooling water system to improve engine operational efficiency. The air intake capacity of each diesel engine associated with diesel generators 1 or 2, at 14.7 psi and ambient temperature, is 10,120 cfm. The air intake flow to the HPCS diesel engine at 14.7 psi and ambient temperature is 10,200 cfm.

The exhaust trains associated with each diesel generator are also housed in separate rooms. Each engine exhaust system consists of an exhaust manifold, turbocharger, exhaust silencer, and the necessary piping and ductwork. Exhaust piping from the diesel-driven air compressor in the HPCS starting air system is connected to the corresponding diesel exhaust line upstream of the exhaust silencer.

Exhaust gases are discharged through the turbocharger from the exhaust manifold and are expelled through ductwork and an exhaust silencer to the exterior of the diesel generator building (north side). The exhaust gas flow from each diesel engine associated with diesel generators 1 or 2 is 23,000 cfm at 770°F and from the HPCS diesel engine is 23,000 cfm at 735°F.

9.5.8.3 Safety Evaluation

The provision of a physically separated and independent intake and exhaust train for each diesel generator unit satisfies the requirements of the single failure criterion for complete independence between units.

Since each air intake and exhaust train is housed within a Seismic Category I building, they are protected from externally generated missiles. No high- or moderate-energy piping is present in the diesel generator building which could present a potential hazard to the operational function of these systems.

The air intake trains are designed so that an adequate supply of quality air is available to the diesel engines as required. To eliminate foreign objects which could restrict the supply of air to an engine, air is drawn into the system from the outside atmosphere through a screened intake louver and prefilter and then through combustion filters; oil bath cleaner for the HPCS engine and a cartridge type air cleaner for the engines associated with diesel generators 1 and 2. The postulated design worst-case dust storm is defined in Section 2.3. The postulated design basis ashfall event is defined as a 20 hour event concurrent with a 2 hour loss of offsite power. The dust storm concern is negligible by comparison with the design worst-case ashfall event due to the smaller amount of particulate accumulation associated with the dust storm. The results of an analysis of the oil bath and cartridge filters for the intake air system shows the adequacy of either of these combustion filters in handling a severe dust storm event without affecting the diesel generators performance. The results of an analysis for the intake air systems shows the adequacy of the combustion filters and pre-filters in handling an ashfall event without affecting the safe shutdown credited Division 1 and 2 diesel generators. Evaluation of a postulated release from the containment inerting nitrogen tank determined that such a release could stall all three diesels for approximately 8 minutes. This postulated release, however would not result in any conditions that would lead to turbine trip or reactor scram. Because the postulated release from a non-mechanistic failure on the nitrogen tank does not result in a reactor scram or turbine trip, offsite power remains available during the postulated nitrogen tank release and reliance on the diesel generators is not required. This assumption is consistent with guidance in Standard Review Plan (SRP) Sections 3.6.1 and 3.6.2.

There is no appreciable effect on a diesel generator's ability to carry its required load as a result of barometric pressure drops which would effect the capacity of the combustion air intake train.

Recirculation of combustion products from the diesel exhaust to the air intake which could significantly effect the operation of the diesel engine is precluded by the degree of horizontal and vertical separation between the exhaust and air intake (see Figure 9.5-2).

9.5.8.4 Inspection and Testing Requirements

The combustion air intake and exhaust system was checked for system leaks and blockage following initial installation and testing of the diesel engines (see Section 14.2).

Periodic cartridge replacement/cleaning of air intake filter units is performed at regular intervals and when the filter differential pressure observed during engine operation indicates the filter is dirty. Periodic inspection of the adapter and screen assemblies in the exhaust manifold is performed as needed. Routine testing of the diesel engines in accordance with the Technical Specifications verifies the integrity of the air intake and exhaust systems. Periodic inspections are conducted no less than once every 30 months in accordance with plant procedures prepared in conjunction with the manufacturer's recommendations.

9.5.9 PLANT DECONTAMINATION FACILITY

9.5.9.1 Design Bases

The plant decontamination facility is designed to provide a central location for equipment decontamination in a relatively safe and efficient environment. Safety of personnel has been carefully considered and built into all aspects of the operation. Local filtration and increased capability, per recommendations of the Handbook of the American Conference of Governmental Industrial Hygienists, have been incorporated into the existing radwaste building ventilation system to minimize airborne contamination. Each of the facility components has been strategically located to provide a safe, efficient, and relatively quiet process from entry to disassembly, cleaning, reassembly, and exit. Controls and indication have been positioned in a central location to minimize setup time and thus reduce personnel exposure. The decontamination facility has been designed to Quality Class II and Seismic Category II requirements.

9.5.9.2 System Description

The decontamination facility is located in the radwaste building on the 467-ft el. adjacent to the contaminated tool room (see Figure 9.5-5). This facility consists of the equipment necessary to enable decontamination of a variety of plant components, tools, and other portable equipment.

To minimize airborne contamination and process fumes in the decontamination room, cleaning tanks are provided with individual exhaust hoods per recommendations of the Ventilation Handbook of Governmental Industrial Hygienists. The exhaust system for each hood is complete with its own high-efficiency particulate air (HEPA) filter unit and exhaust fan. The air from the exhaust fans is ducted to the radwaste building exhaust system (see Section 9.4.3.2 for system description).

Differential pressure switches are provided across the prefilters and the HEPA filters to annunciate in case of a dirty filter condition. The fan flow is controlled by the fan differential pressure controller which controls a modulating damper at the fan discharge. All the fans are located in the contaminated tool room to minimize noise levels in the decontamination room during operation.

An automatic sprinkler system has been installed for protection against the unlikely event of a fire. Curbs have been installed at all doors to the decontamination room, the equipment hatch, and the contaminated tool room to contain flooding caused by a major spill or activation of the sprinkler system. A decontamination sink and an emergency eyewash shower station have been installed to permit immediate treatment in case of a splashing accident.

9.5.9.3 Safety Evaluation

The plant decontamination facility has no safety function. Malfunction or failure of the decontamination facility will not impair normal or emergency plant operations.

9.5.9.4 Testing and Inspection Requirements

On installation and periodically thereafter, HEPA filters are given in-place DOP tests in accordance with ANSI N 510-1980, Testing of Nuclear Air Cleaning Systems.

9.5.10 REFERENCES

9.5-1 H. R. Clay, "Power Generation Control Complex Design Criteria and Safety Evaluation," General Electric NEDO-10466, Revision 1, September 1977.

