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6 ENGINEERED SAFETY FEATURES

The safety objective in reactor design and operation is control of reactor fission products. The methods used to assure this objective are:

a) Core design to preclude release of fission products from the fuel clad (Section 3) boundary.

b) Retention of fission products by the reactor coolant system boundary for whatever leakage occurs (Sections 4, and 6).

c) Retention of fission products by the containment boundary for operational and accidental releases beyond the reactor coolant boundary (Sections 5, and 6).

d) Limit fission product release to minimize population exposure. (Sections 2, and 11).

The Engineered Safety Features are the provisions which implement methods b, c and d above to prevent the occurrence or to minimize the effects of serious accidents.

The Engineered Safety Features are the Containment System, detailed in Section 5; the core Safety Injection System, detailed in Section 6.2; the Emergency Containment Cooling and Filtering System, detailed in Section 6.3; and the Containment Spray System, detailed in Section 6.4. Leak detection is discussed in Section 6.5.

Evaluation of techniques and equipment used to accomplish the safety objective including accident cases are detailed in Section 5, 6 and 14.

6.1 CRITERIA

Criteria applying in common to all engineered safety features are given in Section 6.1.1. Thereafter, criteria which are related to engineered safety features but are more specific to other features or systems are listed and cross referenced in this section.

Those criteria which are specific to one of the engineered safety features are discussed in the description of that system.

6.1.1 ENGINEERED SAFETY FEATURES CRITERIA

Engineered Safety Features Basis for Design

Criterion: Engineered safety features shall be provided in the facility to back up the safety provided by the core design, the reactor coolant pressure boundary, and their protection systems. Such engineered safety features shall be designed to cope with any size reactor coolant piping break up to and including the equivalent of a circumferential rupture of any pipe in that boundary, assuming unobstructed discharge from both ends. (1967 Proposed GDC 37)

The design, fabrication, testing and inspection of the core, reactor coolant system pressure boundary and their protection systems give assurance of safe and reliable operation under all anticipated normal, transient, and accident conditions. However, engineered safety features are provided in the facility to back up the safety provided by these components. These engineered safety features have been designed to cope with any size reactor coolant pipe break up to and including the circumferential rupture of any pipe assuming unobstructed discharge from both ends.

The release of fission products from the reactor fuel is limited by the Safety Injection System which, by cooling the core, keeps the fuel in place and substantially intact and limits the metal-water reaction to an insignificant amount.

The Safety Injection System consists of high and low head centrifugal pumps driven by electric motors, and passive accumulator tanks which are self energized and which act independently of any actuation signal or power source. The release of fission products from the containment is limited in three ways:

1. Blocking the potential leakage paths from the containment. This is accomplished by:

   a. A steel-lined, concrete containment with testable penetrations.

   b. Isolation of process lines by the Containment Isolation System which imposes double barriers in each line which penetrates the containment.

2. Reducing the fission product concentration in the containment atmosphere by containment spray. C26

3. Reducing the containment pressure and thereby limiting the driving potential for fission product leakage by cooling the containment atmosphere using the following independent systems:

   a. Containment Spray System
   b. Emergency Containment Cooling System

Reliability and Testability of Engineered Safety Features

Criterion: All engineered safety features shall be designed to provide such functional reliability and ready testability as is necessary to avoid undue risk to the health and safety of the public. (1967 Proposed GDC 38)

A comprehensive program of testing is formulated for all equipment systems and system control vital to the functioning of engineered safety features. The program consists of performance tests of individual pieces of equipment in the manufacturer's shop, integrated tests of the system as a whole, and periodic tests of the actuation circuitry and mechanical components to assure reliable performance.

The initial tests of individual components and the integrated test of the system as a whole complement each other to assure performance of the system as designed and to prove proper operation of the actuation circuitry.

The engineered safety features components are designed to provide for routine periodic testing.

Missile Protection

Criterion: Adequate protection for those engineered safety features, the failure of which could cause an undue risk to the health and safety of the public, shall be provided against dynamic effects and missiles that might result from plant equipment failures. (1967 Proposed GDC 40)

Equipment failure might result in dynamic effects or missiles. For engineered safety features which are required to ensure safety in the event of such equipment failure, protection is provided primarily by the provisions which are taken in the design to prevent the generation of missiles. In addition, protection is also provided by the layout of equipment or by missile barriers in certain cases. Reference is made to Appendix 5E for a discussion of missile protection.

Layout and structural design specifically protect injection paths leading to unbroken reactor coolant loops against damage as a result of the maximum reactor coolant pipe rupture. (However, dynamic effects of postulated primary loop pipe ruptures have been eliminated from the Turkey Point design basis based on the resolution of Generic Letter 84-04, "Asymmetric LOCA Loads," in NRC letter dated November 28, 1988.) Injection lines penetrate the main missile barrier, and the injection headers are located in the missile- protected area between the missile barrier and the containment outside wall. Individual injection lines, connected to the injection header, pass through the barrier and then connect to the loops. Separation of the individual injection lines is provided to the maximum extent practicable. Movement of the injection line, associated with rupture of a reactor coolant loop is accommodated by line flexibility and by the design of the pipe supports such that no damage outside the missile barrier is possible.

All hangers, stops and anchors are designed in accordance with USAS B31.1 Code for Pressure Piping and ACI 318 Building Code Requirements for Reinforced Concrete which provide minimum requirements on material, design and fabrication with ample safety margin for both dead and dynamic loads.

Engineered Safety Features Performance Capability

Criterion: Engineered safety features, such as the emergency core cooling system and the containment heat removal system, shall provide sufficient performance capability to accommodate the failure of any single active component without resulting in undue risk to the health and safety of the public. (1967 Proposed GDC 41)

Each engineered safety feature provides sufficient performance capability to accommodate any single failure of an active component and still function in a manner to avoid undue risk to the health and safety of the public.

The extreme upper limits of a once-in-a-lifetime public exposure are taken as the levels and time periods presently outlined in 10 CFR 50.67 at the plant exclusion radius and at the low population zone distance. The accident condition considered is the hypothetical case of a release of fission products per Alternative Source Term (AST) Methodology. Also, the total loss of all outside power is assumed concurrently with this accident. C26

Under the above accident condition, the Emergency Containment Cooling System and the Containment Spray System are designed and sized to supply the necessary post-accident cooling capacity to reduce the containment pressure following blowdown and cooling of the core by safety injection.

Engineered Safety Features Components Capability

Criterion: Engineered safety features shall be designed so that the capability of these features to perform their required function is not impaired by the effects of a loss-of-coolant accident to the extent of causing undue risk to the health and safety of the public. (1967 Proposed GDC 42)

All active components of the Safety Injection System (with the exception of hot leg and low head injection line isolation valves) and the Containment Spray System are located outside the containment and not subject to containment accident conditions. The accumulators, emergency coolers, their related active valves and containment spray headers are located in a missile shielded area within containment. C26

Instrumentation, motors, cables and penetrations located inside the containment are selected to meet the most adverse accident conditions to which they may be subjected. These items are either protected from containment accident conditions or are designed to withstand, without failure, exposure to the worst combination of temperature, pressure, and humidity expected during the required operational period.

The Safety Injection System and other engineered safeguard system pipes are restrained such that the rupture of any one pipe will not impair the capability of the safeguards to prevent undue risk to health and safety of the public.

Accident Aggravation Prevention

Criterion: Protection against any action of the engineered safety features which would accentuate significantly the adverse after-effects of a loss of normal cooling shall be provided. (1967 Proposed GDC 43)

The reactor is maintained subcritical following a reactor coolant system pipe rupture accident. Introduction of borated cooling water into the core results in a net negative reactivity addition. The control rods insert and remain inserted.

The delivery of cold safety injection water to the reactor vessel following accidental expulsion of reactor coolant does not cause further loss of integrity of the Reactor Coolant System boundary.

Sharing of Systems

Criterion: Reactor facilities may share systems or components if it can be shown that such sharing will not result in undue risk to the health and safety of the public. (1967 Proposed GDC 4)

Certain components of the Auxiliary, Emergency, and Waste Disposal Systems are shared by the units 3 and 4. Appendix A presents a functional evaluation of the components of the system which are shared by the two units. In addition, any emergency and/or shutdown functions of each system are indicated, together with the ability of the system to meet the emergency condition with either a failure of an active component or during maintenance outage of a single item of equipment.

Only certain components of shared equipment may be called upon to fulfill either an emergency or emergency and shutdown function. As previously stated it is not considered a credible event that both units can simultaneously develop accident conditions where each accident is independent of, and not related in any way, to the other. Thus the criterion in two unit plant design is to have the capability to deal with the affected unit, while maintaining safe control of the second unit. For a two unit plant, the worst situation which is credible is when an accident condition on one unit causes tripping of that unit which in turn leads to the tripping of the second unit. Further, in the event that the loss of the output of the two units leads to the loss of all outside AC supply to the Station, the emergency diesel power supply is required to control the accident situation on the one unit, and maintain the second unit in a safe condition.

Safety injection pump discharge on all four pumps is normally aligned to both units. Two pumps take suction from each refueling water storage tank.

Within each unit the residual heat removal pumps and heat exchangers serve dual functions. Although the normal duty of the residual heat removal exchangers and residual heat removal pumps is performed during periods of reactor shutdown, during all reactor operating periods this equipment is aligned to perform the low head safety injection function. In addition, during the recirculation phase of a loss-of-coolant accident, the capability of this system may be divided between the core cooling and the containment spray cooling functions. Demonstration testing of the system, performed during each refueling period before startup, in addition to the appropriate administrative controls, provides assurance of correct system alignment for the safety function of components.

During the injection phase, the flow path for the safety injection pumps does not depend on any portion of other systems with the exception of the suction line from the refueling water storage tank. During the recirculation phase, if either safety injection or containment spray is required, suction is provided by the residual heat removal pumps.

6.1.2 RELATED CRITERIA

The following are criteria which, although related to all engineered safety features, are more specific to other plant features or systems and, therefore are discussed in other sections as listed.

Name	Discussion
Quality Standards (1967 Proposed GDC 1)	Section 1.3
Records Requirements (1967 Proposed GDC 5)	Section 4.1
Performance Standards (1967 Proposed GDC 2)	Section 4.1
Instrumentation and Control Systems (1967 Proposed GDC 12)	Section 7.1
Engineered Safety Features Actuation System (1967 Proposed GDC 15)	Section 7.5
Emergency Power (1967 Proposed GDC 24)	Section 8.2

6.2 SAFETY INJECTION SYSTEM

6.2.1 DESIGN BASIS

Emergency Core Cooling System Capability

Criterion: An Emergency Core Cooling System with the capability for accomplishing adequate emergency core cooling shall be provided. This core cooling system and the core shall be designed to prevent fuel and clad damage that would interfere with the emergency core cooling function and to limit the clad metal water reaction to acceptable amounts for all sizes of breaks in the reactor coolant piping up to the equivalent of a double-ended rupture of the largest pipe. The performance of such emergency core cooling system shall be evaluated conservatively in each area of uncertainty. (GDC 44)

Adequate emergency core cooling is provided by the Safety Injection System (which constitutes the Emergency Core Cooling System) whose components operate in three modes. These modes are delineated as passive accumulator injection, active safety injection and recirculation.

The primary purpose of the Safety Injection System is to automatically deliver cooling water to the reactor core in the event of a loss-of-coolant accident. This limits the fuel clad temperature and thereby ensures that the core will remain intact and in place, with its heat transfer geometry preserved. This protection is afforded for:

a) All pipe break sizes up to and including the hypothetical instantaneous circumferential rupture of a reactor coolant loop, assuming unobstructed discharge from both ends.

b) A loss of coolant associated with the rod ejection accident.

c) A steam generator tube rupture.

The basic design criteria for loss of coolant accident evaluations are:

1. The cladding temperature is to be less than:
   a. The melting temperature of the fuel cladding. C28
   b. The temperature at which gross core geometry distortion, including clad fragmentation may be expected.

2. The total core metal-water reaction will be limited to less than 1 percent.

Thus, the core geometry is retained to such an extent that effective cooling of the core is not impaired.

For any rupture of a steam pipe and the associated uncontrolled heat removal from the core, the Safety Injection System adds shutdown reactivity so that with a stuck rod, no off-site power and minimum engineered safety features, there is no consequential damage to the Reactor Coolant System and the core remains in place and intact.

Redundancy and segregation of instrumentation and components is incorporated to assure that postulated malfunctions will not impair the ability of the system to meet the design objectives. The system is effective in the event of loss of normal plant auxiliary power coincident with the loss of coolant, and can accommodate the failure of any single component or instrument channel to respond actively in the system.

The ability of the Safety Injection System to meet its capability objectives is presented in Section 6.2.3. The analysis of the accidents is presented in Section 14.

Inspection of Emergency Core Cooling System

Criterion: Design provisions shall, where practical, be made to facilitate physical inspection of all parts of the Emergency Core Cooling System, including reactor vessel internals and water injection nozzles (GDC 45).

Design provisions are available to facilitate access to the critical parts of the reactor vessel internals, injection nozzles, pipes, valves and safety injection pumps for visual or boroscopic inspection for erosion, corrosion and vibration wear evidence, and for non-destructive inspection where such techniques are desirable and appropriate.

Testing of Emergency Core Cooling System Components

Criterion: Design provisions shall be made so that components of the Emergency Core Cooling System can be tested periodically for operability and functional performance. (1967 Proposed GDC 46).

The design provides for periodic testing of active components of the Safety Injection System for operability and functional performance.

Power sources are arranged to permit individual actuation of each active component of the Safety Injection System.

The safety injection pumps can be tested periodically during operation using the full flow recirculation lines provided. The residual heat removal pumps are used every time the residual heat removal loop is put into operation. All remote operated valves can be exercised and actuation circuits can be tested as required by the Technical Specifications.

Testing of Emergency Core Cooling System

Criterion: Capability shall be provided to test periodically the operability of the Emergency Core Cooling System up to a location as close to the core as is practical. (1967 Proposed GDC 47).

An integrated safeguards test can be performed during refueling outages. This test would not introduce flow into the Reactor Coolant System but would demonstrate the operation of the valves, pump circuit breakers, and automatic circuitry upon initiation of safety injection. A test is performed during refueling outages with the safety injection pumps to demonstrate the ability to introduce flow into the reactor coolant system.

The accumulator tank pressure and level are continuously monitored during reactor operation.

The safety injection piping up to the final isolation valve is maintained full of borated water at refueling water concentration while the reactor is in operation. Any makeup that may be required to maintain the piping full of water is obtained from a borated water source in accordance with plant operating procedures.

For the Safety Injection System to be considered operable, it must be filled with water to ensure that it can reliably perform its intended function. To address this, Generic Letter 2008-01 was issued to discuss the consequences of gas entrained in systems such as the Safety Injection System that could compromise their operability. In response to this, a Gas Accumulation Management Program (GAMP) was established to provide long term void management. Locations in the Safety Injection System piping where gases could potentially accumulate are periodically monitored using ultrasonic testing and/or vented to verify the system is filled. From the results of this monitoring, the GAMP ensures that gas accumulated within the Safety Injection System is identified, evaluated, trended, and effectively controlled to prevent unacceptable degradation of performance of any structures, systems or components, ultimately to ensure system operability.

Filling and venting operations and periodic system operational and leakage tests are required to ensure that the Safety Injection System piping and components are not damaged from water-hammer loads that may result from pump flows into voided discharge lines. The system must be periodically verified full by venting the accessible discharge piping high points. The inaccessible discharge piping high points that may be susceptible to gas accumulation are deemed appropriate to proactively provide the capability to vent each of these locations and to allow for future monitoring and trending, if it becomes necessary.

Flow in each of the hot leg high head injection lines, in the hot and cold leg injection headers and in the main flow line for the residual heat removal pumps is monitored by a flow indicator. Pressure instrumentation is also provided for the main flow paths of the high head and residual heat removal pumps. Level and pressure instrumentation are provided for each accumulator tank.

Testing of Operational Sequence of Emergency Core Cooling System

Criterion: TCapability shall be provided to test initially, under conditions as close as practical to design, the full operational sequence that would bring the Emergency Core Cooling System into action, including the transfer to alternate power sources. (1967 Proposed GDC 48).

The design provides for capability to test initially, to the extent practical, the full operational sequence up to the design conditions for the Safety Injection System to demonstrate the state of readiness and capability of the system. Details of the operational sequence testing are presented in Section 6.2.4.

Codes and Classifications

Table 6.2-1 tabulates the codes and standards to which the safety injection system components are designed.

Service Life

All portions of the system located within the containment are designed to operate without benefit of maintenance and without loss of functional performance for the duration of time the component is required during the accident.

6.2.2 SYSTEM DESIGN AND OPERATION

System Description

Adequate emergency core cooling following a loss-of-coolant accident is provided by the Safety Injection System shown in Figures 6.2-1 and 6.2-5 through 6.2-11. The system components operate in the following possible modes:

a) Injection of borated water by the passive accumulators.

b) Injection of borated water from the refueling water storage tank by the safety injection pumps.

c) Injection by the residual heat removal pumps also drawing borated water from the refueling water storage tank.

d) Recirculation of spilled coolant injected water and Containment Spray System drainage back to the reactor from the containment recirculation sump by the safety injection pumps aligned to take suction from the residual heat removal pumps. C26

The initiation signal for core cooling by the safety injection pumps and the residual heat removal pumps is the Safety Injection Signal which is actuated by any of the following:

a) Low pressurizer pressure (2/3).

b) High containment pressure (2/3, Hi level approximately 10% of containment design pressure).

c) Steam line differential pressure two out of three per loop (between steam line and main steam header).

d) High steam flow in one out of two per steam line (2/3 lines) with low $T_{avg.}$ (2/3) or low steam line pressure (2/3).

e) Manual Actuation.

Injection Phase

The principal components of the Safety Injection System which provide emergency core cooling immediately following a loss of coolant are the accumulators (one for each loop), the four safety injection (high head) pumps and the two residual heat removal (low head) pumps.

The accumulators, which are passive components, discharge into the cold legs of the reactor coolant piping when pressure decreases to approximately 660 psig, thus rapidly assuring core cooling for large breaks. They are located inside the containment, and are protected against possible missiles.

The safety injection signal, opens the Safety Injection System isolation valves and starts the safety injection pumps and the residual heat removal pumps. The items on Figures 6.2-1 through 6.2-11 marked with an "S" receive the safety injection signal (refer also to Figure 7.2-2). The high head safety injection pumps take suction from the refueling water storage tank.

The residual heat removal pumps deliver to all three cold legs through the piping between the accumulators and the cold legs. The high head safety injection pumps deliver into two separate headers one going to the cold legs and one to the hot legs. Motor operated valves 864A and 864B at the outlet of the refueling water storage tank and valves 862A and 862B for residual heat removal pump suction from the tank are normally open, and are only closed momentarily for testing or during refueling for maintenance, and are maintained open by keeping the motor circuit breakers locked open in the motor control centers, Motor operated valves 866A and 866B, which control the two flow paths to the hot legs, are maintained inoperative by keeping the motor circuit breakers locked open at the motor control centers. The header to the cold legs divides into three injection lines connecting to the pipes from the accumulators close to the reactor coolant system cold leg piping. The ability is provided to isolate the pumps on separate headers.

For large breaks, the Reactor Coolant System would be depressurized and voided of coolant rapidly (about 10 seconds for the largest break) and a high flow rate is required to quickly recover the exposed fuel rods and limit possible core damage. To achieve this objective, one residual heat removal pump (high flow, low head) is required to deliver borated water to the cold legs of the reactor coolant loops. Two pumps are available in order to provide for an active component failure. Delivery from these pumps supplements the accumulator discharge.

Because the injection phase of the accident is terminated before the refueling water storage tank is completely emptied, all pipes are kept filled with water before recirculation is initiated. Water level indication and alarms on the refueling water storage tank give the operator ample warning to terminate injection phase. Additional level alarms are provided in the containment sumps which also gives back-up indication when injection can be terminated and recirculation initiated.

For small breaks the depressurization of the Reactor Coolant System by the Safety Injection System can be augmented by steam dump and auxiliary feed water addition. As is stated in 14.3.2, use of the steam dump is not required to meet the core cooling objectives. For small breaks (4" and smaller) steam dump will be employed to facilitate the recovery from the accident, and to reduce the reactor coolant pressure to the cut-in pressure of the residual heat removal pumps.

The decision to initiate steam dump will be based on the rate of decrease of Reactor Coolant System pressure as indicated by the pressurizer pressure compared with steam generator pressure. For large breaks (6" and larger) the reactor pressure drops below the steam side pressure quite rapidly. Before any gap activity could be released due to clad bursting, the Reactor Coolant System pressure becomes less than the steam generator pressure. As discussed in 14.3.2 the expected clad temperatures for break sizes 4" and smaller are limited to a value below which clad bursting is expected. If a small tube leak existed prior to the accident, the only activity that could be released during a steam dump would be the activity initially in the coolant. The activity released in this manner would be a fraction of that released for a full tube rupture. The consequences of a steam generator tube rupture are discussed in 14.2.4.

<u>Recirculation Phase</u>

After the injection operation, coolant spilled from the break and water collected from the containment spray is cooled and returned to the Reactor Coolant System by the recirculation system.

Those portions of the Safety Injection System located outside of the containment which are designed to circulate, under post-accident conditions, radioactively contaminated water collected in the containment, meet the following requirements:

a) Shielding to maintain radiation levels within the guidelines set forth in 10CFR50.67. (Section 11.2) C26

b) Collection of discharges from pressure relieving devices into closed systems.

c) Means to limit radioactivity leakage to the environs, within guidelines set forth in 10CFR50.67. C26

When the break is large, depressurization occurs due to the large rate of mass and energy loss through the break to containment. The system is arranged so that the residual heat removal pumps take suction from the sump in the containment floor and delivers flow through the residual heat exchangers to the suction side of the safety injection pump. The safety injection pumps inject the spilled reactor coolant and borated refueling water back to the core. The system is arranged to allow either of the residual heat removal pumps to provide flow to the safety injection pumps. Only one residual heat removal pump should be operated during sump recirculation after the MHA. C26

There are two sump return lines which lead from the containment to the residual heat removal pumps. The arrangement of recirculation equipment is shown on Figures 6.2-1 and 6.2-5.

Filtration of the water entering the residual heat removal pump suction piping is accomplished by a series of stainless steel modular sump strainers serving both containment sump suction inlets. The strainer modules provide sufficient strainer surface area considering the mechanistically determined post LOCA debris load under a MHA such that sufficient available NPSH for the pumps for the required recirculation flow can still be maintained.

Unit 3

The individual strainer modules are interconnected to each other and to the north and south containment sump suction inlets by an interconnecting pipe run. The strainer module plenums are connected in series by piping between the plenum nozzles. The entire strainer system is then connected in parallel to the containment sump suction inlets via a tee to the north sump inlet before terminating at the south sump inlets. Two containment sump suction inlets, each with a 14" diameter outlet, are provided at the 14'-0" elevation. The openings in the interconnected strainer modules are 3/32”, providing protection against clogging the containment spray nozzle 3/8” openings.

Unit 4

Three strainer assemblies are installed on elevation 14'-0". Each strainer assembly consists of five horizontally mounted modules. Each module has thirteen disks. All disks have a 48" width, 30" height and a nominal 1/2" in thickness. Each disk is separated by a screened 1" gap resulting in twelve gaps for each module. Each strainer assembly has a total of 1204.6 ft^2 of strainer surface area. The A, B, and C strainer assemblies have a total strainer area of 3614 ft^2.

Strainer assembly A connects directly through piping to the plenum located over the south sump pit. Strainer assemblies B and C connect to the plenum through an 18" diameter pipe.

An extension pipe is installed from the plenum to the ECCS suction line in the south sump pit with a slip connection. A cross connection pipe between the plenum and the north sump pit connects to the existing ECCS suction pipe with a slip connection. The remaining volumes of the north and south sump pits are filled with concrete.

The maximum allowable debris size that can pass through the strainers is controlled by limiting the perforated plate hole size to a nominal diameter of 0.0938". Particle retention is 100% of particles larger than 0.103", which prevents clogging the spray nozzle 3/8" openings.

On Unit 4 only, debris interceptors are installed at the entrances to the biological shield walls on the 14-foot elevation of the containment to limit the quantity of debris reaching the sump screens and strainer modules during recirculation.

Recirculation may start with a minimum water depth of 3.03 feet on the containment floor at elevation 14'-0". This is equivalent to a volume of 247,000 gallons. The maximum velocity of approach to the Screens is less than 1/2 ft/sec. C26 pH Control

The sodium Tetraborate Decahydrate (NaTB), stored in porous baskets at the lower elevation of containment ensures that the post-LOCA sump pH achieves a minimum value of 7.0 at the onset of spray recirculation and maintains the post-LOCA sump pH between 7 and 8.048 during long-term recirculation. This will minimize the evolution of iodine and prevent stress corrosion cracking of ECCS systems and will ensure that environmental qualification pH limits in Doc Pac 1001, Section 6.4 are not exceeded. Sump water chemistry is discussed in Section 6.4.2. C26

Recirculation loop leakage is discussed in Section 6.2.3.

Recirculation Phase - Hot Leg

The hot leg recirculation flow path via the high head safety injection pumps is provided for continuation of the recirculation phase. A residual heat removal train supplies flow to the SI pumps suctions. The SI pumps discharge to the hot leg injection header. Hot leg recirculation is required to prevent boric acid plate-out on the fuel cladding from reducing core cooling following a cold leg break. See Table 6.2-9(a) for the evaluation of the ability to achieve hot leg recirculation. C26

Recirculation Phase - Cold Leg

For the recirculation phase of the accident the reactor coolant water which eventually drains to the containment recirculation sump is recirculated through the sump line from the containment to the suction of the residual heat removal pump through two independent and redundant recirculation lines. Each line has two motor operated valves. The first valve is located as close as possible to the containment such that the line outside the containment can be isolated in the event of a passive failure. During recirculation one recirculation train will be in service which includes either of the two residual heat removal pumps and either one or two residual heat exchangers. The flow will go from the discharge of the residual heat removal pump through the residual heat exchanger and then into the high head injection path via the safety injection pumps. C26

Alternate Flow Path to Low Head-Safety Injection

An alternate path to the normal low head safety injection path is provided by MOV 872 using the RHR pumps (See Figures 6.2-1, 6.2-10 and 6.2-11). This alternate flow path is provided for use in the long term post-LOCA operating mode after switchover to cold leg recirculation mode. This flow path is provided in the event a beyond-design-basis passive failure occurs in the normal low head flowpath. It is not included in the Turkey Point LOCA design basis analyses or emergency operating procedures. Use of both RHR pumps, at the same time, during recirculation is not allowed.

Alternate Flow Path for Simultaneous Hot Leg and Cold Leg recirculation

In the event that a beyond-design-basis passive failure occurs in the normal hot leg recirculation flowpath, the system is capable of simultaneous cold and hot leg recirculation using the alternate hot leg injection flowpath. In this lineup, hot leg recirculation is established by directing cooled sump water from the RHR heat exchanger, through the shutdown cooling return line, into the ‘C’ hot leg. Concurrent cold leg recirculation would then be provided by either (1) the normal high-head cold leg safety injection flowpath, or (2) by direct low-head cold leg injection from the RHR pumps. These lines provide defense-in-depth protection for a beyond-design-basis passive failure and are not included in the Turkey Point LOCA design basis analyses or emergency operating procedures. C26

Cooling Water

Component Cooling System

During the recirculation mode, the Component Cooling System is used to cool the recirculation fluid as it passes through the residual heat exchanger.

One of the three component cooling pumps and two of the three component cooling heat exchangers provide the core and containment cooling function during recirculation.

Intake Cooling Water System

The intake cooling water system is provided with normally cross-connected, redundant headers such that the three CCW heat exchangers normally receive flow from both headers. One of the three intake cooling water pumps is required to operate during the recirculation phase.

Change-Over from Injection Phase to Recirculation Phase

The sequence, from the time of the safety injection signal, for the changeover from the injection to the recirculation is as follows:

a) First, sufficient water is delivered to provide the required net positive suction head (NPSH) of the residual heat removal pumps to change to recirculation.

b) Second, the first low level alarm on the refueling water storage tank sounds. The operator, at this point, takes appropriate action to assure that sufficient NPSH exists for the operating pumps to run or secure pumps if necessary. This alarm also serves to alert the operator to begin operation to switchover to the recirculation mode.

c) The second low level alarm on the refueling water storage tank sounds. At this time, the operator performs the remaining switchover realignments.

The changeover from injection to recirculation is effected by the operator in the control room via a series of manual switching operations after unlocking and closing L.O. breakers to valves 750, 751, 862A and B, 863A and B, 864A and B and 866A and B outside of the control room.

Remote operated valves for the injection phase of the Safety Injection System which are under manual control, (these are valves which normally are in their ready position and do not receive a safety injection signal) have their positions indicated on a common portion of the control board. At any time during operation when one of these valves is not in the ready position for injection, it is shown visually on the board. Reference is made to Table 6.2-2 which is a listing of the instrumentation readouts on the control board which the operator can monitor during recirculation.

Location of the Major Components Required for Recirculation

The residual heat removal pumps are located in separate residual heat removal rooms at -4'-0" elevation in the auxiliary building. The residual heat exchangers are located in an adjacent room. The two heat exchangers and each of the two pumps are separated from each other by a concrete shield wall.

The high head safety injection pumps are located in a common room with partial shielding between each pair. The component cooling pumps and component cooling heat exchangers for each unit are located in separate roams in the Auxiliary Building, the component cooling pumps and heat exchangers being in the same room.

The intake cooling water pumps are located in the intake structure and redundant piping to the component cooling heat exchangers is run underground.

Components

All associated components, piping, structures, and power supplies, of the Safety Injection System are designed to Class I seismic criteria.

All components inside the containment are capable of withstanding or are protected from differential pressure which may occur during the rapid pressure rise.

Motors which operate only during or after the postulated accident are designed as if used in continuous service. Periodic operation of the motors and the tests of the insulation will ensure that the motors remain in a reliable operating condition.

All motors, instruments, transmitters, and their associated cables located inside the containment which are required to operate following the accident are designed to function under the post-accident temperature, pressure and humidity conditions.

The quality standards of all safety injection system components is tabulated in summary form in Table 6.2-3.

Accumulators

The accumulators are pressure vessels filled with borated water and pressurized with nitrogen gas. During normal operation each accumulator is isolated from the Reactor Coolant System by two check valves in series.

Should the Reactor Coolant System pressure fall below the accumulator pressure, the check valves open and borated water is forced into the Reactor Coolant System. Mechanical operation of the swing-disc check valves is the only action required to open the injection path from the accumulators to the core via the cold leg.

The accumulators are passive engineered safety features because the gas forces injection; no external source of power or signal transmission is needed to obtain a fast-acting, high-flow capability when the need arises. One accumulator is attached to each of the cold legs of the Reactor Coolant System.

The design capacity of the accumulators is based on the assumption that flow from one accumulator spills onto the containment floor through the ruptured loop, and the flow from the remaining accumulators provides sufficient water to fill the volume outside of the core barrel below the nozzles, the bottom plenum, and penetrate the core. Connections for remotely draining or filling the fluid space, during normal operation, are provided.

The level of borated water in each accumulator tank is adjusted remotely as required during normal operation. Refueling water is added using a safety injection pump. Water level is reduced by draining to the reactor coolant drain tank. Samples of the solution in the tanks are taken at the sampling station to confirm boron concentration.

Redundant level and pressure indicators are provided with read outs on the control board. Each indicator is equipped with high and low level alarms.

The accumulator design parameters are given in Table 6.2-4.

Boron Injection Tank

The Boron Injection Tank (BIT) on each unit has been bypassed and abandoned in place. It is no longer part of the safety injection system flow path on either unit. The design parameters of the tank are given in Table 6.2-5.

Refueling Water Storage Tank (RWST)

In addition to its usual duty to supply borated water to the refueling canal for refueling operations, this tank provides borated water to the safety injection pumps, the residual heat removal pumps and the containment spray pumps for the loss-of-coolant accident. During operation it is aligned to the suction of the pumps. It is constructed of epoxy coated carbon steel.

The capacity of the RWST is based on the requirement for filling the refueling canal, given in Table 9.5-1. This capacity provides an amount of borated water to assure:

a) A volume sufficient to refill the reactor vessel above the nozzles.

b) The volume of borated refueling water needed to increase the concentration of initially spilled water to a point that assures no return to criticality with the reactor at cold shutdown.

c) A sufficient volume of water on the floor to permit the initiation of recirculation.

The water in the RWST is borated to a minimum concentration of 2400 ppm boron (approximately 1.4 weight percent boric acid). This ensures the reactor remains sub-critical during the most limiting Post-LOCA case analyzed for EPU conditions. At 32°F the solubility limit of boric acid is 2.7 weight percent. Therefore the concentration of boric acid in the RWST is well below the solubility limit at 32°F. C26

A technical specification minimum level alarm and a high level alarm are provided. Nominal RWST level indication with high and low level alarms are also provided. The low level alarm setpoint has been determined to provide sufficient NPSH for the containment spray pumps

A dynamic response analysis similar to that performed for the Containment Structure has been performed to determine the horizontal loads applied to this tank for a 5% ground acceleration based on yield stresses and a 15% ground acceleration based on maximum deflection. Waves generated in the tank have been taken into account as per "Nuclear Reactors and Earthquake", TID 7024. A membrane stress analysis of the vertical cylindrical tank was performed considering the discontinuities at the base and top.

The design parameters are given in Table 6.2-6.

Safety Injection Pumps

The four high-head safety injection pumps for supplying borated water to the Reactor Coolant System are horizontal centrifugal pumps driven by electrical motors. Parts of the pump in contact with borated water are stainless steel or equivalent corrosion resistant material. A minimum flow bypass line is provided on each pump discharge to recirculate flow to the RWST in the event the pumps are started with the normal flow paths blocked. The design parameters are presented in Table 6.2-7 and Figure 6.2-3 gives the performance characteristic of these pumps.

The two residual heat removal (low head) pumps of the Auxiliary Coolant System are used to inject borated water at low pressure to the Reactor Coolant System. They are also used to recirculate fluid from the containment sump and send it to the suction of the spray pumps or to suction of the high head safety injection pumps. These pumps are of the in-line centrifugal type, driven by electric motors. Parts of the pumps which contact the borated water are stainless steel or equivalent corrosion resistant material. A minimum flow bypass line is provided on the discharge of each RHR pump to recirculate fluid to the suction of the residual heat removal pumps should these pumps be started with their normal flow paths blocked. The duration the pumps can operate on these mini recirculation lines has been determined to be about 44 minutes when aligned to take suction from the RWST. The duration the pumps can operate on mini recirculation is reduced to 10 minutes when the pumps are aligned to take suction form the sump due to the elevated temperature of the sump fluid The original recirculation line on the RHR heat exchanger discharge is currently closed via administrative controls. The design parameters are presented in Table 6.2-7.

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The pressure containing parts of the pumps are castings conforming to ASTM A-351 Grade F8 or F8M. Stainless steel forgings are procured per ASTM A-182 Grade F304 or F316 or ASTM A-336, Grade F8 or F8M, and stainless plate is constructed to ASTM A-240, Type 304 or 316. All bolting material conforms to ASTM A-193. Materials such as weld-deposited Stellite or Colmonoy are used at points of lose running clearances in the pumps to prevent galling and to assure continued performance ability in high velocity areas subject to erosion.

All pressure containing parts of the pumps are chemically and physically analyzed and the results are checked to ensure conformance with the applicable ASTM specification. In addition, all pressure containing parts of the pump are liquid penetrant inspected in accordance with Appendix VIII of Section VIII of the ASME Boiler and Pressure Vessel Code.

The acceptance standard for the liquid penetrant test is USAS B31.1, Code for Pressure Piping, Case N-10. The pump design is reviewed with special attention to the reliability and maintenance aspects of the working components.

Specific areas include evaluation of the shaft seal and bearing design to determine that adequate allowances have been made for shaft deflection and clearances between stationary parts.

Where welding of pressure-containing parts is necessary, a welding procedure including joint detail is submitted for review and approval by Westinghouse. The procedure includes evidence of qualification necessary for compliance with Section IX of the ASME Boiler and Pressure Vessel Code Welding Qualifications. This requirement also applies to any repair welding performed on pressure-containing parts.

The pressure-containing parts of the pump are assembled and hydrostatically tested to 1.5 times the design pressure for 30 minutes.

Each pump is given a complete shop performance test in accordance with Hydraulic Institute Standards. The pumps are run at design flow and head, shut off head and three additional points to verify performance characteristics. Where NPSH is critical, this value is established at design flow by means of adjusting suction pressure.

Details of the component cooling and intake cooling water pumps which serve the Safety Injection System are presented in Section 9.

<u>Heat Exchangers</u>

The two residual heat exchangers of the Auxiliary Coolant System cool the recirculated sump water. These heat exchangers are sized for the cooldown of the Reactor Coolant System. Table 6.2-8 gives the design parameters of the heat exchangers.

The ASME Boiler and Pressure Vessel Code has strict rules regarding the wall thicknesses of all pressure containing parts, material quality assurance provisions, weld joint design, radiographic and liquid penetrant examination of materials and joints, and hydrostatic testing of the unit as well as requiring final inspection and stamping of the vessel by an ASME Code inspector.

The designs of the heat exchangers also conform to the requirements of TEMA (Tubular Exchanger Manufacturers Association) for Class R heat exchangers. Class R is the most rugged class of TEMA heat exchangers and is intended for units where safety and durability are required under severe service conditions. Items such as: tube spacing, flange design, nozzle location, baffle thickness and spacing, and impingement plate requirements are set forth by TEMA Standards.

