Attachment 3

~~2.2 MITIGATING SYSTEMS CORNERSTONE~~

~~The objective of this cornerstone is to monitor the availability, reliability, and capability of systems that mitigate the effects of initiating events to prevent core damage. Licensees reduce the likelihood of reactor accidents by maintaining the availability and reliability of mitigating systems. Mitigating systems include those systems associated with safety injection, decay heat removal, and their support systems, such as emergency ac power. This cornerstone includes mitigating systems that respond to both operating and shutdown events.~~

~~Some aspects of mitigating system performance cannot be adequately reflected or are specifically excluded from the performance indicators in this cornerstone. These aspects include performance of structures, systems, and components (SSCs) specifically excluded from the performance indicators, the effect of common cause failure, and the performance of certain plant specific systems. These aspects of licensee performance will be addressed through the NRC inspection program.~~
~~There are two sets of indicators in this cornerstone:~~

- ~~Mitigating System Performance Index~~
- ~~Safety System Functional Failures~~

MITIGATING SYSTEM PERFORMANCE INDEX

Purpose

The purpose of the mitigating system performance index is to monitor the ~~risk impact of changes in~~ performance of selected systems *based on their ability to perform risk-significant functions as defined here-in.*~~.~~ It is comprised of two elements - system unavailability and system unreliability. ~~For single demand failures and accumulated unavailability, T~~the index is used to determine the significance of performance issues *for single demand failures and accumulated unavailability.*~~.~~ Due to the limitations of the index, the following conditions will rely upon the inspection process for ~~evaluating~~*determining the significance of* performance issues:

1. Multiple concurrent failures of components ~~within a monitored system~~
2. Common cause failures
3. Conditions not capable of being discovered during normal surveillance tests
4. Failures of non-active components

Indicator Definition

Mitigating System Performance Index (MSPI) is the sum of changes in a simplified core damage frequency evaluation resulting from changes in unavailability and unreliability relative to baseline values.

~~Train~~ Unavailability is the ratio of the hours the train*/system* was unavailable to perform its risk-significant functions due to planned and unplanned maintenance or test on active and non-active components during the previous 12 quarters while critical to the number of critical hours

during the previous 12 quarters. (Fault exposure hours are not included; unavailable hours are counted only for the time required to recover the train's risk-significant functions)

~~*Train u*~~*Unreliability* is the probability that the ~~train~~ *system* would not perform its risk-significant functions when called upon during the previous 12 quarters.

Baseline values are the values for unavailability and unreliability against which current changes in unavailability and unreliability are measured. See Appendix F for further details.

The MSPI is calculated separately for each of the following five systems for each reactor type.

BWRs

- emergency AC power system
- high pressure injection systems (high pressure coolant injection, high pressure core spray, or feedwater coolant injection)
- heat removal systems (reactor core isolation cooling)
- residual heat removal system *(or their equivalent function as described in the Additional Guidance for Specific Systems section.)*
- cooling water support system (includes risk significant direct cooling functions provided by service water and component cooling water or their cooling water equivalents for the above four monitored systems)

PWRs

- emergency AC power system
- high pressure safety injection system
- auxiliary feedwater system
- residual heat removal system *(or their equivalent function as described in the Additional Guidance for Specific Systems section.)*
- cooling water support system (includes risk significant direct cooling functions provided by service water and component cooling water or their cooling water equivalents for the above four monitored systems)

Data Reporting Elements

The following data elements are reported for each system

- Unavailability Index (UAI) due to unavailability for each monitored system
- Unreliability Index (URI) due to unreliability for each monitored system

During the pilot, the additional data elements necessary to calculate UAI and URI will be reported monthly for each system on an Excel spreadsheet. See Appendix F.

Calculation

The MSPI for each system is the sum of the UAI due to unavailability for the system plus URI due to unreliability for the system during the previous twelve quarters.

MSPI = UAI + URI

See Appendix F for the calculational methodology for UAI due to system unavailability and URI due to system unreliability.

Definition of Terms

A train consists of a group of components that together provide the risk significant functions of the system as explained in the additional guidance for specific mitigating systems Fulfilling the risk-significant function of the system may require one or more trains of a system to operate simultaneously. The number of trains in a system is *generally* determined as follows:

- for systems that provide cooling of fluids, the number of trains is determined by the number of parallel heat exchangers, or the number of parallel pumps, or the minimum number of parallel flow paths, whichever is fewer.

