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U. S. Nuclear Regulatory Commission
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ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Operational Alternatives for the Calvert Cliffs Service Water System

Based on our meeting with the Nuclear Regulatory Commission (NRC) Staff on July 15, 1997, we are providing a summary of our operational alternatives for the Service Water System during the summer months. These alternatives were presented during the meeting.

Background

The Chesapeake Bay provides cooling water for both Calvert Cliffs Units 1 and 2 through the Saltwater System. In 1993 we discovered that the saltwater heat exchangers might experience fouling which would challenge their ability to maintain adequate cooling to some supported systems at peak Bay temperatures during the summer months. This was reported in Licensee Event Reports 317/93-07 and 317/96-01. During the summer months as the temperature of the Bay increases, this fouling sometimes challenges the operation of the cooling water systems.

The Saltwater System uses the water from the Chesapeake Bay to remove heat from the Service Water System, the Component Cooling Water System, and the Emergency Core Cooling System Pump Room Air Coolers. The Saltwater System interfaces with the Service Water System through two heat exchangers on each unit (one per train).

Large pieces of debris (macrofouling) and the biofilm (microfouling) which grows on tube surfaces interfere with the heat removal capability of the heat exchanger. Both types of fouling change over time and are influenced by environmental conditions. Macrofouling is measured as changes in pressure drop across the heat exchanger tubes (delta P). Heat exchanger tubesheet cleaning removes only the macrofouling on the tubesheet and inlet region of the tubes, while heat exchanger bulleting provides total removal of both macrofouling and microfouling. The Service Water System removes heat from the diesel generators and the Containment Air Coolers following an accident. These are substantial heat loads which comprise most of the heat removal capability of the system. Our challenge is to maintain sufficient heat removal capability for the service water-to-saltwater heat exchangers during periods of

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high Chesapeake Bay temperature. The Technical Specifications that govern the equipment involved are described below.

The peak Bay temperatures affecting operation appear to be the result of a number of environmental factors including average daytime temperature, wind direction, tidal conditions, and rainfall. Historically, Bay temperatures can shift several degrees over a 24-hour period and are influenced by the tidal cycle. Typically the worst case peak temperatures are experienced for only a few hours in the late afternoon when coincident with slack water conditions in the Bay.

Technical Specifications

There is no Limiting Condition for Operation for the ultimate heat sink temperature. None of the cooling water system Bases refer to a limiting ultimate heat sink temperature. The availability of adequate heat removal capability is assumed in the existing Bases for the cooling water systems.

The Service Water System Limiting Condition for Operation requires two independent service water trains to be operable. The Action for one train inoperable requires the restoration of the train within 72 hours or the plant must be shut down.

The Limiting Condition for Operation for the containment air coolers requires two trains of two containment air coolers to be operable. If one train of containment air coolers (two coolers) is inoperable, it must be restored to operable status within seven days or the plant must be shut down. If three containment air coolers are inoperable (two containment air cooler trains) but Containment Spray is operable, one of the containment air coolers must be restored to operable status within eight hours or the plant must be shut down.

The emergency diesel generators, Saltwater System, and Component Cooling Water have 72-hour Action statements for one train not operable.

Maintaining Design Bases

The design requirement of the Service Water System is to remove an adequate amount of heat from the emergency diesel generators, containment air coolers, and other lesser loads. The design requirements of the service water-to-saltwater heat exchanger are based on its ability to remove an adequate amount of heat from those loads. The heat removal capability is based on several factors including saltwater temperature, flow, and fouling of the heat exchanger. Calvert Cliffs Nuclear Power Plant has experienced problems associated with micro and macrofouling. Fouling factors cannot be measured during normal operations. Therefore, a family of curves has been developed using a bounding fouling factor (developed through a combination of full scale thermal performance testing and on-line monitoring) to define the operable conditions for each train. These curves account for measurable conditions such as flow rate, saltwater temperature and the change in pressure across the heat exchanger (delta P). Increases in differential pressure are attributed to the buildup of macrofouling within the heat exchanger which acts to reduce the effective heat transfer area. The curves are designed to take this into account. All of our actions relate to maintaining operation within this family of curves, thereby maintaining the design basis of the Service Water System.