In addition to the above, additional design and inspection requirements were imposed to ensure rugged, high quality heat exchangers such as: confined-type gaskets, main flange studs with two nuts on each end to ensure permanent leak tightness, general construction and mounting brackets suitable for the plant seismic design requirements, tubes and tube sheet capable of withstanding full shell side pressure and temperature with atmospheric pressure on the tube side, ultrasonic inspection in accordance with Paragraph N-324.3 of Section III of the ASME Code of all tubes before bending, penetrant inspection in accordance with Paragraph N-627 of Section III of the ASME Code of all welds and all hot or cold formed parts, a hydrostatic test duration of not less than thirty minutes, the witnessing of hydro and penetrant tests by a qualified inspector, a thorough final inspection of the unit for good workmanship and the absence of any gouge marks or other scars that could act as stress concentration points, a review of the radiographs and of the certified chemical and physical test reports for all materials used in the unit.

The Residual Heat Exchangers are conventional vertical shell and U-tube type units. The tubes are seal welded to the tube sheet. The shell connections are flanged to facilitate shell removal for inspection and cleaning of the tube handle. Each unit has a SA-285 Grade C carbon steel shell, a SA-234 carbon steel shell end cap, SA-213 TP-304 stainless steel tubes, SA-240 Type 304 stainless steel channel, SA-240 Type 304 stainless steel channel cover and SA-240 Type 304 stainless steel tube sheet.

Valves

All parts of valves used in the Safety Injection System in contact with borated water are austenitic stainless steel or equivalent corrosion resistant material. The motor operators on the injection line isolation valves are capable of rapid operation. All valves required for initiation of safety injection or isolation of the system have remote position indication in the control room.

Valving is specified for exceptional tightness. The majority of valves, except those which perform a control function, are provided with backseats which are capable of limiting leakage to less than 1.0 cc per hour per inch of stem diameter, assuming no credit taken for valve packing. Manual and motor operated gate and globe valves that are normally operated and in containment are not backseated. Other normally opened valves are typically backseated. Normally closed globe valves are installed with recirculation flow under the seat to prevent leakage of recirculated water through the valve stem packing. Relief valves are totally enclosed. Control and motor-operated valves, 2 1/2" and above, are typically provided with double-packed stuffing boxes and stem leakoff connections which are piped to the Waste Disposal System except where the need for bonnet relief has been deemed necessary inside the containment for pressure locking considerations, i.e., MOV-*-744A, MOV-*-744B and MOV-*-751.

The check valves which isolate the Safety Injection System from the Reactor Coolant System are installed adjacent to the reactor coolant piping to reduce the probability of an injection line rupture causing a loss-of-coolant accident.

Three relief valves are provided to protect lines required for SI/ECCS functions against overpressurization due to RCS back-leakage. One is located outside the containment upstream of MOV-*-843A&B to prevent overpressure in the header and relieves to the RWST. The high head safety injection piping leading to the hot legs is protected by the second, that is the relief valve which is inside the containment in the piping associated with containment Penetration No. 18. This valve relieves to the pressurizer relief tank. The third valve is located on the residual heat removal loop common header leading to the accumulator pipes. This valve is inside containment and relieves to the pressurizer relief tank.

The relieving capacity of these valves is based on a flow several times greater than the expected leakage rate through the check and isolation valves. They will also prevent overpressurization due to thermal expansion. The relief valves on the accumulator protect them from pressures in excess of the design values.

Motor Operated Valves

The pressure containing parts (body, bonnet and discs) of the valves employed in the Safety Injection System are designed per criteria established by the USAS B16.5 or MSS SP66 specifications. The materials of construction for these parts are procured per ASTM A182, F316 or A351, GR F8M, or F8. All material in contact with the primary fluid, except the packing, is austenitic stainless steel or equivalent corrosion resisting material. The pressure containing cast components are radiographically inspected as outlined in ASTM E-71 Class 1 or Class 2. The body, bonnet and discs are liquid penetrant inspected in accordance with ASME Boiler and Pressure Vessel Code Section VIII, Appendix VIII. The liquid penetrant acceptable standard is as outlined in USAS B31.1 Case N-10. When a gasket is employed the body-to-bonnet joint is designed per ASME Boiler and Pressure Vessel Code Section VIII or USAS B16.5 with a fully trapped, controlled compression, spiral wound gasket with provisions for seal welding, or of the pressure seal design with provisions for seal welding. The body-to-bonnet bolting and nut materials are procured per ASTM A193 and A194, respectively.

The entire assembled unit is hydrotested as outlined in MSS SP-61 with the exception that the test is maintained for a minimum period of 30 minutes per inch of wall thickness. Any leakage is cause for rejection. The seating design is of the Darling parallel disc design, the Crane flexible wedge design, or the equivalent. These designs have the feature of releasing the mechanical holding force during the first increment of travel. Thus, the motor operator has to work only against the frictional component of the hydraulic unbalance on the disc and the packing box friction. The discs are guided throughout the full disc travel to prevent chattering and provide ease of gate movement. The seating surfaces are hard faced (Stellite No. 6 or equivalent) to prevent galling and reduce wear. C26

The stem material is ASTM A276 Type 316 condition B or precipitation hardened 17-4 PH stainless procured and heat treated to Westinghouse Specifications. These materials are selected because of their corrosion resistance, high tensile properties, and their resistance to surface scoring by the packing. The valve stuffing box is designed with a lantern ring leak-off connection with a minimum of a full set of packing below the lantern ring and a maximum of one-half of a set of packing above the lantern ring; a full set of packing is defined as a depth of packing equal to 1-1/2 times the stem diameter. The experience with this stuffing box design and the selection of packing and stem materials has been very favorable in both conventional and nuclear power plants.

The RHR suction isolation valve MOV-*-751 and the RHR low head safety injection isolation valves (MOV-*-744A, MOV-*-744B) are provided with a single set of packing and no stem leakoff.

The motor operator is extremely rugged and is noted throughout the power industry for its reliability. The unit incorporates a "hammer blow" feature that allows the motor to impact the discs away from the fore or backseat upon opening or closing. This "hammer blow" feature not only impacts the disc but allows the motor to attain its operational speed.

The valve is assembled, hydrostatically tested, seat-leakage tested (fore and back), operationally tested, cleaned and packaged per specifications. All manufacturing procedures employed by the valve supplier such as hard facing, welding, repair welding and testing are submitted to Westinghouse for approval.

For those valves which must function on the safety injection signal, stroke-time certified operators are provided. For all other valves in the system, the valve operator completes its cycle from one position to the other within 180 seconds. Valve stroke times may be increased as a result of evaluations performed in accordance with NRC Generic Letter 89-10.

Valves are required to function under the maximum differential pressures determined in accordance with the requirements of NRC Generic Letter 89-10.

Safety related power operated gate valves were evaluated for their susceptibility to pressure locking and thermal binding as required by NRC Generic Letters 89-10 and 95-07. The following motor operated valves each have a design feature (either a hole drilled in one of the discs or a bonnet vent to provide relief from the inter-disc space) which preclude the potential for pressure locking as described in the two generic letters:

MOV-*-350, MOV-*-750/751, MOV-*-843A/B, MOV-*-860A/B, MOV-*-861A/B, MOV-*-866A/B, MOV-*-869, MOV-*-872, and MOV-*-744A/B. C26

Manual Valves

The stainless steel manual globe, gate and check valves are designed and built in accordance with the requirements outlined in the motor operated valve description above.

The carbon steel valves are built to conform with USAS B16.5. The materials of construction of the body, bonnet and disc conform to the requirements of ASTM A105 Grade II, A181 Grade II or A216 Grade WCB or WCC. The carbon steel valves pass only non-radioactive fluids and are subjected to hydrostatic test as outlined in MSS SP-61, except that the test pressure is maintained for at least 30 minutes per inch of wall thickness. Since the fluid controlled by the carbon steel valves is not radioactive, the double packing and seal weld provisions are not provided.

Accumulator Check Valves

The pressure containing parts of this valve assembly are designed in accordance with MSS SP-66. All parts in contact with the operating fluid are of austenitic stainless steel or of equivalent corrosion resistant materials procured to applicable ASTM or WAPD specifications. The cast pressure-containing parts are radiographed in accordance with ASTM E-94 and the acceptance standard as outlined in ASTM E-71. The cast pressure-containing parts, machined surfaces, finished hard facings, and gasket bearing surfaces are liquid penetrant inspected per ASME B&PV Code, Section VIII and the acceptance standard is as outlined in USAS B31.1 Code Case N-10. The final valve is hydrotested per MSS SP-66, except that the test pressure is maintained for at least 30 minutes. The seat leakage is conducted in accordance with the manner prescribed in MSS SP-61, except that the acceptable leakage is 2cc/hr/in, nominal pipe diameter.

The valve is designed with a low pressure drop configuration with all operating parts contained within the body, which eliminates those problems associated with packing glands exposed to boric acid. The clapper arm shaft is manufactured from 17-4 PH stainless steel heat treated to Westinghouse Specifications, The clapper arm shaft bushings are manufactured from Stellite No. 6 material, The various working parts are selected for their corrosion resistant, tensile, and bearing properties.

The disc and seat rings are manufactured from a forging. The mating surfaces are hard faced with Stellite No. 6 to improve the valve seating life. The disc is permitted to rotate, providing a new seating surface after each valve opening.

The valves are intended to be operated in the closed position with a normal differential pressure across the disc of approximately 1550 psi. The valves shall remain in this position except for testing and safety injection and are not subjected to impact loads caused by sudden flow reversal.

When the valve is required to function a differential pressure of less than 25 psig will shear any particles that may attempt to prevent the valve from functioning. Although the working parts are exposed to the boric acid solution contained within the reactor coolant loop, a boric acid "freeze up" is not expected with this low a concentration.

The experience derived from the check valves employed in the Emergency Injection System of the Carolina - Virginia Tube Reactor in a similar system indicates that the system is reliable and workable.

The CVTR Emergency Injection System, normally maintained at containment ambient conditions was separated from the main coolant piping by a single six inch check valve. Leak detection was provided at a proper elevation to accumulate any leakage coming back through the check valve. A level alarm provided a signal on excessive leakage. The pressure differential was 1500 psi and the system was stagnant. The valve was located 2 to 3 feet from the main coolant piping which resulted in some heatup and cooldown cycling. The CVTR went critical late in 1963 and operated until 1967. During that time, the level sensor in the detection never alarmed due to check valve leakage.

<u>Relief Valves</u>

The accumulator relief valves are sized to pass nitrogen gas at a rate in excess of the accumulator gas fill line delivery rate. The relief valves will also pass water in excess of the expected leak rate, but this is not necessary because the time required to fill the gas space gives the operator ample opportunity to correct the situation. For an inleakage rate 15 times the manufacturing test rate, there will be about 1000 days before water will reach the relief valves. Prior to this, level and pressure alarms would have been actuated.

The safety injection test line relief valve at Penetration No. P-17 is provided to relieve any pressure, above design, that might build up in the piping. The valve will pass a nominal 50 gpm which is far in excess of the manufacturing design leak rate of 24 cc/hr.

The relief valve in the high head safety injection line leading to the hot leg at penetration P-18 will pass a nominal flow of 20 gpm, which is approximately twice the maximum technical specification permitted leak rate through valves *-874A/B and MOV-*-866A A/B. Valves *-874 A/B and MOV-*-866 A/B isolate this portion of the SI system from the reactor coolant system.

Leakage Limitations

Valving is specified for exceptional tightness. The majority of valves, except those which perform a control function, are provided with backseats which are capable of limiting leakage to less than one cubic centimeter per hour per inch of stem diameter assuming no credit for packing in the valve. Normally closed globe valves are installed with recirculation flow under the seat to prevent stem leakage from the more radioactive fluid side of the seat. Manual and motor operated gate and globe valves that are normally open and inside containment are not backseated. Other normally open valves are backseated.

Motor operated valves, which are exposed to recirculation flow, are provided with double-packed stuffing boxes and stem leakoff connections which are piped to the pressurizer relief tank (PRT) enroute to the waste disposal system, except the RHR suction isolation valve MOV-*-751, the HHSI hot leg injection valves MOV-*-866A/B and the RHR low head safety injection isolation valves (MOV-*-744A, MOV-*-744B) which have one set of packing and no stem leak-off connections.

The specified leakage across the valve disc required to meet the equipment specification and hydrotest requirements is as follows:

a) Conventional globe - 3 cc/hr/in. of nominal pipe size.
b) Gate valves - 3 cc/hr/in. of nominal pipe size; 10 cc/hr/in for 300 and 150 pound USA Standard.
c) Motor-operated gate valves - 3 cc/hr/in. of nominal pipe size; 10 cc/hr/in for 300 and 150 pound USA Standard.
d) Check valves - 3 cc/hr/in. of nominal pipe size; 10 cc/hr/in for 300 and 150 pound USA Standard
e) Accumulator check valves -2 cc/hr/in. of nominal pipe size

Relief valves are totally enclosed. Leakage from components of the recirculation loop including valves is tabulated in Table 6.2-12.

Piping

All Safety Injection System piping in contact with borated water is austenitic stainless steel. Piping joints are welded except for the flanged connections at the safety injection, containment spray pumps, accumulator fill line check valves and the containment spray dissimilar metal flanged connection inside containment. C30

The piping beyond the accumulator stop valves is designed for Reactor Coolant System conditions (2485 psig, 650°F). All other piping connected to the accumulator tanks is designed for 700 psig and 400°F.

The safety injection pump suction piping (210 psig at 300°F) from the refueling water storage is designed for low pressure losses to meet NPSH (net positive suction head) requirements of the pumps.

The safety injection high pressure branch lines (1500 psig at 300°F) to the hot legs are designed for high pressure losses to limit the flow rate out of a potential rupture of a branch line at the connection to the reactor coolant loop.

The piping is designed to meet the minimum requirements set forth in (1) the USAS B31.1 Code for the Pressure Piping, (2) Nuclear Code Case N-7, (3) USAS Standards B36.10 and B36.19 and (4) ASTM Standards, and (5) supplementary standards plus additional quality control measures.

Minimum wall thicknesses are determined by the USAS Code formula in the power piping Section 1 of the USAS Code for Pressure Piping. This minimum thickness is increased to account for the manufacturer's permissible tolerance of minus 12-1/2 per cent on the nominal wall. Purchased pipe and fittings have a specified nominal wall thickness that is no less than the sum of that required for pressure containment, mechanical strength, and manufacturing tolerance.

Thermal and seismic piping flexibility analyses are performed. Special attention is directed to the piping configuration at the pumps with the objective of minimizing pipe imposed loads at the suction and discharge nozzles. Piping is supported to accommodate expansion due to temperature changes during the accident.

Pipe and fitting materials are procured in conformance with all requirements of the ASTM and USAS specifications. All materials are verified for conformance to specification and documented by certification of compliance to ASTM material requirements. Specifications impose additional quality control upon the suppliers of pipes and fittings as listed below:

a) Quality assurance records will be maintained on both the purchased pipe and fittings.

b) Pipe branch lines between the reactor coolant pipes and the isolation stop valves conform to ASTM A376 and meet the supplementary requirement S6 ultrasonic testing.

c) Fittings conform to the requirements of ASTM A403. Fittings 3 inch and above have requirements for UT inspection similar to S6 of A376.

Shop fabrication of piping subassemblies is performed by reputable suppliers in accordance with specifications which define and govern material procurement, detailed design, shop fabrication, cleaning, inspection, identification, packaging and shipment.

Welds for pipes sized 2-1/2" and larger are butt welded. Reducing tees are used where the branch size exceeds 1/2 of the header size. Branch connections of sizes that are equal to or less than 1/2 of the header size are of a design that conforms to the USAS rules for reinforcement set forth in the USAS B31.1 Code for Pressure Piping. Bosses for branch connections are attached to the header by means of full penetration welds.

All welding is performed by welders and welding procedures qualified in accordance with the ASME Boiler and Pressure Vessel Code Section IX, Welding Qualifications. The Shop Fabricator is required to submit all welding procedures and evidence of qualifications for review and approval prior to release for fabrication. All welding materials used by the Shop Fabricator must have prior approval.

All high pressure piping butt welds containing radioactive fluid, at greater than 600°F temperature and 600 psig pressure or equivalent, are radiographed. The remaining piping butt welds are randomly radiographed. The technique and acceptance standards are those outlined in UW-51 of the ASME B&PV Code Section VIII. In addition, butt welds are liquid penetrant examined in accordance with the procedure of ASME B&PV Code, Section VIII, Appendix VIII and the acceptance standard as defined in the USAS Nuclear Code Case N-10. Finished branch welds are liquid penetrant examined on the outside and where size permits, on the inside root surfaces.

A post-bending solution anneal heat treatment is performed on hot-formed stainless steel pipe bends. Completed bends are then completely cleaned of oxidation from all affected surfaces. The shop fabricator is required to submit the bending, heat treatment and clean-up procedures for review and approval prior to release for fabrication.

General cleaning of completed piping subassemblies (inside and outside surfaces) is governed by basic ground rules set forth in the specifications. For example, these specifications prohibit the use of hydrochloric acid and limit the chloride content of service water and demineralized water.

Packaging of the piping subassemblies for shipment is done so as to preclude damage during transit and storage. Openings are closed and sealed with tight-fitting covers to prevent entry of moisture and foreign material. Flange facings and weld end preparations are protected from damage by means of c-over plates securely fastened in position. The packing arrangement proposed by the shop fabricator is subject to approval.

Pump and Valve Motors

Motors Outside the Containment

Motor electrical insulation systems are supplied in accordance with USAS, IEEE and NEMA standards and are tested as required by such standards. Temperature rise design selection is such that normal long life is achieved even under accident loading conditions.

Although the motors which are provided only to drive engineered safety features equipment are normally run only for test, the design loading and temperature rise limits are based on accident conditions. Normal design margins are specified for these motors to make sure the expected lifetime includes allowance for the occurrence of accident conditions.

Motors Inside the Containment

The motor operators for the valves inside containment are designed to withstand containment environment conditions following the loss of coolant accident so that the valves can perform the required function during the recovery period.

Periodic operation of the motors and tests of the insulation ensure that the motors remain in a reliable condition.

Tests to demonstrate the adequacy of valve motor operators of the type used in the design to be functional after exposure to temperature, pressure and radiation are being conducted in two groups.

The first group is the exposure of valve motor operators to both temperature and pressures similar to that predicted for the incident:

a) Operator is located inside a pressure vessel which is exposed to approximately 330°F at 90 psig.

b) Operator will be cycled approximately three times under simulated valve operating loads.

c) Pressures and temperatures will be reduced in step changes to 285°F at 60 psig, 219°F at 20 psig and 152°F at atmosphere or less.

d) Operator will be cycled approximately three times at each of the levels of change. Full recordings of pertinent data will be taken throughout the tests.

e) Unit shall be examined after completion of test and operating data compared to data prior to exposure.

The second group test is the radiation test on a motor from the valve operator.

a) Two production line motors are being used for this test. One is to be exposed to 1.5×10^{8} rads of gamma for approximate period of one month. The other motor will be used for the final comparative analysis.

b) Both units will be tested for coil resistance, insulation meggering both before and after motor vibration and reversing operations.

Electrical Supply

Details of the normal and emergency power sources for the Safety Injection System are presented in Section 8.

Protection Against Dynamic Effects

All three cold leg injection lines and the hot leg injection header penetrate the containment via the auxiliary building, pipe and valve room.

The portion of the high head injection system within the containment is connected to the accumulator injection lines attached to each loop cold leg piping and to the hot leg piping of two loops. The portion of the low head injection system within the containment is connected to the accumulator injection lines attached to each loop cold leg piping.

For most of their routing, these lines are outside the primary and secondary shielding, and hence they are protected from missiles originating within these areas.

All hangers, stops and anchors are designed in accordance with USAS B31.1 Code for Pressure Piping and ACI 318-63 Building Code Requirements for Reinforced Concrete which provide minimum requirements on materials, design and fabrication with ample safety margins for both dead and operational dynamic loads over the life of the equipment. In addition to the normal load conditions the requirements of Table 5A-1 for the loading combinations shown are used in design of supports. Specifically, these standards require the following:

(1) All materials used are in accordance with ASTM specifications which establish quality levels for the manufacturing process, minimum strength properties, and for test requirements which ensure compliance with the specifications.

(2) Qualification of welding processes and welders for each class of material welded and for types and positions of welds.

(3) Maximum allowable stress values are established which provide an ample safety margin on yield strength for normal loads and ultimate strength for design basis accident or maximum hypothetical seismic loads.

6.2.3 DESIGN EVALUATION

Range of Core Protection

The measure of effectiveness of the Safety Injection System is the ability of the pumps and accumulators to keep the core flooded or to reflood the core rapidly where the core has been uncovered for postulated large area ruptures. The result of the performance is to sufficiently limit any increase in clad temperature below a value where emergency core cooling objectives are met (Section 6.2.1). The range of core protection as a function of break diameter provided by the various components of the Safety Injection System is presented in Figure 6.2-4.

Figure 6.2-4 was developed from the results of the loss of coolant accident studies presented in Section 14.3. Simulations of a sufficient number of break sizes were performed to demonstrate that the Safety Injection components meet the emergency core cooling requirements. The injection from the following combination of components was analyzed as discussed below. C26

Bar A Two Safety Injection Pumps
Bar B One Residual Heat Removal Pump and Two Accumulators
Bar C Two Safety Injection Pumps and Two Accumulators
Bar D Two Safety Injection Pumps, One Residual Heat Removal Pump and Two Accumulators *

With one safety injection pump, associated with the shutdown non-accident unit, inoperable and the failure of an emergency diesel generator, associated with the accident unit, the emergency core cooling equipment available is represented by Bar D (two out of four safety injection pumps, one out of two residual heat removal pumps, and two out of three accumulators). With these systems, the calculated maximum fuel cladding temperature is limited to 2200°F, which meets the emergency core cooling design objectives for all break sizes up to and including the double-ended severance of the reactor coolant pipe. Section 14.3.2 discusses the analyzed design basis as represented by Bar D.

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* No credit is taken for the accumulator which is attached to the ruptured loop, nor for spillage from broken lines.

The limiting single active short-term failure assumed in the Best Estimate Large Break LOCA (BELOCA) analysis in Section 14.3.2 is the loss of a safeguards train, and the pumped emergency core cooling flow rates are conservatively calculated based on minimum (bounding) safeguards assumptions designed to minimize pumped Emergency Core Cooling System flow to the core. Therefore, the Emergency Core Cooling System flow assumed for a large break LOCA only includes one residual heat removal pump and two safety injection pumps in operation, which matches the Safety Injection component design basis represented by Bar D. C26

The remaining three combinations (Bars A, B, C,) represent degraded cases with operation of less than the minimum design emergency core cooling equipment. These cases are shown only to present the capability of individual portions of the systems and to demonstrate the overall margins to loss of clad geometric integrity and to clad burst of the system. The operation of two safety injection pumps, (Bar A) provides core protection for break sizes up to an equivalent break diameter of approximately 4 inches. The operation of two safety injection pumps would allow flow spilling from a broken safety injection line to go uncorrected by operator action. Isolation of the broken line by operator action would increase the range of protection.

In Section 14.3.2 an analysis is presented that demonstrated the ability of the two high head pumps to keep the core hot spot covered for all breaks up to a 4" equivalent diameter hole. When the hot spot remains covered, no core damage is expected.

The cases represented by Bars B and C are presented to demonstrate the redundancy between the low and high head pumping systems to provide protection for large area rupture. For large area ruptures analyzed (14.3.2) the clad temperatures are turned around by the accumulator injection. The active pumping components serve only to complete the refill started by the accumulators. Either two safety injection pumps or one residual heat removal pump provides sufficient addition of water to continue the reduction of clad temperature initially caused by the accumulator.

Bars A, B, and C are presented solely to demonstrate the redundant sufficiency of the system and do not represent the design basis of the system which is depicted by Bar D. The four inch break represents the upper limit of protection for the high head safety injection system. Two safety injection pumps limit the peak clad temperatures to levels well below the temperature where clad bursting is expected.

For all breaks four inches and smaller the release of fission products will be limited to the activity initially in the coolant. For larger ruptures, up to and including the double ended rupture of the reactor coolant pipe, the accumulators together with various combinations of high and low head pumps limit the peak clad temperatures to levels well below the temperature where any loss of clad geometric integrity is expected (Bars B and C).

System Response

To provide protection for large area ruptures in the Reactor Coolant System the Safety Injection System must respond to rapidly reflood the core following the depressurization and core voiding that is characteristic of large area ruptures. The accumulators act to begin the rapid reflooding function with no dependence on the normal or emergency power sources, and also with no dependence on the receipt of an actuation signal.

Operation of this system with two of the three available accumulators delivering their contents to the reactor vessel (one accumulator spilling through the break) prevents fuel clad melting and limits metal-water reaction to an insignificant amount (<1%).

The function of the safety injection or residual heat removal pumps is to complete the refill of the vessel and ultimately return the core to a subcooled state. As discussed earlier the flow from either two safety injection pumps or one residual heat removal pump is sufficient to complete the refill with no loss of level in the core. Moreover, there is sufficient excess water delivered by the accumulators to tolerate a delay in starting the pumps.

Initial response of the injection systems is automatic, with appropriate allowances for delays in actuation of circuitry and active components. The active portions of the injection systems are automatically actuated by the safety injection signal (Section 7). In addition, manual actuation of the entire injection system and individual components can be accomplished from the control room. In analysis of system performance, delays in reaching the programmed trip points and in actuation of components are conservatively established on the basis that only emergency on-site power is available.

The starting sequence of the safety injection and residual heat removal pumps and the related emergency power equipment is designed so that delivery of the full rated flow is reached within 25 seconds after the process parameters reach the setpoints for the injection signal. See Section 8.2.

The delay of 35 seconds is assumed in the analysis of the loss-of-coolant accident as described in Section 14.

For the small break analysis, an additional delay time is allowed to account for the receipt of safety injection signal, either from low pressurizer pressure or from high containment pressure.

Single Failure Analysis

A single active failure analysis is presented in Table 6.2-9(a). All credible active system failures are considered. The analysis of the loss-of-coolant accident presented in Section 14 is consistent with the single failure analysis.

It is based on the worst single failure (generally a safeguards train) affecting both the safety injection and residual heat removal pumping systems. The analysis shows that the failure of any single active component will not prevent fulfilling the design function.

In addition, an evaluation of an alternative flow path to maintain core cooling is given in Table 6.2-9(b) in the event a beyond-design-basis single passive failure disrupts hot leg or cold leg recirculation. C26

Failure analyses of the component cooling and intake cooling water system under loss-of-coolant accident conditions are described in Section 9.3 and 9.6, respectively.

Reliance-on Interconnected Systems

During the injection phase, the flow path for the high head safety injection pumps does not depend on any portion of other systems, with the exception of the suction line from the RWST. During the recirculation phase of the accident for small breaks, suction to the safety injection pumps is provided by a residual heat removal pump.

The residual heat removal (low head) pumps are normally used during reactor shutdown operations. Whenever the reactor is at power, the pumps are aligned for emergency duty.

Operation of a single residual heat removal loop is permitted for decay heat removal when fuel is in the reactor vessel and the refueling cavity is flooded to greater than or equal to 23 feet above the reactor vessel flange. A loss of this single residual heat removal loop has been evaluated to ensure that adequate natural circulation cooling can be maintained for decay heat removal. The analysis utilized GOTHIC thermal-hydraulic analysis software to evaluate natural circulation cooling conditions with both the reactor vessel upper internals assembly installed and with the upper internals assembly removed. In each case, the results of the analysis demonstrate that no fuel design limits will be exceeded for at least 30 hours, and this is more than enough time to initiate emergency procedures to maintain core cooling. Furthermore, the calculated increase in heat flux in the core volume is only a small fraction of the CHF for the fuel, and is considered a minimal (essentially negligible) increase. This negligible impact on fuel CHF ensures that no fuel design limits are approached or challenged during the fuel cavity boil-off period. Also, the possibility of inadvertent criticality is minimized since the capability exists to inject boron into the reactor vessel to mitigate a reduction in boron concentration during boil-off, and demonstrated natural circulation flow paths exist in the core volume to minimize boron stratification. The presence of the natural circulation flow paths provide assurance that, in the event of a loss of the single residual heat removal loop, the backup decay heat removal capability afforded by the 23 feet of water above the vessel flange can be credited, regardless of whether the upper internals assembly is installed or removed. For more detailed information regarding the analysis, see Reference 1.

Component Function Evaluation

Table 6.2-10 is an evaluation of the main components, which have been previously discussed and a brief description of how each component functions during normal operation and during an incident.

Passive Systems

The accumulators are a passive safety feature in that they perform their design function in the total absence of an actuation signal or power source. The only moving parts in the accumulator injection train are in the two check valves.

The working parts of the check valves are exposed to fluid of relatively low boric acid concentration contained within the reactor coolant loop. Even if some unforeseen deposition accumulated, calculations have shown that a differential pressure of about 25 psi will shear any particles in the bearing that may attempt to prevent the valve from functioning.

The isolation valve at each accumulator is designed to withstand full reactor coolant system pressure and is only closed momentarily for testing or when the reactor is intentionally depressurized. The isolation valve (865) is normally open and is maintained inoperative by keeping the motor circuit breaker locked open in the motor control center.

The check valves operate in the closed position with a nominal differential pressure across the disc of approximately 1550 psi. They remain in this position except for testing or when called upon to function. Since the valves operate normally in the closed position and are therefore not subject to the abuse of flowing operation or impact loads caused by sudden flow reversal and seating, they do not experience any wear of the moving parts, and function as required.

When the Reactor Coolant system is being pressurized following refueling outages, the accumulator check valves are tested for leakage. The testing performed ensures that the associated check valve is in the closed position and verifies seat leakage is acceptable while maintaining a minimum test pressure differential across each valve. This testing is completed prior to the reactor coolant system pressure exceeding 1000 psig, at which point the discharge isolation valves are opened and de-energized, placing the accumulators in their required standby configuration for normal operation.

The accumulators are located inside the reactor containment and protected from the reactor coolant system piping and components by a missile barrier. Accidental release of the gas charge in the three accumulators would cause an increase in the containment pressure of approximately 0.1 psi. This release of gas has been included in the containment pressure analysis for the loss-of-coolant accident, Section 14.3.

During normal operation, the flow rate through the reactor coolant piping is approximately five times the maximum flow rate from the accumulator during injection. Therefore fluid impingement on reactor vessel components during operation of the accumulator is not restricting.

Emergency Flow to the Core

Special attention is given to factors that could adversely affect the accumulator and safety injection flow to the core. These factors are:

a) Steam binding in the core, including flow blockage due to loop sealing

b) Carryover of accumulator water during blowdown

c) Short circuiting of the accumulator from the core to another part of the Reactor Coolant System

d) Loss of accumulator water through the break

All of the above are considered in the analysis, and are discussed quantitatively in Section 14.

Recirculation Loop Leakage

Table 6.2-12 summarizes the maximum potential leakage from the leak sources of the recirculation loop which goes through the residual heat removal pumps, a residual heat exchanger and the high head safety injection pumps. In the analysis, a maximum leakage is assumed from each leak source. For conservatism, a leakage of 5 drops per minute was assumed from each flange although each flange would be adjusted to essentially zero leakage. The total maximum potential leakage resulting from all sources is listed in Table 6.2-12. C26

During external recirculation, significant margin exists between the design and operating conditions of the residual heat removal system components, as shown in Table 6.2-13. In addition, during normal cooldown, operation of the residual heat removal system is initiated when the reactor coolant pressure and temperature have been reduced to 450 psig and 350°F respectively. The maximum accident operating conditions are far less rigorous. In view of the design margins, it is considered that the leakage rates in Table 6.2-12 are conservative.

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Leakage detection exterior to containment is achieved through use of sump level detection. The Auxiliary Building sump pumps start automatically in the event that liquid accumulates in the sump and an alarm in the control room indicates that water has accumulated in the sump. Valving is provided to permit the operator to isolate individually the residual heat removal pumps.

Pump NPSH Requirements

Residual Heat Removal Pumps

The NPSH of the residual heat removal pumps is evaluated for normal shutdown operation, and both the injection and recirculation phase operation of the design basis accident. Recirculation operation gives the limiting NPSH requirement, and sufficient NPSH to initiate recirculation is determined by the containment water level switches. During recirculation an adequate margin exists between the available and required NPSH.

Safety Injection Pumps

The NPSH for the safety injection pumps is evaluated for both the injection and recirculation phase operation of the design basis accident. The end of injection phase operation gives the limiting NPSH requirement and the NPSH available is determined from the elevation head and vapor pressure of the water in the RWST, and the pressure drop in the suction piping from the tank to the pumps.

6.2.4 INSPECTIONS AND TESTS

Inspection Capability

All components of the Safety Injection System can be inspected periodically to demonstrate system readiness.

The pressure containing components are inspected for leaks from pump seals, valve packing, flanged joints and safety valves during system testing.

In addition, to the extent practical, the critical parts of the reactor vessel internals, pipes, valves and pumps are inspected visually or by boroscopic examination for erosion, corrosion, and vibration wear evidence, and for non-destructive test inspection where such techniques are desirable and appropriate.

Pre-Operational Testing

Component Testing

Pre-operational performance tests of the components are performed in the manufacturer's shop. The pressure-containing parts of the pump are hydrostatically tested in accordance with Paragraph UG-99 of Section VIII of the ASME Code. Each pump is given a complete shop performance test in accordance with Hydraulic Institute Standards. The pumps are run at design flow and head, shut-off head and at additional points to verify performance characteristics. NPSH is established at design flow by means of adjusting suction pressure for a representative pump. This test is witnessed by qualified Westinghouse personnel.

The remote operated valves in the safety injection systems will be motor-operated. Shop tests for each valve include a hydrostatic pressure test, leakage tests, a check of opening and closing time, and verification of torque switch and limit switch settings. The ability of the motor operator to move the valve with the design differential pressure across the gate is demonstrated by opening the valve with an appropriate hydrostatic pressure on one side of the valve.

The recirculation piping and accumulators are initially hydrostatically tested at 150 percent of design pressure. The intake cooling water and component cooling water pumps are tested prior to initial operation.

System Testing

An initial functional test of the core cooling portion of the safety injection systems is conducted during testing of the reactor coolant system before initial startup. The purpose of the initial systems test is to demonstrate the proper functioning of actuation circuits and to evaluate the dynamics of placing the system in operation. This test is performed following the flushing and hydrostatic testing of the system.

The functional test is performed with the Reactor Coolant System initially cold and at low pressure. The safety injection system valving is set to initially simulate the system alignment for power operation.

To initiate the test, the safety injection block switch is moved to the unblock position to provide control power allowing the automatic actuation of the safety injection relays from the low pressure signals from the pressurizer instrumentation. Simultaneously, the breakers supplying outside power to the 4160 volt buses are tripped manually and operation of the emergency diesel system automatically commences. The high head safety injection pumps and the residual heat removal pumps are started automatically following the prescribed diesel loading sequence. The valves are operated automatically to align the flow path for injection into the reactor coolant system.

The rising water level in the pressurizer provides indication of systems delivery. Flow into the reactor coolant system is terminated at a prescribed pressurizer level by manually stopping safety injection pumps.

Tests are performed to provide information to confirm valve operating times, pump motor starting times, the proper automatic sequencing of, load addition to the emergency diesels, and delivery rates of injection water to the reactor coolant system.

Tests are performed for the various modes of operation needed to demonstrate performance at partial effectiveness, i.e., to demonstrate the proper loading sequence with loss of one of the diesel generator power sources. These latter cases are performed without delivery of water to the reactor coolant system, but include starting of all pumping equipment involved in each test.

The systems are accepted only after demonstration of proper actuation and after demonstration of flow delivery and shutoff head within design requirements.

Flow is introduced into the Reactor Coolant loops through the accumulator discharge line to demonstrate operability of the check valves and remotely actuated stop valve and confirm L/D ratios of accumulator discharge lines used in the calculation.

Post-Operational Testing

Component Testing

Routine periodic testing of the safety injection system components and all necessary support systems at power is planned. No inflow to the Reactor Coolant System will occur whenever the reactor coolant pressure is above 1500 psi. If such testing indicates a need for corrective maintenance, the redundancy of equipment in these systems permits such maintenance to be performed without shutting down or reducing load under conditions defined in the Technical Specifications. These conditions include such matters as the period within which the component should be restored to service and the capability of the remaining equipment to meet safety limits within such a period.

The accumulator discharge remote stop valves, MOV-*-865A, B, C, may be tested for stroke time while the unit is in a hot standby to cold shutdown condition for a refueling outage. Test capabilities are provided to periodically examine the leakage back through the check valves and to ascertain that these valves seat. It is expected that this test will be routinely performed when the reactor is being returned to power after a refueling outage.

The residual heat removal and high head safety injection pumps will be run periodically. Idle intake cooling water and component cooling water pumps will be put in service periodically as part of the normal rotation of machinery use. The content of the accumulators and the RWST are sampled periodically to determine that the required boron concentration is present.

System Testing

System testing can be conducted during shutdown to demonstrate proper automatic operation of the Safety Injection System. The system test demonstrates the operation of the valves, pump circuit breakers, and automatic circuitry. Isolation valves in the injection line will be blocked closed so that flow is not introduced into the reactor coolant system. The test is considered satisfactory if control board indication and visual observations indicate all components have operated and sequenced properly.

During periodic RHR/HHSI pump testing, independent of the integrated safeguards testing, it is verified that the pumps attain their required discharge heads. The accumulators and the injection piping up to the final isolation valve are maintained full of borated water while the unit is in operation. The accumulators and the high head injection lines are refilled with borated water as required by using the safety injection pumps.

Flow in each of the safety injection headers and in the main flow line for the residual heat removal pumps is monitored by a flow indicator. Pressure instrumentation is also provided for the main flow paths of the safety injection and residual heat removal pumps.