- for emergency AC power systems the number of trains is the number of class 1E emergency (diesel, gas turbine, or hydroelectric) generators at the station that are installed to power shutdown loads in the event of a loss of off-site power. (This does not include the diesel generator dedicated to the BWR HPCS system, which is included in the scope of the HPCS system.)

Risk Significant Functions: those at power functions of risk-significant SSCs as modeled in the plant-specific PRA. Risk metrics for identifying risk-significant functions are:

Risk Achievement Worth > 2.0, *or*
Risk Reduction Worth >*1*~~0~~.005 *(Fussell-Vesely>0.005), or*
The risk significant functions that appear in the PRA cutsets that account for the top 90% of core damage frequency~~90% of core damage frequency accounted for.~~

Risk-Significant Mission Times: The mission time modeled in the PRA for satisfying the risk-significant function of reaching a stable plant condition where normal shutdown cooling is sufficient. Note that PRA models typically analyze an event for 24 hours, which may exceed the time needed for the risk-significant function captured in the MSPI. However, other intervals as justified by analyses and modeled in the PRA may be used.

Success criteria are the plant specific values of parameters the train/system is required to achieve to perform its risk-significant function. Default values of those parameters are the plant's design bases values unless other values are modeled in the PRA.

Clarifying Notes

Documentation

Each licensee will have the system boundaries, active components, risk-significant functions and success criteria readily available for NRC inspection on site. Additionally, plant-specific information used in Appendix F should also be readily available for inspection.

Success Criteria

~~The success criteria are based on train/system mission times, not on component mission times.~~ Individual component capability must be evaluated against train/system level success criteria *(e.g., a valve stroke time may exceed an ASME requirement, but if the valve still strokes in time to meet the PRA success criteria for the train/system, the component has not failed for the purposes of this indicator because the risk-significant train/system function is still satisfied).* Important plant specific performance factors that can be used to identify the required capability of the train/system to meet the risk-significant functions include, but are not limited to.

- Actuation
  - Time
  - Auto/manual
  - Multiple or sequential
- Success requirements
  - Numbers of components or trains
  - Flows
  - Pressures
  - Heat exchange rates
  - Temperatures
  - Tank water level
- Other mission requirements
  - Run time
  - State/configuration changes during mission
- Accident environment from internal events
  - Pressure, temperature, humidity
- Operational factors
  - Procedures
  - Human actions
  - Training
  - Available externalities (e.g., power supplies, special equipment, etc.)

System/Component Interface Boundaries

For active components that are supported by other components from both monitored and unmonitored systems, the following general rules apply:

- For control and motive power, only the last relay, breaker or contactor necessary to power or control the component is included in the active component boundary. For example, if an ESFAS signal actuates a MOV, only the relay that receives the ESFAS signal in the control circuitry for the MOV is in the MOV boundary. No other portions of the ESFAS are included.

- For water connections from systems that provide cooling water to an active component, only the final active connecting valve is included in the boundary. For example, for service water that provides cooling to support an AFW pump, only the final active valve in the service water system that supplies the cooling water to the AFW system is included in the AFW system scope. This same valve is not included in the cooling water support system scope.

<u>Water Sources and Inventory</u>

Water tanks are not considered to be active components. As such, they do not contribute to URI. However, periods of insufficient water inventory contribute to UAI if they result in loss of the risk-significant train function for the required mission time. Water inventory can include operator recovery actions for water make-up provided the actions can be taken in time to meet the mission times and are modeled in the PRA. If ~~alternate~~ *additional* water sources are required ~~to provide make-up~~ to satisfy train mission times, only the connecting active valve from the ~~alternate system~~*additional water source* is considered as an active component for calculating URI. *If there are valves in the primary water source that must change state to permit use of the additional water source, these valves are considered active and should be included in URI for the system.*

<u>Monitored Systems</u>

Systems have been generically selected for this indicator based on their importance in preventing reactor core damage. The systems include the principal systems needed for maintaining reactor coolant inventory following a loss of coolant accident, for decay heat removal following a reactor trip or loss of main feedwater, and for providing emergency AC power following a loss of plant off-site power. One risk-significant support function (cooling water support system) is also monitored. The cooling water support system monitors the risk significant cooling functions provided by service water and component cooling water, or their direct cooling water equivalents, for the four front-line monitored systems. No support systems are to be cascaded onto the monitored systems, e.g., HVAC room coolers, DC power, instrument air, etc.