Several alternatives exist for maintaining the Service Water System operable. Two alternatives concentrate on maintaining delta P below the maximum allowed thereby improving the available operating margin. These alternatives are cleaning heat exchangers and bulleting heat exchangers. An additional alternative focuses on reducing the heat load on the service water-to-saltwater heat exchangers post-accident by reducing power. These alternatives are explained below.

Clean a service water heat exchanger tubesheet - Service water heat exchanger tubesheet cleaning removes debris trapped on the tubesheet and in the entrance region of the tubes. Tubesheet cleaning requires about four hours to complete. Cleaning begins to lose its effectiveness over time, because a greater percentage of the macrofouling is trapped within the tubes. Thus, each cleaning does not remove 100% of the macrofouling from the heat exchanger. Eventually, cleaning will fail to provide a satisfactory improvement in heat exchanger condition. It should also be noted that the affected saltwater header and all of its supported equipment is out-of-service during the cleaning evolution. This includes an emergency diesel generator and its entire train of Emergency Core Cooling System equipment (such as high pressure safety injection, containment spray, low pressure safety injection, and two containment air coolers). The advantage of tubesheet cleaning is that it can be done quickly, thus limiting the unavailability of the heat exchanger. In addition, the heat exchanger can be restored to service quickly during a cleaning, assuming no other maintenance is occurring on the heat exchanger.

Bullet a service water heat exchanger - This alternative cleans the macro and microfouling from the tubes of the heat exchanger allowing enhanced heat removal. Bulleting would remove macrofouling that was inaccessible during previous cleaning attempts thereby restoring the heat exchanger to its baseline condition. Bulleting requires approximately 16-18 hours to complete. While bulleting, the affected saltwater header and all of its supported equipment are out-of-service. This includes an emergency diesel generator and its entire train of Emergency Core Cooling System equipment. Since this is normally a planned event, maintenance often occurs on related equipment while it is inoperable. The length of the process is a disadvantage. Additionally the heat exchanger may not be restored to operability quickly during portions of the process.

Reduce power to 80% - The power reduction reduces the amount of decay heat stored in the core, which reduces the amount of energy that could be released during the recirculation phase of the accident response. Therefore, there is less heat for the containment air coolers to remove from Containment and reject to the Service Water System. Reducing power affects the containment response during the recirculation-portion of the accident, shifting the limiting case to the injection phase of the accident response. This alternative does not impact the existing differential pressure across the heat exchanger. However, operating margin is improved by the reduction in heat load on the service water heat exchanger. This acts to increase the allowable delta P across tube heat exchanger for a given Bay temperature. It takes at least six hours to implement this alternative. Therefore, this alternative must be exercised prior to the occurrence of a high Bay temperature transient. This would allow the affected heat exchangers to remain operable at higher Bay temperature and increased heat exchanger fouling.

Restoring Design Basis

If the heat exchangers are degraded by excessive macrofouling in combination with high Chesapeake Bay temperature (i.e., outside the family of operable curves), other alternatives are available. These alternatives consist of declaring a service water train inoperable or isolating service water flow to a containment air cooler on the affected service water train. If environmental or operational conditions warrant, the affected units will be shut down. These alternatives are explained below.

<u>Declare service water train inoperable</u> - If the limiting conditions (temperature and delta P) for the service water heat exchanger are exceeded, the affected train would be declared inoperable. The Action statement for the service water train would be entered. This is a 72-hour Action statement. While in this Action statement, the affected emergency diesel generator and containment air coolers are also out-of-service. We could remain in this Action statement until either the Bay temperature was reduced or until the affected heat exchanger could be bulleted (or cleaned), whichever is appropriate. The disadvantage of this alternative is the degree to which its increases risk for the Unit as described below.