9.5-2 Electro-Motive Division, General Motors, LaGrange, IL, "Stationary Power Operating Manual," Volume 11, 2nd Edition, June 1971.

9.5-3 SER Licensing Condition No. 9. Letter from G. D. Bouchey, Supply System, to A. Schwencer, NRC, dated June 4, 1982 (G02-82507).

Table 9.5-2

Locations of Fixed Emergency Lighting

Safe Shutdown Equipment Areas/Access Egress	Normal-Emergency AC (DG Backed)	DC (125V Plant Battery Backed)	Battery Packs: Life Safety (1.5-hr Batteries)	Battery Packs: (8-hr Batteries)
RADWASTE BUILDING				
Access route from the Control Room to RSD Room via stairwell A-7	YES	YES		EBU
Remainder of stairwell A-7 for PFSS event mitigation	YES		EBU	EBU
Control Room	YES (with Fluorescent Lighting Fixtures)	YES	EBU	EBU
RSD Room	YES	YES		EBU
ARSD Panel	YES			EBU
SM-8	YES (with Fluorescent Lighting Fixtures)			EBU
SM-7	YES			
Battery Chargers Div. 2	YES		ERB	
RPS 1A	YES		EBU	
RPS 1B	YES		EBU	
125 VDC Div. 1 Battery			ERB	
125 VDC Div. 2 Battery			ERB	
Remainder of RW el. 467 ft for PFSS event mitigation	YES		EBU	EBU
RW el. 525 ft PFSS event mitigation	YES		EBU, ERB	
Remainder of RW	YES		EBU, ERB, High Intensity Discharge Light	

Table 9.5-2

Locations of Fixed Emergency Lighting (Continued)

Safe Shutdown Equipment Areas/Access Egress	Normal-Emergency AC (DG Backed)	DC (125V Plant Battery Backed)	Battery-Packs Life Safety (1.5-hr Batteries)	Battery-Packs (8-hr Batteries)
TURBINE BUILDING				
Corridor C121 at el. 441 ft	YES			EBU
Corridor C120 at el. 441 ft (remainder of the access route from the Control Room to the DG Bldg. For PFSS event mitigation)	YES			EBU
SM-1, 2, 3; SH-5, 6 at el. 471 ft	YES		EBU, High Intensity Discharge Light	
Remainder of TG	YES		EBU, ERB, High Intensity Discharge Light	
DIESEL GEN. BUILDING				
Corridor D104 at el. 441 ft	YES			
Div. 1 DG	YES		EBU	
Div. 2 DG	YES		EBU	EBU
HPCS DG, SM-4	YES		EBU	
SSW PUMPHOUSE				
Pumphouse 1A (Div. 1)				
Pumphouse 1B (Div. 2 & 3)				

Table 9.5-2

Locations of Fixed Emergency Lighting (Continued)

Safe Shutdown Equipment Areas/Access Egress	Normal-Emergency AC (DG Backed)	DC (125V Plant Battery Backed)	Battery-Packs: Life Safety (1.5-hr Batteries)	Battery-Packs: (8-hr Batteries)
REACTOR BUILDING				
Access route via stairwell A-6 for PFSS event mitigation	YES		EBU	
Fuel Pool at el. 606 ft	YES		EBU, High Intensity Discharge Light	
MCCs at el. 572 ft	YES		EBU	
SSW Valves at el. 548 ft	YES		EBU	
RWCU-V-32 at el. 501 ft	YES		EBU	
MCCs at el. 522 ft	YES		EBU	
RHR-P-3 at el. 422 ft	YES		EBU	
LPCS-P-2 at el. 422 ft	YES		EBU	
Access Route from corridor C402 at el. 501 ft via stairwell S3 to el. 522 ft	YES		EBU	
Remainder of RB	YES		EBU	
TECHNICAL SUPPORT CENTER			EBU	

EBU Fixed Emergency Battery Units (Life Safety Units 1.5-hr, PFSS Units 8-hr)
ERB Fixed “Emergency Remote Ballast” with 1.5-hr Battery

Table 9.5-3

Diesel Generator Fuel Oil Storage and Transfer System[a]

Number	3
Capacity (gal)	
Diesel generator 1A or 1B	60,000
HPCS diesel generator	50,000
Type	Horizontal - buried
Shell material	ASME SA-515 Grade 70
Shell thickness (in.)	3/4-15/16
Design temperature	150
Design pressure	Atmosphere plus static head
Corrosion allowance (in.)	3/16
Code	ASME Section III, Class 3, April 1973
Seismic Category	I
Diesel Oil Day Tank	
Number	3
Capacity (gal)	3000
Type	Horizontal
Shell material	ASME SA-285 Grade C
Shell thickness (in.)	3/8
Design pressure	Atmosphere plus static head
Corrosion allowance (in.)	3/16
Code	ASME Section III, Class 3, April 1973
Seismic Category	I
Diesel Oil Transfer Pumps	
Number	3
Type	Vertical turbine
Rated speed (rpm)	3500
Rated capacity (gpm)	25
Total dynamic head (ft)	51
Code	ASME Section III, Class 3, April 1973
Seismic Category	I