<u>Diverse Systems</u>

Except as specifically stated in the indicator definition and reporting guidance, no credit is given for the achievement of a risk-significant function by an unmonitored system in determining unavailability or unreliability of the monitored systems.

<u>Common Components</u>

Some components in a system may be common to more than one train or system, in which case the unavailability/*unreliability* of a common component is included in all affected trains or systems

Short Duration Unavailability

Trains are generally considered to be available during periodic system or equipment realignments to swap components or flow paths as part of normal operations. Evolutions or surveillance tests that result in less than 15 minutes of unavailable hours per train at a time need not be counted as unavailable hours. Licensees should compile a list of surveillances/evolutions that meet this criterion and have it available for inspector review. In addition, equipment misalignment or mispositioning which is corrected in less than 15 minutes need not be counted as unavailable hours. The intent is to minimize unnecessary burden of data collection, documentation, and verification *because these short durations have insignificant risk impact.*

If a licensee is required to take a component out of service for evaluation and corrective actions for greater than 15 minutes (for example, related to a Part 21 Notification), the unavailable hours must be included.

~~Treatment of Degraded Conditions~~

~~If a degraded condition results in the failure to meet an established success criterion, unavailable hours must be included for the time required to recover the train's risk-significant function(s). If an active component, as defined in Appendix F, is degraded such that it cannot meet its risk-significant function, a demand and a demand failure are also counted. If subsequent analysis identifies additional margin for the success criterion, future unavailable hours for degraded conditions may be determined based on the new criterion. However, unavailability must be based on the success criteria of record at the time the degraded condition is discovered. If the degraded condition is not addressed by any of the pre-defined success criteria, an engineering evaluation to determine the impact of the degraded condition on the risk-significant function(s) should be completed and documented. The use of component failure analysis, circuit analysis, or event investigations is acceptable. Engineering judgment may be used in conjunction with analytical techniques to determine the impact of the degraded condition on the risk-significant function. The engineering evaluation should be completed as soon as practicable. If it cannot be completed in time to support submission of the PI report for the current quarter, the comment field shall note that an evaluation is pending. The evaluation must be completed in time to accurately account for unavailability/unreliability in the next quarterly report. Exceptions to this guidance are expected to be rare and will be treated on a case-by-case basis. Licensees should identify these situations to the resident inspector.~~

~~Failures on Demand~~

~~Failures of active components (see Appendix F) on demand, either actual or test, while critical, are included in unreliability. Failures on demand while non-critical must be evaluated to determine if the failure would have resulted in the train not being able to perform its risk-significant at power functions, and must therefore be included in unreliability. Unavailable hours~~

~~are included only for the time required to recover the train's risk-significant functions and only when the reactor is critical.~~

~~Discovered Conditions that are capable of being discovered by normal surveillance tests~~

~~Normal surveillance tests are those tests that are performed at a frequency of a refueling cycle or more frequently. Discovered conditions that render an active component incapable of performing its risk-significant functions are included in unreliability as a demand and a failure (unless corrected in less than 15 minutes). Unavailable hours are counted only for the time required to recover the train's risk-significant functions and only when the reactor is critical. The ROP inspection process would be used to determine the significance of discovered conditions that rendered a train incapable of performing its risk-significant function, but were not active component conditions (for example, a shut manual suction valve).~~

~~Demand failures or discovered conditions that are not capable of being discovered during normal surveillance tests~~

~~These failures or conditions are usually of longer exposure time. Since these failure modes have not been tested on a regular basis, it is inappropriate to include them in the performance index statistics. These failures or conditions are subject to evaluation through the inspection process. Examples of this type are failures due to pressure locking/thermal binding of isolation valves, blockages in lines not regularly tested, or inadequate component sizing/settings under accident conditions (not under normal test conditions). While not included in the calculation of the index, they should be reported in the comment field of the PI data submittal.~~

Treatment of Demand /Run Failures and Degraded Conditions

1. *Treatment of Demand and Run Failures*
   Failures of active components (see Appendix F) on demand or failures to run, either actual or test, while critical, are included in unreliability. Failures on demand or failures to run with the reactor shutdown~~while non-critical~~ must be evaluated to determine if the failure would have resulted in the train not being able to perform its risk-significant at power functions, and must therefore be included in unreliability. Unavailable hours are included only for the time required to recover the train's risk-significant functions and only when the reactor is critical.