The external recirculation flow paths are leak checked during periodic retests at the normal operating pressures. This is accomplished by running each pump which could be utilized during external recirculation (safety injection and residual heat removal pumps) in turn at near shutoff head conditions and checking the discharge and recirculation test lines. The suction lines are tested by running the residual heat removal pumps and opening the flow path to the safety injection pumps in the same manner as described above. Note that an external pressure source may also be used.

During the above test, all system joints, valve packings, pump seals, leakoff connections or other potential points of leakage are visually examined. Valve gland packing, pump seals, and flanges are adjusted or replaced as required to reduce the leakage to acceptable proportions. For power operated valves, final packing adjustments are made, and the valves are put through an operating cycle before a final leakage examination is made.

The entire recirculation loop except the recirculation line to the residual heat removal pumps is pressurized during periodic testing of the engineered safety features components. Portions of the recirculation line to the residual heat removal pump are capable of being leak checked during unit shutdown. The unisolable suction line to the containment sump is leak tested as part of the containment integrated leak rate test (ILRT).

6.2.5 REFERENCES

1. Engineering Evaluation PTN-ENG-SENS-07-032, "RHR System Operation with the Reactor Cavity Filled and the Vessel Upper Internals In Place," Revision 0.

2. Letter from R.C. Jones (USNRC) to N.J. Liparulo (Westinghouse), “Acceptance for Referencing of the Topical Report WCAP-12945(P), Westinghouse Code Qualification Document for Best-Estimate Loss of Coolant Analysis,” June 28, 1996.

3. DELETED C26

4. Unit 3 PC/Ms that implemented the changes to address Generic Safety Issue 191, “Assessment of Debris Accumulation on PWR Sump Performance”:

   PC/M 06-030, Containment Recirculation Sump Debris GSI-191 Resolution

   PC/M 06-075, Containment Recirculation Sump Cross-Connect Core Bore

   PC/M 07-006, Reactor Coolant Pump And Pressurizer Surge Line Insulation Replacement

5. Unit 4 PC/Ms that implemented the changes to address Generic Safety Issue 191, “Assessment of Debris Accumulation on PWR Sump Performance”:

   PC/M 06-031, Containment Recirculation Sump Debris GSI-191 Resolution

   PC/M 06-049, Interim Containment Recirculation Sump Debris GSI-191 Resolution

   PC/M 06-055, Bioshield Wall Scupper Seals

   PC/M 06-071, Containment Recirculation Sump Cross-Connect Core Bore

   PC/M 07-007, Reactor Coolant Pump Insulation Replacement

   PC/M 07-081, Containment Spray Pump Seal Modification

6. Westinghouse Technical Report WCAP-17152-P Rev. 0, “Turkey Point Units 3 & 4 Extended Power Uprate Engineering Report,” August 2012. C26

TABLE 6.2-1

SAFETY INJECTION SYSTEM - CODE REQUIREMENTS

Component	Code
Refueling Water Storage Tank	AWWA D100-65
Residual Heat Exchanger	
Tube Side	ASME Section III*Class C
Shell Side	ASME Section VIII
Accumulators	ASME Section III Class C
Boron Injection Tank****	ASME Section III Class C
Valves	USAS B16.5**
Piping	USAS B31.1***

*ASME Section III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code Section III, Nuclear Vessels - 1965

**Aloyco valve weld ends in accordance with Westinghouse Spec. No. G-676241, Dwg. No. 498B932, hydrostatically retested at system test pressure after installation

***USAS B31.1 - Code for Pressure Piping - 1955

****The units 3/4 BIT have been bypassed and removed from the system flowpath.

INSTRUMENTATION READOUTS ON THE CONTROL BOARD FOR OPERATOR MONITORING DURING RECIRCULATION

Valves

System	Valve Number
SIS	MOV 3-860 A, B
SIS	MOV 3-861 A, B
SIS	MOV 3-862 A, B
SIS	MOV 3-863 A, B
SIS	MOV 3-864 A, B
SIS	MOV 3-866 A, B
SIS	MOV 3-843 A, B
SIS	MOV 3-869
SIS	MOV 3-880 A, B
SIS	MOV 3-856 A, B
ACS	HCV 3-758
ACS	HCV 3-605
ACS	MOV 3-744 A, B
ACS	MOV 3-749 A, B

Instrumentation

System	Channel Number
SIS	FI 3-940
SIS	FI 3-943
SIS	FI 3-932
SIS	FI 3-933
SIS	LS3-1570
SIS	LS3-1571
SIS	LI-3-6583A
SIS	LI-3-6583B

Note: Prefix 3 indicates that the component also is supplied for unit 4.

Instrumentation

System	Channel Number
SIS	PI 3-940
SIS	PI 3-943
ACS	Fl 3-605
ACS	LI 3-613 A
ACS	LI 3-614 A
ACS	TR 3-604 A, B
ACS	TR 3-606
RCS	LRCA 3-459
RCS	LICA 3-460
RCS	LICA 3-461
RCS	LI 3-462

Pumps

SIS	Safety Injection
SIS	Containment Spray
ACS	Residual Heat Removal
ACS	Component Cooling
ICS	Intake Cooling

TABLE 6.2-3

QUALITY STANDARDS OF SAFETY INJECTION SYSTEM COMPONENTS

RESIDUAL HEAT EXCHANGER

A. Tests and Inspections

1. Hydrostatic Test
2. Radiograph of longitudinal and girth welds (tube side only)
3. UT of tubing or eddy current tests
4. Dye penetrant test of welds
5. Dye penetrant test of tube to tube sheet welds
6. Gas leak test of tube to tube sheet welds before hydro and expanding tubes

B. Special Manufacturing Process Control

1. Tube to tube sheet weld qualifications procedure
2. Welding and NDT and procedure review
3. Surveillance of supplier quality control and product

COMPONENT COOLING HEAT EXCHANGER

A. Test and Inspections

1. Hydrostatic Test
2. Dye penetrant test of welds

B. Special Manufacturing Process Control

1. Welding and NDT and procedure review
2. Surveillance of supplier quality control and product

SAFETY INJECTION, AND RESIDUAL HEAT REMOVAL PUMPS

A. Tests and Inspections

1. Performance Test
2. Dye penetrant of pressure retaining parts
3. Hydrostatic test

B. Special Manufacturing Process Control
   1. Weld, NDT and inspection procedures for review
   2. Surveillance of suppliers quality control system and product

ACCUMULATORS

A. Tests and Inspections
   1. Hydrostatic test
   2. Radiography of longitudinal and girth welds
   3. Dye penetrant/magnetic particle of weld

B. Special Manufacturing Process Control
   1. Weld, fabrication, NDT and inspection procedure review
   2. Surveillance of suppliers quality control and product

VALVES

A. Tests and Inspections
   (a) 200 psi and 200 F or below (cast or bar stock)
      1. Dye Penetrant Test
      2. Hydrostatic Test
      3. Seat Leakage Test

   (b) Above 200 psi and 200 F
      (i) Forged Valves
         1. UT of billet prior to forging
         2. Dye penetrant 100% of accessible areas after forging
         3. Hydrostatic Test
         4. Seat Leakage Test

      (ii) Cast Valves
         1. Radiographic 100%*
         2. Dye Penetrant all accessible areas*
         3. Hydrostatic Test
         4. Seat Leakage Test

* For valves in radioactive services only

(c) Functional Tests Required for:
1. Motor Operated Valves
2. Auxiliary Relief Valves

B. Special Manufacturing Process Control
1. Weld, NDT, performance testing, assembly and inspection procedure review
2. Surveillance of suppliers quality control and product
3. Special Weld process procedure qualification (e.g. hard facing)

PIPING

A. Tests and Inspections
Butt Weld Inspection Schedule.

Pipe Specification Class No.	LIQUID PENETRANT		RADIOGRAPHY	
	Root Pass	Finished Weld	Random 10%	All Welds 100%
2501	R	N&R	N	R
2502	R	N&R	N	R
2503	R	N&R	N	R
1501	R	N&R	N	R
1502	R	N&R	N	R
901	R	N&R	N	R
902	R	N&R	N	R
903	R	N&R	N	R
601	R	N&R	N	R
602	R	N&R	N	R
301	R	N&R	N	R
302	R	N&R	N	R
151	R	N&R	N	R
152	R	N&R	N	R

N -- for non-radioactive service
R -- for radioactive service

B. Special Manufacturing Process Control
Surveillance of suppliers quality control and product.

TABLE 6.2-4

ACCUMULATOR DESIGN PARAMETERS

Number	3
Type	Stainless steel clad/ carbon steel
Design pressure, psig	700
Design temperature, °F	300
Operating temperature, °F	70 - 120
Normal pressure, psig	660
Minimum pressure, psig	600
Total volume, ft.^{3}	1200
Minimum water volume at operating conditions, ft.^{3}	875 (2)
Boron concentration, ppm	2300 - 2600
Relief valve set point (1), psig	700

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NOTES :

1. The relief valves have soft seats and are designed and tested to ensure zero leakage at normal operating pressure

2. A minimum Technical Specification volume of 872 ft.^{3} for the tank above has been approved by the NRC as Operating Licensee Amendment Nos. 143/138, dated May 29, 1991. This approved minimum tank volume takes credit for the accumulator water stored in the piping run between the accumulator tank and the first check valve which, when added to the tank volume, equals 875 ft.^{3}

TABLE 6.2-5

BORON INJECTION TANK

Number	1
Type	Vertical
Total Volume [(1)]	900 gal
Design Pressure	1750 psig
Design Temperature	300°F
Operating Pressure	0 - 1750 psig
Operating Temperature	Ambient
Fluid [(1)]	1950 +400, -0 ppm Boric Acid Solution
Material	Austenitic Stainless Steel
Code	Class C, Section III ASME

NOTES :

1. The Units 3/4 BIT are empty, bypassed, and abandoned in place.

TABLE 6.2-6

REFUELING WATER STORAGE TANK DESIGN PARAMETERS

Number	1
Material	Carbon Steel with Epoxy Lining
Total volume, gal.	332,000 C26
Normal pressure, psig	atmospheric
Operating temperature, F	ambient
Design pressure, psig	atmospheric
Design temperature, F	200
Nominal boron concentration, ppm	2500
Boron concentration, ppm	2400 - 2600 C26

TABLE 6.2-7

PUMP PARAMETERS

Safety Injection Pump Design Parameters

Number	4 (shared - Reference Appendix A)
Design pressure, discharge, psig	1,750
Design temperature, F	300
Design flow rate, gpm	300
Max. flow rate, gpm	625
Design head, ft	2,500
Shutoff head, ft	3,450
Material	11 - 13 Chrome
Motor H.P.	350
Type	Horizontal centrifugal

Residual Heat Removal Pump Design Parameters

Number of pumps	2 (per unit)
Type	Inline centrifugal
Design pressure, discharge, psig	600
Design temperature F	400
Design flow, gpm	3750
Design head, ft.	240
Material	Austenitic Stainless steel
Maximum flow rate, gpm	3750 with NPSH of 14 ft.
Shutoff head, ft.	325
Motor H.P.	300

TABLE 6.2-8

RESIDUAL HEAT EXCHANGERS DESIGN PARAMETERS

Number	2
Design heat duty, Btu/hr (Normal)	29.4×10^6
Design UA, Btu/hr/ °F	1.41×10^6
Design Cycles (50 °F - 400 °F)	200
Type	Vertical Shell and U-tube

	Tube-Side	Shell-side
Design pressure psig	600	150
Design flow, lb/hr	1.875×10^6	5.12×10^6
Inlet temperature, °F	140	107.4
Outlet temperature, °F	124.4	113.2

NOTE :

1. Tube-side and shell-side parameters will vary from the design values for the Extended Power Uprate Project. Refer to Westinghouse Uprating Engineering Report WCAP-17152-P, Rev.0, August 2012 (Reference 6). C26

TABLE 6.2-9 (a)

SINGLE FAILURE ANALYSIS - SAFETY INJECTION SYSTEM

	COMPONENT	MALFUNCTION	COMMENTS
A.	Accumulator (injection phase)	Delivery to broken loop	Totally passive system with one accumulator per loop. Evaluation based on two accumulators delivering to the core and one spilling from ruptured loop
B.	Pump: (injection phase)		
	1) High head safety injection	Fails to start	Four provided for two units. Evaluation based on operation of two** C29
	2) Residual heat removal	Fails to start	Two provided. Evaluation based on operation of one
	3) Component cooling*	Fails to start	Three provided. One required for recirculation
	4) Intake cooling water	Fails to start	Three provided. Evaluation based on operation of one. (See also Section 6.2-3)
C.	Automatically Operated Valves: Open on SIS - Injection phase		
	1) High head cold leg isolation injection header valve	Fails to open	Two parallel valves. One required to open.
	2) Residual heat removal pump isolation valve at injection line	Fails to open	Two parallel valves. One required to open.

* Recirculation phase

** Evaluation credits two HHSI pumps under a single train failure, one from the accident Unit and one from the opposite Unit. C29

COMPONENT	MALFUNCTION	COMMENTS
D. Valves Operated from Control Room for Recirculation: (recirculation phase cold leg)		
1) Containment Sump	Fails to open	Two lines parallel with two valves in recirculation isolation series in each line, one pair of valves in either line is required to open.
2) Safety injection pump suction, suction valve at residual heat exchanger discharge	Fails to open	Two parallel valves. One required to open.
3) Isolation valve on the test line returning to the re-fueling water storage tank	Fails as is	Two valves in series. One required to close.
4) Isolation valve at suction header from refueling water storage tank	Fails to close	Two valves in series. One required to close.
5) Isolation valves at residual heat removal pump suction line from refueling water storage tank	Fails to close	Two valves in series. One required to close.

The status of all active components of the Safety Injection System is indicated on the control board.

Reference is made to Table 6.2-2.

	COMPONENT	MALFUNCTION	COMMENTS
D.	6) High head injection cold leg injection valve (outside containment)	Fails to close (for hot leg recirculation)	Two parallel valves. Remote isolation capability is provided by an upstream manual valve equipped with a reach rod. C29
	7) Residual heat removal pump injection valve at injection line (inside containment)	Fails to close	Two parallel valves, both required to close for piggy-back recirculation. Remote isolation capability of direct cold leg injection downstream of each RHR heat exchanger is provided by manual isolation valves equipped with a reach rod. C29
E.	Valves Operated from Control Room for Recirculation: (recirculation phase – hot leg)		
	1) High head safety injection hot leg injection valve (outside containment)	Fails to open	There is a manual bypass valve installed in parallel with this valve that can be opened utilizing a reach rod.
	2) High head safety injection hot leg valves (inside containment)	Fails to open	Two parallel valves. One required to open.

COMPONENT	MALFUNCTION	COMMENTS
F. Valves Operated from Control Room for Recirculation: (recirculation phase – return to cold leg)		
1) High head safety injection hot leg injection valve (outside containment)	Fails to close	The two high head safety injection valves inside containment can be closed to isolate this flow path.
2) High head safety injection hot leg injection valves (inside containment)	Fails to close	The high head safety injection valves outside containment can be closed to isolate this flow path.

TABLE 6.2-9 (b)

LOSS OF RECIRCULATION FLOW PATH

Flow Path	Indication of Loss of Flow Path	Alternative Flow Path
From containment sump to low head injection pump to residual heat exchanger to high head injection pumps to hot or cold legs	No flow on high head cold leg injection header or high head hot leg injection header (independent flow monitor on each injection path).	Cold Leg Recirculation: From containment sump to low head injection pump to residual heat exchanger to cold legs via the normal or alternate direct injection line. Hot Leg Recirculation: From containment sump to low head injection pump to residual heat exchanger to alternate hot leg injection path through shutdown cooling supply line to the RCS 'C' hot leg. Use of this flowpath requires concurrent cold leg recirculation.

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NOTE: As shown on Figure 6.2-1, there are valves at all locations where alternative flow paths are provided. The alternate flowpaths are defense-in-depth measures for a beyond-design-basis passive failure that could occur in the normal hot leg or cold leg recirculation lineups. Te alternate flowpaths are not analyzed in the design basis LOCA safety analyses and are not credited lineups in the emergency operating procedures.

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TABLE 6.2-10

COMPONENT FUNCTIONS EVALUATIONS

Component	Normal Operating Function	Normal Operating Arrangement	Accident Function	Accident Arrangement
Boron Injection Tank (Unit 3/4 BIT are bypassed and abandoned in place)	None	N/A	N/A	N/A
Refueling Water Storage Tanks (1 per unit, can be shared)	Storage tank for refueling operations one to each unit	Line up to suction of safety injection residual heat removal and spray pumps, one to each unit	Source of borated water for core and spray nozzles spray	Lined up to suction of safety injection residual heat removal, and
Accumulators (3 per unit)	None	Line up to cold legs of reactor coolant piping	Supply borated water to core	Line up to cold legs of reactor coolant piping
Safety Injection Pumps (4 shared)	None	Line up to hot and cold legs of reactor coolant piping, two to each unit	Supply borated water to core	Line up to hot and cold legs of reactor coolant piping, two to each unit
Residual Heat Removal Pumps per unit)	Supply water to core to remove residual heat during shutdowns	Lined up to take suction from refueling water storage tank	Supply borated water to core	Lined up to take suction from (2 refueling water storage tank
Intake Cooling Water Pumps (3 per unit)	Supply cooling canal water to component cooling heat exchangers	Two pumps in service	Supply cooling canal water to component cool-ing heat exchangers	One pump in service (See Section 6.2-3)

Component	Normal Operating Function	Normal Operating Arrangement	Accident Function	Accident Arrangement
Component Cooling Pumps (3 per unit)	Supply cooling water to station nuclear components	One pump in service	Supply cooling water to residual heat exchangers and S.I. pump bearings	One pump in service
Residual Heat Exchangers (2 per unit)	Remove residual heat from core during shutdown	Line up for recirculation	Cool water from containment sump for core cooling and containment spray	Lined up for recirculation
Component Cooling Heat Exchangers (3 per unit)	Remove heat from component cooling water	Three heat exchangers in service	Cool water for residual heat exchangers	Two heat exchangers in service

TABLE 6.2-11

ACCUMULATOR INLEAKAGE

[DELETED]

TABLE 6.2-12
MAXIMUM POTENTIAL
RECIRCULATION LOOP LEAKAGE

Items	No. of Units	Type of Leakage Control and Unit Leakage Rate Used in the Analysis	Leakage to Atmosphere, cc/hr	Leakage to Waste Holdup Tank, cc/hr
1. Residual Heat Removal Pumps	2	Mechanical seal with auxiliary backup packing with leakoff in between.	0	0
2. Spray Pumps	2	Mechanical Seal	0	0
3. Safety Injection Pumps	4	Mechanical Seal	0	0
4. Flanges:		Gasket - adjusted to zero leakage following any test - 5 drops/min/ flange used in analysis		
a. Pumps	14		210	0
b. Valves bonnet to body (larger than 2")	78		1170	0
c. Control Valves	5		75	0
5. Valves - Stem Leakoffs	10	Backseated, double packing with leakoff - 1 cc/hr/in stem diameter	0	10
6. Valves - Bonnet Equalizing	2	Backseated, single packing with zero leakage	0	0
7. Misc. Small Valves	90	Flanged body packed stems - 1 drop/mn used	270	0
8. Containment Spray	2	Gasket - 30 cc/hr for each of the orifices	60	0
			1785	10

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TABLE 6.2-13

RESIDUAL HEAT REMOVAL SYSTEM
DESIGN, OPERATION AND TEST CONDITIONS

	Pumps	Heat Exchangers	Valves	Pipes and Fittings
Design Conditions				
Pressure, psig	600	600	665	700
Temperature, °F	400	400	400	400
Operating Conditions (Max) (NOTE 1)				
Pressure, psig	160	160	160	160
Temperature, °F (NOTE 2)	200	200	200	200
Test Pressure, psig	1200	900	1100	900
Allowable Pressure at Operating Temp. psig	>600	>600	>690	>850

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NOTES :

1. During post loss-of-coolant recirculation.

2. Maximum calculated RHR heat exchanger outlet temperature was calculated to be 198.8 °F for Extended Power Uprate. Refer to Westinghouse Uprating Engineering Report WCAP-17152-P, Rev. 0, August 2012 (Reference 6). C26

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-1

REFER TO ENGINEERING DRAWING

5613-M-3050 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

RESIDUAL HEAT REMOVAL SYSTEM

FIGURE 6.2-1

Security-Related Information - Withheld Under 10 CFR 2.390

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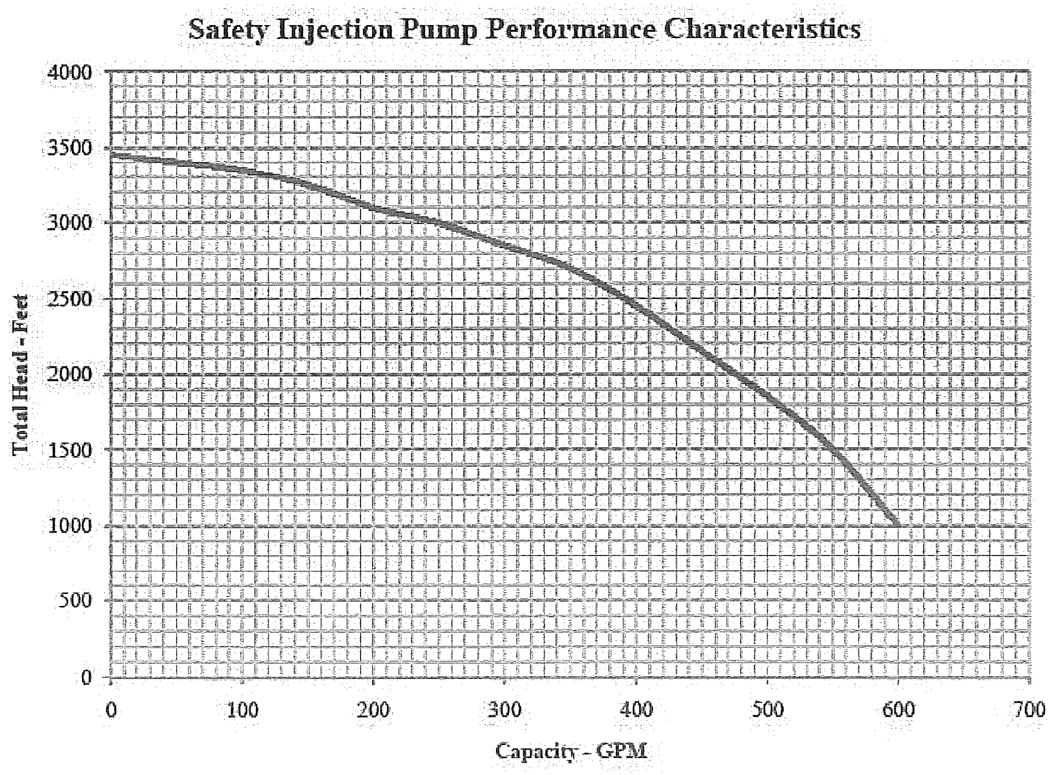
TURKEY POINT PLANT UNITS 3 & 4

CONTAINMENT POST LOCA RECIRCULATION
FIGURE 6.2-2



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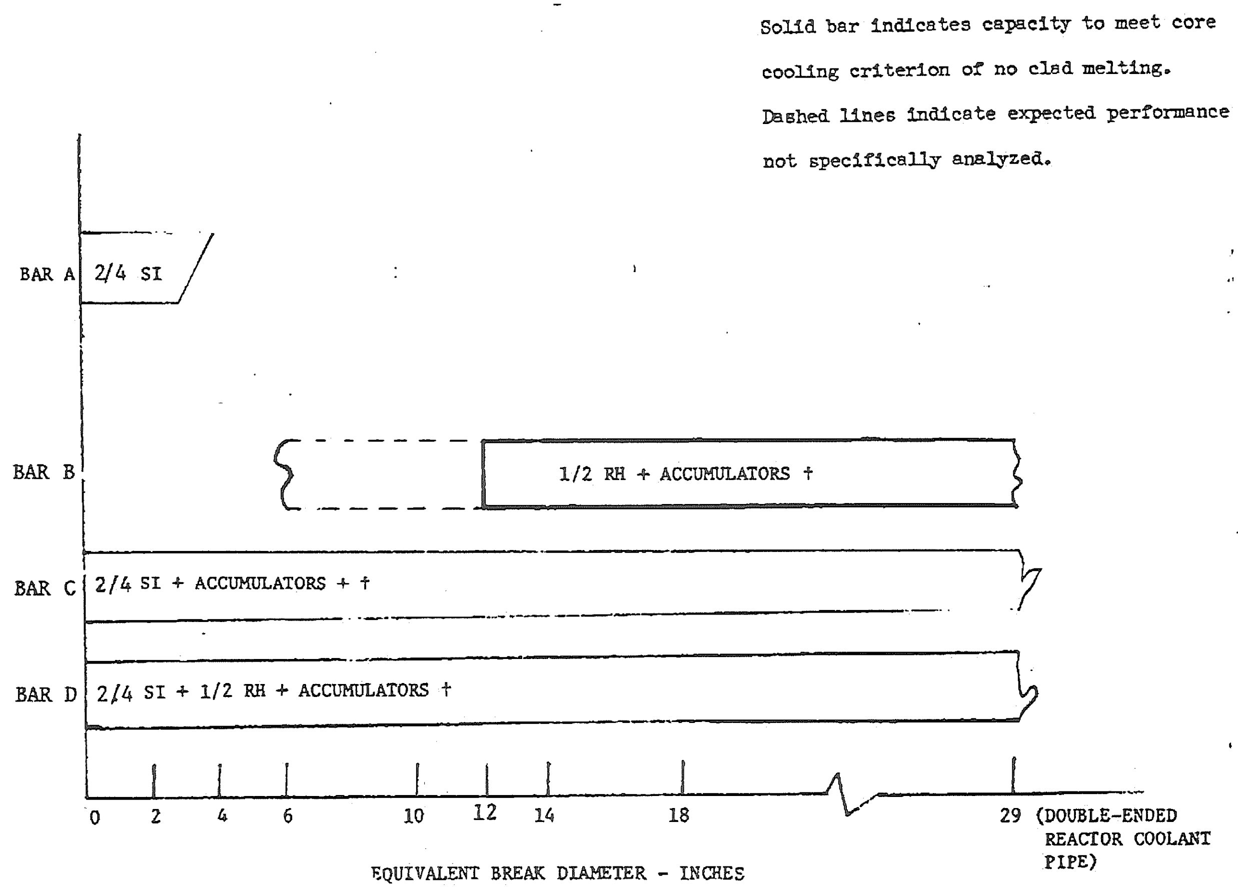
FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

SAFETY INJECTION PUMP
PERFORMANCE CHARACTERISTICS

FIGURE 6.2-3



NOTE: FOR ALL CASES ONE OF TWO RECIRCULATION PUMPS REQUIRED FOR RECIRCULATION

† NO CREDIT IS TAKEN FOR THE ACCUMULATOR WHICH IS ATTACHED TO THE RUPTURED LEG IN THE CASE OF A COLD LEGBREAK

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TURKEY POINT PLANT UNITS 3 & 4

RANGE OF PROTECTION BY SAFETY INJECTION STSTEM
FIGURE 6.2-4

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-5

REFER TO ENGINEERING DRAWING

5614-M-3050 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 4

RESIDUAL HEAT REMOVAL SYSTEM

FIGURE 6.2-5

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-6

REFER TO ENGINEERING DRAWING

5613-M-3062 , SHEET 1

REV. 13 (10/96)

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TURKEY POINT PLANT UNIT 3

SAFETY INJECTION SYSTEM

FIGURE 6.2-6

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-7

REFER TO ENGINEERING DRAWING

5613-M-3062 , SHEET 2

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

SAFETY INJECTION SYSTEM

FIGURE 6.2-7

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-8

REFER TO ENGINEERING DRAWING

5614-M-3062 , SHEET 1

REV. 13 (10/96)

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TURKEY POINT PLANT UNIT 4

SAFETY INJECTION SYSTEM

FIGURE 6.2-8

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-9

REFER TO ENGINEERING DRAWING

5614-M-3062 , SHEET 2

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TURKEY POINT PLANT UNIT 4

SAFETY INJECTION SYSTEM

FIGURE 6.2-9

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-10

REFER TO ENGINEERING DRAWING

5613-M-3064 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

SAFETY INJECTION
ACCUMULATOR SYSTEM
INSIDE CONTAINMENT
FIGURE 6.2-10

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-11

REFER TO ENGINEERING DRAWING

5614-M-3064 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 4

SAFETY INJECTION
ACCUMULATOR SYSTEM
INSIDE CONTAINMENT
FIGURE 6.2-11

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TURKEY POINT PLANT UNIT 4

CONTAINMENT SUMP STRAINER PIPING LAY-OUT

FIGURE 6.2-12

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FINAL SAFETY ANALYSIS REPORT

FIGURE 6.2-13

REFER TO ENGINEERING DRAWING

5613-M-157 , SHEET 1

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TURKEY POINT PLANT UNIT 3

CONTAINMENT SUMP STRAINER

PIPING LAY-OUT

FIGURE 6.2-13

6.3 EMERGENCY CONTAINMENT COOLING

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6.3.1 DESIGN BASIS

Containment Heat Removal Systems

Criterion: Where an active heat removal system is needed under accident conditions to prevent exceeding containment design pressure, this system shall perform its required function, assuming failure of any single active component. (GDC 52)

Adequate heat removal capability for the Containment is provided by two separate, engineered safety features systems. These are the Containment Spray System, whose components are described in Section 6.4 and the Emergency Containment Cooling System whose components operate as described in Section 6.3.2. Although these systems operate simultaneously during a MHA to keep the containment pressure from exceeding design pressure, each subsystem is provided with redundant equipment such that they can accomplish their safety function under any single active failure condition.

Performance Objectives

The Emergency Containment Cooling system is designed to provide the following engineered safeguard functions: C26

(a) Cooling System: Remove sufficient heat from the reactor containment following a MHA, coincident with the operation of the Containment Spray System (See Section 6.4), to keep the containment pressure from exceeding design pressure. The emergency fan cooling units continue to remove heat after the MHA and reduce the pressure to atmospheric. (See Fig. 6.3-1). Refer to Sect. 14.3.4 for heat removal capacity.

(b) Filtering System: The Emergency containment filtering system is no longer credited to reduce the iodine concentration in the containment atmosphere due to the implementation of the Alternative Source Term (AST) methodology for Turkey Point (Reference 1). The AST methodology implementation credits the use of sodium tetraborate decahydrate (NaTB) inside containment for post-LOCA containment sump fluid pH control and for post-LOCA iodine removal/retention in conjunction with containment spray system operation. Therefore, the emergency containment filtering system has been disconnected and abandoned in place. C26

Details of the site boundary and control room dose calculations are given in Section 14.3.5 for the MHA.

The housing of the emergency containment filtering systems have been abandoned in place after removal of the demisters, HEPA and charcoal filters. These housings contribute to the heat sink inventory in Unit 3 and Unit 4 containments, credited in the accident analysis with mitigating peak containment pressure and temperature, as described in UFSAR Section 14.3.4. C26

Portions of other systems which share functions and become part of this emergency containment cooling system when required, are designed to meet the criterion of this section. Any single active component failure in such systems will not degrade the heat removal capability of containment cooling. C26

Where supporting systems are located outside containment, the following features are incorporated in the design for operation under post accident conditions:

(a) Means for isolation of any section under malfunction or failure conditions (expected fault conditions).

(b) Means to detect and control radioactivity leakage into the environs, to the limits consistent with guidelines set forth in 10 CFR 50.67. C26

6.3.2 SYSTEM DESIGN

The systems are described in the flow diagrams, Section 9. The Emergency Containment Cooling System components and their supports meet the requirements for Class I structures. C26

Cooling System Characteristics

The Emergency Containment Cooling System, in each containment consists of three fan cooling units; each consisting of a motor, fan, bare tube cooling coil, instrumentation and controls. The units are located above the refueling floor, around the inside of each containment between the containment wall and the secondary compartment shield walls. The location of the three fan cooling units provides individual isolation and prevents recirculation between units.

Each fan is designed to provide 25,000 CFM at both the design condition of 283°F and 59 psig and the in-place testing condition at atmospheric pressure. The emergency cooling unit design pressure and temperature (59 psig/283 $^{\circ}$F) conservatively envelope the licensed containment design basis conditions of 55 psig and 283 $^{\circ}$F. The fans are of the directly driven vane-axial type (See Table 6.3-1).

The temperature of the component cooling water from each fan cooling unit is recorded in the control room. The total return water flow from all fan cooling units is indicated in the control room. Following a loss-of-coolant accident, the safety injection signal will automatically energize motor circuits to start the dedicated Train A and B emergency cooling fans. The third swing emergency containment cooling fan automatically starts in the event of a valve or fan failure in either of the other two emergency containment cooling units. This ensures that two emergency containment cooling units are available post accident. The third swing emergency containment cooling fan can also be manually started. These units are not normally in service during reactor operation.

The original design basis allowed all three emergency containment fans to start on a safety injection signal. With various postulated single active failures, two or three fans could operate. For the Thermal and Extended Power Uprate Projects, revised containment and component cooling water system thermal analyses were performed. The revised containment analyses have demonstrated that two emergency containment fan coolers and one train of Containment Spray are required for short-term accident mitigation. To ensure long-term containment post-accident conditions can be reduced to within applicable electrical equipment qualification bases, two emergency containment fan coolers and one train of Containment Spray are required at 24 hours. The revised analyses have demonstrated that significant operating margin can be gained if only two emergency containment fans operate. Based on these analyses, the Thermal Uprate Project modified the plant configuration such that only two of the three emergency containment fans can start on a safety injection signal. To maintain adequate long-term containment cooling capability, the third emergency containment fan is required to be available and will automatically start if there is a failure of one of the other units.

During the emergency operation the air-steam mixture is forced upward through the coils and discharged into the upper regions of the containment. The condensate will drain downward and out the bottom of the unit from whence it will flow by gravity through the floor drain system to the containment sump.

Filtering System Characteristics - DELETED C26

Redundancy Provisions

The cooling water requirements for three emergency fan cooling units can be supplied by any one of the component cooling water pumps. Component cooling water pumps will be automatically started as part of the emergency loading sequence on loss of normal A.C. power, coincident with a requirement for engineered safety features operation (safety injection signal).

The emergency containment cooling units are supplied by individual lines from the component cooling water loop. Each inlet line is provided with a power operated shut-off valve and a drain valve. Similarly, each discharge line from a cooler is provided with a power operated shut-off valve and bypass valve. This allows each cooler to be isolated individually for maintenance.

The cooling coils and water lines are completely closed inside the containment. No radioactive leakage is expected into these coils because there is no interface with the RCS, and the coolers operate with the component cooling water pressure greater than the containment pressure.

During normal operation, a minimal cooling water flow through the emergency fan cooling units is maintained. A bypass is provided around the full flow valve on the discharge line from each unit. The full flow valve opens automatically in the event that its associated fan starts. On loss of instrument air in Unit 3 an accumulator maintains air supply to the full flow valve for a short time, then it fails open. On a loss of instrument air the bypass valve fails closed. On Unit 4 the full flow valve will fail open upon a loss of instrument air and the bypass valve will fail closed. The full flow valve fails closed on a loss of power to its associated fan and the bypass valve fails open allowing only minimal bypass flow to be diverted to an inactive Emergency Containment Cooler.

Actuation Provisions

Receipt of safety injection signal will energize motor control circuits to start the dedicated Train A and B emergency fan cooling units. The swing emergency cooling fan shall start automatically following failure of a dedicated Train. C26

Overload protection for the fan motors is provided at the Motor Control Center by overcurrent trip devices in the motor starters. The fan motors can be operated from the control room, with one exception. The fan motors, power cables and control circuits for the Unit 3 and 4 emergency containment filter units 3V3A, 3V3B, 3V3C, 4V3A, 4V3B, 4V3C were disconnected and abandoned in place, and the control switches were removed from the control room. C26

Environmental Protection

The fan motor enclosures, electrical insulation and bearings are designed for operation during accident conditions, with one exception. The Unit 3 and 4 emergency filtering system is no longer required to operate during accident conditions. ECF units 3V3A, 3V3B, 3V3C, 4V3A, 4V3B, 4V3C and related SSCs and design features were disconnected, removed and/or abandoned in place. These ECs removed the demisters, HEPA and charcoal filters from the Unit 3 and 4 ECF units and isolated the ECF dousing lines from the Unit 3 and 4 containment spray system. The Unit 3 and 4 ECF units are no longer functional or credited with post LOCA iodine removal and retention. C26

6.3.3 DESIGN EVALUATION

Flow Tests and Analysis

Provisions have been included in the emergency cooling system to balance and adjust water flow to satisfy post-accident conditions.

Reliance on Interconnected Systems

The Operation of the Emergency Containment Cooling System is dependent on the following systems:

1. Component cooling water
2. Electrical System
3. Intake Cooling Water System

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The redundancy provisions of these systems are described in Sections 6, 8 and 9.

6.3.4 MINIMUM OPERATING CONDITIONS

Technical specifications establish limiting conditions regarding the operability of the Emergency Containment Cooling units when the reactor is critical.

6.3.5 TESTS AND INSPECTIONS

Inspection of Containment Pressure-Reducing Systems

Criterion: Design provisions shall be made to extent practical to facilitate the periodic physical inspection of all important components of the containment pressure-reducing systems, such as pumps, valves, spray nozzles, tanks and sumps. (GDC 58)

Design provisions are made to the extent practical to facilitate access for visual inspection of all important components of the Emergency Containment Cooling System.

The fan motors and the fan rotating assemblies are statically and dynamically tested for proper balance.