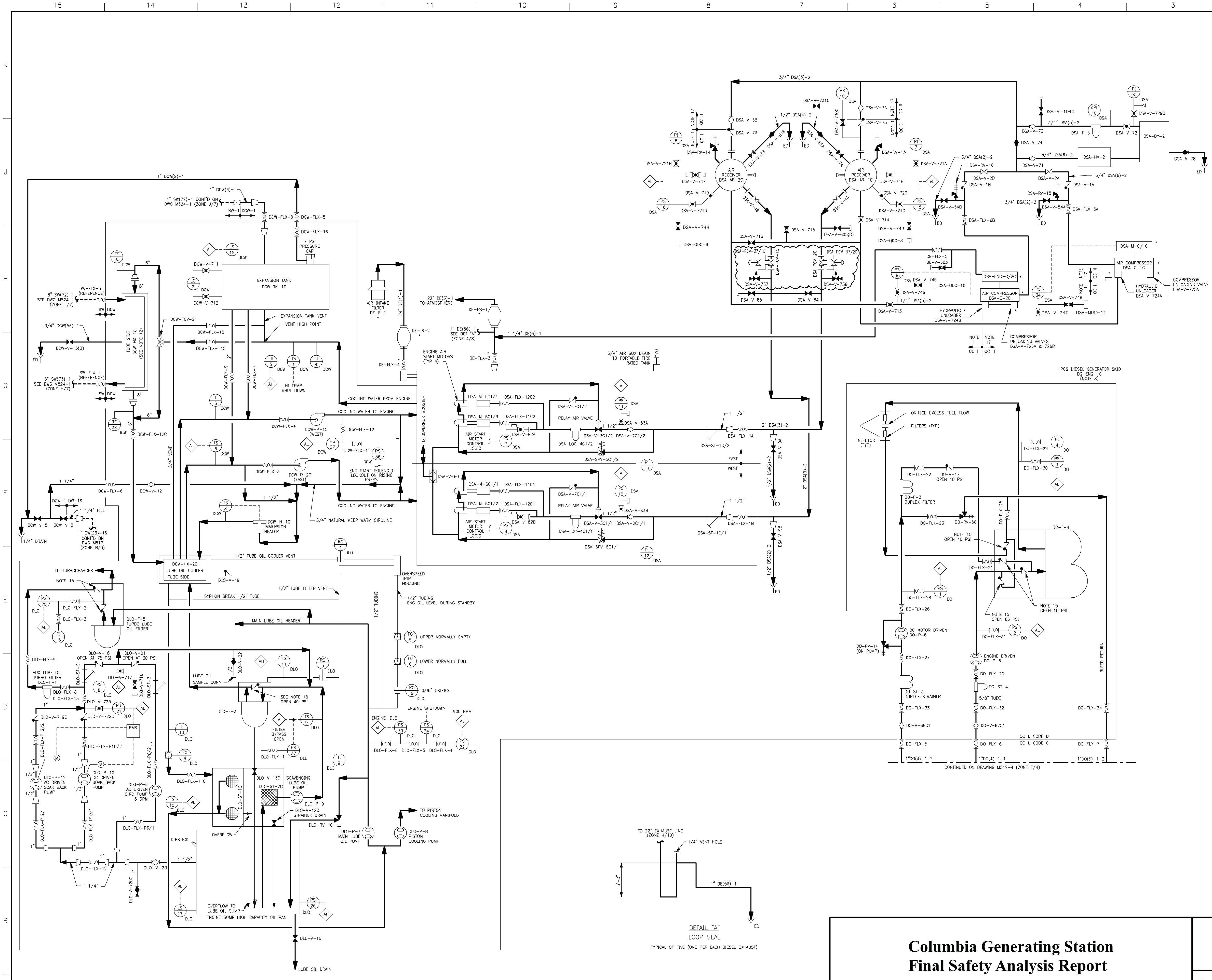
[a]Capacities are on a per component basis.

Table 9.5-4

Diesel Generator Heat Exchanger
Design and Performance Data

	Shell Side	Tube Side
Diesel generators 1A and 1B		
Fluid circulated	Engine water	Standby service water
Number per engine	1	1
Flow (gpm)	1100	825
Temp in (°F)	190	95
Temp out (°F)	175.4	113.9
Fouling factor	0.0005	0.001
Heat load (Btu/hr)	7,800,000[a]	
Design temperature (°F)	300	300
HPCS generators 1C		
Fluid circulated	Engine water	Standby service water
Number per engine	1	1
Flow (gpm)	1100	910
Temp in (°F)	187	95
Temp out (°F)	170	118
Fouling factor	0.0005	0.00185
Heat load (Btu/hr)	8,872,000[a]	
Design temperature (°F)	250	200

[a] This heat rejection value is based on 110% of the continuous rating of the diesel generator.



NOTES:

1. ALL DIESEL STARTING AIR (DSA), DIESEL COOLING WATER (DCW), AND DIESEL EXHAUST (DE) PIPING AND ASSOCIATED COMPONENTS ON THIS DRAWING INCLUDED IN CONTRACTS 2, 53 AND 215 EXCEPT AS NOTED IN NOTE 17 ARE CLASSIFIED:
   - QUALITY CLASS I
   - CODE GROUP D
   - SEISMIC CATEGORY I
2. ALL DIESEL OIL (DO) PIPING AND ASSOCIATED COMPONENTS ON THIS DRAWING EXCEPT AS NOTED IN NOTES 11 AND 22 ARE CLASSIFIED:
   - QUALITY CLASS I
   - CODE GROUP C FOR CONTRACT 215
   - CODE GROUP D FOR CONTRACT 2 AND 53
   - SEISMIC CATEGORY I
3. (DELETED)
4. ALL PIPING AND FITTINGS FOR DE(1)-1 AND DE(2)-1 ARE SUPPLIED BY CONTRACT 53 AND SUPPORTED AND ERECTED BY CONTRACT 215.
5. DELETED
6. EQUIPMENT TAG NUMBER WITH SUFFIX A1 REFERS TO NUMBER 1 ENGINE OF DIESEL GENERATOR DG-ENG-1A. SUFFIX A2 REFERS TO NUMBER 2 ENGINE OF DIESEL GENERATOR DG-ENG-1A. SUFFIX B1 REFERS TO NUMBER 1 ENGINE OF DIESEL GENERATOR DG-ENG-1B AND SUFFIX B2 REFERS TO NUMBER 2 ENGINE OF DIESEL GENERATOR DG-ENG-1B.
7. ALL ITEMS MARKED * ARE FURNISHED WITH ASSOCIATED DG SKID SUPPLIER.
8. ALL PIPING COMPONENTS AND INSTRUMENTATION SHOWN WITHIN THE CONFINES OF THE ENGINE SKID OR AIR RECEIVER SKID ARE SUPPLIED BY THE DG SUPPLIER AND ARE:
   - QUALITY CLASS I
   - CODE GROUP D
   - SEISMIC CATEGORY I
9. (DELETED)
10. (DELETED)
11. ALL DIESEL OIL(DO) PIPING AND ASSOCIATED COMPONENTS ON THIS DRAWING INCLUDED IN CONTRACT 215 AND REFERRED TO BY THIS NOTE ARE CLASSIFIED:
    - QUALITY CLASS II
    - CODE GROUP D
    - SEISMIC CATEGORY II
12. DCW-HX-1C IS SUPPLIED BY CONTRACT 2 AND IS ASME SECTION VIII DIVISION 1. DCW-HX-1A1, 1A2, 1B1, 1B2 WERE SUPPLIED BY CONTRACT 53 AND ARE ASME III, 3.
13. (DELETED)
14. CODE BREAK DEFINITIONS FOR THERMOWELLS ARE SHOWN ON DRAWING M610 "INSTALLATION OF THE THERMOWELLS AND SAMPLE PROBES".
15. ALL ITEMS REFERRING TO THIS NOTE ARE INSTALLED WITHIN THE FILTER MANIFOLD.
16. (DELETED)
17. DSA PIPING & EQUIPMENT REFERRED TO BY THIS NOTE ARE CLASSIFIED:
    - QUALITY CLASS II
    - CODE GROUP D
    - SEISMIC CATEGORY I*
    - * SEISMIC MOUNTING ONLY
18. THE DIESEL LUBE OIL (DLO) SYSTEM FOR DG-ENG-1A & 1B IS A DUPLICATE OF STEWART & STEVENSONS VENDOR DRAWING NUMBER 209 (CVI NUMBER 53-00,53) AS MODIFIED BY POWER SYSTEMS DRAWING 6911R03002 SHEET 1 THRU SHEET 4 (CVI NUMBER 332-00,1,1 THRU 332-00,1,4 RESPECTIVELY).
19. (DELETED)
20. THE DIESEL LUBE OIL PRESSURE SWITCHES ARE INSTALLED BUT JUMPER IS INSTALLED TO BYPASS THEM. SEE ZONES D1 AND E15 ON SHEETS 2 AND 3.
21. THESE DIESEL LUBE OIL PRESSURE SWITCHES ARE SPARED IN PLACE. SEE ZONES D2 AND D15 ON SHEETS 2 AND 3.
22. ALL DIESEL OIL (DO) PIPING AND ASSOCIATED COMPONENTS ON THIS DRAWING INCLUDED IN CONTRACT 215 AND REFERRED TO BY THIS NOTE ARE CLASSIFIED:
    - QUALITY CLASS II
    - CODE GROUP D+
    - SEISMIC CATEGORY I
23. SEE DWG M501 FOR FLOW DIAGRAM LEGENDS, SYMBOLS AND ABBREVIATIONS.