2. *Treatment of Degraded Conditions*

   a) *Capable of Being Discovered By Normal Surveillance Tests*
   Normal surveillance tests are those tests that are performed at a frequency of a refueling cycle or more frequently.

   Degraded conditions, ~~where~~ even if no actual demand existed, that render an active component incapable of performing its risk-significant functions are included in unreliability as a demand and a failure. The appropriate failure mode must be accounted for. For example, for valves, a demand and a demand failure would be assumed and included in URI. For pumps and diesels, if the degraded condition *would have prevented a successful start demand, a demand and a failure is included in URI, but there would be no run time hours or run failures. If it was determined that the pump/diesel would start and load run, but would fail sometime during the 24 hour run test or its surveillance test equivalent~~but not run for the risk-significant mission time~~, the evaluated failure time would be included in run hours and a run failure would be assumed. A start demand and start failure would not be included. Unavailable hours are included for the time required to recover the risk-significant function(s).*

Degraded conditions, or actual unavailability due to mispositioning of non-active components that render a train incapable of performing its risk-significant functions are only included in unavailability for the time required to recover the risk-significant function(s).

Loss of risk significant function(s) is assumed to have occurred if the established success criteria has not been met. If subsequent analysis identifies additional margin for the success criterion, future impacts on URI or UAI for degraded conditions may be determined based on the new criterion. However, URI and UAI must be based on the success criteria of record at the time the degraded condition is discovered. If the degraded condition is not addressed by any of the pre-defined success criteria, an engineering evaluation to determine the impact of the degraded condition on the risk-significant function(s) should be completed and documented. The use of component failure analysis, circuit analysis, or event investigations is acceptable. Engineering judgment may be used in conjunction with analytical techniques to determine the impact of the degraded condition on the risk-significant function. The engineering evaluation should be completed as soon as practicable. If it cannot be completed in time to support submission of the PI report for the current quarter, the comment field shall note that an evaluation is pending. The evaluation must be completed in time to accurately account for unavailability/unreliability in the next quarterly report. Exceptions to this guidance are expected to be rare and will be treated on a case-by-case basis. Licensees should identify these situations to the resident inspector.

b) <u>Not Capable of Being Discovered by Normal Surveillance Tests</u>
These failures or conditions are usually of longer exposure time. Since these failure modes have not been tested on a regular basis, it is inappropriate to include them in the performance index statistics. These failures or conditions are subject to evaluation through the inspection process. Examples of this type are failures due to pressure locking/thermal binding of isolation valves, blockages in lines not regularly tested, or inadequate component sizing/settings under accident conditions (not under normal test conditions). While not included in the calculation of the index, they should be reported in the comment field of the PI data submittal.

<u>Credit for Operator Recovery Actions to Restore the Risk-Significant Function</u>

1. *During testing or operational alignment*:
   Unavailability of a risk-significant function during testing or operational alignment need not be included if the test configuration is automatically overridden by a valid starting signal, or the function can be promptly restored ~~in time to meet the PRA risk success criteria~~ either by an operator in the control room or by a designated operator[1] stationed locally for that purpose. Restoration actions must be contained in a written procedure[2], must be uncomplicated (*a single action or a few simple actions*), *must be capable of being restored in time to satisfy PRA success criteria* and must not require diagnosis or repair. Credit for a designated local operator can be taken only if (s)he is positioned at the proper location throughout the duration of the test for the purpose of restoration of the train should a valid demand occur. The intent of this paragraph is to allow licensees to take credit for restoration actions that are virtually certain to be successful (i.e., probability nearly equal to 1) during accident conditions.

   The individual performing the restoration function can be the person conducting the test and must be in communication with the control room. Credit can also be taken for an operator in the main control room provided (s)he is in close proximity to restore the equipment when needed. Normal staffing for the test may satisfy the requirement for a dedicated operator, depending on work assignments. In all cases, the staffing must be considered in advance and an operator identified to perform the restoration actions independent of other control room actions that may be required.

   Under stressful, chaotic conditions, otherwise simple multiple actions may not be accomplished with the virtual certainty called for by the guidance (e.g., lifting test leads and landing wires; or clearing tags). In addition, some manual operations of systems designed to operate automatically, such as manually controlling HPCI turbine to establish and control injection flow, are not virtually certain to be successful. These situations should be resolved on a case-by-case basis through the FAQ process.