Testing of Containment Pressure-Reducing Systems Components

Criterion: The containment pressure-reducing systems shall be designed to the extent practical so that components, such as pumps and valves, can be tested periodically for operability and required functional performance. (GDC 59)

The Emergency Containment Cooling System is designed to the extent practical so that the components can be tested, after any component maintenance for operability and functional performance. Provisions for hydro-testing of the coils during shutdown are provided.

Testing of Operational Sequence of Containment Pressure-Reducing Systems

Criterion: A capability shall be provided to test initially under conditions as close to practical to the design and the full operational sequence that would bring the containment pressure-reducing systems into action including the transfer to alternate power sources. (GDC 61)

Means are provided to test initially to the extent practical the full operational sequence of the Emergency Containment Cooling System including transfer to alternate power sources.

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6.3.6 MOTORS FOR EMERGENCY CONTAINMENT FANS

General

These totally enclosed fan cooled motors will have a useful life of eighty years under the normal containment service conditions as demonstrated by the appropriate EQ documentation package (See Appendix 8A). Internal heaters will dispel moisture condensation when motor is idle, with one exception. The fan motors, power cables and control circuits for the Unit 3 and 4 emergency containment filter units 3V3A, 3V3A, 3V3B, 3V3C, 4V3A, 4V3b, 4V3c were disconnected and abandoned in place, and the control switches were removed from the control room. C31

Insulation

The insulation will be a special Class B suitable for MHA conditions. The insulation system is described in Table 6.3-2.

Bearings

The bearings will be specially selected, conservatively rated ball bearings with clearances, held to closer tolerances than standard bearings.

The lubricant will be a high temperature, radiation resistant grease listed in Table 6.3-2.

The bearing housing will be so constructed that a sudden pressure wave will in no way impair the lubrication or serviceability of the bearings.

Qualification of materials is stated in Section 6.7.

6.3.7 REFERENCES

1. Turkey Point Units 3 and 4 - Issuance of Amendments Regarding Alternative Source Term (Tac Nos. ME 1624 and ME 1625), Issued June 23, 2011, ML 110800666.

TABLE 6.3-1

EMERGENCY CONTAINMENT COOLING UNIT CHARACTERISTICS

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Component	(Each Unit) Design Characteristics	(Each Unit) Flow	Accident Arrangement		
Emergency Containment Cooling Units (3)	Remove heat at rate of 60 x 10^6 BTU/hr	25,000 cfm	2 operating, one on standby and automatically start if a failure occurs in another unit.		
			Type	Description	
Emergency Containment Cooling Coil one/ cooling Unit (3)	Remove 60 x 10^6 BTU/hr	2,000 GPM(1)	Bare staggered tube, admiralty metal; 150 psig design.	air/water inlet temp. 283°F/125°F	air/water outlet temp. 278°F/185°F

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NOTE:

1. 2,000 gpm - Continuous Operation
   3,200 gpm - 1 Month (Post-LOCA Recirculation Limit)
   3,600 gpm - 1 week
   5,000 gpm - 24 Hours (Initial Safety Injection)
   5,500 gpm -1 Hour

TABLE 6.3-2

EMERGENCY CONTAINMENT COOLER

FAN AND MOTOR DATA

Cooler Fan and Motor:

Fan:	Joy Manufacturing Company
	Series 2000 Axivane, 38" diameter
	Cast Steel Hub and Blades
Motor:	Reliance Electric Company
(Note 1)	30 hp., 1170 RPM, 460 VAC, 3Φ, 60 Hz, TEAO
Motor:	Baldor Electric Company
(Note 2)	30 hp., 1185 RPM, 460 VAC, 3Φ, 60 Hz, TEAO

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Filter Fan:

Motor Materials: (Abandoned in Place)

Insulation:	Type RN per EQ Doc Pac 16.0
Bearings:	Thrust and Radial Bearings: double shielded ball bearings held in place by a cast iron cartridge enclosure.
	Lubricant: Chevron SRI No. 2 grease, or as an alternate, Mobil Polyrex EM NLGI Grade 2

Note 1: For ECCF Motors 3/4 V30 B,C.

Note 2: For ECCF Motors 3/4 V30 A.

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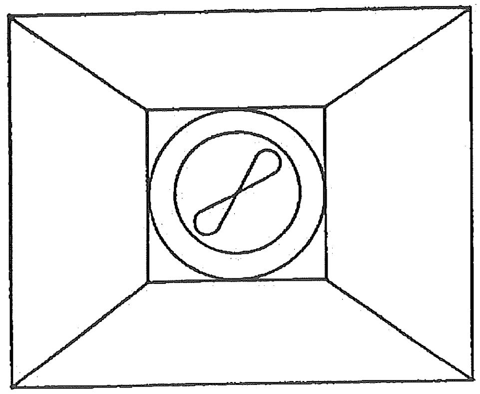

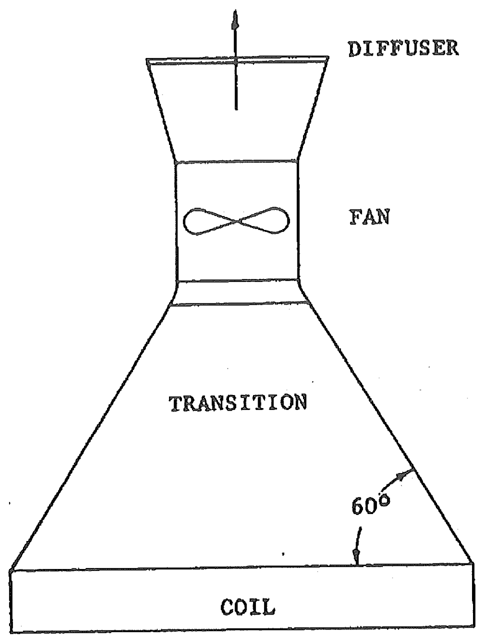

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TURKEY POINT PLANT UNITS 3&4

EMERGENCY CONTAINMENT COOLER

FIGURE 6.3-1

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TURKEY POINT PLANT UNITS 3 & 4

EMERGENCY CONTAINMENT FILTER

FIGURE 6.3-2

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FILTER SPRAY SYSTEM
FIGURE 6.3-3

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TURKEY POINT PLANT UNITS 3 & 4

PLAN OF CONTAINMENT LAYDOWN AND STORAGE AREA, EL 58'-0"

FIGURE 6.3-4

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TURKEY POINT PLANT UNITS 3 & 4

TYPICAL FILTER CELL

FIGURE 6.3-5

6.4 CONTAINMENT SPRAY SYSTEM

6.4.1 DESIGN BASES

Containment Heat Removal Systems

Criterion: Where an active heat removal system is needed under accident conditions to prevent exceeding containment design pressure, this system shall perform its required function, assuming failure of any single active component. (GDC 52)

Adequate containment heat removal capability for the Containment is provided by two separate, engineered safety feature systems. The Containment Spray System, whose components operate in the sequential modes described in 6.4.2, and the Emergency Containment Cooling and Filtering System which is discussed in Section 6.3.

The primary purpose of the Containment Spray System is to spray cool water into the containment atmosphere when appropriate in the event of a loss-of-coolant accident (LOCA) or main steam line break (MSLB). Operation of the Containment Spray System and the Emergency Containment Cooling System will ensure that containment pressure does not exceed its design value which is 55 psig at 283 °F (100% R.H.). This protection is afforded for all pipe break sizes up to and including the hypothetical instantaneous circumferential rupture of a reactor coolant pipe. Pressure and temperature transients for loss of coolant accident are presented in Section 14. Although the water in the core after a loss-of-coolant accident is quickly subcooled by the Safety Injection System, the Containment Spray System design is based on the conservative assumption that the core residual heat is released to the containment as steam. C26

The original design basis for containment heat removal considered simultaneous operation of one spray pump and 2 of 3 emergency containment coolers. The design basis relative to the emergency containment coolers was changed to provide significant component cooling water system operating margin at uprated conditions. For short-term accident mitigation, only 1 of 3 emergency containment coolers is required and long-term mitigation would require 2 of 3 emergency containment coolers. This is the basis for the containment pressure transient calculations in Section 14.

Inspection of Containment Pressure Reducing Systems

Criterion: Design provisions shall be made to the extent practical to facilitate the periodic physical inspection of all important components of the containment pressure reducing systems, such as pumps, valves, spray nozzles and sumps. (GDC 58)

Where practicable, all active components and passive components of the Containment Spray Systems are inspected periodically to assure system readiness. The pressure containing systems are inspected for leaks from pump seals, valve packing, flanged joints and safety valves. During operational testing of the containment spray pumps, the portions of the systems subjected to pump pressure are inspected for leaks. Design provisions for inspection of the Safety Injection System, which also function as part of the Containment Spray System, are described in Section 6.2.5.

Testing of Containment Pressure - Reducing Systems Components

Criterion: The containment pressure reducing systems shall be designed, to the extent practical so that active components, such as pumps and valves, can be tested periodically for operability and required functional performance (GDC 59).

All active components in the Containment Spray Systems are adequately tested both in pre-operational performance tests in the manufacturer's shop and in-place testing after installation. Thereafter, periodic tests are also performed after any component maintenance. Testing of the components of the Safety Injection System used for containment spray purposes are described in Section 6.2.5.

The component cooling water pumps and the intake cooling water pumps which supply the cooling water to the residual heat exchangers are in operation on a relatively continuous schedule during plant operation. Those pumps not running during normal operation may be tested by changing the operating pump(s).

Testing of Containment Spray Systems

Criterion: A capability shall be provided to the extent practical to test periodically the delivery capability of the containment spray system at a position as close to the spray nozzles as is practical. (1967 Proposed GDC 60)

Test lines (2-inch permanent for mini-flow, a permanent 6-inch for full flow for Unit 3 and Unit 4) for all the containment spray loops are located so that all components up to the containment isolation valves may be tested. The manual isolation valves are checked for leakage during local leak rate testing (LLRT).

The spray nozzles in containment are periodically verified to be unobstructed by verification of air flow by the use of thermography or other appropriate means.

The Containment Spray System piping up to the final isolation valve is maintained full of borated water at refueling water concentration while the reactor is in operation to ensure that the Containment Spray System can reliably perform its intended function. To address this, Generic Letter 2008-01 was issued to discuss the consequences of gas entrained in systems such as the Containment Spray System that could compromise their operability. In response to this, a Gas Accumulation Management Program (GAMP) was established at the Turkey Point Nuclear Units to provide long-term void management. Locations in the Containment Spray System in the pump discharge and suction piping up to the first closed discharge line isolation valve where gases could potentially accumulate are periodically monitored using ultrasonic testing and/or vented to verify the system is filled. From the results of this monitoring, the GAMP ensures that gas accumulated within the Containment Spray System is identified, evaluated, trended, and effectively controlled to prevent unacceptable degradation of performance of any structures, systems or components, ultimately to ensure system operability.

Filling and venting operations and periodic system operational and leakage tests are required to ensure that the Containment Spray System is not damaged from water-hammer loads that may result from pump flows into voided discharge lines. The system must be periodically verified full by venting the accessible discharge piping high points. The inaccessible discharge piping high points that may be susceptible to gas accumulation are deemed appropriate to proactively provide the capability to vent each of these locations and to allow for future monitoring and trending, if it becomes necessary.

Testing of Operational Sequence of Containment Pressure-Reducing Systems

Criterion: A capability shall be provided to test initially under conditions as close as practical to the design and the full operational sequence that would bring the containment pressure-reducing systems into action, including the transfer to alternate power sources. (1967 Proposed GDC 61)

Capability is provided to test initially to the extent practical the operational startup sequence beginning with transfer to alternate power sources and ending with near design conditions for the Containment Spray System, including the transfer to the alternate emergency diesel-generator power source.

Performance Objectives

The Containment Spray System was originally designed to spray at least 2900 gpm of borated water into the containment building whenever the coincidence of two out of three high and two out of three (high-high) containment pressure signals occurs or a manual signal is given. Either of two subsystems containing a pump and associated valving and spray headers are independently capable of delivering one-half of this flow or 1450 gpm. The current containment analysis models the spray flow as a function of containment pressure. For example, for the limiting case of the containment analysis, spray flow capability at 50 psig is 1293 gpm during injection phase and 1575 gpm during cold leg recirculation phase. C26

Inspection of Air Cleanup Systems

Criterion: Design provisions shall be made to the extent practical to facilitate physical inspection of all critical parts of containment air cleanup systems, such as ducts, filters, fans and dampers, (GDC 62) Access is available for visual inspection of Emergency Containment Filtering System components.

The NaTB Baskets shall be inspected to ensure there is no damage and that they can readily perform their safety related function of dispersing the NaTB for pH control.

Engineered Safety Features Components Capability C26

Criterion: Engineered safety features shall be designed so that the capability of these features to perform their required function is not impaired by the effects of a loss-of -coolant accident to the extent of causing undo risk to the health and safety of the public (1967 proposed GDC 42)

The NaTB Baskets are designed to disperse the NaTB readily once in contact with flood water. A loss-of-coolant accident would not affect the engineered safety features of the NaTB Baskets.

Accident Aggravation Prevention

Criterion: Protection against any action of the engineered safety features which would accentuate significantly the adverse after-effects of normal cooling shall be provided. (1967 proposed GDC 43).

C26

The NaTB Baskets disperse NaTB in the flood water raising the pH to the range of 7.0 to 8.048. This results in prevention of iodine generation, stress corrosion cracking in stainless steels and fuel scaling and debris generation due to aluminum.

The design basis is to provide sufficient heat removal capability, in conjunction with the Emergency Containment Cooling System, to maintain the post-accident containment pressure below the design pressure assuming that the core residual heat is released to the containment as steam. A further design basis is to remove sufficient containment heat to reduce the containment temperature within the time limits of the Environmental Qualification (EQ) curve. This requires a heat removal capacity of the subsystem, with either pump operating, at least equivalent to two fan-coolers heat removal capability at the containment design conditions.

The spray system is designed to operate over an extended time period, following a reactor coolant system failure to help restore and maintain containment conditions at near atmospheric pressure. It can accomplish its containment pressure reducing function (and consequent containment leakage reduction) under the most limiting single active failure condition.

Portions of other systems which share functions and become part of the containment cooling system when required are designed to meet the criteria of this section. Any single failure of active components in such systems does not degrade the heat removal capability of containment cooling.

Those portions of the spray systems located outside of the containment which are designed to circulate, under post-accident conditions, radioactively contaminated water collected in the containment meet the following requirements:

a) Adequate shielding to maintain radiation levels within the guidelines of 10 CFR 100 (Section 11.2).

b) Collection of discharges from pressure relieving devices into closed systems.

c) Means to limit radioactivity leakage to the environs, consistent with guidelines set forth in 10 CFR 100.

System active components are redundant. System piping located within the containment is redundant and separable in arrangement and is fully protected from damage which may follow any reactor coolant system failure.

System isolation valves relied upon to operate for containment cooling are redundant, with automatic actuation or manual actuation.

Service Life

All portions of the system located within containment are designed to withstand, without loss of functional performance, the post-accident containment environment and operate without benefit of maintenance for the duration of time to restore and maintain containment conditions at near atmospheric pressure.

The NaTB Baskets located in the containment sump will passively achieve a minimum pH of 7.0 at the onset of containment spray recirculation and will ensure that environmental qualification and chemical effects pH limits are not exceeded. The NaTB Baskets are located below the minimum post-LOCA flood height ensuring the NaTB is quickly and completely dissolved in the sump fluid. C26

Codes and Classifications

Table 6.4-1 tabulates the codes and standards to which the containment spray system components are designed.

6.4.2 SYSTEM DESIGN AND OPERATION

System Description

Post-accident containment heat removal is provided, in part, by the Containment Spray System shown in Figures 6.4-2 and 6.4-3 whose components operate in sequential modes. These modes are:

a) Spray a portion of the contents of the refueling water storage tank into the entire containment atmosphere using the containment spray pumps.

b) Recirculation of water from the containment sump is provided by the diversion of a portion of the recirculation flow from the discharge of the residual heat removal heat exchangers to the suction of the spray pumps after injection from the refueling water storage tank has been terminated.

The bases for the selection of the various conditions requiring system actuation is presented in Section 14.

The principal components of the Containment Spray System which provides containment cooling following a loss of coolant accident consists of two pumps, spray ring headers and nozzles, and the necessary piping and valves. The containment spray pumps are located in the Auxiliary Building and the spray pumps take suction directly from the refueling water storage tank.

The Containment Spray System also utilizes the two residual heat removal pumps, two residual heat exchangers and associated valves and piping of the Safety Injection System for the long term recirculation phase of containment cooling.

The spray system will be actuated by the coincidence of two out of three high and two out of three (high-high) containment pressure signals. This starting signal will start the pumps and open the discharge valves to the spray header. If required, the operator can manually actuate the system from the control room, and periodically, the operator will actuate system components to demonstrate operability.

The system design conditions were selected to be compatible with the design conditions for the low pressure injection system since both of these systems share the same suction line.

The NaTB Baskets located in the containment sump will passively achieve a minimum pH of 7.0 at the onset of containment spray recirculation and will ensure that environmental qualification and chemical effects pH limits are not exceeded. The NaTB Baskets are located below the minimum post-LOCA flood height ensuring the NaTB is quickly and completely dissolved in the sump fluid. C26

<u>Recirculation Phase</u>

Revised limiting containment integrity analyses assume one spray pump in operation for the duration of the event (injection and recirculation phases). The heat removal capacity of two of the three fan coolers operating in conjunction with one containment spray pump is sufficient to remove the corresponding energy addition to the vapor space resulting from steam boil o from the core assuming flow into the core from one residual heat removal pump at the beginning of recirculation without exceeding containment design pressure. C26

C26

Cooling Water

The cooling water for the residual heat exchangers has been described in Section 9.3.

Change-Over

The procedure for the changeover from injection to recirculation has been described in Section 6.2.

Remote operated valves of the Containment Spray System which are under manual control (that is, valves which normally are in their ready position and do not receive a containment spray signal) have their positions indicated on a common portion of the control board. At any time during operation when one of these valves is not in the ready position for injection, it is shown visually on the board.

Components

All associated components, piping, structures, and power supplies of the Containment Spray System are designed to Seismic Class I criteria.

The Containment Spray System shares the refueling water storage tank liquid capacity with the Safety Injection System. Refer to Section 6.2.2 for a detailed description of this tank.

Pumps

The two containment spray pumps are of the horizontal centrifugal type driven by electric motors. These motors can be powered from both normal and emergency power sources.

The design head of the pumps is sufficient to continue at rated capacity with a minimum level in the refueling water storage tank against a head equivalent to the sum of the design pressure of the containment, the head to the uppermost nozzles, and the line and the nozzle pressure losses. Pump motors are direct-coupled and large enough for the maximum power requirements of the pumps. The materials of construction are stainless steel or equivalent corrosion resistant material. Design parameters are presented in Table 6.4-2.

The original containment spray pumps are designed in accordance with the specifications discussed for the pumps in the Safety Injection System, Section 6.2.2. Spare containment spray pump pullout assemblies (a pullout assembly is the pump less the casing, coupling, and motor) are used interchangeably with the original pumps to enhance reliability and availability of the pumps. The spare assemblies are designed, fabricated and inspected to ASME Section III, Class 2 (less N stamp), 1980 Edition through Winter 1982 Addenda. All parts in contact with a boric acid solution are austenitic stainless steel type 304L or 316L. All pressure containment parts of the pullout assemblies are chemically and mechanically analyzed and the results are checked to ensure conformance with the applicable ASME specification. In addition, all pressure retaining part materials are nondestructively examined in accordance with the ASME Boiler & Pressure Vessel Code, 1980 Edition through Winter 1982 Addenda.

The pump motors are direct-coupled and non-overloading to the end of the pump curve.

Details of the component cooling pumps and intake cooling water pumps, which serve the Safety Injection System, are presented in Section 9.

Spray Nozzles

The spray nozzles, of the ramp bottom design, are not subject to clogging by particles less than 3/8 inch in maximum dimension, and are capable of producing a mean drop size of approximately 700 microns in diameter at a flow rate of 15.2 gpm @ 40 psid per nozzle. C26

During containment spray recirculation operation, the water is filtered through a series of strainer modules with 3/32 inch openings. The spray nozzles are bronze and have a 3/8 inch diameter orifice. The nozzles are connected to five straight parallel horizontal fingers on each header. There are 86 Spraco Model 1713 nozzles on each of two main headers located in Unit 4 containment and 86 nozzles in Unit 3’s North header and 85 nozzles in the South header.

The nozzles and headers are so oriented as to ensure adequate coverage of the containment volume.

Heat Exchangers

The two residual heat exchangers which are used during the recirculation phase are described in Section 6.2.2.

Valves

The valves for the Containment Spray System are designed in accordance to the specifications discussed for the valves in the Safety Injection System.

Valving descriptions and valve details are shown in Section 6.2.

Piping

The piping for the Containment Spray System is designed in accordance to the specifications discussed for the piping in the Safety Injection System (Section 6.2.2).

The pump suction piping is designed for 200 psig at 300 ^{o}F and discharge piping up to valves 3/4-891A/B is designed for 300 psig at 300 ^{o}F. The piping downstream of 3/4-891A/B is designed for 200 psig at 300 ^{o}F. C30

NaTB Baskets

The NaTB Baskets provide (1) a means of containing the NaTB, (2) a means of measuring the quality of NaTB, and (3) a means for the NaTB to dissolve and mix with the sump fluid. The pH buffering function provided by NaTB helps minimize the evolution of iodine and prevent stress corrosion cracking of stainless steels and will ensure that environmental qualification pH limits in Doc Pac 1001, Section 6.4 are not exceeded. Limiting the PH to the range of 7.0 to 8.048 is also critical in preventing fuel scaling and the generation of debris due to chemical reaction of the Carbon Steel (CS) and Aluminum and other containment materials such as insulation.

In order to bound any potential acidic material addition to the containment such as boric acid leaks, the chemical effects analysis for determining sump strainer debris loading and fuel scaling was done assuming an additional amount of NaTB was added to containment equal to a small basket. With the additional basket added, a pH value of 8.079 was determined for analysis purposes. Utilizing a pH of 8.079 bounds the maximum pH of 8.048 calculated using 10 baskets.

To support Alternate Source Term (AST), the location and storage geometry of the NaTB support the safety related function to provide pH buffering. Therefore, the basket screens and the basket frame which support these functions are Safety Related. The NaTB Baskets are seismically designed. In response to NRC RAI question 2 (L-2009-195) the baskets are designed to withstand Class III loads which will preclude interaction with Class I SSC's.

The Locations for the NaTB Baskets were chosen based on the following considerations:

- Distribution in containment to ensure contact with flooding.
- Avoid seismic interaction with safety related SSC's.
- Outside the area of influence for High Energy Line Breaks (HELB). C26
- Does not interfere with plant operations.
- At least 30 feet unobstructed distance from existing sump strainers.
- Not in containment Sump High Flow areas.

The following is a list of NaTB Basket critical attributes necessary to accomplish the component safety functions:

- All 4 Leveling feet must be on the containment floor. No casters should support basket.
- Basket bottom screens must be no greater than 4.5" off the floor for small baskets and 3.5" off the floor for large baskets.
- Baskets must be in their specified locations.
- Baskets must be filled with NaTB chemical to a level between the minimum fill bar and the top of the basket.
- Basket covers must be installed to prevent dissolving any of the NaTB caused by any potential spray from leaking system

<u>Motors for Pumps and Valves</u>

The motors for the Containment Spray System are designed in accordance to the specifications discussed for motors in the Safety Injection System. (Section 6.2.2)

Electrical Supply

Details of the normal and emergency power sources are presented in the discussion of the Electrical System, Section 8.

Environmental Protection

The spray headers are located outside and above the primary and secondary concrete shield. During operation a movable shield also provides missile protection for the area immediately above the reactor vessel. The spray headers are therefore protected from missiles originating within the shield.

All of the active components of the containment spray system are located outside the containment, and hence are not required to operate in the steam-air environment produced by the accident.

Material Compatibility

Parts of the system in contact with borated water, are stainless steel or an equivalent corrosion resistant material, except for the spray headers (and piping risers) which are carbon steel.

6.4.3 DESIGN EVALUATION

Range of Containment Protection

During the injection phase following the maximum loss-of-coolant accidents (i.e., during the time that the containment spray pumps take their suction from the refueling water storage tank) this system, in conjunction with two emergency containment fan coolers, provides the design heat removal capacity for the containment. After the injection phase, each train of the recirculation system provides sufficient cooled recirculated water to keep the core flooded as well as providing, if required, sufficient flow to the suction of the containment spray pumps to satisfy the Containment Spray System heat removal requirements. This applies for all reactor coolant pipe sizes up to and including the hypothetical instantaneous circumferential rupture of a reactor coolant pipe. Only one pumping train and one heat exchanger are required to operate for this capability at the earliest time recirculation is initiated.

For the MHA concurrent with limiting cooling system heat removal capability, continued operation of recirculation spray may be required during long-term recirculation to restore post-accident containment temperatures to pre-event conditions.

During the injection and recirculation phases the spray water is raised to the temperature of the containment in falling through the steam-air mixture. The minimum fall path of the droplets is approximately 70 ft. from the spray headers to the operating deck. The actual fall path is longer due to the trajectory of the droplets sprayed out from the header. Heat transfer calculations, based upon 700 micron droplets, show that thermal equilibrium is reached in a distance of approximately five feet. Thus, the spray water reaches essentially the saturation temperature. The model for spray droplet heat removal is discussed in Section 14.3.

In addition to heat removal, the spray system is effective in scrubbing fission products from the containment atmosphere. However, no credit is taken for absorption of iodine in the analysis of the hypothetical accident (Section 14.3).

System Response

The starting sequence of the containment spray pumps and their related emergency power equipment is designed so that delivery of the minimum required flow is reached within 60 seconds which is the delay assumed for the starting of emergency containment cooling (Section 14.3).

Single Failure Analysis

A failure analysis has been made on all active components of the system to show that the failure of any single active component will not prevent fulfilling the design function. This analysis is summarized in Table 6.4-3.

The analysis of the loss-of-coolant accident presented in Section 14 reflects the single failure analysis.

Reliance on Interconnected Systems

The Containment Spray System initially operates independently of other engineered safety features following a loss-of-coolant accident. For extended operation in the recirculation mode, water is supplied through the residual heat removal pumps. Spray pump cooling is supplied from the component cooling loop.

During the recirculation phase, the flow leaving the residual heat exchangers may be directed to the suction of the containment spray pumps and the high head safety injection pumps. The systems are designed, and administrative controls provided to assure adequate safety injection and containment spray flow in the recirculation phase is maintained without the need for manual flow adjustments.

The Containment Spray System operates in conjunction with the Emergency Containment Cooling System during both the injection and recirculation phases of a loss-of-coolant accident to provide the required heat removal capability.

Normal and emergency power supply requirements are discussed in Section 8.

6.4.4 INSPECTIONS AND TESTS

Inspection Capability

All components of the Containment Spray System can be inspected periodically to demonstrate system readiness.

On an 18 month interval, during operational testing of the containment spray pumps, the portions of the system subjected to pump pressure are inspected for leaks. This includes pump seals, valve packings, flanged joints and safety valves.

Component Testing

All active components in the Containment Spray System are tested both in preoperational performance tests in the manufacturer's shop and in-place testing after installation.

The containment spray pumps can be tested singly by opening the valve in the containment spray recirculation test line. Each pump, in turn, can be started by operator action and checked for flow establishment. The spray valves can be tested with the pumps shut down.

During these tests the equipment will be visually inspected for leaks. Leaking seals, packing, or flanges may be tightened to eliminate leakage or evaluated for continued service. Valves and pumps will be operated and inspected as appropriate after any maintenance to ensure proper operation.

The containment spray nozzle availability is tested by blowing air through the nozzles and observing the flow through the various nozzles in the containment by use of thermography or other appropriate means.

System Testing

Permanent test lines for all containment spray loops are located so that the system, up to the motor operated containment isolation valves, can be tested. Permanent test line (Unit 3 and Unit 4) provisions are provided for the containment spray pumps so that the system, up to the manual isolation valves (*891A/B), can be tested to full containment spray pump flow. The manual isolation valves and check valves can be checked separately for leakage during local leak rate testing (LLRT). C25

The spray nozzles in containment are periodically verified to be unobstructed by verification of air flow by the use of thermography or other appropriate means.

Operational Sequence Testing

The functional test of the Safety Injection System described in Section 6.2 demonstrates proper transfer to the emergency diesel generator power source in the event of loss of power. A test signal simulating the containment spray signal will be used to demonstrate operation of the spray system up to the manual isolation valves on the pump discharge line.

6.4.5 REFERENCES

1. NRC letter to FPL, dated September 20, 1991, Safety Evaluation of the Inservice Testing (IST) Program for Pumps and Valves - Turkey Point Plant Units 3 and 4.

2. Westinghouse Letter, 94-JB-UP-5285, dated September 1, 1994. (Attachment 4, Case 1)

3. Westinghouse Technical Report WCAP-17152, “Turkey Point Units 3 & 4 Extended Power Uprate Engineering Report,” August 2012. C26

TABLE 6.4-1

CONTAINMENT SPRAY SYSTEM-CODE REQUIREMENTS

Component	Code
Valves	USAS B16-5
Piping (including headers and spray nozzles)	USAS B31.1

TABLE 6.4-2

CONTAINMENT SPRAY PUMP DESIGN PARAMETERS

Quantity	2
Design pressure, discharge, psig	300
Design temperature, F	300
Design flow rate, gpm	1450
Design head, ft.	470
Shutoff head, ft.	617
Motor HP	250
Type	Horizontal- Centrifugal

TABLE 6.4-3

SINGLE FAILURE ANALYSIS - CONTAINMENT SPRAY SYSTEM

		Component	Malfunction	Comments and Consequences
A.		Spray Nozzles	Clogged	Large number of nozzles renders clogging of a significant number of nozzles as incredible.
B.		Pumps		
	1)	Containment Spray Pump	Fails to start	Two provided. Containment peak pressure evaluation based on one pump operation for the duration of the event. In addition, two fan coolers are operating for the remainder of the transient. C26
	2)	Residual Heat Removal Pump	Fails to start	Two provided. Evaluation based on operation of one pump and two out of three containment cooling fans operating during long-term recirculation phase.
	3)	Intake Cooling water Pump	Fails to start	Three provided. operation of one pump during recirculation required.
	4)	Component Cooling	Fails to start	Three provided. Operation of one pump during recirculation required.
C.		Automatically operated Valves: (open on coincidence of 2/3 [Hi-Hi] containment pressure signals)		
	1)	Containment spray pump discharge isolation valve	Fails to open	Two provided. operation of one required.

TABLE 6.4-3

SINGLE FAILURE ANALYSIS - CONTAINMENT SPRAY SYSTEM

	Component	Malfunction	Comments and Consequences
D.	Valves Operated From Control Room		
1)	Containment sump recirculation isolation	Fails to open	Two lines in parallel, each with two valves in series. One line required.
2)	Containment spray header isolation valve from heat exchangers residual	Fails to open	Two valves provided. Operation of one required.
3)	Residual heat removal pump suction line	Fails to open	Two valves in series, one required to close.

TABLE 6.4-4

SODIUM TETRABORATE DECAHYDRATE (NaTB) BASKET DESIGN PARAMETERS

Quantity	2 Large 8 Small
Minimum total amount of NaTB	11061 lbm
Maximum total amount of NaTB	14264 lbm
Bulk density of NaTB	48.82 lbm/ft^3 to 54.13 lbm/ft^3
Small Size	3.0’ x 3.0’ x 2.5’
Large Size	4.5’ x 4.5’ x 2.7’
Materials of Construction	Stainless Steel
Screen Mesh size (same for each size)	Course - 4 Mesh - 0.047” wire cloth Small - 100 Mesh - 0.0045” wire cloth
Location	Elevation 14 ft. in containment
Maximum Height of Bottom Screen	Large Basket 3.5 in. off floor Small Basket 4.5 in. off floor

C26

Design Features:

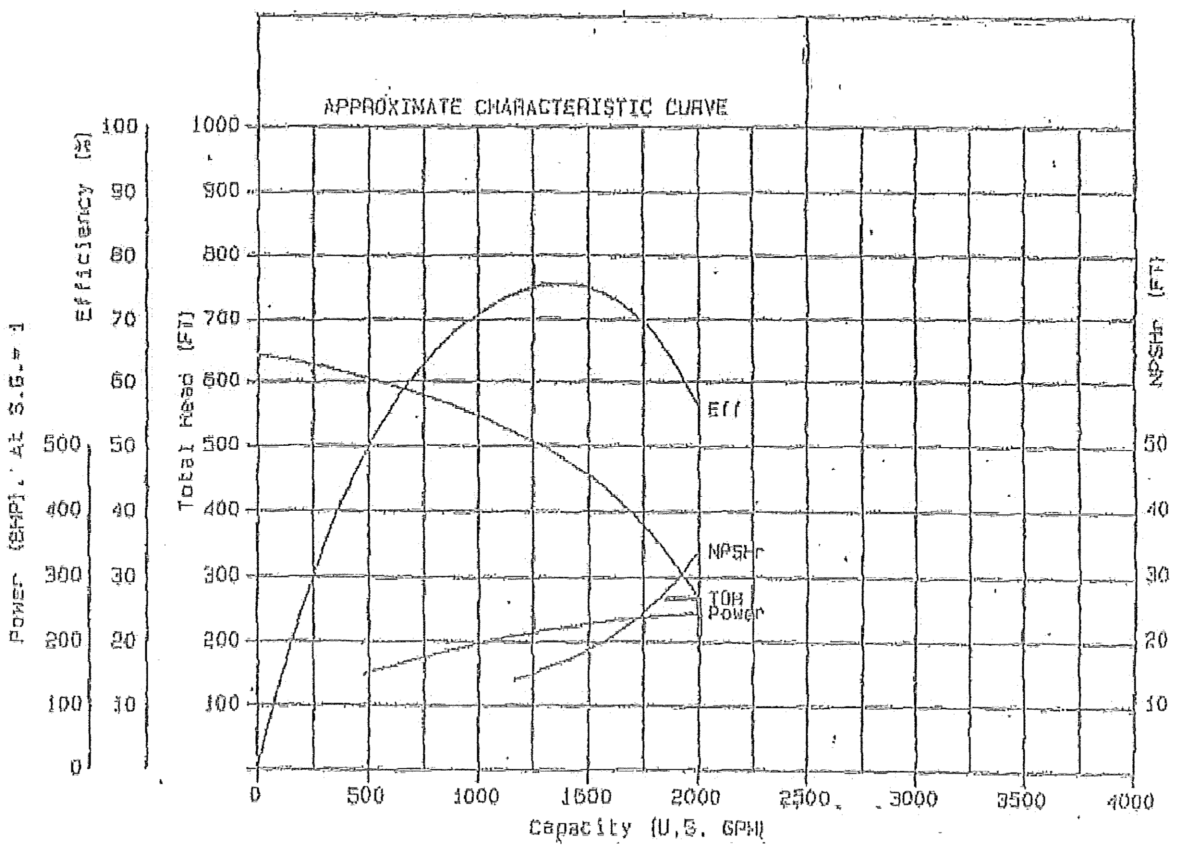
1. Basket side and bottom panels are provided with an outer coarse stainless steel mesh screen providing support for a fine inner mesh screen minimizing any leakage for material. Screen ensures that NaTB is quickly and completely dissolved in the sump fluid.

2. Top of baskets are located below minimum Post-LOCA sump water level.

3. Baskets have adjustable legs providing bottom surface area for dissolution, protect NaTB from spills and provide adjustment for uneven floor.

4. Baskets are provided with stainless steel cover equipped with drip edge to prevent inadvertent dissolution of NaTB from spill and condensation.

5. The Baskets are freestanding structures and will not interact with walls or any SSCs.



The Curve represents minimum expected performance for replacement parts, and lbr the originally supplied units at the rating point.

Note:
Only one curve is available for four pumps. Installed serial numbers are:

4B	217B871.3	3B	217B871.2
4A	217B871.4	3A	217B871.2

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Revised 04/17/2013

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3&4

CONTAINMENT SPRAY PUMP
PERFORMANCE CHARACTERISTICS

FIGURE 6.4-1

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.4-2

REFER TO ENGINEERING DRAWING

5613-M-3068 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 3

CONTAINMENT SPRAY SYSTEM

FIGURE 6.4-2

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.4-3

REFER TO ENGINEERING DRAWING

5614-M-3068 , SHEET 1

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNIT 4

CONTAINMENT SPRAY SYSTEM

FIGURE 6.4-3

6.5 LEAKAGE DETECTION AND PROVISIONS FOR THE REACTOR AND AUXILIARY COOLANT LOOP

6.5.1 LEAKAGE DETECTION SYSTEMS

The leakage detection systems reveal the presence of significant leakage from the reactor and auxiliary coolant loops.

DESIGN BASES

Monitoring Reactor Coolant Leakage

Criterion: Means shall be provided to detect significant uncontrolled leakage from the reactor coolant pressure boundary. (GDC 16)

Positive indications in the control room of leakage of coolant from the Reactor Coolant System to the containment are provided by equipment which permits continuous monitoring of containment air activity. This equipment provides indication of normal background which is indicative of a basic level of leakage from primary systems and components. Any increase in the observed parameters is an indication of change within the containment, and the equipment provided is capable of monitoring this change. The basic design criterion is the detection of deviations from normal containment environmental conditions including air particulate activity, radiogas activity, and in addition, in the case of gross leakage, the liquid inventory in the process systems and containment sump.

Monitoring Radioactivity Releases

Criterion: Means shall be provided for monitoring the containment atmosphere and the facility effluent discharge paths for radioactivity released from normal operations, from anticipated transients, and from accident conditions. An environmental monitoring program shall be maintained to confirm that radioactivity releases to the environs of the plant have not been excessive. (GDC 17)

The containment atmosphere, the ventilation exhausts from the Auxiliary Building, the component cooling loop liquid, the steam generator blowdown and the condenser air ejector exhaust are monitored for radioactivity concentration.