LEGEND:

1. ALL VALVES SUFFIXED WITH A (V) DENOTE A VENT VALVE.
2. ALL VALVES SUFFIXED WITH A (D) DENOTE A DRAIN VALVE.
3. ALL VALVES SUFFIXED WITH A (TH) DENOTE A THROTTLED VALVE.

Columbia Generating Station
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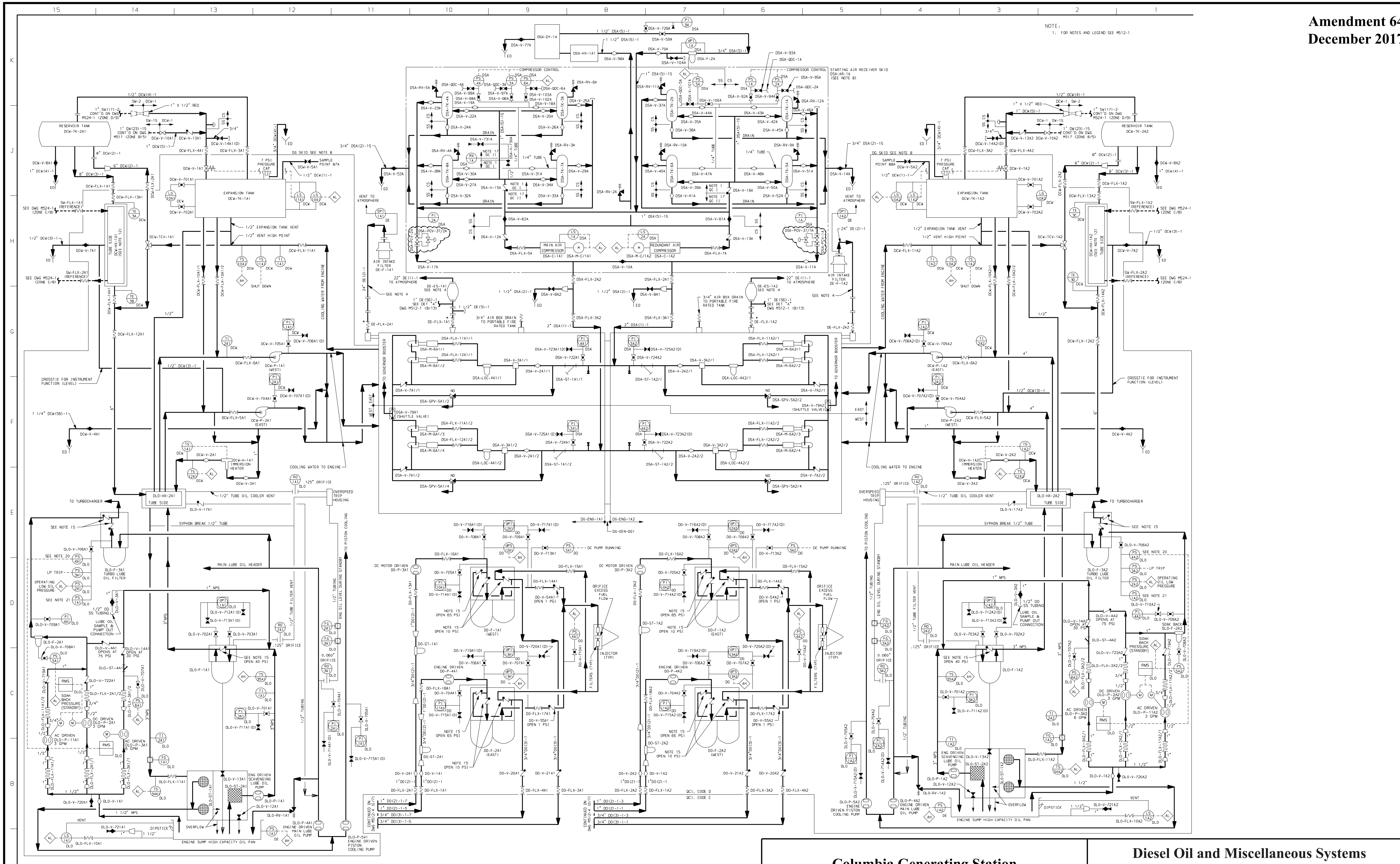
Diesel Oil and Miscellaneous Systems