2. *During Maintenance*
   Unavailability of a risk-significant function during maintenance need not be included if the risk-significant function can be promptly restored ~~in time to meet the PRA success criteria~~ either by an operator in the control room or by a designated operator[3] stationed locally for that purpose. Restoration actions must be contained in a written procedure[4], must be uncomplicated (*a single action or a few simple actions*), *must be capable of being restored in*

---

[1] Operator in this circumstance refers to any plant personnel qualified and designated to perform the restoration function.

[2] Including restoration steps in an approved test procedure.

[3] Operator in this circumstance refers to any plant personnel qualified and designated to perform the restoration function.

[4] Including restoration steps in an approved test procedure.

time to satisfy PRA success criteria and must not require diagnosis or repair Credit for a designated local operator can be taken only if (s)he is positioned at a proper location throughout the duration of the maintenance activity for the purpose of restoration of the train should a valid demand occur. The intent of this paragraph is to allow licensees to take credit for restoration of risk-significant functions that are virtually certain to be successful (i e., probability nearly equal to 1). The individual performing the restoration function can be the person performing the maintenance and must be in communication with the control room. Credit can also be taken for an operator in the main control room provided (s)he is in close proximity to restore the equipment when needed. Under stressful chaotic conditions otherwise simple multiple actions may not be accomplished with the virtual certainty called for by the guidance (e.g., lifting test leads and landing wires, or clearing tags). These situations should be resolved on a case-by-case basis through the FAQ process.

3. Satisfying *PRA success criteria*~~Risk-Significant Mission Times~~
Risk significant operator actions to satisfy pre-determined train/system *risk-significant* mission times can only be credited if they are modeled in the PRA.

Swing trains and components shared between units

Swing trains/components are trains/components that can be aligned to any unit. To be credited as such, their swing capability should be modeled in the PRA to provide an appropriate Fussell-Vessely value.

Unit Cross Tie Capability

Components that cross tie monitored systems between units should be considered active components if they are modeled in the PRA and meet the active component criteria in Appendix F Such active components are counted in each unit's performance indicators

Maintenance Trains and Installed Spares

Some power plants have systems with extra trains to allow preventive maintenance to be carried out with the unit at power without impacting the risk-significant function of the system. That is, one of the remaining trains may fail, but the system can still perform its risk significant function To be a maintenance train, a train must not be needed to perform the system's risk significant function

An "installed spare" is a component (or set of components) that is used as a replacement for other equipment to allow for the removal of equipment from service for preventive or corrective maintenance without impacting the risk-significant function of the system. To be an "installed spare," a component must not be needed for the system to perform the risk significant function.

For unreliability, spare active components are included if they are modeled in the PRA. Unavailability of the spare component/train is only counted in the index if the spare is substituted for a primary train/component. Unavailability is not monitored for a component/train when that component/train has been replaced by an installed spare or maintenance train.

Use of Plant-Specific PRA and SPAR Models

The MSPI is an approximation using some information from a plant's actual PRA and is intended as an indicator of system performance. Plant-specific PRAs and SPAR models cannot be used to question the outcome of the PIs computed in accordance with this guideline.

Maintenance Rule Performance Monitoring

It is the intent that NUMARC 93-01 be revised to require consistent unavailability and unreliability data gathering as required by this guideline.

ADDITIONAL GUIDANCE FOR SPECIFIC SYSTEMS

This guidance provides typical system scopes. Individual plants should ~~apply~~ *include those systems employed at their plant that are necessary to satisfy the* specific risk–significant functions *described below and* reflected in their PRAs.

Emergency AC Power Systems

Scope

The function monitored for the emergency AC power system is the ability of the emergency generators to provide AC power to the class 1E buses upon a loss of off-site power while the reactor is critical, including post-accident conditions. The emergency AC power system is typically comprised of two or more independent emergency generators that provide AC power to class 1E buses following a loss of off-site power. The emergency generator dedicated to providing AC power to the high pressure core spray system in BWRs is not within the scope of emergency AC power.

The electrical circuit breaker(s) that connect(s) an emergency generator to the class IE buses that are normally served by that emergency generator are considered to be part of the emergency generator train.

Emergency generators that are not safety grade, or that serve a backup role only (e.g., an alternate AC power source), are not included in the performance reporting.