Principles of Design

The principles for design of the leakage detection systems can be summarized as follows:

1. Increased leakage could occur as the result of failure of pump seals, valve packing glands, flange gaskets or instrument connections. The maximum leakage rate calculated for these types of failures is 50 gpm which would be the anticipated flow rate of water through the pump seal if the seal failed and the area between the shaft and housing were completely open.

2. The leakage detection systems shall not produce spurious annunciation from normal expected leakage rates but shall annunciate increasing leakage.

3. Increasing activity level shall be annunciated in the control room. Operator action will be required to isolate the leak in the offending system.

SYSTEMS DESIGN AND OPERATION

Various methods are used to detect leakage from either the reactor coolant or the auxiliary system. Although described to some extent under each system description, all methods are included here for completeness.

Reactor Coolant System

During normal operation and anticipated reactor transients the following methods are employed to detect leakage from the Reactor Coolant System. At least one leakage detection system with a sensitivity capable of detecting a 1 gpm leak in 4 hours must be operable (References 1 and 2). The sensitivities of the containment air particulate monitors and containment radioactive gas monitors have been demonstrated to meet the design and licensing bases requirements applicable to Turkey Point for Reactor Coolant System Leakage detection systems (Reference 3). C26

Containment Air Particulate Monitor

This channel takes continuous air samples from the containment atmosphere and measures the air particulate radioactivity. The samples, drawn outside the containment, are in a closed, sealed system and are monitored by a scintillation counter-filter paper detector assembly. The filter paper collects all particulate matter greater than 1 micron in size on its constantly moving surface, which is viewed by a hermetically sealed scintillation-photomultiplier combination. After passing through the gas monitor, the samples are returned to the containment.

The filter paper has a 25-day minimum supply at normal speed. The filter paper mechanism, an electromagnetic assembly which controls the filter paper movement, is provided as an integral part of the detector unit.

The detector assembly is in a completely closed housing. The detector output is amplified by a preamplifier and transmitted to the Radiation Monitoring System cabinet. Lead shielding is provided to reduce the background radiation level to where it does not interfere with the detector's sensitivity.

The activity is indicated on numerical displays and recorded by a multipoint recorder. High-activity alarm indications are displayed on the Radiation Monitoring cabinets. Local alarms provide operational status of supporting equipment such as pumps, motors and flow and pressure controllers.

The containment air particulate monitor is the most sensitive instrument of those available for detection of reactor coolant leakage into the containment. This instrument must be capable of detecting particulate activity in concentrations as low as 10^{-9} uc/cc of (micro curies per cubic centimeter) containment air. The minimum required measuring range is 10^{-9} to 10^{-6} uc/cc. The range of the instrument provided is approximately 10^{-11} to 10^{-5} uc/cc (CO^{60}).

The sensitivity of the air particulate monitor to an increase in reactor coolant leak rate is dependent upon the magnitude of the normal baseline leakage into the containment. The sensitivity is greatest where base-line leakage is low as has been demonstrated by the experience of Indian Point Unit No. 1, Yankee Rowe and Dresden Unit 1. Where containment air particulate activity is below the threshold of detectability, operation of the monitor with stationary filter paper would increase leak sensitivity to a few cubic centimeters per minute. Assuming a low background of containment air particulate radioactivity, a reactor coolant corrosion product radioactivity (Fe, Mn, Co, Cr) of 0.2 uc/cc (a value consistent with little or no fuel cladding leakage), and complete dispersion of the leaking radioactive solids into the containment air, the air particulate monitor is capable of detecting leaks as small as approximately 0.013 gpm (50 cc/minute) within twenty minutes after they occur. If only ten percent of the particulate activity is actually dispersed in the air, leakage rates of the order of 0.13 gpm (500 cc/minute) are well within the detectable range.

For cases where base-line reactor coolant falls within the detectable limits of the air particulate monitor, the instrument can be adjusted to alarm on leakage increases from two to five times the base-line value.

The containment air particulate monitor together with the other radiation monitors mentioned in this Section are further described in Section 11.2.

Containment Radioactive Gas Monitor

This channel measures the gaseous beta radioactivity in the containment by taking the continuous air samples from the containment atmosphere, after they pass through the air particulate monitors, and drawing the samples through a closed, sealed system to a gas monitor assembly. C23

Each sample is constantly mixed in the fixed, shielded volume, where it is viewed by a beta sensitive scintillation photomultiplier combination detector. The sample is then returned to the containment.

The detector is in a completely enclosed housing containing a beta sensitive scintillating detector mounted in a constant gas volume container. Lead shielding is provided to reduce the background radiation level to a point where it does not interfere with the detector's sensitivity. A preamplifier and impedance matching circuit are mounted at the detector.

The detector outputs are transmitted to the Radiation Monitoring System cabinets. The activity is indicated by numerical displays and recorded by a multipoint recorder. High-activity alarm indications are displayed on the control board annunciator in addition to the Radiation Monitoring System cabinets. Local alarms annunciate the supporting equipments' operational status.

The containment radioactive gas monitor is inherently less sensitive (required threshold at 10^{-6} uc/cc) than the containment air particulate monitor, and would function in the event that significant reactor coolant gaseous activity exists from fuel cladding defects. The minimum required measuring range is 10^{-6} to 10^{-3} uc/cc. Assuming a reactor coolant activity of 0.3 uc/cc, the occurrence of a leak of two to four gpm would double the zero leakage background in less than an hour's time. In these circumstances this instrument is a useful backup to the air particulate monitor. The range of the detector provided is approximately 10^{-7} uc/cc to 10^{-1} uc/cc (Xe^{133}).

The containment air particulate and radioactive gas monitors have assemblies that are common to both channels. They are described as follows:

i) The flow assembly includes a pump unit and selector valves that provide a representative sample (or a "clean" sample) to the detector.

ii) The pump unit consists of:

1. A pump to obtain the air sample.
2. A flowmeter to indicate the flow rate.
3. A flow control valve to provide flow adjustment.
4. A flow alarm assembly to provide low and high flow alarm signals.

iii) Selector valves are used to direct the desired sample to the detector for monitoring and to allow flow when the channel is in maintenance or "purging" condition.

iv) A temperature sensor and pressure sensor are used to protect the system from high sample stream temperatures and pressures. The output of either sensor is capable of isolating sample flow.

v) Purging is accomplished with a valve control arrangement whereby the normal sample flow is blocked and the detector purged with a "clean" sample. This facilitates detector calibration by establishing the background level and aids in verifying sample activity level.

vi) The mass flow transmitter produces an analog signal based on sample stream flow. The microprocessor automatically regulates sample flow using the flow transmitter output signal as input to adjust the flow control valve. Visual indicators show sample flow rate, inlet vacuum, and sample pressure.

vii) A sample flow rate indicator is calibrated form 0 to 6.90 scfm.

Alarm lights are actuated by the following:

1. Flow alarm assembly (low and high flow)
2. The pressure/temperature sensor assembly (high pressure/temperature)
3. The filter paper sensor (paper drive malfunction)
4. Failure of any microprocessor controlled self test

Component Cooling Liquid Monitors

These channels continuously monitor the component cooling loops of the Auxiliary Coolant System for activity indicative of a leak of reactor coolant from either the Reactor Coolant System, the recirculation loop, or the residual heat removal loop of the Auxiliary Coolant System. A scintillation counter is located in an in-line well in each component cooling pump suction header. Each detector assembly output is amplified by a preamplifier and transmitted to the Radiation Monitoring System cabinets in the control room. The activity is indicated on a meter and recorded by a multipoint recorder. High-activity alarm indications are displayed on the control board annunciator in addition to the Radiation Monitoring System cabinets.

The measuring range of each monitor is 10.0 to 10^6 cpm.

Reactor Vessel Head Leakage Detection System

A sampling skid located in containment is capable of sampling and analyzing each CRDM Cooler Ventilation discharge and the containment atmosphere on an as-needed basis. The output from the analyzer is transmitted to the monitoring cabinet (3C367) located in the computer room. The monitoring cabinet is common to both units. An increasing trend in CRDM discharge radioactivity levels over containment background radioactivity levels indicates a Reactor Vessel Head Leak. The monitoring cabinet also contains sample pump controls, sample valve status, and air filter unit control.

Condenser Air Ejector Gas Monitors R-*-15, RAD-6304 C31

R-*-15 monitors the discharge from the Steam Jet Air Ejector exhaust header for gaseous radiation which is indicative of a primary to secondary system leak. R-*-15 uses an inline beta scintillator to monitor a fixed volume sufficiently shielded to prevent background radiation from reducing maximum sensitivity. R-*-15 has a range of 1.0E-07 to 1.0E-01 uCi/cc for Kr-85. The effluent is routed to the atmosphere.

The R-*-15 detector output is transmitted to the Radiation Monitoring System cabinets in the control room. The activity is indicated by a meter and recorded by a multipoint recorder. High-activity alarm indications are displayed on the control board annunciator in addition to the Radiation Monitoring cabinets.

The Steam Jet Air Ejector effluent is also monitored by plant vent radiation Monitor RAD-6304 SPINGs, which use a beta scintillation counter for low range C31 noble gas and energy- compensated G-M detectors for medium and high range noble gas. SPINGs comply with Regulatory Guide 1.97 on high-range monitoring in response to post Three Mile Island initiatives. RAD-6304 has a range from C31 1.0E-07 to 1.0E+05 uCi/cc for Xe-133.

Steam Generator Liquid Sample Monitor

This channel monitors the liquid phase of the secondary side of the steam generator for radiation, which would indicate a primary-to-secondary system leak, providing backup information to that of the condenser air ejector gas monitor. Samples from the bottom of each of the three steam generators are mixed to a common header and the common sample is continuously monitored by a scintillation counter and holdup tank assembly. Upon indication of a high-radiation level (R-19), blowdown is automatically isolated. Each steam generator is then manually sampled in order to determine the source of the activity. This sampling sequence is achieved by manually obtaining steam generator liquid samples at the primary sample sink for laboratory analysis after allowing sufficient time for sample equilibrium to be established.

A remote indicator panel, mounted at the detector location, indicates the radiation level and high-radiation alarm.

The measuring range of this monitor is 10.0 to 10^6 cpm.

A photomultiplier tube - scintillation crystal (NaI) combination, mounted in a hermetically sealed unit, is used to monitor liquid effluent activity. Lead shielding is provided to reduce the background level so it does not interfere with the detector's maximum sensitivity. The in-line, fixed-volume container is an integral part of the detector unit.

During cold shutdown personnel can enter the containment and make a visual inspection for leaks. The location of any leak in the Reactor Coolant System would be determined by the presence of boric acid crystals near the leak. The leaking fluid transfers the boric acid crystals outside the Reactor Coolant System and the process of evaporation leaves them behind.

If an accident involving gross leakage from the Reactor Coolant System occurred it could be detected by the following methods.

Pump Activity

During normal operation only one charging pump is operating. If a gross loss of reactor coolant to another closed system occurred which was not detected by the methods previously described, the speed of the charging pump would indicate the leakage.

The leakage from the reactor coolant will cause a decrease in the pressurizer liquid level that is within the sensitivity range of the pressurizer level indicator. The speed of the charging pump will automatically increase to try to maintain pressurizer programmed level. If the pump reaches a high speed limit, an alarm is actuated.

A break in the primary system would result in reactor coolant flowing into the containment sump. Gross leakage to this sump would be indicated by the frequency of operation of the containment sump pumps and by indication on the containment sump level recorder.

Liquid Inventory

Gross leaks might be detected by unscheduled increases in the amount of reactor coolant makeup water which is required to maintain the normal level in the pressurizer. This is inherently a low precision measurement, since makeup water is necessary as well for leaks from systems outside the containment.

A large tube side to shell side leak in the non-regenerative (letdown) heat exchanger would result in reactor coolant flowing into the component cooling water and a rise in the liquid level in the component cooling water head tank. The operator would be alerted by a high water alarm for the head tank and high radiation and temperature alarms actuated by monitors at the component cooling water pump suction header.

A high level alarm for the component cooling water head tank and high radiation and temperature alarms actuated by monitors at the component cooling pump suction header could also indicate a thermal barrier cooling coil rupture in a reactor coolant pump. However, in addition to these alarms, high temperature and high flow on the component cooling outlet line from the pump would activate alarms. In the event of a thermal barrier rupture, high flow as sensed by FIC-626 will normally close MOV-*-626, which will terminate leakage into the CCW system.

Gross leakage might also be indicated by a rise in the normal containment sump level. High level in this sump will actuate an alarm.

<u>Residual Heat Removal Loop</u>

The residual heat removal loop removes residual and sensible heat from the core and reduces the temperature of the Reactor Coolant System during the second phase of shutdown.

Leakage from the residual heat removal loop during normal operation would be detected by the component cooling loop radiation monitor (see analysis of detection of leakage from the Reactor Coolant System in this section).

The physical layout of the two residual heat removal pumps will be within separate shielded and isolated rooms outside of the containment. This will permit the detection of a leaking residual heat removal pump by means of the radiation monitor located in the plant vent. Supplemental radiation monitoring will be provided by the plant vent gas monitoring system. Alarms in the control room will alert the operator when the activity exceeds a preset level. Small leaks to the environment could be detected with these systems within a short time after they occurred.

Should a large tube side to shell side leak develop in a residual heat exchanger or the seal water heat exchanger of a residual heat removal pump, the water level in the component cooling water head tank would change, rising or falling dependent upon specific operating conditions of the interfacing systems. The operator would be alerted by a high or low water level alarm. The high water level alarm would also isolate RCV-*-609 to prevent uncontrolled overflow into the Waste Holdup Tank (WHT). Maximum CCW system pressure would then be controlled by RV-*-707, which would relieve to the WHT, as required. Radiation and temperature monitors at the component cooling water pump suction header may also signal an alarm.

Leakage from the residual heat removal pumps is drained to separate sumps equipped with a sump pump. The failure of either sump pump or leakage greater than sump pump capacity will be indicated by annunciation in the control room as a means of detection of gross leakage, i.e., a seal failure, from a residual heat removal pump.

<u>Component Cooling Loop</u>

Leakage from the component cooling loop inside the reactor containment will be detected by level change in the containment sump or by decrease in component cooling water head tank level via low level alarm.

Visual inspection inside the containment is possible during cold shutdown.

Gross leakage from the component cooling loop would be indicated inside the containment by a rise in the liquid level of the containment sump. This sump has a high level recorder and a high level alarm.

If the leakage is from a part of the component cooling loop outside the containment, it would be detected by a drop in the head tank level below the low level alarm setpoint and confirmed by the level in the sight glass installed on the affected tank. If an external leak occurs in an area provided with sump pumps which have control room indication for their operation, the leak can be located by the indication of the associated sump pump operation; otherwise the leak will be located by visual inspection of the system. For an internal leak, e.g., from the CCW to any other system, the leak may be located by sequential isolation of inspection of equipment in the affected loop.

The Reactor Vessel Head Area Leakage Detection System supplements the monitoring performed via primary side monitoring systems and containment area radiation monitoring to provide detection of any leaks in the area of the reactor head.

The system monitors samples drawn from the CRDM cooler discharge as well as from the containment atmosphere for a reference. The system is designed to detect small RCS leaks by monitoring particulate radiation levels in the reactor vessel head area by means of these samples.

It includes a sampling skid located within the containment and a remote control and display rack in the computer room. The sample pump delivers a sample through a slow moving filter set-up. Particulates emitted are trapped on the filter paper and are monitored by a beta scintillation detector. The beta detector provides a digital signal to the Universal Digital Ratemeter located inside in the remote control and display rack in the computer room.

6.5.2 LEAKAGE PROVISIONS

Provisions are made for the isolation or containment of any leakage.

DESIGN BASIS

The design provisions prevent uncontrolled leakage of reactor coolant or auxiliary cooling water. This is accomplished by (1) isolation of the leak by valves, (2) designing relief valves to accept the maximum flow rate of water from the worst possible leak, (3) supplying redundant equipment which allows a standby component to be placed in operation while the leaking component is repaired and (4) routing the leakage to various sumps and holdup tanks.

DESIGN AND OPERATION

Various provisions for leakage avert uncontrolled leakage from the reactor and auxiliary coolant loops.

Reactor Coolant System

When significant leakage from the Reactor Coolant System is detected, action is taken to prevent the release of radioactivity to the atmosphere outside the containment.

If either the containment air particulate beta activity or the radioactive gas activity exceed pre-set levels on the containment air particulate and radioactive gas monitors, respectively, the containment purge supply and exhaust duct valves and instrument air bleed valves are closed. C23

A high radiation alarm actuated by the steam generator liquid sample monitor initiates closure of the isolation valves in the blowdown lines and sample lines.

If the component cooling loop radiation monitor signals a high radiation alarm, the valve in the component cooling water head tank vent line automatically closes to prevent gaseous activity release.

If a leak from the Reactor Coolant System to the component cooling loop was a gross leak or if the leak could not be isolated from the component cooling loop before the inflow completely filled head tank, the relief valve on the surge tank would lift. The discharge from this valve is routed to the waste holdup tank in the Auxiliary Building.

A large leak in the Reactor Coolant System pressure boundary, which does not flow into another closed loop, would result in reactor coolant flowing into the containment sump.

Residual Heat Removal Loop

High containment air particulate beta activity or high radioactive gas activity will result in an alarm being activated by either the containment air particulate or radioactive gas monitors, respectively. The containment purge supply and exhaust duct valves and pressure relief line valves are closed. This prevents the release of radioactivity to the atmosphere outside the containment. C23

If leakage from the residual heat removal loop into the component cooling loop occurs, the component cooling radiation monitor will actuate an alarm and the valve in the component cooling water head tank vent line is automatically closed to prevent gaseous radioactivity release. If the leaking component (i.e. , a residual heat exchanger) could not be isolated from the component cooling loop before the inflow completely filled the head tank, the relief valve on the surge tank would lift and the effluent would be discharged to the auxiliary building waste holdup tank.

Gross leakage from the section of the residual heat removal loop inside the containment, which does not flow into another closed loop, would result in reactor coolant flowing into the containment sump.

Other leakage provisions for the residual heat removal loop are discussed is Section 9.3.

Component Cooling Loop

Gross leakage from the section of the component cooling loop inside the containment which does not flow into another closed loop will flow into the containment sump. Outside the containment major leakage would be drained to the auxiliary building sump. From here it is pumped to the waste holdup tank. The location of the CCW head tank and associated piping prevents the auxiliary building drain system from collecting any leakage from this portion of the CCW system. Leakage from that tank would not be captured; however, the capacity of the head tank is limited (300 gal) and would not constitute a major source of leakage.

Other provisions made for leakage from the component cooling loop are discussed in Section 9.3.

6.5.3 References

1. FPL Letter L-88-481, "Application of Leak Before Break Technology to Primary Coolant System Piping", dated November 1, 1988.

2. NRC Letter dated November 28, 1988, "Turkey Point Units 3 and 4 Generic Letter 84-04, Asymmetric LOCA Loads".

3. Calculation PTN-BFJN-96-001, "Calculation Related to R-11/R-12 response Time to a 1 GPM Reactor coolant System Leak," Revision 0, 10/17/1996. C26

6.6 CONTAINMENT ISOLATION

6.6.1 DESIGN BASIS

System piping that penetrates the containment leakage limiting boundary is designed to maintain or establish isolation of the containment from the outside environment under the following postulated conditions:

(a) Any accident for which isolation is required and,

(b) A coincident independent single failure or malfunction (expected fault condition) occurring in any active system component within the isolated bounds.

The following General Design Criteria (GDC) must be satisfied by the containment penetrations:

Criterion: "Penetrations that require closure for the containment functions shall be protected by redundant valving and associated apparatus." (1967 Proposed GDC 53)

Following the events at Three Mile Island, this criterion was provided with the added clarification that the redundant barriers must not require operator action in order to effect isolation.

Piping penetrating the containment was designed for pressures at least equal to the containment design pressure. Isolation capability for fluid system lines penetrating the containment generally involves at least two redundant barriers against leakage of radioactive fluids to the outside environment. Such releases might be due to rupture of a line within the containment concurrent with a LOCA, or due to rupture of a line within the containment which connects to a source of radioactive fluid within the containment.

These barriers, in the form of isolation valves or closed systems, are defined on an individual penetration basis. In addition to satisfying the following containment isolation criteria, valving is designed to facilitate normal operation and maintenance of the systems and to ensure reliable operation of other engineered safeguards systems. Table 6.6-1 identifies the barriers for each penetration. Normally open manual valves which may be in the penetration pressure boundary are not isolation barriers. Vents, drains and test connections are considered to be extensions of the penetration pressure boundary and are administratively controlled. Valves in these lines are not considered containment isolation valves, and they have not been included in the table.

6.6.2 SYSTEM DESIGN

NUREG 0578 established the penetration classifications of "essential" and "non-essential". Essential lines are those fluid system process lines that are required to mitigate or monitor an accident, or those which, if unavailable, could increase the magnitude of the accident. Essential lines may not be isolated in response to containment isolation signals; they may even be opened to ensure the required process function is met. Non-essential lines include all other fluid system penetrations. There are several penetrations for which neither classification is applicable; these include the hatches and airlocks as well as the spare penetrations.

The barriers for each penetration are identified in Table 6.6-1. Further discussion of the barrier design is provided below in Subsection 6.6.2.1 for all barriers, and Subsection 6.6.2.2 for valving.

6.6.2.1 BARRIERS

The containment isolation features at Turkey Point may include valving, closed systems, caps, and blind flanges. Each of these devices is considered to be an effective barrier against leakage of the containment atmosphere. In some cases a single integral barrier has been credited as the means of isolation. In other cases, redundant barriers consisting of valves, closed systems or other closure devices are utilized. Subsection 6.6.2.2 discusses design requirements applicable to valving. This subsection discusses the design requirements for closed systems, integral barriers and other closure devices.

A closed system, for containment isolation purposes, shall meet the following requirements:

(a) Withstand temperature and pressure equal to the containment design conditions;

(b) Meet Seismic Category I design requirements;

(c) Be protected against overpressure from thermal expansion of contained fluid when isolated;

(d) Be protected against high energy line breaks and missiles unless it can be demonstrated that these hazards will not result in the need for containment isolation; and

(e) Be capable of being leak tested, unless system integrity is being maintained during normal operation at a pressure equal to or greater than the containment design pressure (closed systems outside containment).

In addition, a closed system inside containment must not communicate with the primary coolant or the containment atmosphere; a closed system outside containment must not communicate with the outside atmosphere.

Branch lines located within the boundary of a closed system barrier must meet similar criteria out to the valve or barrier which provides isolation. These branch lines, which may be vents, drains, test connections, or intersystem connections are generally provided with valves which are subject to administrative controls to assure they support the containment function.

Main Steam, Steam Generator blowdown, feedwater and engineered safeguards lines penetrating the containment have been designed to assure that they are capable of withstanding the maximum hypothetical earthquake.

Penetrations which are provided with a pipe cap as a barrier are considered to be extensions of the containment liner. The cap, located either inside or outside containment, forms a single integral barrier against leakage. The caps may be welded or threaded; if threaded, the cap will be administratively controlled. Threaded caps will also be subject to local leak rate testing to provide continued assurance of their integrity.

A special example of the use of a single integral barrier involves the containment pressure monitoring instrumentation (Penetrations 46 (Unit 4) and 62 (Unit 3)). These penetrations provide a sensing line into containment for the pressure instrumentation used by the Engineered Safeguards Features Actuation System (ESFAS). This is an essential function which is required to ensure initiation of containment isolation and actuation of safety injection. The leakage barrier includes the piping and tubing as well as the instrument pressure boundary. The instruments have been designed to monitor post-accident conditions. This single barrier is considered to be appropriate considering the required function provided by the monitors.

Flanges, when used as a penetration boundary at Turkey Point, rely on their gasketing as the barrier against leakage. Redundant barriers have been identified for such penetrations. These include, for example, double gaskets such as those used on the fuel transfer tube or two barriers where a single gasket flange is used. The containment personnel access and emergency escape airlocks, although provided with redundant seal rings at each door, also have an equalization line with a single valve through each side. For this reason, their redundant isolation barriers are identified as the door and valve on each side, rather than just the redundant seal rings on one door. Mechanical interlocks have been provided to assure that one door is closed at all times when containment integrity is required. The space between the seal rings may be tested to provide assurance that the door is properly sealed.

6.6.2.2 CONTAINMENT ISOLATION VALVES

Containment isolation valves are provided with actuation and control equipment appropriate to the valve type. For example, air operated globe and diaphragm valves are generally provided with air diaphragm operators, with fail-safe operation ensured by redundant control devices in the instrument air supply to the valves. Motor operated gate valves are capable of being supplied from reliable on-site emergency power as well as their normal power source. Check valves and relief valves are considered to be automatic isolation valves but do not require actuation by control systems. Manual and remote manual valves which do not receive an automatic actuation signal are administratively controlled to preserve containment integrity.

Containment isolation "trip" valves are actuated to the closed position by the containment isolation signal, derived automatically from the signals as listed in Table 6.6-1. Non-automatic isolation valves, i.e., remote stop valves and manual valves, are used in lines which are normally closed. Administrative controls are used to ensure they are in, or can be placed in, their required position in the event of an accident.

The objective of establishing valve closure times is to limit the release of radioactivity from containment. Fast closure times are typically required for valves in lines which provide direct communication between the containment and the outside atmosphere (i.e., containment purge and vent lines; see below). The stroke time of selected containment isolation valves have been evaluated to demonstrate they are capable of meeting their design objectives. The nominal stroke times of other automatic containment isolation valves, for which component specific analyses have not been performed, meet the guidance of the Standard Review Plan, Section 6.2.4. The capability of the valves to meet the required closure times is verified periodically during performance of the In-Service Testing (IST) Program. Operability requirements for these automatic isolation valves are as provided in the Technical Specifications.

The large tight sealing butterfly valves used to isolate the containment purge ventilation ducts are equipped with air-cylinder operators, with spring returns. These valves fail to the closed position on loss of control signal or instrument air. The maximum closure time for these valves is 5 seconds from receipt of an automatic isolation signal. As discussed in Subsection 9.8.2, the opening angle of the valves has been limited. These valves can be closed either manually or automatically upon a signal of high radioactivity level in the containment or by the containment isolation signal. These valves are normally closed during reactor power operation. Refer to Table 6.6-2 for a single failure analysis of the containment purge valves. Debris screens are present upstream (with respect to Post LOCA flow) of the supply and exhaust purge valves. These debris screens will protect the containment isolation valves from debris that might follow as a result of a LOCA.

Isolation valves located inside containment are subject to the high pressure, high temperature, steam laden atmosphere resulting from an accident as well as a possible earthquake. Operability of these valves in the accident environment is ensured by proper design, construction and installation, as reflected by the following considerations:

(a) All components in the valve installation, including valve bodies, trim and moving parts, actuators, instrument air lines and control and power wiring, are constructed of materials sufficiently temperature resistant to be unaffected by the accident environment. Special attention is given to electrical insulation, air operator diaphragms and stem packing material.

(b) In addition to normal pressures, the valves are designed to withstand maximum pressure differentials in the reverse direction imposed by the accident conditions. This criterion is particularly applicable to the butterfly type isolation valves used in the containment purge lines.

(c) Valves are located in a manner to reduce the accelerations on the valves. Piping spans have been designed to adequately accommodate the loads to which the span would be subjected. Valves are mounted in the position recommended by the manufacturer.

(d) Earthquake forces on the operating parts of the valve are calculated to be small compared to the other forces present in the piping system.

(e) Control cables to the valve operators are designed and installed to assure that the flexure of the line does not endanger the control system. Appendages to the valve, such as position indicators and operators, are designed for structural adequacy.

Status monitoring of plant conditions, including containment integrity, during and following an accident, has been provided in accordance with the requirements of Regulatory Guide 1.97, Revision 3. This guide recommended that valve position indication be provided to permit the operators to ascertain the status of containment integrity and main steam safety valve positions. The valves which have been provided with position indication to comply with the Regulatory Guide 1.97 commitments are included in Table 6.6.1.

6.6.2.3 ISOLATION ACTUATION

Phase A Isolation is initiated by a safety injection (SI) signal. Phase B Isolation is initiated by a high containment pressure coincident with high-high containment pressure. Containment Ventilation Isolation is initiated by a safety injection signal or high containment radioactivity (R-11 or R-12) signals. Additional information is provided in Table 7.2-1.

Table 6.6-1 provides a listing of isolation valves and their actuating signals. Automatic closure of the valves listed in Table 6.6-1 will achieve containment isolation in accordance with the requirements of the 1967 Proposed GDC 53 and the plant Technical Specifications. The listed valves are considered to be part of the isolation barrier capability even if they open in response to accident conditions. That is, selected valves in essential penetration flow paths may receive a signal to open (e.g., SI signal or Auxiliary Feedwater Actuation signal). Barriers that provide a containment integrity function, but which do not receive an isolation signal (e.g., manual valves), have also been included in Table 6.6-1.

6.6.3 TESTING AND INSPECTION

The Turkey Point Units 3 and 4 containment structure was designed such that the maximum allowable containment vessel leakage rate shall not exceed 0.25% per day of containment free volume at the conditions of a Maximum Hypothetical Accident (MHA), that is, 49.9 psig and 276 ^{o}F. 10 CFR 50, Appendix J requires pre-operational and periodic operational verification by testing of the leak-tight integrity of the containment structure and lines penetrating containment. The testing consists of Type A, Type B, and Type C tests. Testing performed to meet 10 CFR 50, Appendix J provides assurance that leakage through the primary reactor containment and systems penetrating containment does not exceed this maximum allowable leakage rate. The combined leakage from all penetrations subject to Type B and C tests must be less than 0.6 times the maximum allowable leakage rate (La) prior to increasing the Reactor Coolant System temperature above 200°F.

Type A tests are the Integrated Leak Rate Tests (ILRT), which measure the containment structure overall integrated leak rate. FSAR Section 5.1.7 describes the pre-operational ILRTs. Integrated leak rate tests are performed periodically over the operating life of the plant.

Type B Local Leak Rate Tests (LLRT) detect local leaks across pressure-containing or leakage limiting boundaries other than valves. Containment penetrations that are required to be Type B tested include:

(a) Personnel and Emergency Air locks

(b) Equipment access hatch

(c) Fuel transfer tube flange

(d) Electrical penetrations

(e) Other containment penetrations whose design incorporates degradable mechanical parts such as resilient seals, gaskets or sealant compounds.

Type C Local Leak Rate tests measure containment isolation valve leakage rates. Containment isolation valves in the following categories (from 10 CFR 50, Appendix J) shall be leak rate tested in accordance with the Type C test requirements:

(a) Valves located in lines that provide a direct connection between the inside and outside atmospheres of the primary reactor containment under normal operation, such as purge, ventilation, vacuum relief, and instrumentation valves;

(b) Valves required to close automatically upon receipt of a containment isolation signal in response to controls intended to effect containment isolation; and

(c) Valves required to operate intermittently under post accident conditions.

In general, Type C tests are performed by pressurizing the valves from the side facing the inside of containment. However, there are configurations in which such testing is not practical. Alternative test configurations have been reviewed to ensure that the reverse testing is equivalent to the preferred test direction. In particular, the review must consider any potential leak paths (such as valve packing or vents, drains, or test connections) which would not be detected by the reverse flow test.

Periodic local leak rate testing and pre-operational leak rate testing discussed above describe a reasonable approach to assuring that the containment leakage is maintained below design limits during the life of the plant. Periodic local leak testing provides an accurate method of monitoring changes in the leakage characteristics of the containment. An integrated leak rate test (ILRT) is performed less frequently. An ILRT is also performed if major maintenance or modification to the containment was made. Periodic testing is conducted as determined by the Containment Leakage Rate Testing Program, in accordance with the plant Technical Specifications. C31

Automatic and power-operated containment isolation valve closure times shall be verified periodically by testing in accordance with the inservice test requirements of ASME Section XI.

TABLE 6.6-1

CONTAINMENT PIPING PENETRATIONS
AND ISOLATION BARRIERS

TABLE LEGEND

SYSTEMS

AFWS	Auxiliary Feedwater System
BA	Breathing Air System
CSS	Containment Spray System
CVCS	Chemical and Volume Control System
CCWS	Component Cooling Water System
IAS	Instrument Air System
FW	Feedwater System
MS	Main Steam
PACVS	Post Accident Containment Ventilation System
PAHMS	Post Accident Hydrogen Monitoring System
RCS	Reactor Coolant System
RHRS	Residual Heat Removal System
SGBD	Steam Generator Blowdown System
SIS	Safety Injection System
SS	Sample System
Vent	Containment Ventilation System
WDS	Waste Disposal System

ABBREVIATIONS

Cntmt	Containment
Constr	Construction
CSIC	Closed System Inside Containment
CSOC	Closed System Outside Containment
Exch	Exchanger
ILRT	Integrated Leak Rate Test
LC	Locked Closed
LLRT	Local Leak Rate Test
NA	Not Applicable
PCV	Pressure Control Valve
PRT	Pressurizer Relief Tank
RCDT	Reactor Coolant Drain Tank
RCP	Reactor Coolant Pump
RM	Remote Manual
SG	Steam Generator
SI	Safety Injection

FLOW DIRECTIONS

In	Indicates that the predominate flow direction is into containment during normal operation.
Out	Indicates that the predominate flow direction is out of containment during normal operation.

DEFINITIONS

Normal Position	Expected position of valve during plant operation. Actual valve position may vary Depending on specific plant Conditions.

TABLE 6.6-1

CONTAINMENT PIPING PENETRATIONS
AND ISOLATION BARRIERS

TABLE LEGEND
(Continued)

METHODS OF ACTUATION

Auto	Self actuating valve (Check, PCV, Relief)
PWR	Power operated valve (Air, MOV, Solenoid)
Manual	Handwheel (or reach rod) operated valve

SIGNALS (Refer to Table 7.2-1 for additional information)

Phase A	Containment Isolation Signal initiated by a Safety Injection Signal (Also known as a T-signal) - closes non-essential automatic containment valves.
Phase B	Containment Isolation Signal initiated by containment pressure (Also known as a P-signal) - closes selected automatic isolation valves which are beneficial to remain open following a Phase A signal. See Table 7.2-1 for cause of actuation.
AFAS	Auxiliary Feedwater Actuation Signal - opens essential steam flow to the AFW pump turbine and actuates auxiliary feedwater. See Table 7.2-1 for cause of actuation.
CVS	Containment Ventilation System Isolation initiated by Safety Injection Signal or Containment High Radiation Signal - isolates non-essential containment ventilation lines.
FWIS	Main Feedwater Isolation Signal - closes the main feedwater control and bypass valves and the backup feedwater isolation valves. See Table 7.2-1 for cause of actuation. C26
MSIS	Main Steam Isolation Signal - isolates non-essential portions of the main steam lines. See Table 7.2-1 for cause of actuation.
RM	Remote Manual (Power operated)
SIS	Safety Injection Signal - initiates Phase A isolation and actuates safety injection.