Draw. No. M512-1	Rev. 47	Figure 9.5-1.1

Amendment 64
December 2017



Columbia Generating Station
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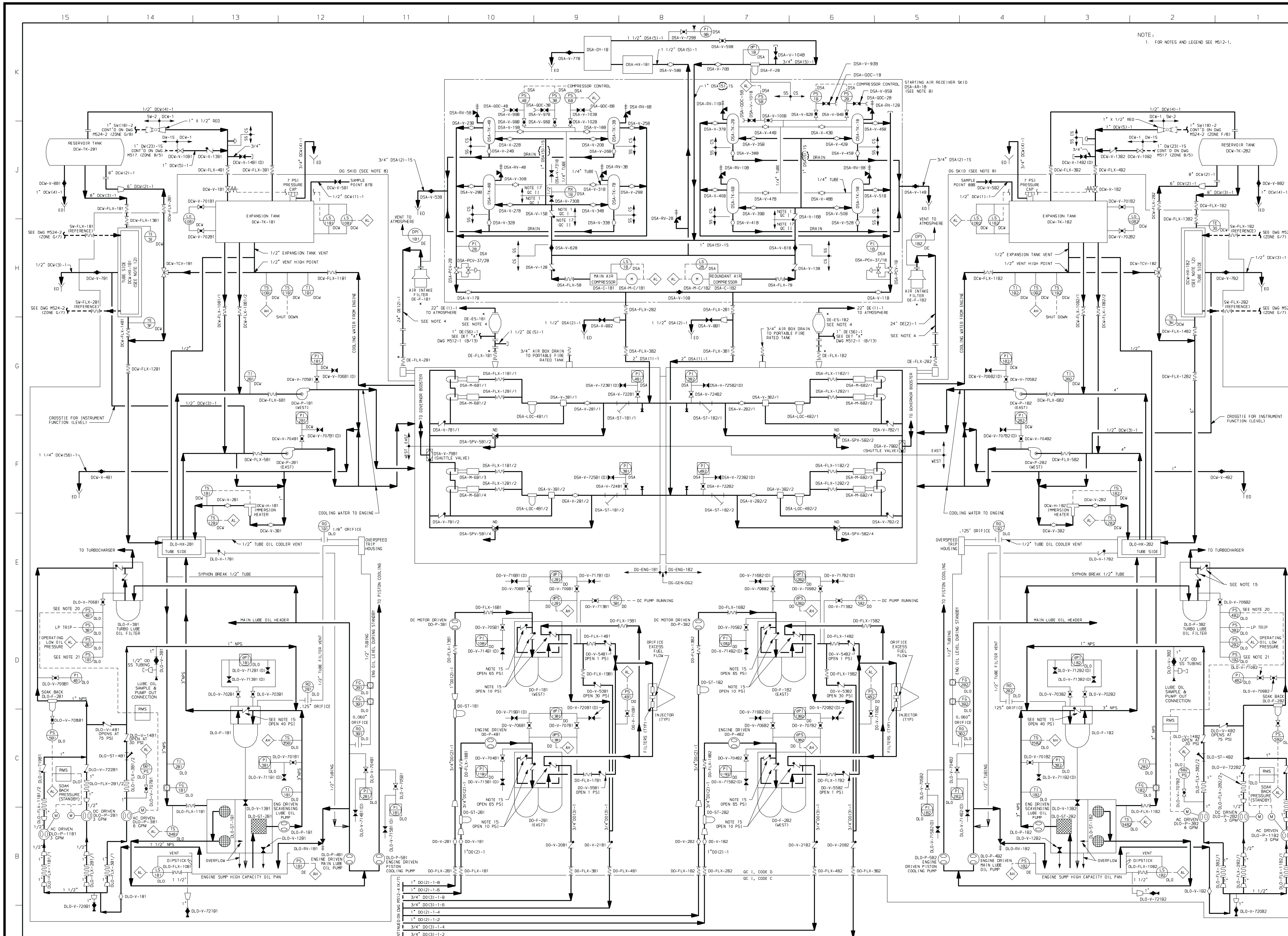
Diesel Oil and Miscellaneous Systems

Draw. No. M512-2 | Rev. 37 | Figure 9.5-1.2

Form No. 960690ai



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Diesel Oil and Miscellaneous Systems