Train Determination

The number of emergency AC power system trains for a unit is equal to the number of class 1E emergency generators that are available to power safe-shutdown loads in the event of a loss of off-site power for that unit. There are three typical configurations for EDGs at a multi-unit station·

1. EDGs dedicated to only one unit.

2. One or more EDGs are available to "swing" to either unit
3. All EDGs can supply all units

For configuration 1, the number of trains for a unit is equal to the number of EDGs dedicated to the unit. For configuration 2, the number of trains for a unit is equal to the number of dedicated EDGs for that unit plus the number of "swing" EDGs available to that unit (i e , The "swing" EDGs are included in the train count for each unit) For configuration 3, the number of trains is equal to the number of EDGs

<u>Clarifying Notes</u>

The emergency diesel generators are not considered to be available during the following portions of periodic surveillance tests unless recovery from the test configuration during accident conditions is virtually certain, as described in "Credit for operator recovery actions during testing," can be satisfied; or the duration of the condition is less than fifteen minutes per train at one time.

- Load-run testing
- Barring

An EDG is not considered to have failed due to any of the following events:

- spurious operation of a trip that would be bypassed in a loss of offsite power event
- malfunction of equipment that is not required to operate during a loss of offsite power event (e.g., circuitry used to synchronize the EDG with off-site power sources)
- failure to start because a redundant portion of the starting system was intentionally disabled for test purposes, if followed by a successful start with the starting system in its normal alignment

Air compressors are not part of the EDG boundary. However, air receivers that provide starting air for the diesel are included in the EDG boundary.

If an EDG has a dedicated battery independent of the station's normal DC distribution system, the dedicated battery is included in the EDG system boundary.

If the EDG day tank is not sufficient to meet the EDG mission time, the fuel transfer function should be modeled in the PRA. However, the fuel transfer pumps are not considered to be an active component in the EDG system because they are considered to be a support system.

BWR High Pressure Injection Systems

(High Pressure Coolant Injection, High Pressure Core Spray, and Feedwater Coolant Injection)

Scope

These systems function at high pressure to maintain reactor coolant inventory and to remove decay heat following a small-break Loss of Coolant Accident (LOCA) event or a loss of main feedwater event.

The function monitored for the indicator is the ability of the monitored system to take suction from the suppression pool (and from the condensate storage tank, if credited in the plant's accident analysis) and inject -into the reactor vessel.

Plants should monitor either the high-pressure coolant injection (HPCI), the high-pressure core spray (HPCS), or the feedwater coolant injection (FWCI) system, whichever is installed. The turbine and -governor (or motor-driven FWCI pumps), and associated piping and valves for turbine steam supply and exhaust are within the scope of these systems. Valves in the feedwater line are not considered within the scope of these systems. The emergency generator dedicated to providing AC power to the high-pressure core spray system is included in the scope of the HPCS. The HPCS system typically includes a "water leg" pump to prevent water hammer in the HPCS piping to the reactor vessel. The "water leg" pump and valves in the "water leg" pump flow path are ancillary components and are not included in the scope of the HPCS system. Unavailability is not included while critical ~~but~~ *if the system* ~~is below~~*is below* steam pressure specified in technical specifications at which the system can be operated.

Train Determination

The HPCI and HPCS systems are considered single-train systems. The booster pump and other small pumps are ancillary components not used in determining the number of trains. The effect of these pumps on system performance is included in the system indicator to the extent their failure detracts from the ability of the system to perform its risk-significant function For the FWCI system, the number of trains is determined by the number of feedwater pumps. The number of condensate and feedwater booster pumps are not used to determine the number of trains.

BWR Heat Removal Systems
(Reactor Core Isolation Cooling or check:Isolation Condenser)

Scope

This system functions at high pressure to remove decay heat following a loss of main feedwater event. The RCIC system also functions to maintain reactor coolant inventory following a very small LOCA event.

The function monitored for the indicator is the ability of the RCIC system to cool the reactor vessel core and provide makeup water by taking a suction from either the condensate storage tank or the suppression pool and injecting at rated pressure and flow into the reactor vessel.

The Reactor Core Isolation Cooling (RCIC) system turbine, governor, and associated piping and valves for steam supply and exhaust are within the scope of the RCIC system. Valves in the feedwater line are not considered within the scope of the RCIC system. The Isolation Condenser and inlet valves are within the scope of Isolation Condenser system. Unavailability is not included while critical ~~but~~ *if the system is* below steam pressure specified in technical specifications at which the system can be operated.