TABLE 6.6-1
CONTAINMENT PIPING PENETRATIONS AND ISOLATION BARRIERS

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
1	Shutdown Cooling Suction/ Alternate Hot Leg Injection (Essential/RHRS)	Out/In	Water	2	14"	In	Gate	MOV-*-751	PWR	RM	L.C.	As Is	Closed	Yes	NA	Note 10, 18
				1	14"	In	Gate	MOV-*-750	PWR	RM	L.C.	As Is	Closed	Yes	NA	Note 1, 10, 18
2	Shutdown Cooling Return/ Low Head Cold Leg Injection (Essential/RHRS)	In	Water	2	12"	In	Gate	MOV-*-744A	PWR	SIS	Closed	As Is	Open	Yes	NA	Note 2, 22
				2	12"	In	Gate	MOV-*-744B	PWR	SIS	Closed	As Is	Open	Yes	NA	Note 2, 22
				2	6"	In	Gate	*-734	Manual	NA	L.C.	NA	Closed	No	NA	Note 22
				2	2"	In	Relief	RV-*-706	Auto	NA	Closed	NA	Closed	No	NA	Note 22
				1	8"	In	Check	*-876A	Auto	NA	Closed	NA	Open	No	NA	Note 22
				1	8"	In	Check	*-876B	Auto	NA	Closed	NA	Open	No	NA	Note 22
				1	8"	In	Check	*-876C	Auto	NA	Closed	NA	Open	No	NA	Note 22
3	Reactor Coolant Pump Cooling Water Supply (Essential/CCWS)	In	Water	1	6"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	6"	Out	Gate	MOV-*-716B	PWR	Ph B	Open	As Is	Closed	Yes	NA	Note 18
4	RCP Oil Cooler Water Return (Essential/CCWS)	Out	Water	1	6"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	6"	Out	Gate	MOV-*-730	PWR	Ph B	Open	As Is	Closed	Yes	NA	Note 18
5	PRT Gas Analyzer Sample (Non-Essential/WDS)	Out	Gas	1	3/8"	Out	Globe	SV-*-6385	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 3, 18
				2	3/8"	Out	Globe	CV-*-516	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
6	PRT Nitrogen Supply (Non-Essential/WDS)	In	Gas	1	3/4"	In	Check	*-518	Auto	NA	Closed	NA	Closed	No	C	Note 18
				2	3/4"	In	Piston Check (check)	3-519 4-519	Auto	NA	Closed	NA	Closed	No	C	Note 9, 18

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Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
7	Primary Water to PRT and RCP Stand-Pipes (Non-Essential/Primary)	In	Water	1	3"	In	Dphrm	CV-*-519B	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/4"	In	Dphrm	CV-*-522A	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/4"	In	Dphrm	CV-*-522B	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/4"	In	Dphrm	CV-*-522C	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				2	3"	Out	Dphrm	CV-*-519A	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
8	Pressurizer Steam Space Sample (Non-Essential/SS)	Out	Water	1	3/8"	In	Globe	CV-*-951	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				2	3/8"	Out	Globe	CV-*-956A	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
9	Pressurizer Liquid Space Sample (Non-Essential/SS)	Out	Water	1	3/8"	In	Globe	CV-*-953	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				2	3/8"	Out	Globe	CV-*-956B	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
				1	3/4"	In	Relief	RV-*-300	Auto	NA	Closed	NA	Closed	No	C	
10	RCDT Vent and Nitrogen Supply (Non-Essential/WDS)	Out/In	Gas	1	1"	Out	Dphrm	CV-*-4658A	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				2	1"	Out	Dphrm	CV-*-4658B	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				1	1"	Out	Dphrm	*-4656	Manual	None	L.C.	NA	Closed	No	C	Note18
				2	3/4"	Out	Dphrm	*-4639	Manual	None	L.C.	NA	Closed	No	C	Note 18
				2	3/8"	Out	Globe	*-3449	Manual	None	L.C.	NA	Closed	No	C	Note 18
11	Alternate Low Head Cold Leg Injection (Essential/RHRS)	In	Water	1	8"	In	Check	*-876D	Auto	NA	Closed	NA	Closed	No	NA	Note 22
				1	8"	In	Check	*-876E	Auto	NA	Closed	NA	Closed	No	NA	Note 22
				2	8"	Out	Gate	MOV-*-872	PWR	RM	Closed	As Is	Closed	Yes	NA	Note 22
12	Excess Letdown Heat Exch.Cooling Water Supply (Non-Essential/CCWS)	In	Water	1	3"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	3"	In	Check	*-738	Auto	NA	Open	NA	Closed	No	NA	Note 18

TABLE 6.6-1
CONTAINMENT PIPING PENETRATIONS AND ISOLATION BARRIERS

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
13	Excess Letdown Heat Exch.Cooling Water Return (Non-Essential/CCWS)	Out	Water	1	3"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	3"	Out	Globe	CV-*-739	PWR	Ph A	Open	Closed	Closed	Yes	NA	Note 18
14	CVCS Normal Letdown (Non-Essential/CVCS)	Out	Water	1	2"	In	Globe	CV-*-200A	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				1	2"	In	Globe	CV-*-200B	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
				1	2"	In	Globe	CV-*-200C	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
				1	2"	In	Relief	RV-*-203	Auto	NA	Closed	NA	Closed	No	C	
				2	2"	Out	Globe	CV-*-204	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
15	CVCS Charging (Non-Essential/CVCS)	In	Water	1	3"	In	Check	*-312C	Auto	NA	Open	NA	Closed	No	NA	Note 4, 18
				2	3"	Out	CSOC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
16	Post-Accident Containment Air Sampling (Non-Essential)	Out	Gas	1	2"	Out	Dphrm	HV-*-1	Manual	NA	L.C.	NA	Closed	No	C	Note 9, 18
				2	3/4"	Out	Globe	PAHM-*-002A	Manual	NA	L.C.	NA	Closed	No	C	Note 9, 18
17	Safety Injection Test and Purge (Non-Essential/SIS)	Out	Water	1	3/4"	In	Globe	*-884A-F	Manual	NA	L.C.	NA	Closed	No	NA	
				1	3/4"	In	Relief	RV-*-859	Auto	NA	Closed	NA	Closed	No	NA	
				2	3/4"	Out	Globe	*-895V	Manual	NA	L.C.	NA	Closed	No	NA	Note 18
18	Hot Leg Injection (Essential/SIS)	In	Water	1	2"	In	Gate	MOV-*-866A/B	PWR	RM	Closed	As Is	Closed	Yes	NA	Note 8, 10, 22
				1	1"	In	Globe	CV-*-851ABC	PWR	RM	Closed	Closed	Closed	Yes	NA	Note 9, 22
				1	3/4"	In	Relief	RV-*-6511	Auto	NA	Closed	NA	Closed	No	NA	Note 22
				2	3"	Out	Gate	MOV-*-869	PWR	RM	Closed	As Is	Closed	Yes	NA	Note 8, 22
				2	3”	Out	Gate	*-990	Manual	NA	L.C.	NA	Closed	No	NA	Note 8,22

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Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
19A	Containment Spray (Essential/CSS)	In	Water	2	6"	Out	Gate	MOV-*-880A	PWR	Ph B	Closed	As Is	Open	Yes	C	Note 22
				2	1"	Out	Globe	*-883M	Manual	NA	L.C.	NA	Closed	No	C	Note 9, 22
				1	6"	Out	Check	*-890A	Auto	NA	Closed	NA	Open	No	C	Note 22
19B	Containment Spray (Essential/CSS)	In	Water	2	6"	Out	Gate	MOV-*-880B	PWR	Ph B	Closed	As Is	Open	Yes	C	Note 22
				2	1"	Out	Globe	*-883N	Manual	NA	L.C.	NA	Closed	No	C	Note 9, 22
				1	6"	Out	Check	*-890B	Auto	NA	Closed	NA	Open	No	C	Note 22
20	Reactor Coolant System Hot Leg Sample (Non-Essential/SS)	Out	Water	1	3/8"	In	Globe	SV-*-6427A	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/8"	In	Globe	SV-*-6427B	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				2	3/8"	Out	Globe	SV-*-6428	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
21	Normal Containment Cooling Water Supply (Non-Essential/CCWS)	In	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Gate	MOV-*-1417	PWR	Ph A	Open	As Is	Closed	Yes	NA	Note 18
22	Normal Containment Cooling Water Return (Non-Essential/CCWS)	Out	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Gate	MOV-*-1418	PWR	Ph A	Open	As Is	Closed	Yes	NA	Note 18
23	Containment Sump Discharge (Non-Essential/WDS)	Out	Water	1	3"	Out	Globe	CV-*-2822	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				2	3"	Out	Globe	CV-*-2821	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
24A	Seal Water Injection (Non-Essential/CVCS)	In	Water	1	2"	In	Check	*-298A	Auto	NA	Open	NA	Closed	No	NA	Note 18
				2	2"	Out	CSOC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19

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Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes	
24B	Seal Water Injection (Non-Essential/CVCS)	In	Water	1	2"	In	Check	*-298B	Auto	NA	Open	NA	Closed	No	NA	Note 18	C30
				2	2"	Out	CSOC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19	
24C	Seal Water Injection (Non-Essential/CVCS)	In	Water	1	2"	In	Check	*-298C	Auto	NA	Open	NA	Closed	No	NA	Note 18	C30
				2	2"	Out	CSOC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19	
25	RCP Seal Water Leakoff/ Excess Letdown (Non-Essential/CVCS)	Out	Water	1	3"	In	Gate	MOV-*-6386	PWR	Ph A	Open	As Is	Closed	Yes	C	Note 18	
				2	3"	Out	Gate	MOV-*-381	PWR	Ph A	Open	As Is	Closed	Yes	C	Note 18	
				1	3/4"	In	Relief	RV-*-303	Auto	NA	Closed	NA	Closed	No	C		
26A	Main Steam/AFWS Steam Supply (Essential/Secondary)	Out	Steam	1	26"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19	
				2	3/4"	Out	Globe	SGWL-*-022	Manual	NA	L.C.	NA	Closed	No	NA	Note 23	
				2	6"	Out	Globe	CV-*-1606	PWR	RM	Closed	Closed	Closed	Yes	NA	Note 23	
				2	12"	Out	Relief	RV1400/1/2/3	Auto	NA	Closed	NA	Closed	No	NA	Note 23	
				2	4"	Out	Globe	MOV-*-1403	PWR	AFAS	Closed	As Is	Open	Yes	NA	Note 22, 23	
				2	26"	Out	Stop Check	POV-*-2604	PWR	MSIS	Open	Closed	Closed	Yes	NA	Note 5, 9, 23	
				2	2"	Out	Globe	MOV-*-1400	PWR	MSIS	Closed	As Is	Closed	Yes	NA	Note 23	
				2	3/4"	Out	Globe	3-10-107 (4-10-105)	Manual	NA	Open	NA	Open	No	NA	Note 17	
26B	Main Steam/AFWS Steam Supply (Essential/Secondary)	Out	Steam	1	26"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19	
				2	3/4"	Out	Globe	SGWL-*-028	Manual	NA	L. C.	NA	Closed	No	NA	Note 23	
				2	6"	Out	Globe	CV-*-1607	PWR	RM	Closed	Closed	Closed	Yes	NA	Note 23	
				2	12"	Out	Relief	RV1405/6/7/8	Auto	NA	Closed	NA	Closed	No	NA	Note 23	
				2	4"	Out	Globe	MOV-*-1404	PWR	AFAS	Closed	As Is	Open	Yes	NA	Note 22, 23	
				2	26"	Out	Stop Check	POV-*-2605	PWR	MSIS	Open	Closed	Closed	Yes	NA	Note 5, 9, 23	

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
				2	2" "	Out	Globe	MOV-*-1401	PWR	MSIS	Closed	As Is	Closed	Yes	NA	Note 23
				2	3/4	Out	Globe	*-10-207	Manual	NA	Open	NA	Open	No	NA	Note 17
26C	Main Steam/AFWS Steam Supply (Essential/Secondary)	Out	Steam	1	26"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	3/4"	Out	Globe	SGWL-*-046	Manual	NA	L.C.	NA	Closed	No	NA	Note 23
				2	6"	Out	Globe	CV-*-1608	PWR	RM	Closed	Closed	Closed	Yes	NA	Note 23
				2	12"	Out	Relief	RV1410/1/2/3	Auto	NA	Closed	NA	Closed	No	NA	Note 23
				2	4"	Out	Globe	MOV-*-1405	PWR	AFAS	Closed	As Is	Open	Yes	NA	Note 22, 23
				2	26"	Out	Stop Check	POV-*-2606	PWR	MSIS	Open	Closed	Closed	Yes	NA	Note 5, 9, 23
				2	2"	Out	Globe	MOV-*-1402	PWR	MSIS	Closed	As Is	Closed	Yes	NA	Note 23
				2	3/4"	Out	Globe	*-10-307	Manual	NA	Open	NA	Open	No	NA	Note 17
27A	Main Feedwater/Aux. Feedwater (Essential/Secondary)	In	Water	1	14"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	14"	Out	Globe	FCV-*-478	PWR	FWIS	Open	Closed	Closed	Yes	NA	Note 6, 23
				2	4"	Out	Globe	FCV-*-479	PWR	FWIS	Closed	Closed	Closed	Yes	NA	Note 23
				2	2"	Out	Gate	SGWL-*-007	Manual	NA	Closed	NA	Closed	No	NA	Note 23
				2	1/2"	Out	Check	*-20-137	Auto	NA	Closed	NA	Closed	No	NA	Note 23
				2	4"	Out	Globe	CV-*-2816	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 22, 23, 6, 15
				2	4"	Out	Globe	CV-*-2831	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 6, 15, 22, 23
27B	Main Feedwater/Aux. Feedwater (Essential/Secondary)	In	Water	1	14"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	14"	Out	Globe	FCV-*-488	PWR	FWIS	Open	Closed	Closed	Yes	NA	Note 6, 23
				2	4"	Out	Globe	FCV-*-489	PWR	FWIS	Closed	Closed	Closed	Yes	NA	Note 23
				2	2"	Out	Gate	SGWL-*-025	Manual	NA	Closed	NA	Closed	No	NA	Note 23
				2	1/2"	Out	Check	*-20-237	Auto	NA	Closed	NA	Closed	No	NA	Note 23
				2	4"	Out	Globe	CV-*-2817	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 22, 23, 6, 15
				2	4"	Out	Globe	CV-*-2832	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 6, 15, 22, 23

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
27C	Main Feedwater/Aux. Feedwater (Essential/Secondary)	In	Water	1	14"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	14"	Out	Globe	FCV-*-498	PWR	FWIS	Open	Closed	Closed	Yes	NA	Note 6, 23
				2	4"	Out	Globe	FCV-*-499	PWR	FWIS	Closed	Closed	Closed	Yes	NA	Note 23
				2	2"	Out	Gate	SGWL-*-042	Manual	NA	Closed	NA	Closed	No	NA	Note 23
				2	1/2"	Out	Check	*-20-337	Auto	NA	Closed	NA	Closed	No	NA	Note 23
				2	4"	Out	Globe	CV-*-2818	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 22, 23, 6, 15
				2	4"	Out	Globe	CV-*-2833	PWR	AFAS	Closed	Closed	Open	Yes	NA	Note 6, 15, 22, 23
28A	Steam Generator Blowdown & Wet Layup (Non-Essential/Secondary)	Out/In	Water	1	4"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	6"	Out	Globe	CV-*-6275A	PWR	Ph A	Open	AS-IS	Closed	Yes	NA	Note 23 Note 26
				2	3/4"	Out	Globe	SGB-*-082A	Manual	NA	L.C.	NA	Closed	NA	NA	Note 23
				2	2"	Out	Globe	SGWL-*-011	Manual	NA	L.C.	NA	Closed	No	NA	Note 23 C26
28B	Steam Generator Blowdown & Wet Layup (Non-Essential/Secondary)	Out/In	Water	1	4"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19 Note 26
				2	6"	Out	Globe	CV-*-6275B	PWR	Ph A	Open	AS-IS	Closed	Yes	NA	Note 23
				2	3/4"	Out	Globe	SGB-*-082B	Manual	NA	L.C.	NA	Closed	NA	NA	Note 23
				2	2"	Out	Globe	SGWL-*-031	Manual	NA	L.C.	NA	Closed	No	NA	Note 23
28C	Steam Generator Blowdown & Wet Layup (Non-Essential/Secondary)	Out/In	Water	1	4"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	6"	Out	Globe	CV-*-6275C	PWR	Ph A	Open	AS-IS	Closed	Yes	NA	Note 23 Note 26
				2	3/4"	Out	Globe	SGB-*-082C	Manual	NA	L.C.	NA	Closed	NA	NA	Note 23
				2	2"	Out	Globe	SGWL-*-049	Manual	NA	L.C.	NA	Closed	NA	NA	Note 23

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
29	Instrument Air Supply (Non-Essential/IAS)	In	Gas	1	2"	In	Stop Check (Check)	3-40-340A (4-40-340A)	Auto	NA	Open	NA	Closed	No	C	Note 9, 18
				2	2"	In	Check	*-40-336	Auto	NA	Open	NA	Closed	No	C	Note 18
30	Sealed Closed/Spare	NA	NA	1	2.5”	Out	Integral	NA	NA	NA	NA	NA	NA	NA	NA	**Note** 19 C28
31	RCDT Gas Analyzer Sample (Non-Essential/WDS)	Out	Gas	1	3/4"	Out	Dphrm	CV-*-4659A	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
				2	3/4"	Out	Dphrm	CV-*-4659B	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 3, 18
32	Containment Air Sample Return (Non-Essential/Vent)	In	Gas	1	1"	In	Check	*-11-003	Auto	NA	Closed	NA	Closed	No	C	Note 9, 18
				2	1"	Out	Globe	SV-*-2912	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				2	1"	Out	Globe	PAHM-*-001A	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18
				2	1"	Out	Globe	PAHM-*-001B	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18
33	Containment Air Sample (Non-Essential/Vent)	Out	Gas	1	1"	Out	Globe	SV-*-2913	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				2	1"	Out	Globe	SV-*-2911	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
34	Service Air Supply (Non-Essential/Service Air)	In	Gas	1	2”	In	Gate	*-40-205	Manual	NA	L.C.	NA	Closed	No	C	Note 18
				2	2”	Out	Gate	*-40-204	Manual	NA	L.C.	NA	Closed	No	C	Note 18
35	Containment Purge Supply (Non-Essential/Vent)	In	Gas	1	48"	In	Butterfly	POV-*-2601	PWR	CVS	Closed	Closed	Closed	Yes	C	Note 18, 21
				2	48"	Out	Butterfly	POV-*-2600	PWR	CVS	Closed	Closed	Closed	Yes	C	Note 18, 21
36	Containment Purge Exhaust (Non-Essential/Vent)	Out	Gas	1	54"	In	Butterfly	POV-*-2603	PWR	CVS	Closed	Closed	Closed	Yes	C	Note 18, 21
				2	54"	Out	Butterfly	POV-*-2602	PWR	CVS	Closed	Closed	Closed	Yes	C	Note 18, 21
37 (U-3)	Sealed Closed/Unusable	NA	NA	1	NA	In	Integral	NA	NA	NA	NA	NA	NA	NA	B	Note 19
37 (U-4)	Sealed Closed/Spare	NA	NA	1	3/8"	Out	Integral	NA	NA	NA	NA	NA	NA	NA	B	Note 19
38	Electrical Penetrations (Low Voltage)	NA	NA	1	NA	In	Electrical Penetrtn	NA	NA	NA	NA	NA	NA	NA	B	Note 19, 24
	Spare			1	NA	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19, 24
39	Fuel Transfer Tube	NA	NA	1	20"	In	Blind Flange	NA	NA	NA	Installed	NA	Installed	NA	B	Double Gasketed, Note 19
40	Equipment Hatch	NA	NA	1	168"	NA	Hatch Cover	NA	NA	NA	Installed	NA	Installed	NA	B	Double Gasketed, Note 19

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
41	Personnel Access Airlock	NA	NA	1	114"	In	Door Valve	NA *-S8B	NA Manual	NA NA	Closed Closed	NA NA	Closed Closed	Yes No	B B	Note 20 Note 20
				2	114"	Out	Door Valve	NA *-S8A	NA Manual	NA NA	Closed Closed	NA NA	Closed Closed	Yes No	B B	Note 20 Note 20
42	N2 Supply to SI Accumulators (Non-Essential/SIS)	In	Gas	1	1"	In	Stop Check (Check)	3-945E (4-945E)	Auto	NA	Closed	NA	Closed	No	C	Note 9, 18
				2	1"	Out	Gate	CV-*-855	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 11, 18
43	RCP Thermal Barrier Cooling Water Return (Essential/CCWS)	Out	Water	1	3"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	3"	Out	Gate	MOV-*-626	PWR	Ph B	Open	As Is	Closed	Yes	NA	Note 18
44A	Emergency Containment Cooling Water Supply (Essential/CCWS)	In	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-3-2905 (CV-4-2904)	PWR	SIS	Open	Open	Open	Yes	NA	Note 14, 22
44B	Emergency Containment Cooling Water Supply (Essential/CCWS)	In	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-*-2903	PWR	SIS	Open	Open	Open	Yes	NA	Note 14, 22
44C	Emergency Containment Cooling Water Supply (Essential/CCWS)	In	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-3-2904 (CV-4-2905)	PWR	SIS	Open	Open	Open	Yes	NA	Note 14, 22
45A	Emergency Containment Cooling Water Return (Essential/CCWS)	Out	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-3-2908 (CV-4-2907)	PWR	SIS	Closed (Open)	Open	Open	Yes	NA	Note 14, 22, 25
				2	6"	Out	Globe	CV-3-2814 (CV-4-2812)	PWR	RM	Open (Closed)	Closed	Open	Yes	NA	Note 22, 25

TABLE 6.6-1
CONTAINMENT PIPING PENETRATIONS AND ISOLATION BARRIERS

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
45B	Emergency Containment Cooling Water Return (Essential/CCWS)	Out	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-3-2906 (CV-4-2906)	PWR	SIS	Closed (Open)	Open	Open	Yes	NA	Note 14, 22, 25
				2	6"	Out	Globe	CV-3-2810 (CV-4-2810)	PWR	RM	Open (Closed)	Closed	Open	Yes	NA	Note 22, 25
45C	Emergency Containment Cooling Water Return (Essential/CCWS)	Out	Water	1	10"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	10"	Out	Butterfly	CV-3-2907 (CV-4-2908)	PWR	SIS	Closed (Open)	Open	Open	Yes	NA	Note 14, 22, 25
				2	6"	Out	Globe	CV-3-2812 (CV-4-2814)	PWR	RM	Open (Closed)	Closed	Open	Yes	NA	Note 22, 25
46A,B,C	Sealed Closed/Spare (U-3) Containment Pressure Sensors(U4)	NA	NA	1	1"	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
		NA	NA	1	1"	Out	Integral	NA	NA	NA	NA	NA	NA	NA	B	Note 12, 19
47	Primary Water Supply to Wash Header (Non-Essential/Primary)	In	Water	1	2"	In	Gate	*-10-582	Manual	NA	L.C.	NA	Closed	No	C	Note 18
				2	2"	Out	Check	*-10-567	Auto	NA	Closed	NA	Closed	No	C	Note 18
				1	3/4"	In	Relief	RV-*-302	Auto	NA	Closed	NA	Closed	No	C	
48	Electrical Penetrations (High Voltage)	NA	NA	1	NA	In	Electrical Penetrtn	NA	NA	NA	NA	NA	NA	NA	B	Note 19, 24
	Spare															
				1	NA	NA	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19, 24
49	Emergency Escape Airlock	NA	NA	1	66"	In	Door Valve	NA *-S9B	NA Manual	NA NA	Closed Closed	NA NA	Closed Closed	NA NA	B B	Note 20 Note 20
				2	66"	Out	Door Valve	NA *-S9A	NA Manual	NA NA	Closed Closed	NA NA	Closed Closed	NA NA	B B	Note 20 Note 20

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
51 (U-4)	Post-Accident Containment Air Sampling (Non-Essential)	Out	Gas	1	2"	Out	Dphrm	HV-4-3	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18 C29
				2	3/4"	Out	Globe	PAHM-4-002B	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18
52	RCDT Pump Discharge (Non-Essential/WDS)	Out	Water	1	3"	Out	Dphrm	CV-*-4668A	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
				2	3"	Out	Dphrm	CV-*-4668B	PWR	Ph A	Open	Closed	Closed	Yes	C	Note 18
53 (U-3)	Post-Accident Containment Air Sampling (Non-Essential)	Out	Gas	1	2"	Out	Dphrm	HV-3-3	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18
				2	3/4"	Out	Globe	PAHM-3-002B	Manual	NA	L.C.	NA	Closed	No	C	Note 7, 9, 18
54A	Containment Sump Recirculation (Essential/RHR)	Out/In	Water	1	14"	Out	Gate	MOV-*-860A	PWR	RM	Closed	As Is	Closed	Yes	NA	Note 9, 13, 22
				1	1"	Out	Check	*-2052	Auto	NA	Closed	NA	Closed	No	NA	Note 22
				2	14"	Out	Gate	MOV-*-861A	PWR	RM	Closed	As-Is	Closed	Yes	NA	Note 9, 13, 22
				2	3/4"	Out	Relief	RV-*-871	Auto	NA	Closed	Closed	Closed	No	NA	Note 22
54B	Containment Sump Recirculation (Essential/RHR)	Out/In	Water	1	14"	Out	Gate	MOV-*-860B	PWR	RM	Closed	As Is	Closed	Yes	NA	Note 9, 13, 22
				2	14"	Out	Gate	MOV-*-861B	PWR	RM	Closed	As-Is	Closed	Yes	NA	Note 9, 13, 22
55	Accumulator Sample (Non-Essential/SS)	Out	Water	1	3/8"	In	Globe	CV-*-955C	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/8"	In	Globe	CV-*-955D	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				1	3/8"	In	Globe	CV-*-955E	PWR	RM	Closed	Closed	Closed	Yes	C	Note 9, 18
				2	3/8"	Out	Globe	CV-*-956D	PWR	Ph A	Closed	Closed	Closed	Yes	C	Note 18
				1	3/4"	In	Relief	RV-*-301	Auto	NA	Closed	NA	Closed	No	C	

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
56	Sealed Closed/Spare	NA	NA	1	1/2" (3/8)	In (Out)	Integral	NA	NA	NA	NA	NA	NA	NA	NA (B)	Unit 3, Note 19 (Unit 4), Note 19
57	Sealed Closed/Spare	NA	NA	1	4"	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
58	High Head Cold Leg Injection (Essential/SIS)	In	Water	1	2"	In	Check	*-873A	Auto	NA	Closed	NA	Open	No	NA	Note 22
				2	6"	Out	Gate	MOV-*-843A,B	PWR	SIS	Closed	As Is	Open	Yes	NA	Note 22
59	High Head Cold Leg Injection (Essential/SIS)	In	Water	1	2"	In	Check	*-873B	Auto	NA	Closed	NA	Open	No	NA	Note 22
				2	6"	Out	Gate	MOV-*-843A,B	PWR	SIS	Closed	As-Is	Open	Yes	NA	Note 22
60	High Head Cold Leg Injection (Essential/SIS)	In	Water	1	2"	In	Check	*-873C	Auto	NA	Closed	NA	Open	NA	NA	Note 22
				2	6"	Out	Gate	MOV-*-843A,B	PWR	SIS	Closed	As-Is	Open	Yes	NA	Note 22
61A	Sealed Closed/Spare (U-3) Sealed Closed Unusable (U-4)	NA	NA	1	1"	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
		NA	NA	1	3/8"	Out	Globe	4-2030	Manual	NA	Closed	NA	Closed	NA	B	Note 19
				2	3/8"	Out	Cap	NA	NA	NA	NA	NA	NA	NA	NA	
61B	Sealed Closed/Spare	NA	NA	1	3/8"	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19

Pen No.	Service (Classification/System)	Flow Dir.	Fluid	Barrier Number	Line Size	Loc.	Barrier Type	Valve No.	Method of Act'n	Signal	Normal Pos.	Pwr Flr Pos.	Post Accident Position	Rem Pos Ind	App J Test Type (B or C)	Notes
62A,B,C Unit 3	Containment Pressure Sensors	NA	NA	1	1"	Out	Integral	NA	NA	NA	NA	NA	NA	NA	B	Note 12, 19
63	Instrument Air Bleed (Non-Essential/Vent)	Out	Gas	1	2"	In	Globe	CV-*-2819	PWR	CVS	Open	Closed	Closed	Yes	C	Note 18
				2	2"	Out	Globe	CV-*-2826	PWR	CVS	Open	Closed	Closed	Yes	C	Note 18
64A	S/G Blowdown Sample (Non-Essential/Secondary)	NA	Water	1	1"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	1"	Out	Gate	MOV-*-1427	PWR	Ph A	Open	As Is	Closed	Yes	NA	Note 23
64B	S/G Blowdown Sample (Non-Essential/Secondary)	NA	Water	1	1"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	1"	Out	Gate	MOV-*-1426	PWR	Ph A	Open	As Is	Closed	Yes	NA	Note 23
64C	S/G Blowdown Sample (Non-Essential/Secondary)	NA	Water	1	1"	In	CSIC	NA	NA	NA	NA	NA	NA	NA	NA	Note 19
				2	1"	Out	Gate	MOV-*-1425	PWR	Ph A	Open	As Is	Closed	Yes	NA	Note 23
65A	ILRT Service Penetration (Non-Essential/None)	In/Out	Gas	1	8"	In	Flange	NA	NA	NA	Installed	NA	Installed	NA	B	Note 19
				2	8"	Out	Flange	NA	NA	NA	Installed	NA	Installed	NA	B	
65B	ILRT Service Penetration (Non-Essential/None)	Out	Gas	1	3/4"	In	Flange	NA	NA	NA	Installed	NA	Installed	NA	B	Note 19
				2	3/4"	Out	Globe	*-2025	Manual	NA	Closed	NA	Closed	NA	C	Note 18
65C	ILRT Service Penetration (Non-Essential/None)	Out	Gas	1	3/4"	In	Flange	NA	NA	NA	Installed	NA	Installed	NA	B	Note 19
				2	3/4"	Out	Globe	*-2026	Manual	NA	Closed	NA	Closed	NA	C	Note 18
66A,B	Sealed Closed/Spare	NA	NA	1	1"	In	Integral	NA	NA	NA	NA	NA	NA	NA	NA	Note 19

TABLE 6.6-1

CONTAINMENT PIPING PENETRATIONS
AND ISOLATION BARRIERS

TABLE NOTES

1. Inside secondary shield. Open for shutdown cooling.

2. Normal residual heat removal loop flow path. Missile protected - between secondary shield and containment. Low head safety injection flow path, into 3 loops. Valve opens and remains open for normal safety injection.

3. With valve switch in auto during normal operation, valve auto opens on gas analyzer signal.

4. Charging line may provide supplemental safety injection flow. First valve inside containment is outside shield wall in a separate shielded area.

5. Redundant (Train A & Train B) solenoid operators are provided for POV-2604, 2605, 2606.

6. Indication is a demand signal.

7. Valves may be manually opened for post-accident hydrogen monitor operation.

8. Valves may be opened for hot leg recirculation.

9. Valve positions shown in this table reflect those expected during normal or post-accident operation without operator intervention. Position other than that shown may be acceptable if performed under appropriate control or authorization (e.g., see Notes 7, 8, or 13). Position for stop-check valves reflect disk position and not necessarily handwheel position.

10. Administratively controlled; breakers locked open.

11. CV-855 may be opened to pressurize SI Accumulators with fill N_2 and during flux mapping operations.

12. Pressure transmitter located outside of containment; boundary includes degradable materials so this penetration must be tested.

13. Valves may be opened for sump recirculation.

14. Valves open based on emergency containment fan start (which is on SI signal).

15. Valves CV-*-2816, / 2817 / 2818 / 2831 / 2832 / 2833 are normally closed. They automatically open when any of the AFW steam supply valves (MOV-*-1403, 1404, 1405) on corresponding unit open. These valves may remain open if the AFW pump is operating and the differential pressure across the valve is above approximately 900 psig.

CONTAINMENT PIPING PENETRATIONS
AND ISOLATION BARRIERS

TABLE NOTES
(Continued)

16. Deleted C28

17. Valve located in main steam sample line. Post-accident position evaluated and found acceptable.

18. This valve is a containment isolation valve (i.e., closes on a Phase A, Phase B, or Containment Ventilation Isolation signal; is a normally closed manual isolation valve; or is a non-essential system check valve).

19. This is the primary barrier relied upon to support containment integrity.

20. This barrier is part of a containment airlock.

21. This barrier is associated with a containment purge supply or exhaust penetration.

22. This barrier is associated with an essential penetration. Its system safety function overrides the containment isolation safety function.

23. These valves are secondary system barriers. Where applicable, they are subject to secondary system/component requirements. Testing and leak tightness of these valves are not required for the LOCA events for which containment isolation is needed.

24. This penetration designation is actually a series of electrical penetrations. Each consists of active electrical canisters and spare canister locations, which are considered integral containment barriers.

25. Valves CV-*-2906, CV-*-2907, and CV-*-2908 fail open on loss of instrument air and fail closed on loss of electrical power. Valves CV-*-2810, CV-*-2812, and CV-*-2814 fail closed on loss of instrument air and fail open on loss of electrical power.

26. Valves CV-*-6275A, CV-*-6275B, and CV-*-6275C “fail-as-is” on loss of instrument air and “fail closed” on loss of electrical power.

TABLE 6.6-2

SINGLE FAILURE ANALYSIS - CONTAINMENT PURGE VALVES

COMPONENT	FAILURE MODE	RESULTS
Valve Operator	Fails to close or fails to seat or signal to close not received.	2nd purge air valve in series will provide the required isolation.
Instrument Air Supply to the Operator	Failure or air.	Purge air valves are closed by spring, air is NOT required for closure.
Solenoid Valve	Fails to operate (i.e., does NOT isolate the operator cylinder from air supply and does NOT provide air bleed off for the cylinder).	The 2nd purge air valve in series will provide the required isolation.

TABLE 6.6-3

AUTOMATIC CONTAINMENT ISOLATION VALVE CLOSURE TIMES

A. PHASE "A" ISOLATION VALVES

VALVE NUMBER (Note 1)	PENET NUMBER	SYSTEM/FUNCTION	CONTROL ROOM LABEL	CLOSURE TIME (SECONDS)
CV-*-200A	14	CVCS Normal Letdown	L/D Orifice	Note 2
CV-*-200B	14	CVCS Normal Letdown	L/D Orifice	Note 2
CV-*-200C	14	CVCS Normal Letdown	L/D Orifice	Note 2
CV-*-204	14	CVCS Normal Letdown	L/D Isol	Note 2
MOV-*-381	25	CVCS Excess Letdown/ RCP Seal Water Return	Seal Rtn Isol	Note 2
CV-*-516	5	PRT Gas Analyzer Sample	PRT to GA	Note 2
CV-*-519A	7	PRT Makeup Primary Water Supply	PW to Cntmt	Note 2
CV-*-739	13	CCW Return from Excess Letdown Heat Exchanger	Exc L/D Hx	Notes 3,5
CV-*-855	42	Nitrogen Supply to Accumulators	N2 to Accum	Note 2
CV-*-956A	8	Pressurizer Steam Space Sample	Przr Sample	Note 2
CV-*-956B	9	Pressurizer Liquid Space Sample	Przr Sample	Note 2
CV-*-956D	55	Accumulator Sample	Accum Sample	Note 2
MOV-*-1417	21	CCW Supply to Normal Containment Coolers	NCC Inlet	Notes 2,5
MOV-*-1418	22	CCW Return from Normal Containment Coolers	NCC Outlet	Notes 2,5
CV-*-2821	23	Containment Sump Discharge	Sump Isol	Note 2
CV-*-2822	23	Containment Sump Discharge	Sump Isol	Note 2
SV-*-2911	33	Containment Air Sample	PRMS Isol	Note 2
SV-*-2912	32	Containment Air Sample Return	PRMS Isol	Note 2
SV-*-2913	33	Containment Air Sample	PRMS Isol	Note 2
CV-*-4658A	10	RC Drain Tank Vent	RCDT Vent	Note 2
CV-*-4658B	10	RC Drain Tank Vent	RCDT Vent	Note 2
CV-*-4659A	31	RC Drain Tank Gas Analyzer Sample	RCDT to GA	Note 2
CV-*-4659B	31	RC Drain Tank Gas Analyzer Sample	RCDT to GA	Note 2
CV-*-4668A	52	RC Drain Tank Pump Discharge	RCDT Disch	Note 2
CV-*-4668B	52	RC Drain Tank Pump Discharge	RCDT Disch	Note 2
SV-*-6385	5	PRT Gas Analyzer	PRT to GA(7)	Note 2
MOV-*-6386	25	CVCS Excess Letdown/RCP Seal Water Return	Seal Rtn Isol	Note 2
SV-*-6428	20	RCS Hot Leg Sample	RCS Sample	Note 2

C28

AUTOMATIC CONTAINMENT ISOLATION VALVE CLOSURE TIMES

B. PHASE "B" ISOLATION VALVES

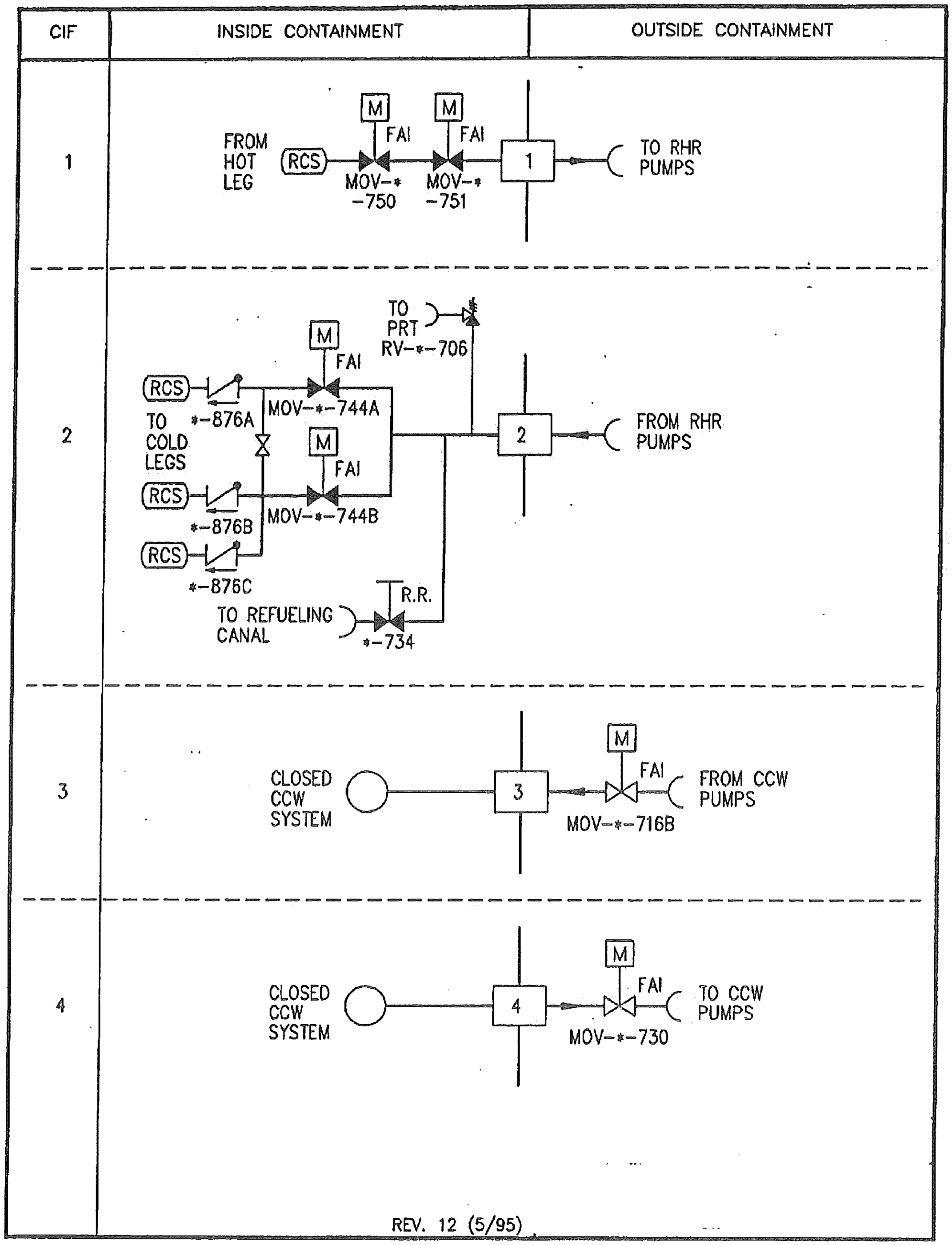
VALVE NUMBER (Note 1)	PENET NUMBER	SYSTEM/FUNCTION	CONTROL ROOM LABEL	CLOSURE TIME (SECONDS)
MOV-*-626	43	CCW Return from RCP Thermal Barriers CLRS	RCP Clg Wtr	Notes 2,5
MOV-*-716B	3	CCW Supply to RCPs	RCP Clg Wtr	Notes 2,5
MOV-*-730	4	CCW Return from RCP Oil Coolers	RCP Clg Wtr	Notes 2,5