Draw. No. M512–3 | Rev. 38 | Figure 9.5–1.3

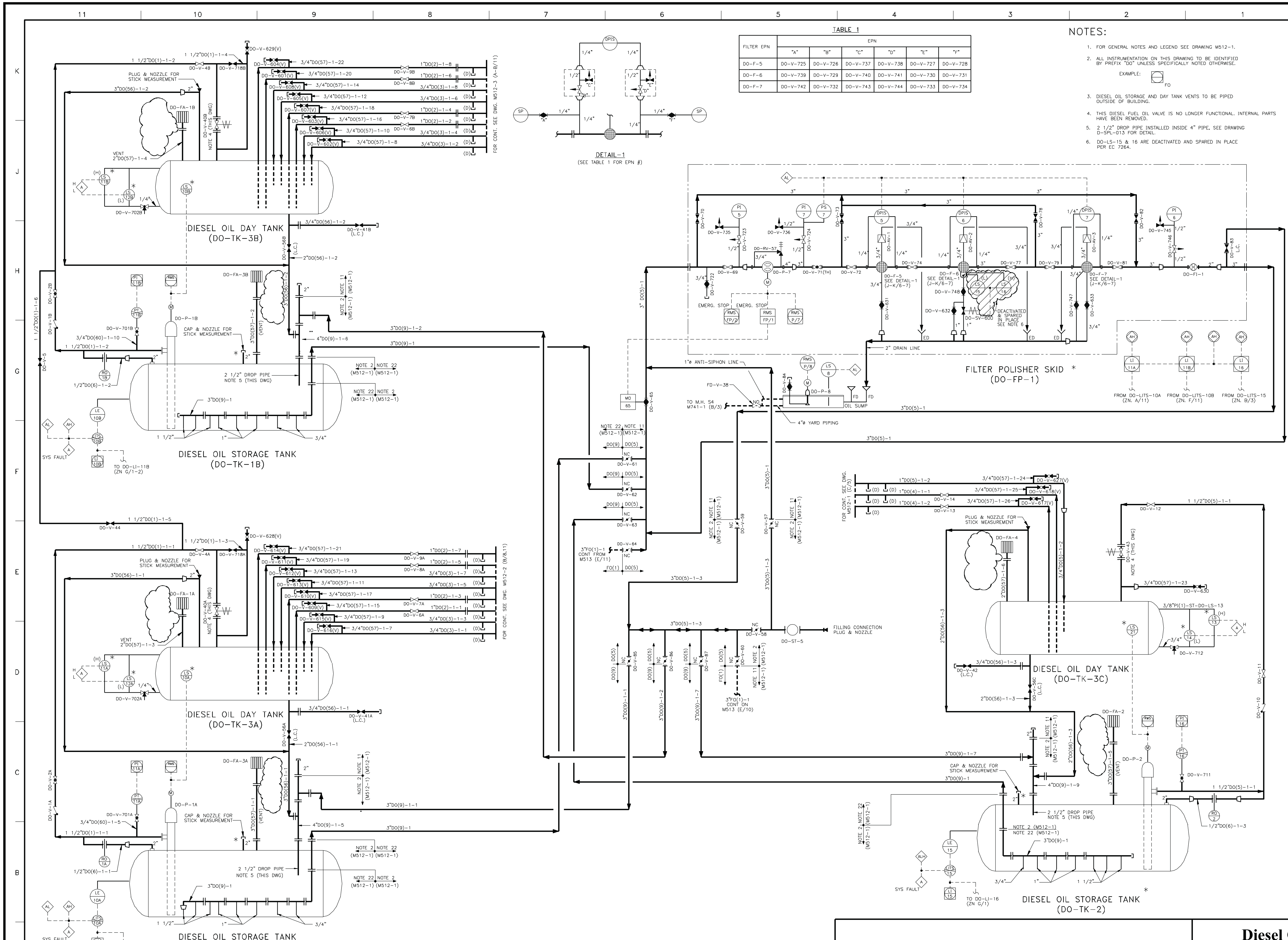

TABLE 1

FILTER EPN	EPN					
	"A"	"B"	"C"	"D"	"E"	"F"
DO-F-5	DO-V-725	DO-V-726	DO-V-737	DO-V-738	DO-V-727	DO-V-728
DO-F-6	DO-V-739	DO-V-729	DO-V-740	DO-V-741	DO-V-730	DO-V-731
DO-F-7	DO-V-742	DO-V-732	DO-V-743	DO-V-744	DO-V-733	DO-V-734

NOTES:

1. FOR GENERAL NOTES AND LEGEND SEE DRAWING M512-1.
2. ALL INSTRUMENTATION ON THIS DRAWING TO BE IDENTIFIED BY PREFIX "DO" UNLESS SPECIFICALLY NOTED OTHERWISE.
   EXAMPLE: FO
3. DIESEL OIL STORAGE AND DAY TANK VENTS TO BE PIPED OUTSIDE OF BUILDING.
4. THIS DIESEL FUEL OIL VALVE IS NO LONGER FUNCTIONAL. INTERNAL PARTS HAVE BEEN REMOVED.
5. 2 1/2" DROP PIPE INSTALLED INSIDE 4" PIPE, SEE DRAWING D-SPL-013 FOR DETAIL.
6. DO-LS-15 & 16 ARE DEACTIVATED AND SPARED IN PLACE PER EC 7264.