Train Determination

The RCIC system is considered a single-train system. The condensate and vacuum pumps are ancillary components not used in determining the number of trains The effect of these pumps on RCIC performance is included in the system indicator to the extent that a component failure results in an inability of the system to perform its risk significant function.

BWR Residual Heat Removal Systems

Scope

The function*s* monitored for the BWR residual heat removal (RHR) system ~~is~~ *are* the ability of the RHR system to remove heat from the suppression pool, provide low pressure coolant injection, and provide *post-accident decay heat removal.* ~~shutdown cooling.~~ The pumps, heat exchangers, and associated piping and valves for those functions are included in the scope of the RHR system.

Train Determination

The number of trains in the RHR system is determined by the number of parallel RHR heat exchangers

PWR High Pressure Safety Injection Systems

Scope

These systems are used primarily to maintain reactor coolant inventory at high pressures following a loss of reactor coolant. HPSI system operation following a small-break LOCA involves transferring an initial supply of water from the refueling water storage tank (RWST) to cold leg piping of the reactor coolant system. Once the RWST inventory is depleted, recirculation of water from the reactor building emergency sump is required. The function monitored for HPSI is the ability of a HPSI train to take a suction from the primary water source (typically, a borated water tank), or from the containment emergency sump, and inject into the reactor coolant system at rated flow and pressure.

The scope includes the pumps and associated piping and valves from both the refueling water storage tank and from the containment sump to the pumps, and from the pumps into the reactor coolant system piping. For plants where the high-pressure injection pump takes suction from the residual heat removal pumps, the residual heat removal pump discharge header isolation valve to the HPSI pump suction is included in the scope of HPSI system. Some components may be included in the scope of more than one train For example, cold-leg injection lines may be fed from a common header that is supplied by both HPSI trains. In these cases, the effects of testing or component failures in an injection line should be reported in both trains.

Train Determination

In general, the number of HPSI system trains is defined by the number of high head injection paths that provide cold-leg and/or hot-leg injection capability, as applicable.

For Babcock and Wilcox (B&W) reactors, the design features centrifugal pumps used for high pressure injection (about 2,500 psig) and no hot-leg injection path. Recirculation from the containment sump requires operation of pumps in the residual heat removal system. They are typically a two-train system, with an installed spare pump (depending on plant-specific design) that can be aligned to either train.

For two-loop Westinghouse plants, the pumps operate at a lower pressure (about 1600 psig) and there may be a hot-leg injection path in addition to a cold-leg injection path (both are included as a part of the train).

For Combustion Engineering (CE) plants, the design features three centrifugal pumps that operate at intermediate pressure (about 1300 psig) and provide flow to two cold-leg injection paths or two hot-leg injection paths. In most designs, the HPSI pumps take suction directly from the containment sump for recirculation. In these cases, the sump suction valves are included within the scope of the HPSI system. This is a two-train system (two trains of combined cold-leg and hot-leg injection capability). One of the three pumps is typically an installed spare that can be aligned to either train or only to one of the trains (depending on plant-specific design).

For Westinghouse three-loop plants, the design features three centrifugal pumps that operate at high pressure (about 2500 psig), a cold-leg injection path through the BIT (with two trains of redundant valves), an alternate cold-leg injection path, and two hot-leg injection paths. One of the pumps is considered an installed spare. Recirculation is provided by taking suction from the RHR pump discharges. A train consists of a pump, the pump suction valves and boron injection tank (BIT) injection line valves electrically associated with the pump, and the associated hot-leg injection path. The alternate cold-leg injection path is required for recirculation, and should be included in the train with which its isolation valve is electrically associated. This represents a two-train HPSI system.

For Four-loop Westinghouse plants, the design features two centrifugal pumps that operate at high pressure (about 2500 psig), two centrifugal pumps that operate at an intermediate pressure (about 1600 psig), a BIT injection path (with two trains of injection valves), a cold-leg safety injection path, and two hot-leg injection paths. Recirculation is provided by taking suction from the RHR pump discharges Each of two high pressure trains is comprised of a high pressure centrifugal pump, the pump suction valves and BIT valves that are electrically associated with the pump. Each of two intermediate pressure trains is comprised of the safety injection pump, the suction valves and the hot-leg injection valves electrically associated with the pump. The cold-leg safety injection path can be fed with either safety injection pump, thus it should be associated with both intermediate pressure trains. This HPSI system is considered a four-train system for monitoring purposes.