C. CONTAINMENT VENTILATION ISOLATION VALVES(8)

VALVE NUMBER (Note 1)	PENET NUMBER	SYSTEM/FUNCTION	CONTROL ROOM LABEL	CLOSURE TIME (SECONDS)
POV-*-2600	35	Containment Purge Supply	Supply Iso	5
POV-*-2601	35	Containment Purge supply	Supply Iso	5
POV-*-2602	36	Containment Purge Exhaust	Exh Iso	5
POV-*-2603	36	Containment Purge Exhaust	Exh Iso	5
CV-*-2819	63	Instrument Air Bleed	Air Bleed	Note 2
CV-*-2826	63	Instrument Air Bleed	Air Bleed	Note 2

Notes:

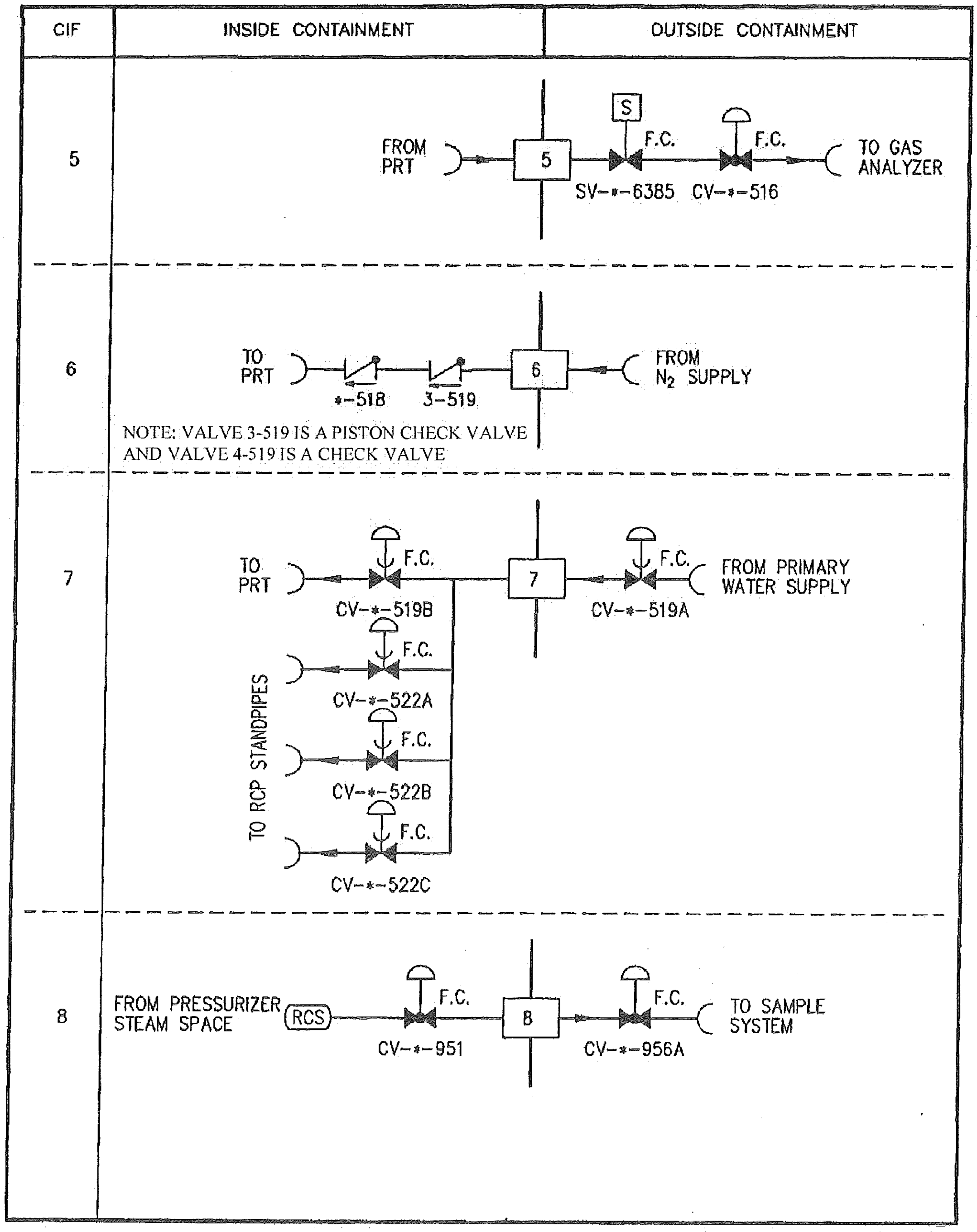
1. * = Unit number (3 or 4)
2. The isolation times of each automatic valve shall be within the limits established for testing in accordance with Section XI of ASME Boiler and Pressure Vessel code and applicable Addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i).
3. Testing requirements are per letter L-89-358 from J. H. Goldberg to U. S. Nuclear Regulatory Commission dated October 3, 1989.
4. Deleted C28
5. Valve is not subject to Type C local leak rate testing of 10 CFR 50, Appendix J.
6. Deleted C28
7. The PRT to GA is labeled CV-*-6385
8. These valves are mounted in the Phase "A" Isolation Valves matrix.



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 1

FIGURE 6.6-1



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Revised 03/29/2010

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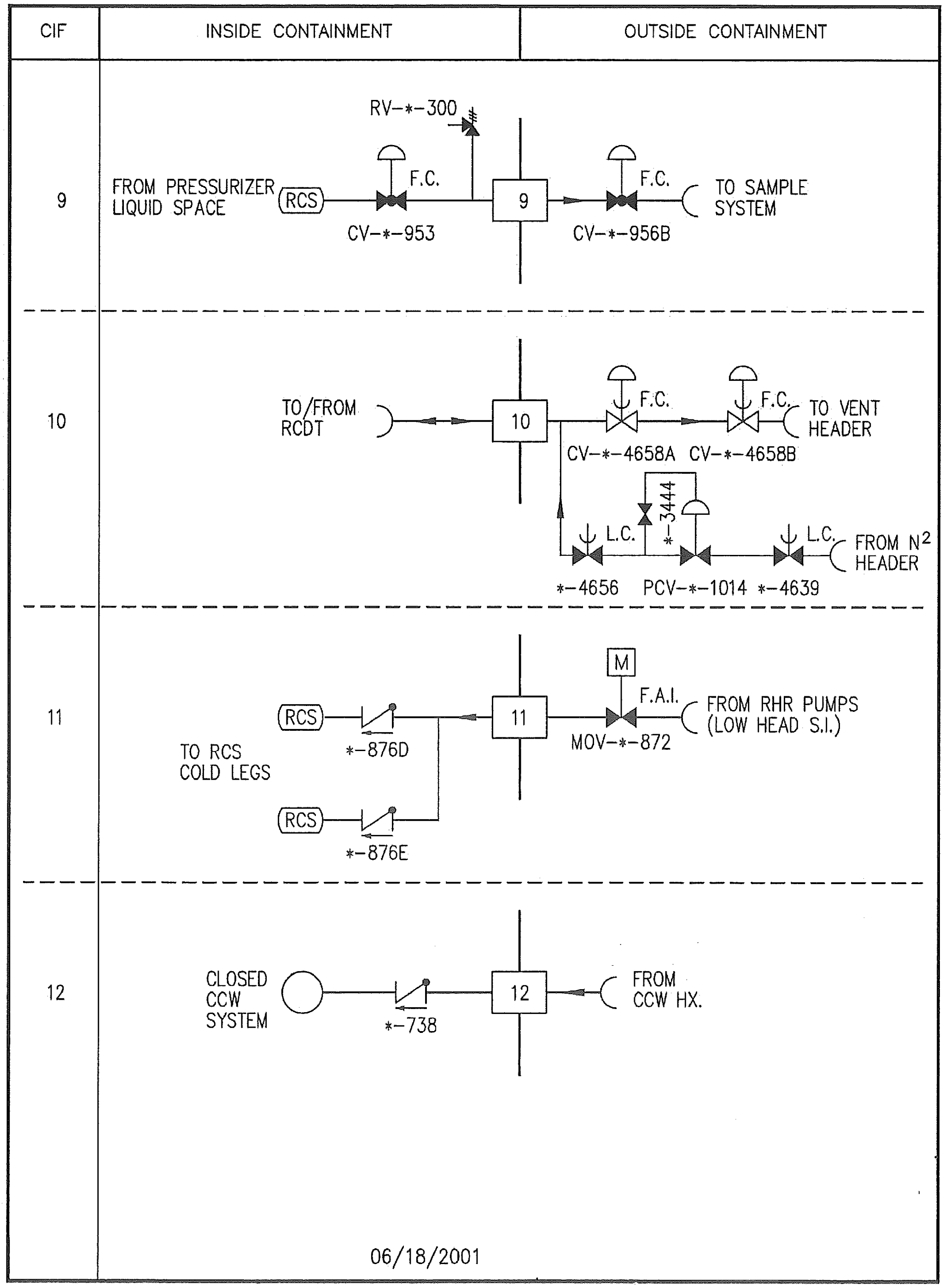
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 2

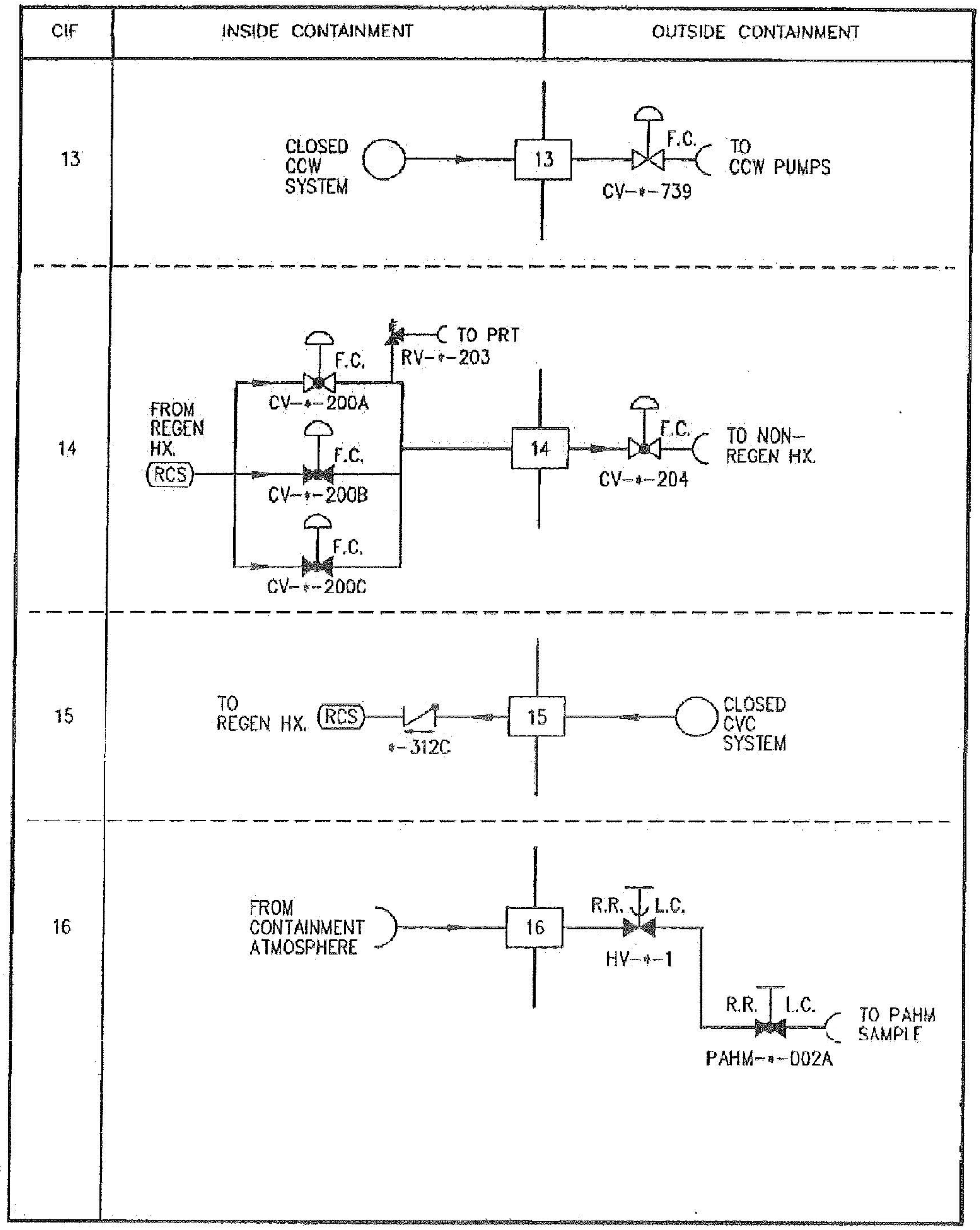
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 3

FIGURE 6.6-1



Revised 04/06/2018

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TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 4

FIGURE 6.6-1

C29

CIF	INSIDE CONTAINMENT	OUTSIDE CONTAINMENT

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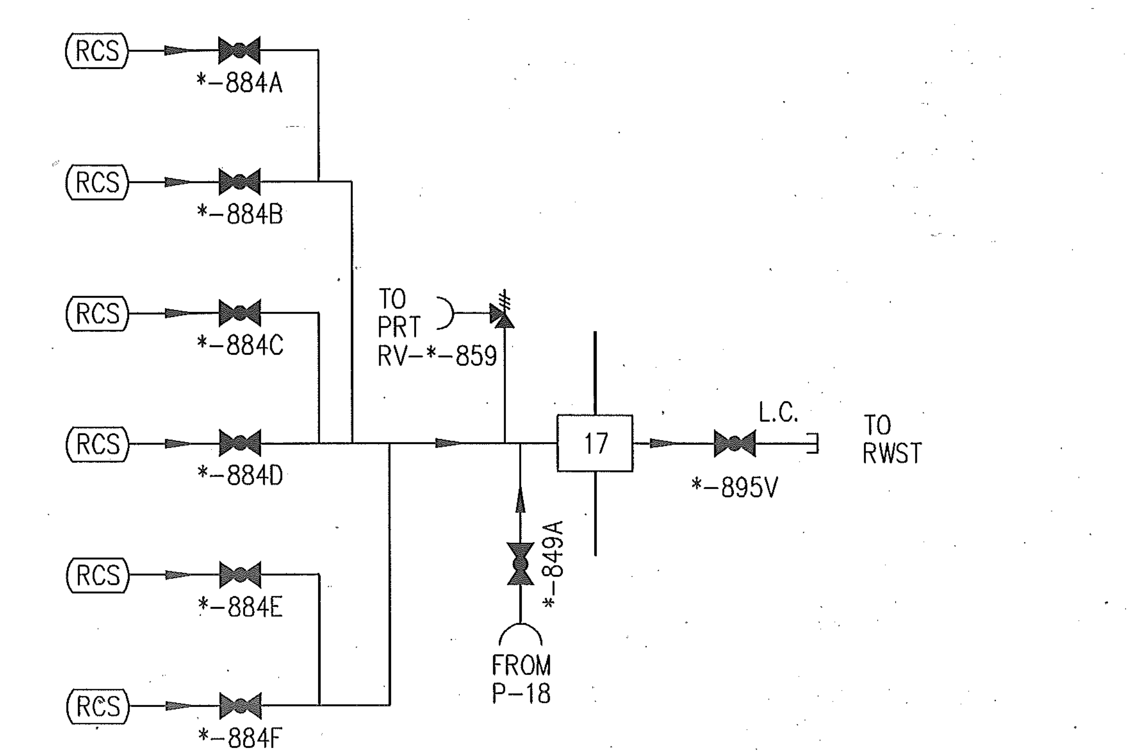
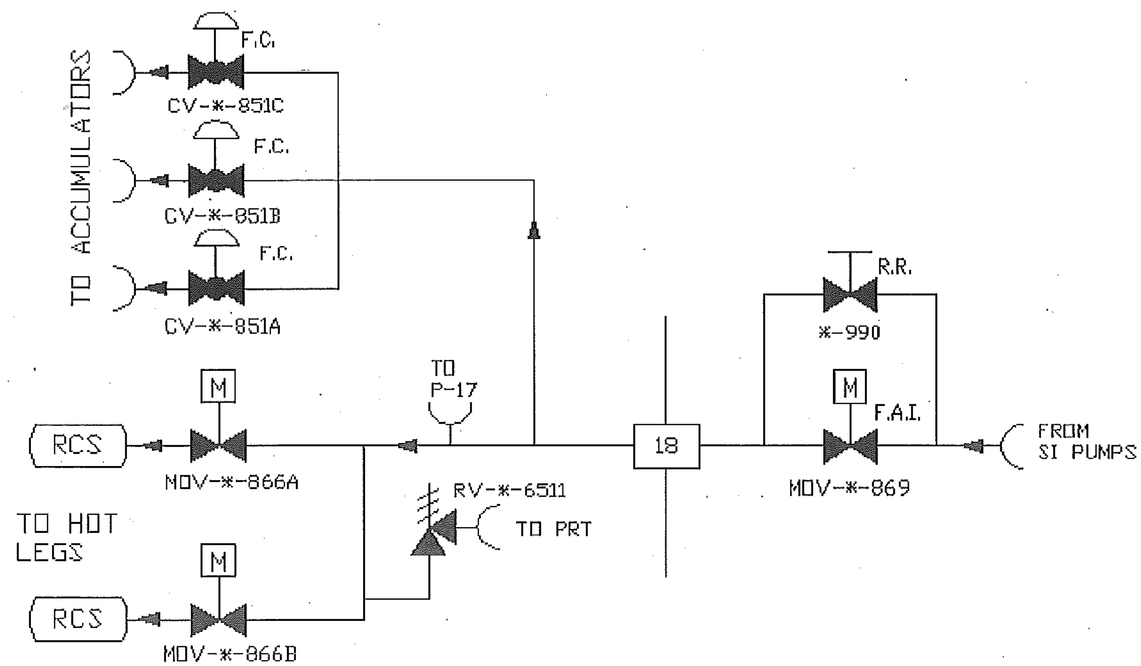


18



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Revised 04/17/2013

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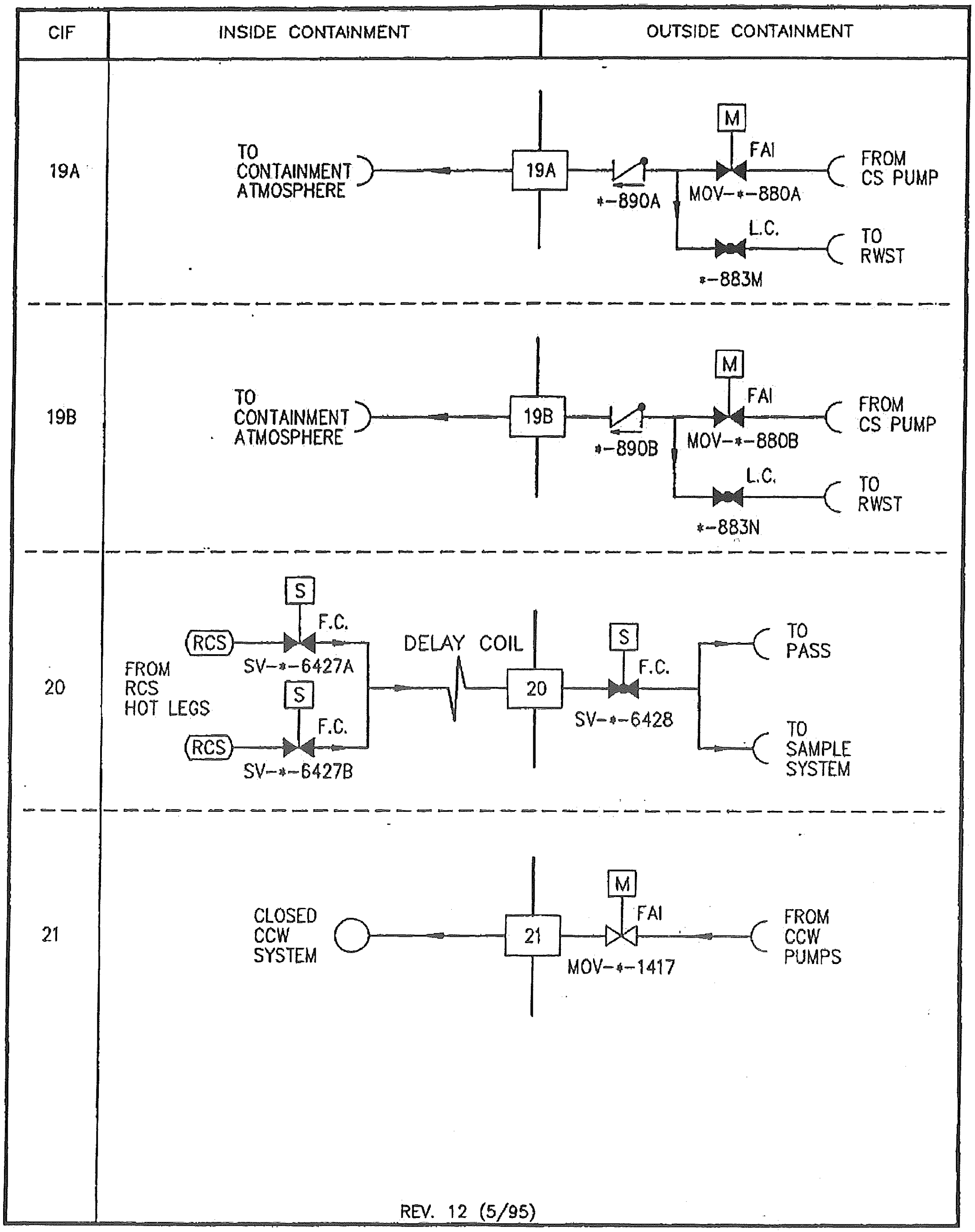
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 5

FIGURE 6.6-1



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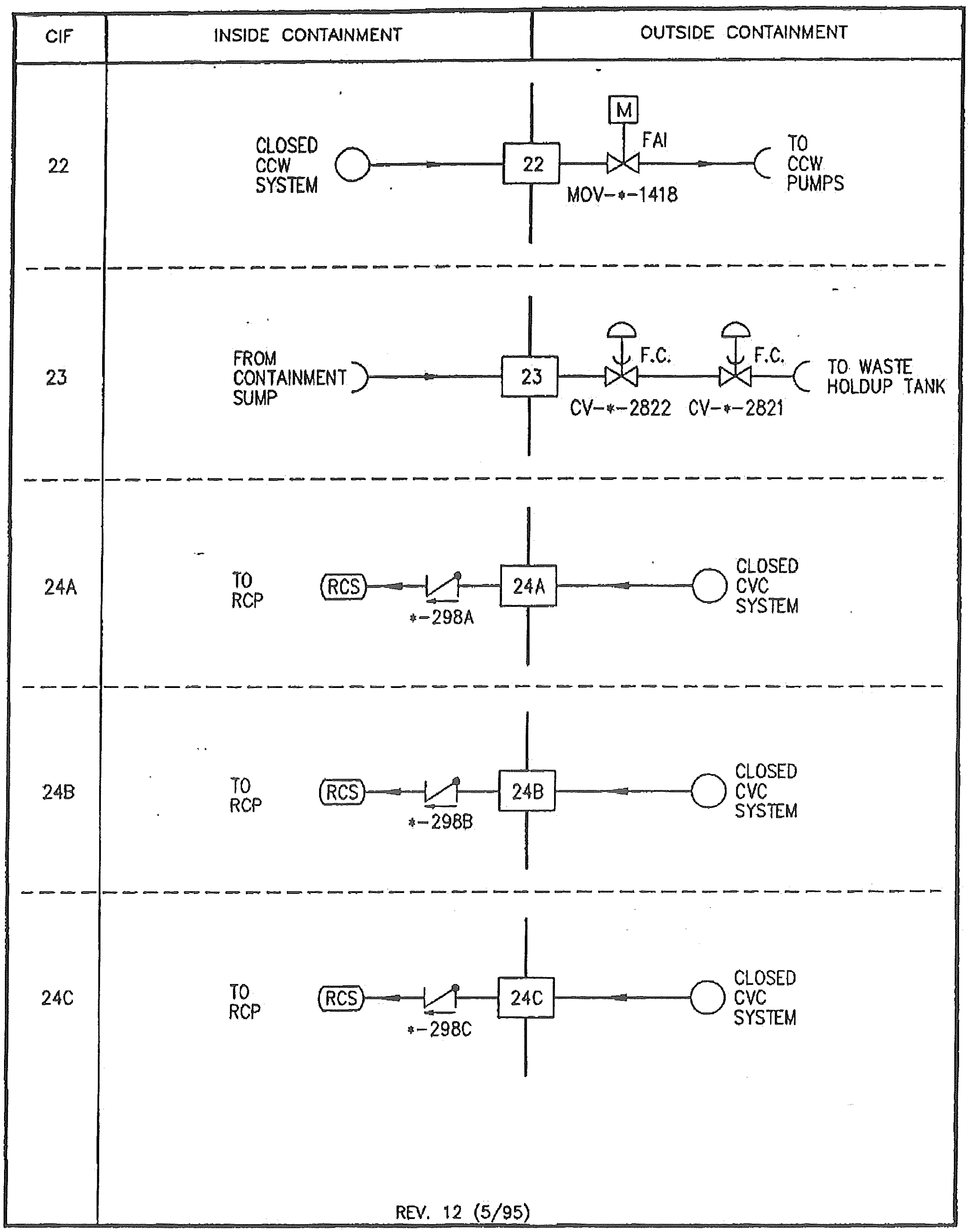
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 6

FIGURE 6.6-1



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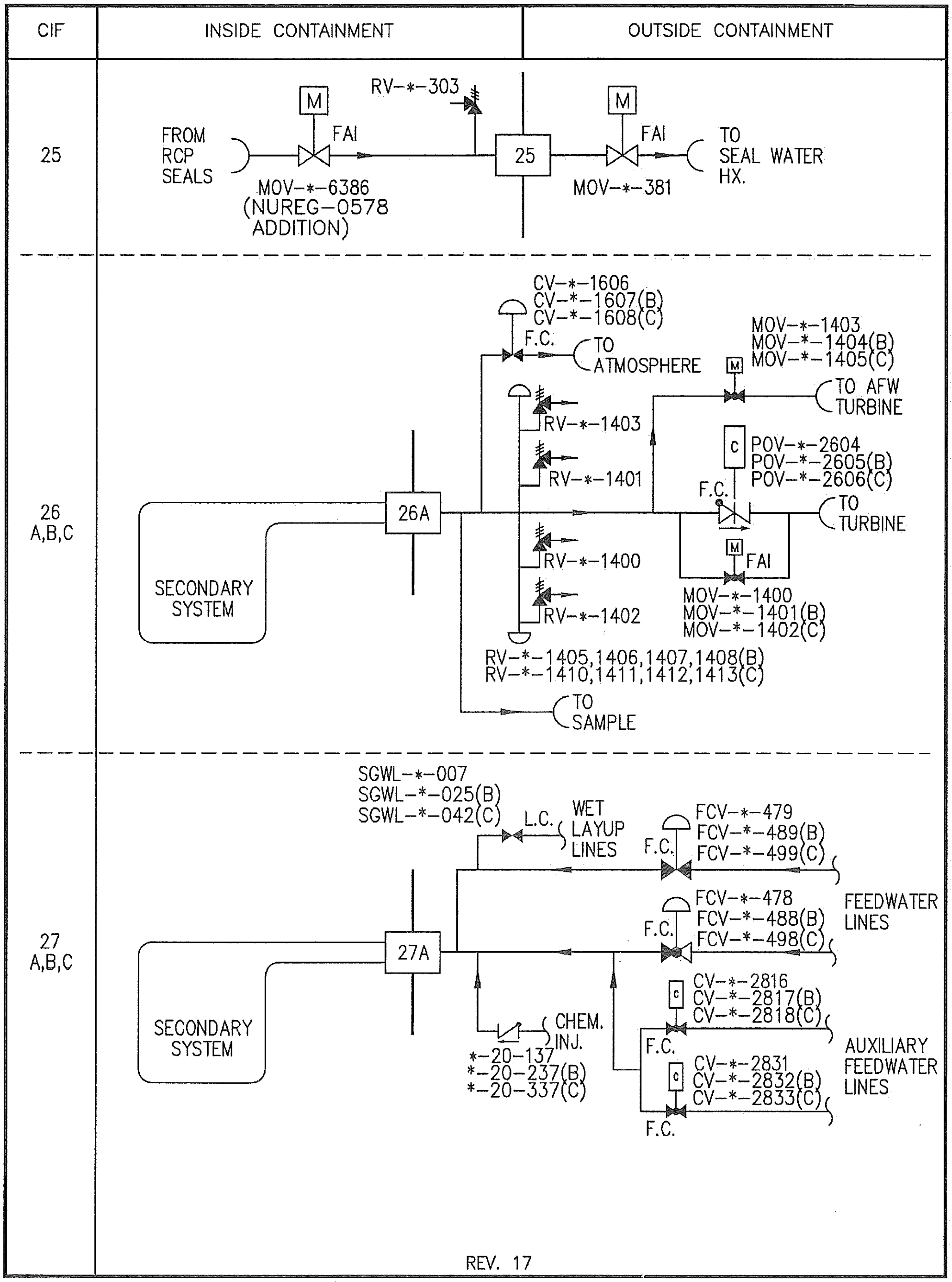
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 7

FIGURE 6.6-1



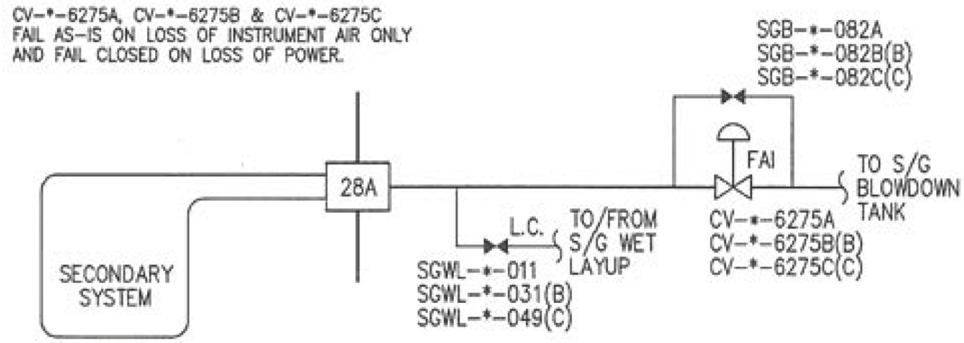
FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 8

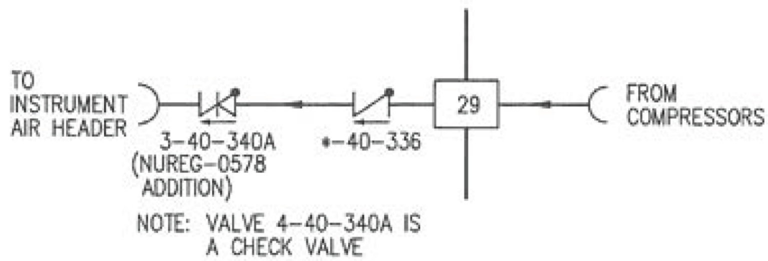
FIGURE 6.6-1

CIF	INSIDE CONTAINMENT	OUTSIDE CONTAINMENT

28
A, B,
C

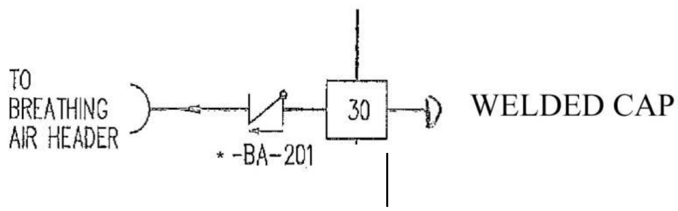


29



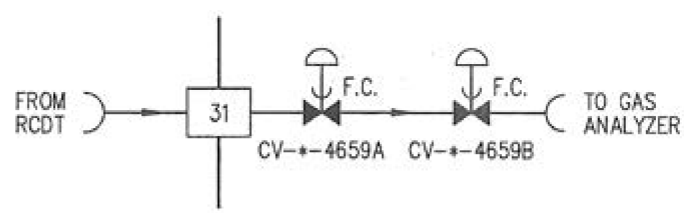
30

Check Valve *-BA-201
Internals removed



C28

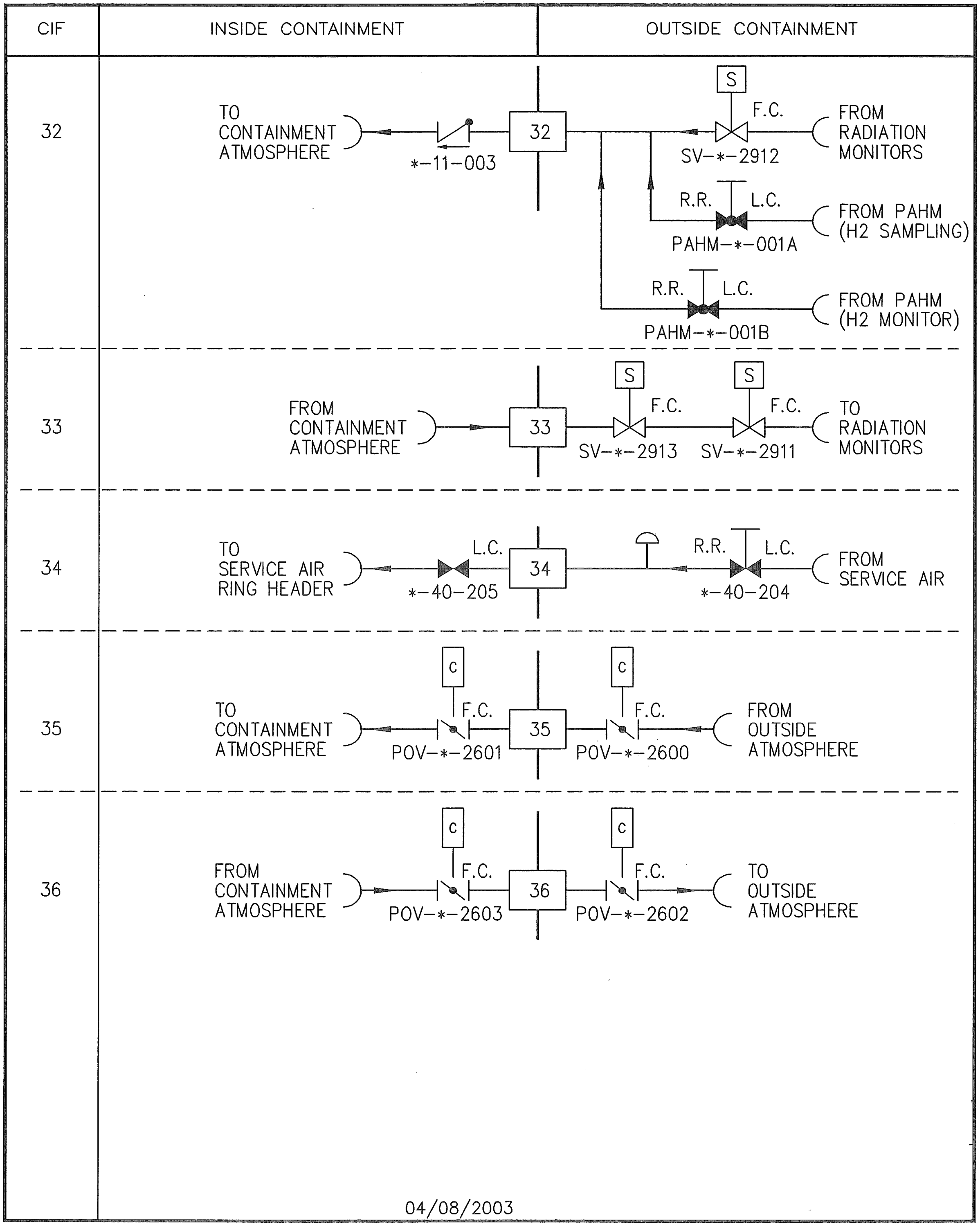
31



Revised 07/28/2016

FLORIDA POWER & LIGHT COMPANY
TURKEY POINT NUCLEAR UNITS 3 & 4

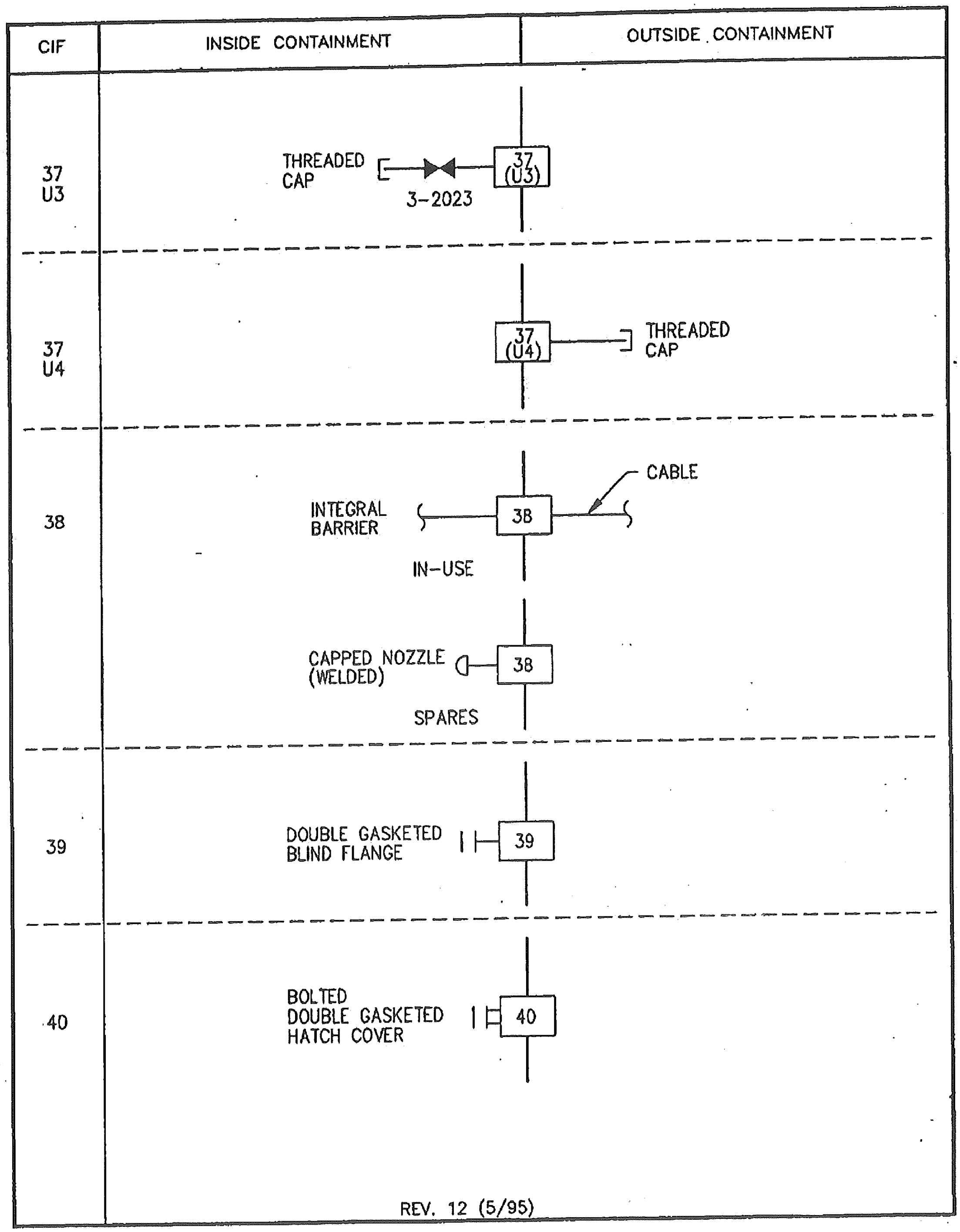
VALVE ARRANGEMENT
SHEET 9
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 10