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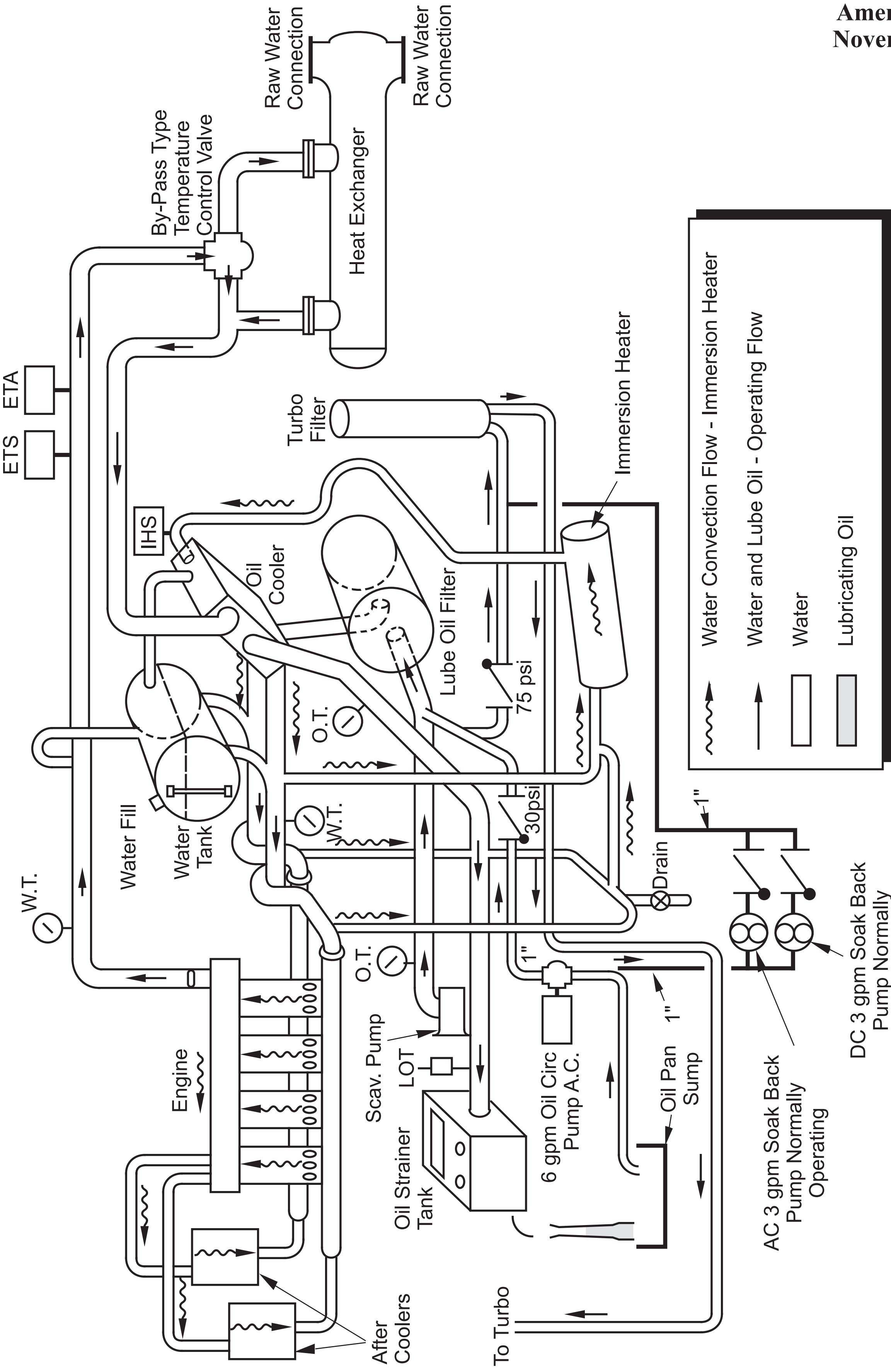
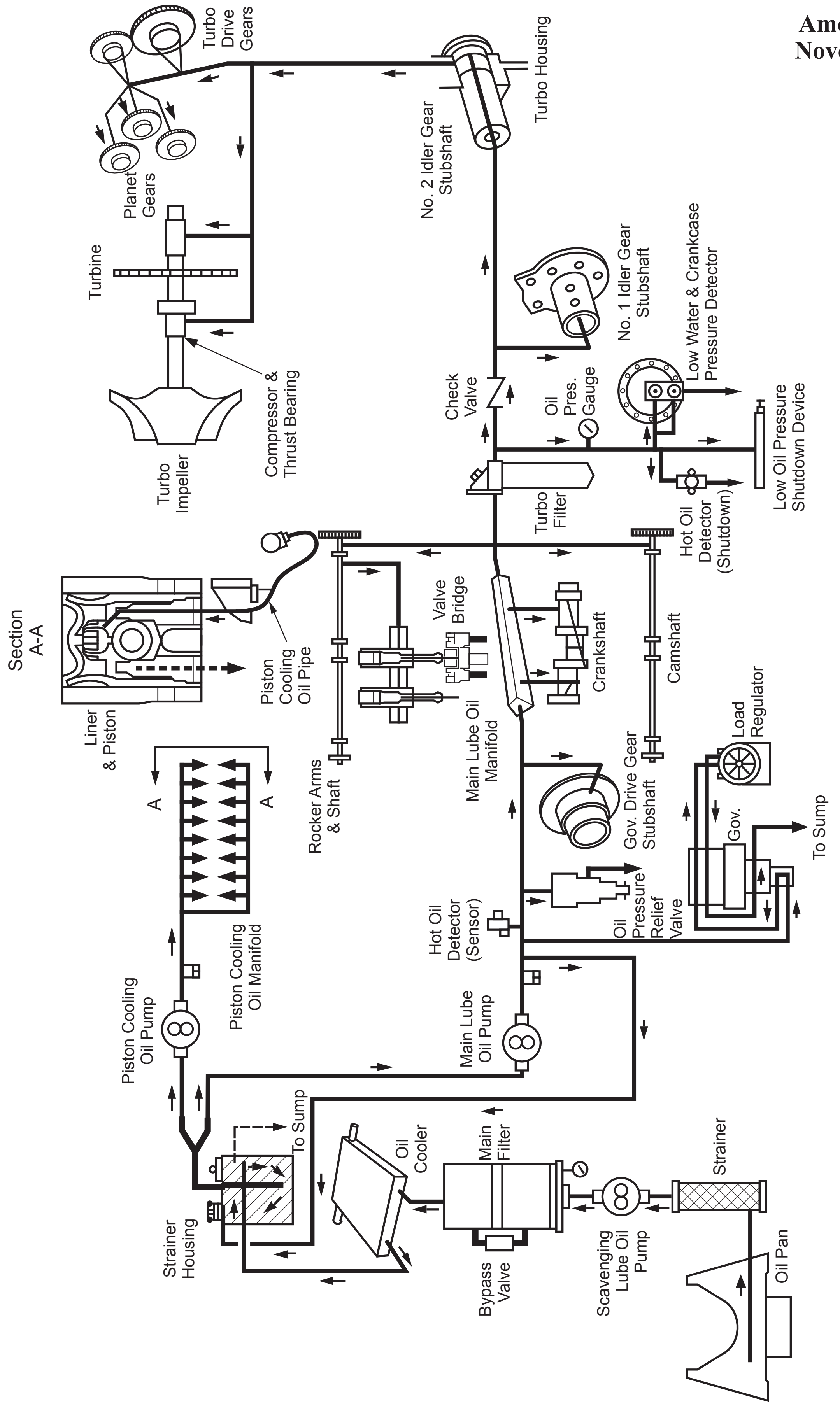
Diesel Oil and Miscellaneous Systems

Draw. No. M512–4 | Rev. 13 | Figure 9.5–1.4



Columbia Generating Station Final Safety Analysis Report	Supporting Systems - Lubricating Oil System and Engine Cooling Water System with Immersion Heater System - Turbocharged Units
	Draw. No. 950021.37 | Rev. | Figure 9.5-3