PWR Auxiliary Feedwater Systems

__Scope__

The AFW system provides decay heat removal via the steam generators to cool down and depressurize the reactor coolant system following a reactor trip. The AFW system is assumed to be required for an extended period of operation during which the initial supply of water from the condensate storage tank is depleted and water from an alternative water source (e.g., the service water system) is required. Therefore components in the flow paths from both of these water sources are included; however, the alternative water source (e g , service water system) is not included.

The function monitored for the indicator is the ability of the AFW system to take a suction from the primary water source (typically, the condensate storage tank) or, if required, from an emergency source (typically, a lake or river via the service water system) and inject into at least one steam generator at rated flow and pressure.

The scope of the auxiliary feedwater (AFW) or emergency feedwater (EFW) systems includes the pumps and the components in the flow paths from the condensate storage tank and, if required, the valve(s) that connect the alternative water source to the auxiliary feedwater system. Startup feedwater pumps are not included in the scope of this indicator.

__Train Determination__

The number of trains is determined primarily by the number of parallel pumps. For example, a system with three pumps is defined as a three-train system, whether it feeds two, three, or four injection lines, and regardless of the flow capacity of the pumps. Some components may be included in the scope of more than one train. For example, one set of flow regulating valves and isolation valves in a three-pump, two-steam generator system are included in the motor-driven pump train with which they are electrically associated, but they are also included (along with the redundant set of valves) in the turbine-driven pump train. In these instances, the effects of testing or failure of the valves should be reported in both affected trains. Similarly, when two trains provide flow to a common header, the effect of isolation or flow regulating valve failures in paths connected to the header should be considered in both trains.

PWR Residual Heat Removal System

Scope

The functions monitored for the PWR residual heat removal (RHR) system are those that are required to be available when the reactor is critical. These typically include the low-pressure injection function (if risk-significant) and the post-accident recirculation mode used to cool and recirculate water from the containment sump following depletion of RWST inventory to ~~satisfy~~ *provide* ~~the~~ post-accident ~~mission times~~*decay heat removal*. ~~These times are defined as reaching a stable plant condition where normal shutdown cooling is sufficient. Typical mission times are 24 hours. However, other intervals as justified by analyses and modeled in the PRA may be used.~~ The pumps, heat exchangers, and associated piping and valves for those functions are included in the scope of the RHR system. Containment spray function should be included if it is identified in the PRA as a risk-significant post accident decay heat removal function. Containment spray systems that only provide containment pressure control are not included.

Train Determination

The number of trains in the RHR system is determined by the number of parallel RHR heat exchangers Some components are used to provide more than one function of RHR. If a component cannot perform as designed, rendering its associated train incapable of meeting one of the risk-significant functions, then the train is considered to be failed. Unavailable hours would be reported as a result of the component failure.

Cooling Water Support System

Scope

The function of the cooling water support system is to provide for direct cooling of the components in the other monitored systems. It does not include indirect cooling provided by room coolers or other HVAC features.

Systems that provide this function typically include service water and component cooling water or their cooling water equivalents. Pumps, valves, heat exchangers and line segments that are necessary to provide cooling to the other monitored systems are included in the system scope up to, but not including, the last valve that connects the cooling water support system to the other monitored systems. This last valve is included in the other monitored system boundary.

Valves in the cooling water support system that must close to ensure sufficient cooling to the other monitored system components to meet risk significant functions are included in the system boundary.

Train Determination

The number of trains in the Cooling Water Support System will vary considerably from plant to plant. The way these functions are modeled in the plant-specific PRA will determine a logical approach for train determination For example, if the PRA modeled separate pump and line segments, then the number of pumps and line segments would be the number of trains

Clarifying Notes

Service water pump strainers and traveling screens are not considered to be active components and are therefore not part of URI. However, clogging of strainers and screens due to expected or routinely predictable environmental conditions that render the train unavailable to perform its risk significant cooling function *(which includes the risk-significant mission times)*are included in UAI.

Unpredictable extreme environmental conditions that render the train unavailable to perform its risk significant cooling function should be addressed through the FAQ process to determine if resulting unavailability should be included in UAI.