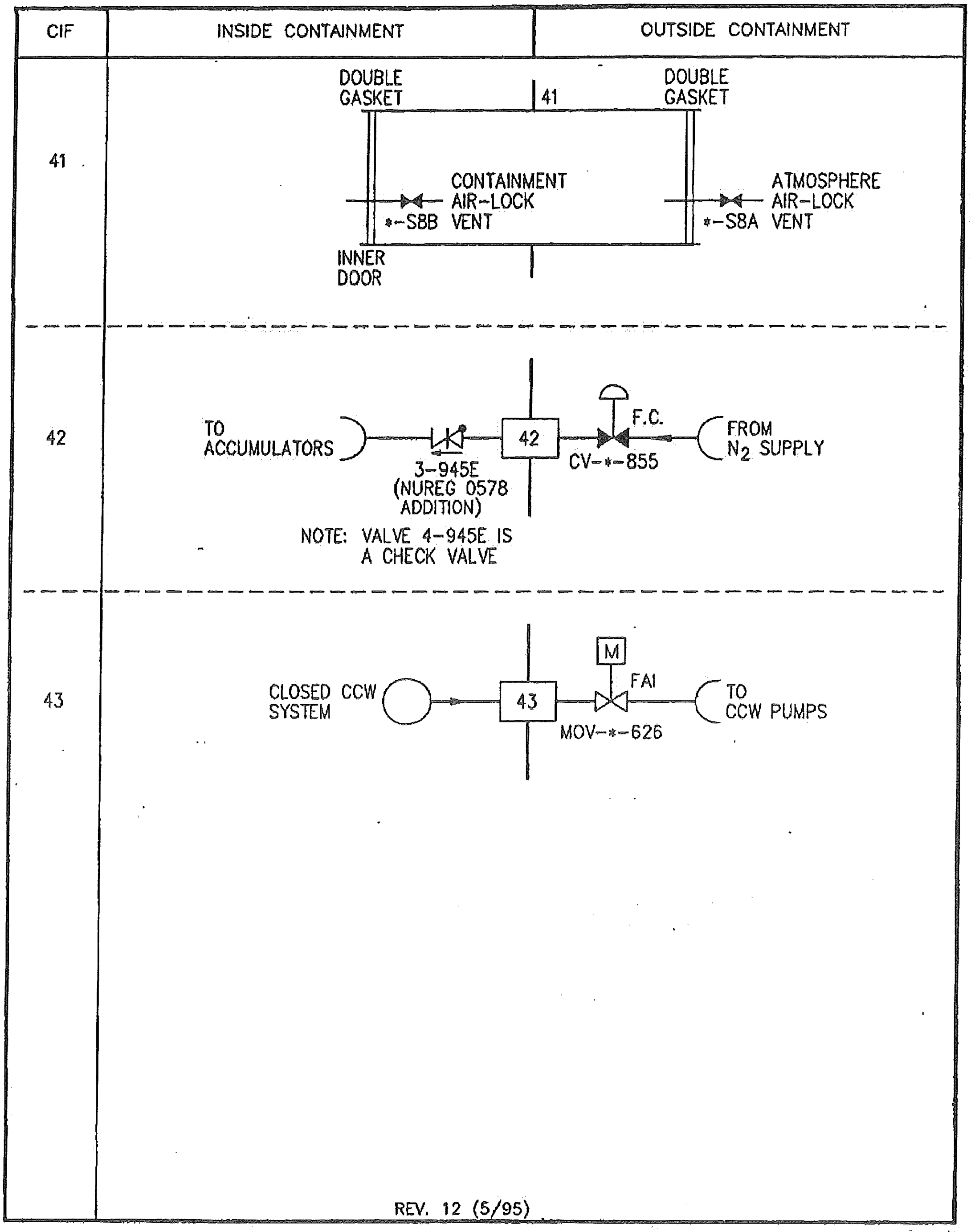
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 11

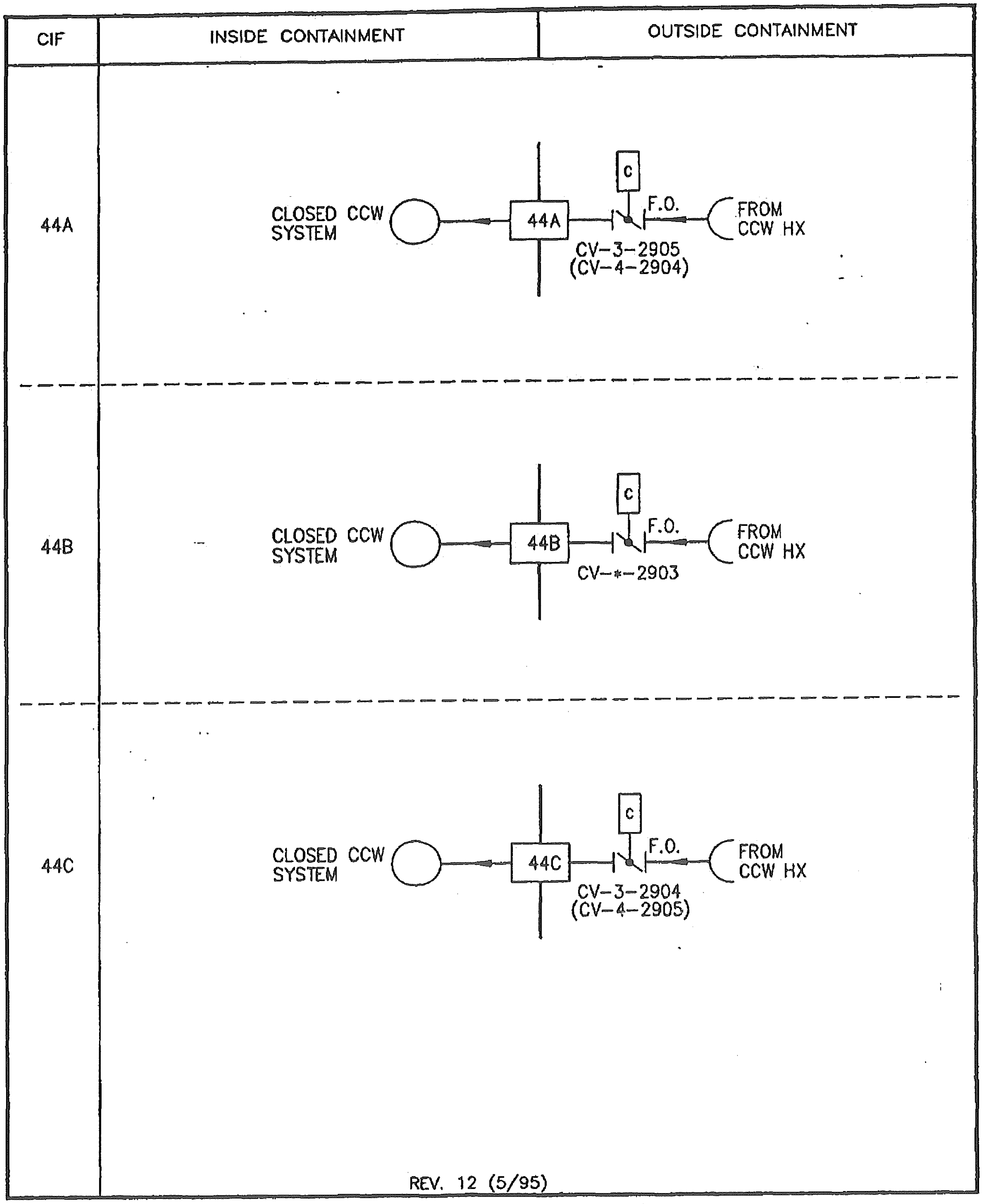
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 12

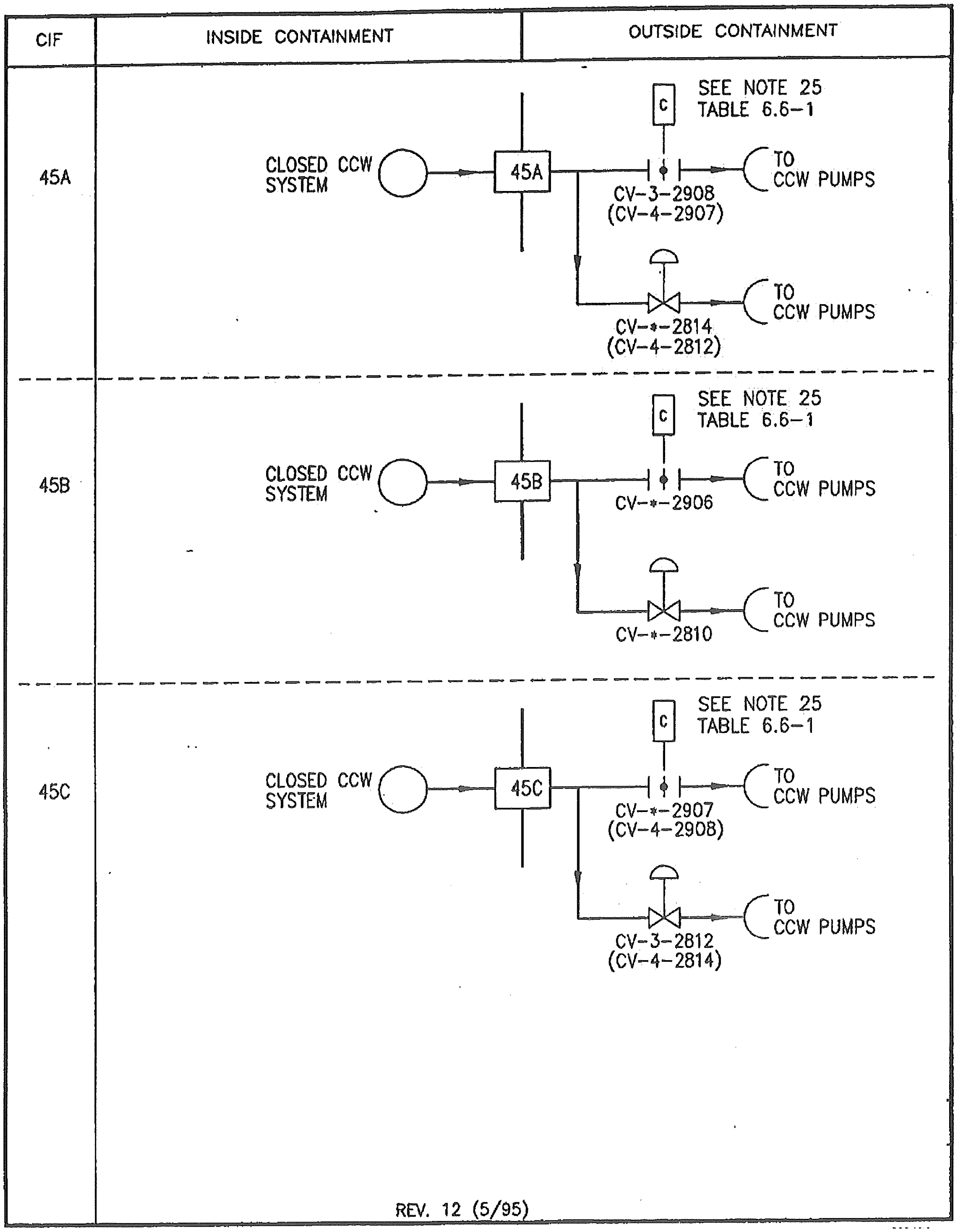
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 13

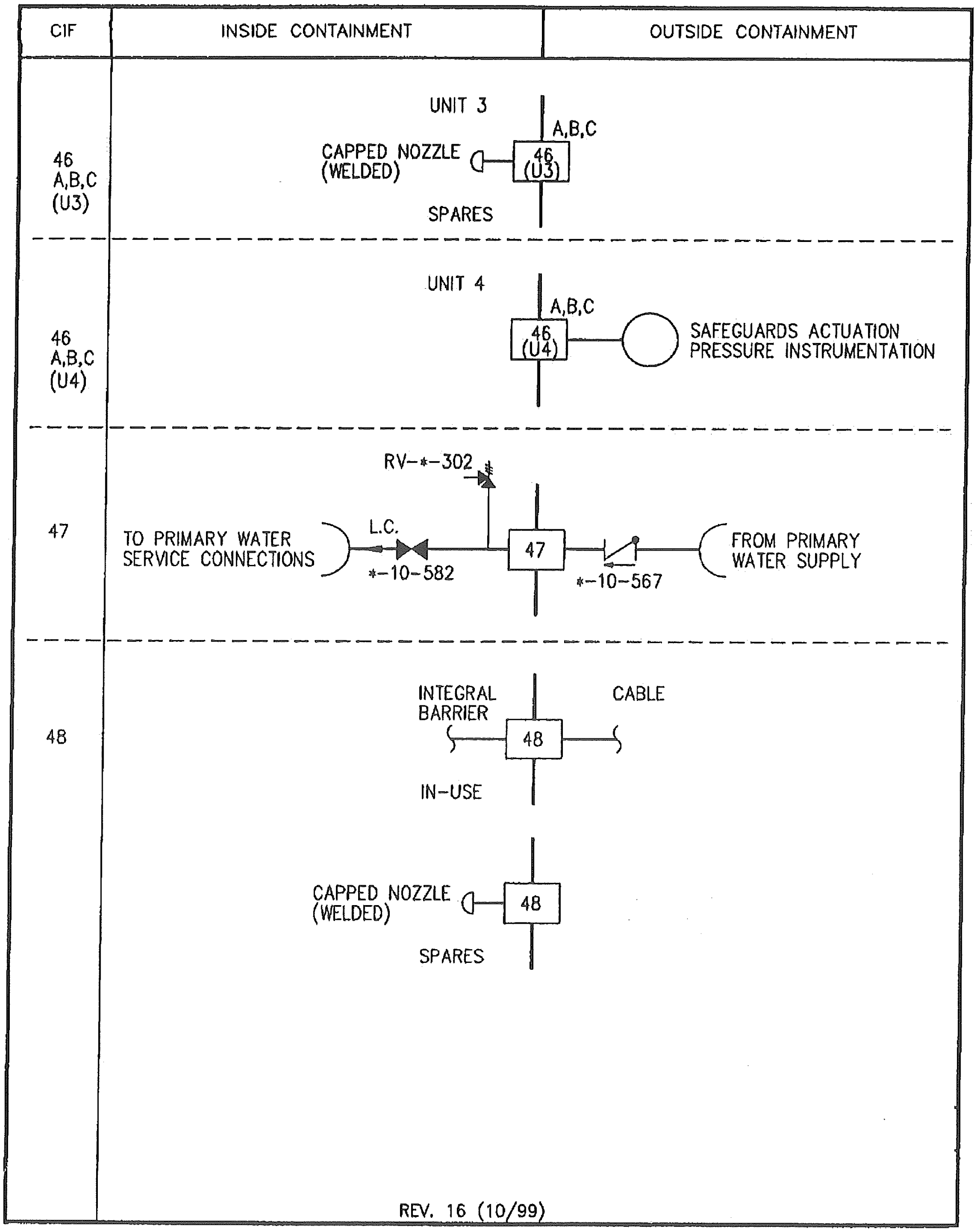
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 14

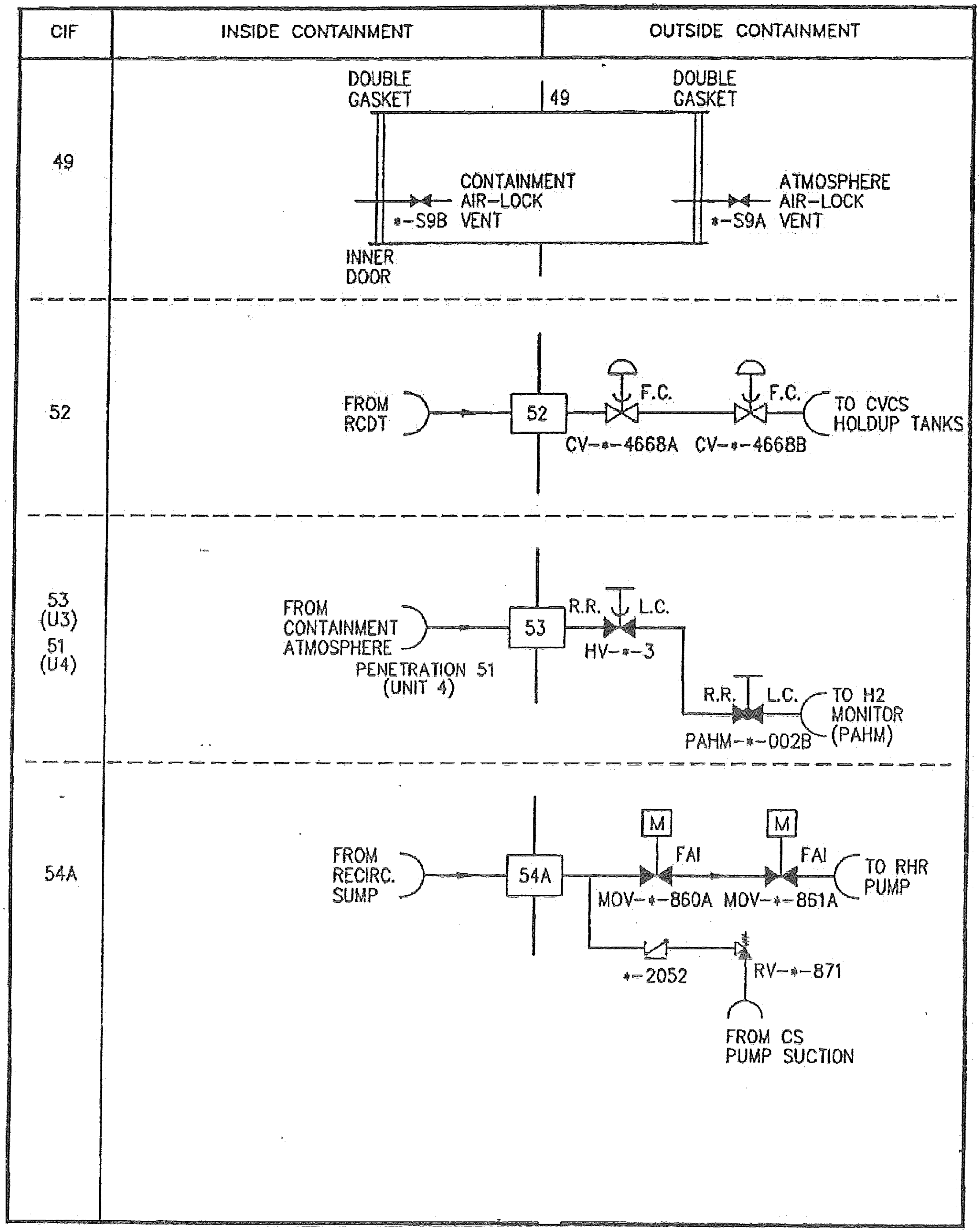
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 15

FIGURE 6.6-1



C26

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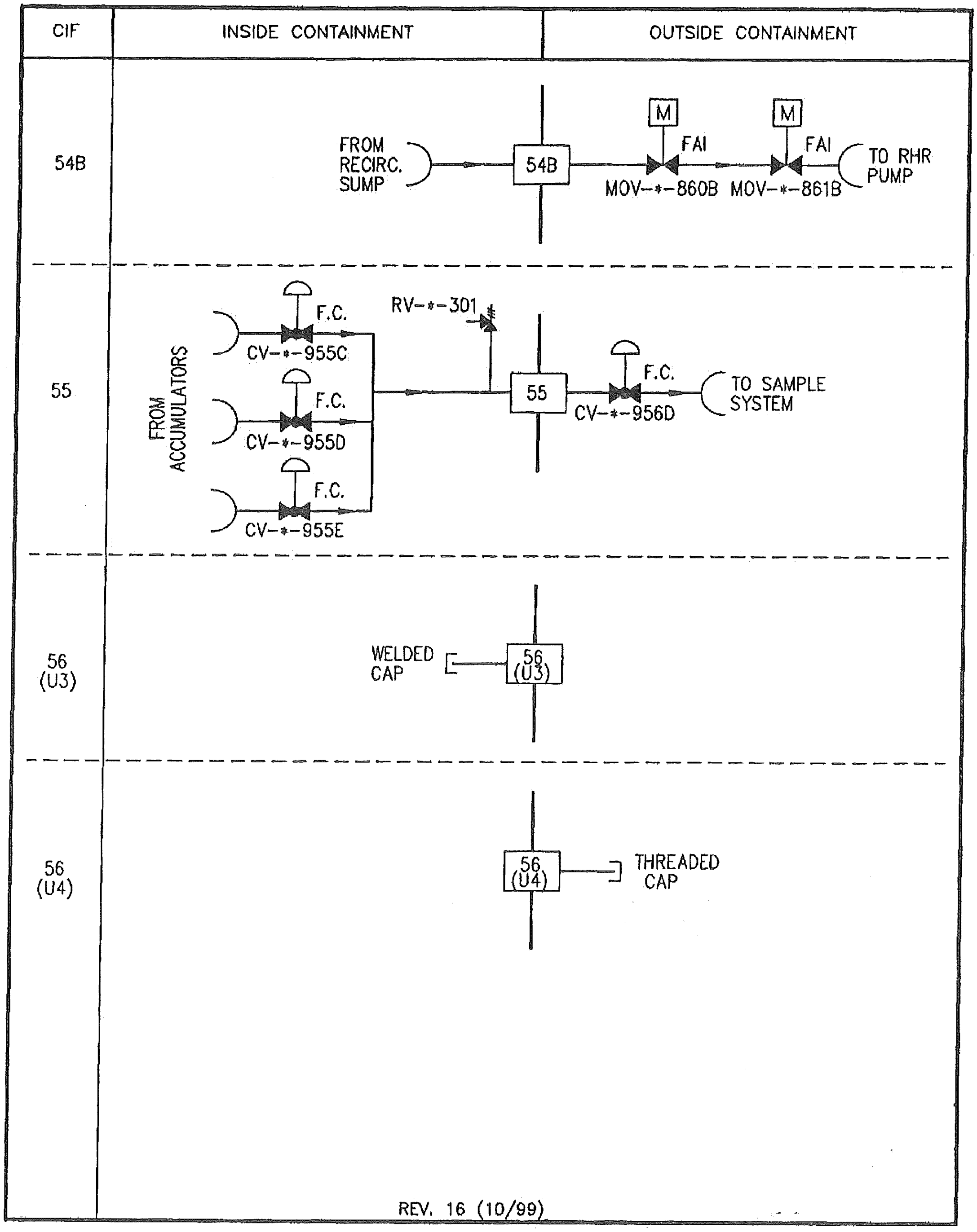
FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 16

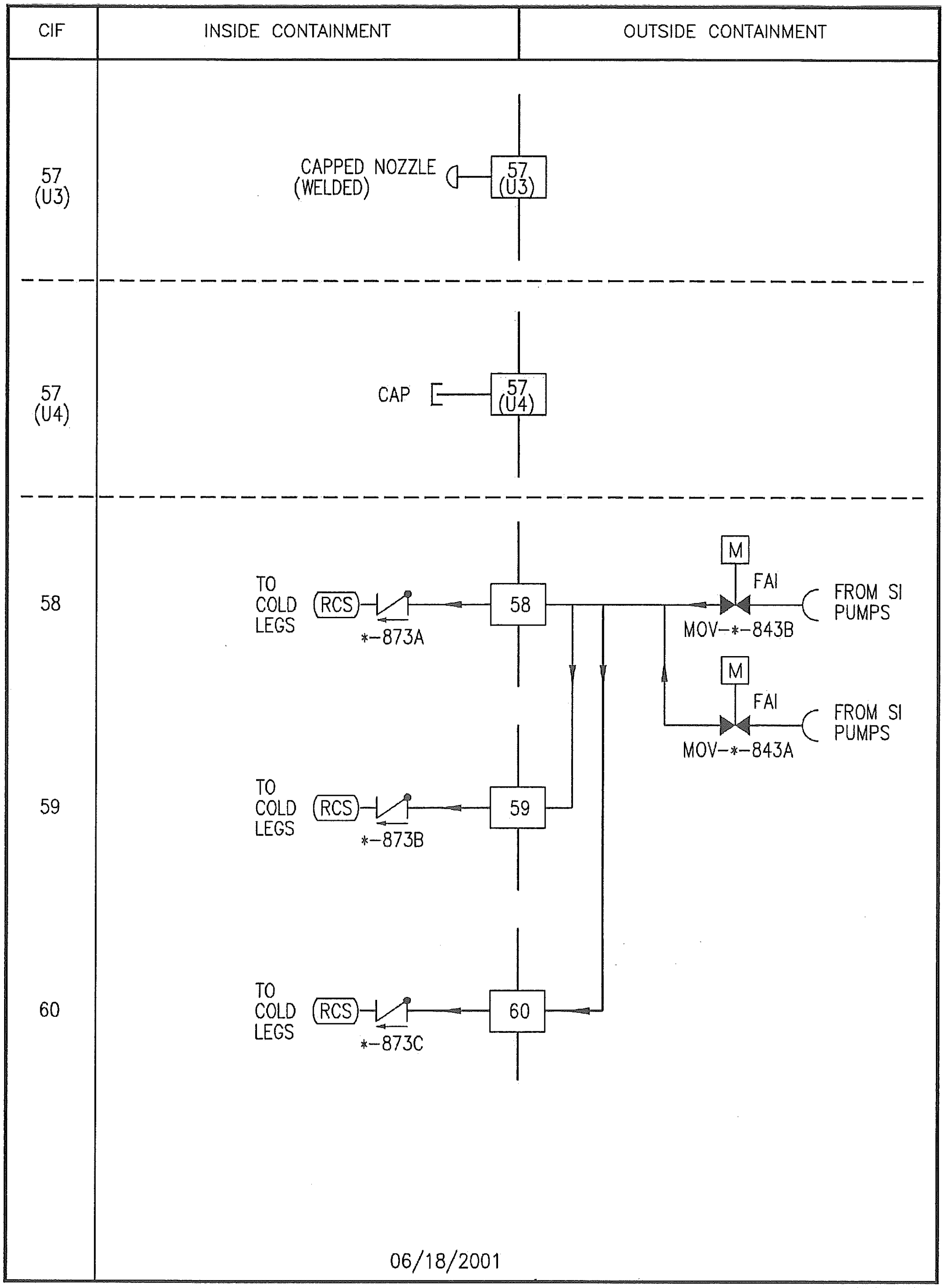
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 17

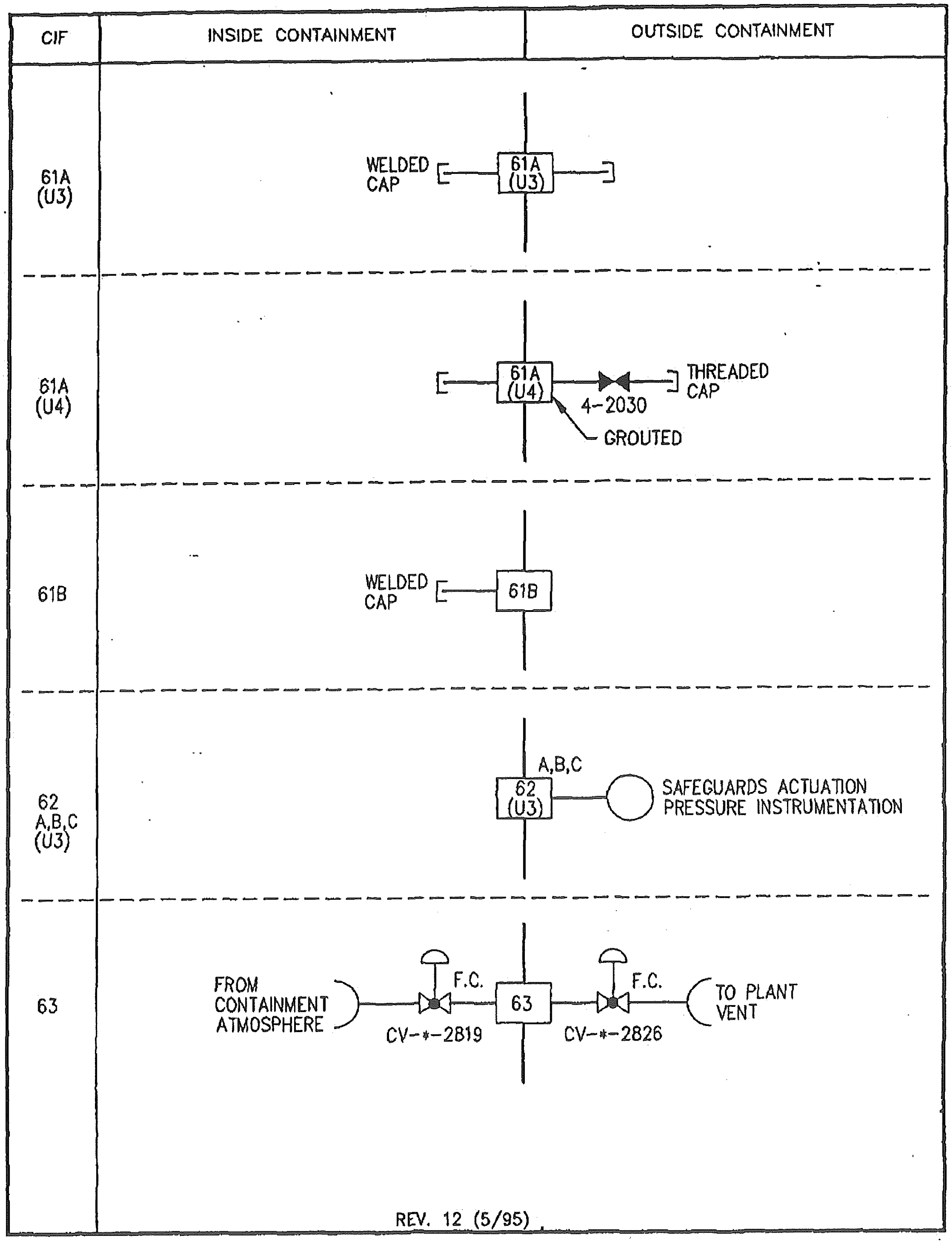
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 18

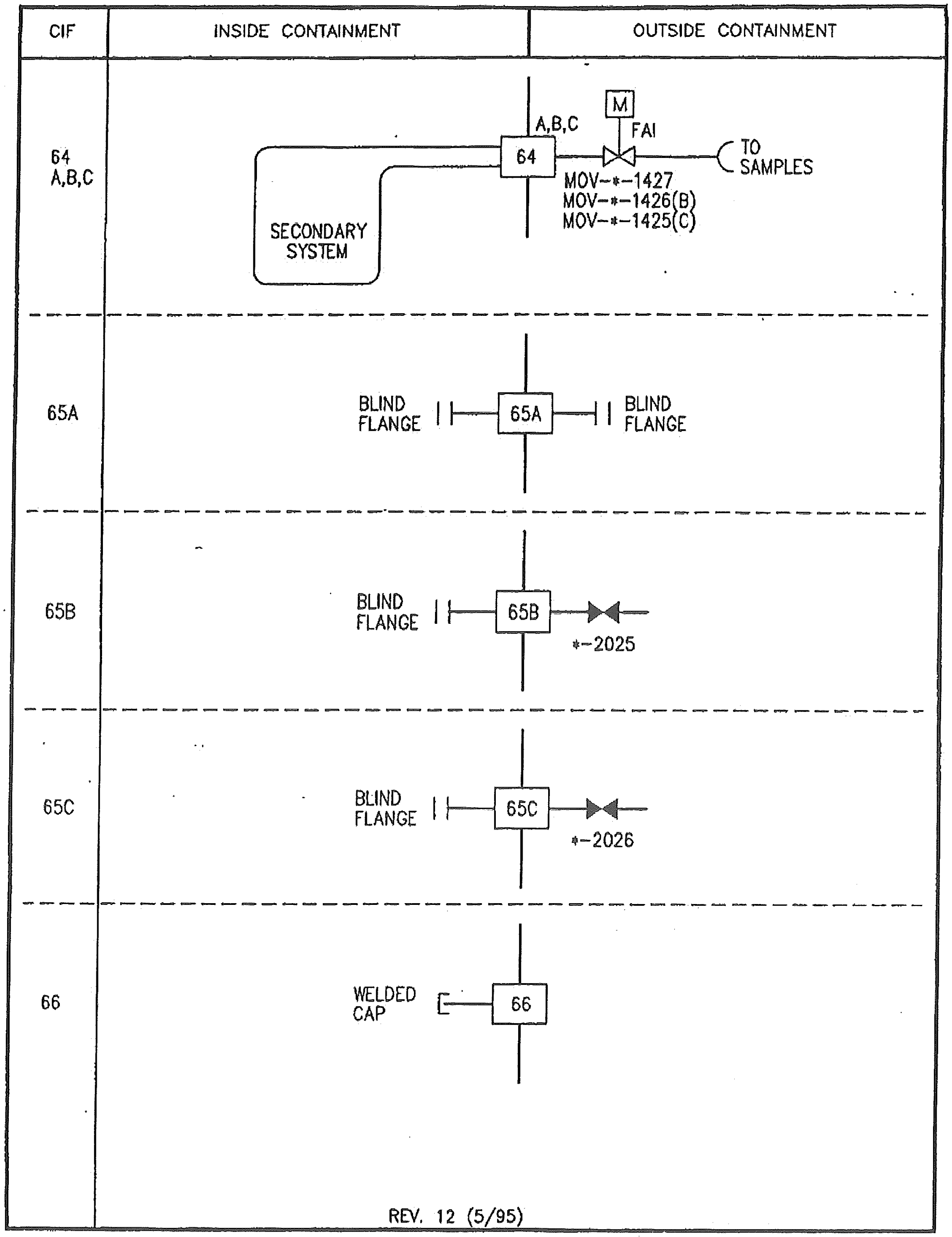
FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 19

FIGURE 6.6-1



FLORIDA POWER & LIGHT COMPANY
TURKEY POINT PLANT UNITS 3 & 4

VALVE ARRANGEMENT
SHEET 20

FIGURE 6.6-1

FINAL SAFETY ANALYSIS REPORT

FIGURE 6.6-2

REFER TO ENGINEERING DRAWING

5610-M-3000 , SHEET 2

REV. 13 (10/96)

FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT UNITS 3 & 4

LEGEND & GENERAL NOTES

FIGURE 6.6-2

6.7 ENVIRONMENTAL QUALIFICATION TESTING OF SAFEGUARD COMPONENTS

6.7.1 GENERAL

The environmental safeguard components that are required for the mitigation of a loss of coolant or a High Energy Line break (inside and outside containment) accident and for the post-accident monitoring, are described in Appendix 8A of the FSAR