Columbia Generating Station
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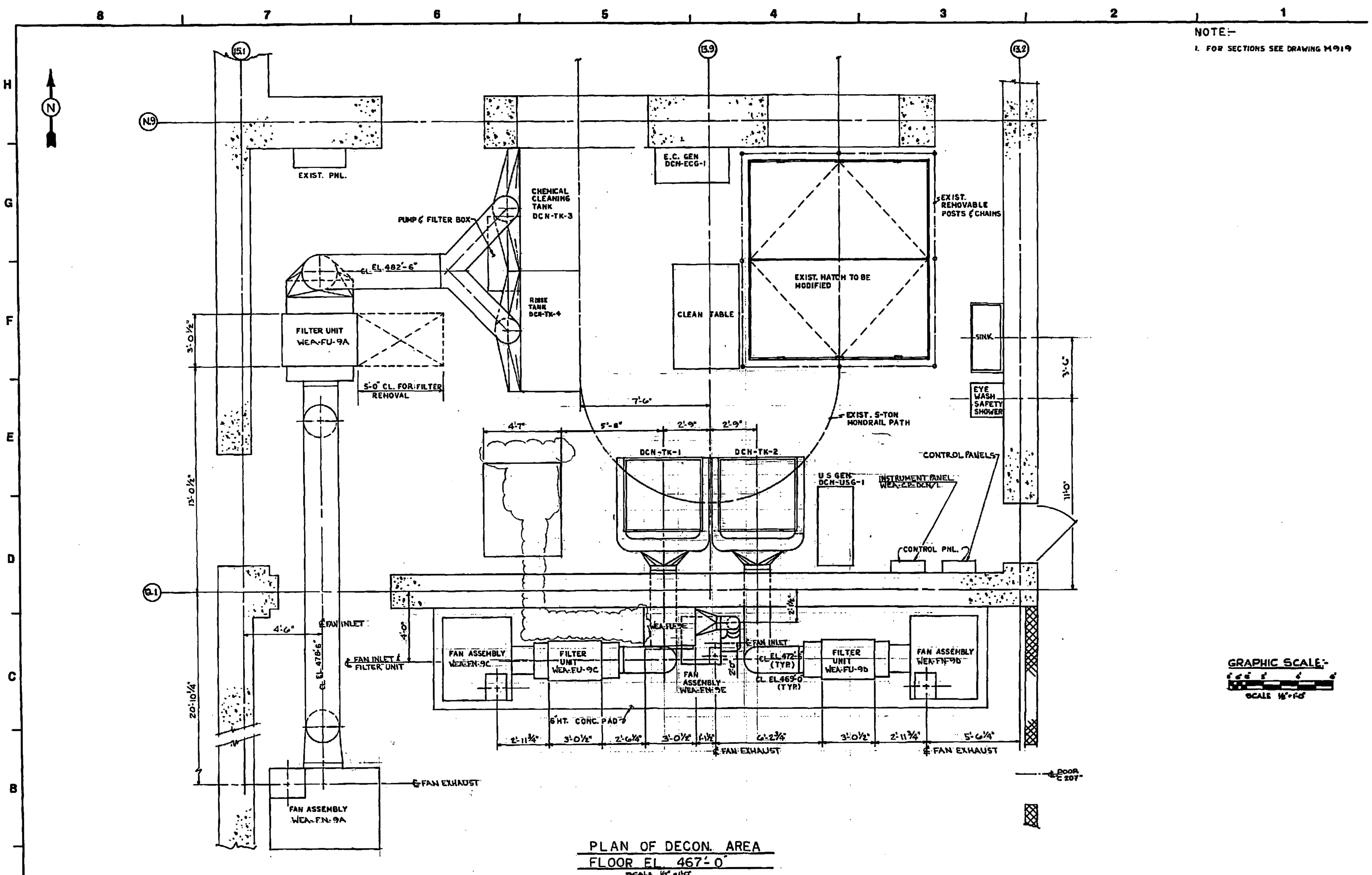
Normal Engine Operation Lube Oil System - Turbocharged Engines

Draw. No. 950021.38	Rev.	Figure 9.5-4



Columbia Generating Station
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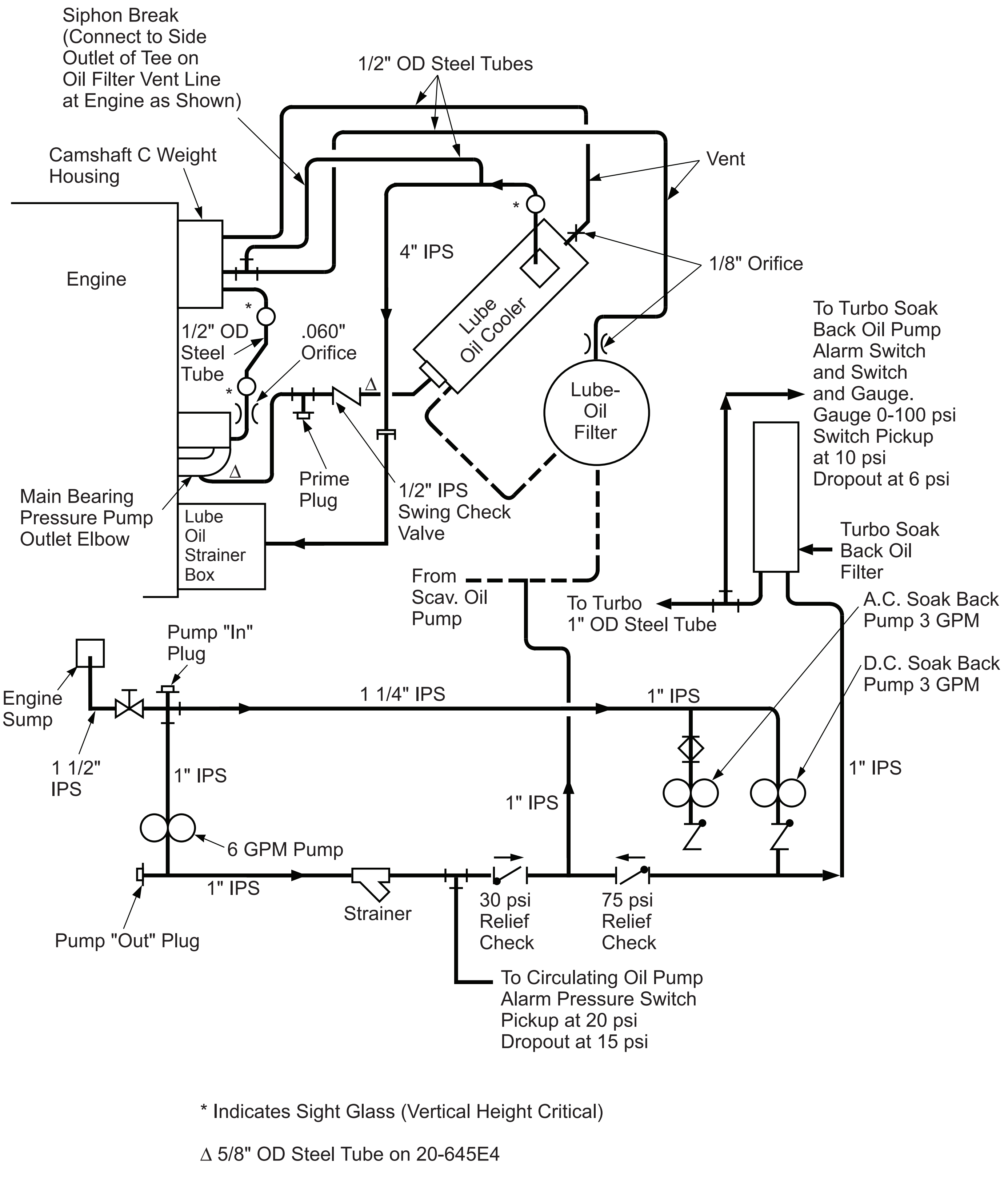
Decontamination Area General Arrangement Plan

Draw. No. M918 | Rev. 2 | Figure 9.5-5



Columbia Generating Station
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Schematic Diagram - Standby Lube Oil Circulating and Keep Full System

Draw. No. 920843.92 | Rev. | Figure 9.5-6