<u>Isolate one of the four containment air coolers to reduce the Service Water System heat load</u> - If a containment air cooler is isolated from the Service Water System, the amount of heat rejected to the Service Water System is significantly reduced, thereby reducing the requirement for the total heat rejected by the Service Water System to the Saltwater System. This allows the Service Water System to return to an operable state and allows other supported systems to return to an operable state (including an emergency diesel generator and its train of Emergency Core Cooling System equipment including the redundant containment air cooler). This alternative would allow the heat exchanger on the affected header to remain operable up to 90°F and increases the allowable delta P to approximately 5 psid.

This alternative would be exercised as follows. If conditions exceeded the operable condition for the service water-to-saltwater heat exchanger, the affected service water train would be declared inoperable. This renders the supported equipment inoperable (i.e., emergency diesel generators and containment air coolers). One of the inoperable containment air coolers would be isolated from the Service Water System (by closing the service water inlet valve to the containment air cooler) and its Technical Specification Action statement entered. An assessment has been performed which establishes alternative operable conditions for the service water-to-saltwater heat exchanger if the containment air cooler is isolated. Based on this assessment, the affected service water train and its supported equipment would be declared operable in conformance with Generic Letter 91-18. (This is similar to actions which would be taken if service water piping to a containment air cooler were to develop a leak.) We would remain in the containment air cooler Action statement until the heat exchanger becomes operable or we reach the end of the Action statement. This may be accomplished by cleaning, bulleting, or waiting for the Chesapeake Bay temperature to fall. This operation may also be extended to limit plant risk based on equipment concurrently out-of-service (such as auxiliary feedwater) and to allow equipment to be returned to service prior to taking an entire service water header out-of-service for cleaning or bulleting a service water heat exchanger.

In considering this alternative, other guidance was reviewed to provide confidence that this approach would be correctly implemented. Nuclear Regulatory Commission Inspection Manual, Part 9900, provides guidance concerning entering Action statements for maintenance purposes. The guidance contains four considerations: performance of the activity would improve safety, abuse of the action statement time is not allowed, redundant equipment should not be removed from service, and performance of the action should not increase the likelihood of a transient. In considering this alternative to the maintenance strategy of cleaning or bulleting we have reviewed this guidance and have considered its implications when isolating a containment air cooler. Removal of a containment air cooler from service is the safest of the available alternatives, as described below. Additionally, we intend to isolate the containment air cooler only for the time necessary to reduce the plant risk. When removing the containment air cooler from service, the operability of redundant equipment will be evaluated and the action not taken unless redundant equipment is available. We do not believe that this action would increase the likelihood of a transient because it is a relatively simple operational evolution with minimal impact on operating systems. Therefore, this action meets the guidance given in the NRC Inspection Manual.

Also considered is the guidance given in NUREG-1432, Standard Technical Specifications for Combustion Engineering plants. The Bases for Limiting Condition for Operation 3.0.2 contain guidance concerning the entry into Action statements. It cautions that entry into Action statements should not be made for operational convenience and must be done in a manner that does not compromise safety. As described below, we believe that this action is the safest of the alternatives, both from a risk perspective and from an operational challenge perspective. This action would not be taken for operational convenience, but to maintain plant safety.

<u>Shut down the affected units</u> - If additional equipment degrades while we are in the above Action statements, the affected unit will be shut down, if appropriate, under Technical Specification requirements.

<u>Safety Assessment</u>

We have evaluated the risk associated with these alternatives. We normally assess the risk (core melt frequency, Level 1 probabilistic risk assessment) associated with equipment remaining out-of-service for maintenance or other purposes. This assessment uses the scheduled maintenance on a given day and assesses the plant risk for that day. Additional equipment can be added to the assessment if plant conditions change. In this way, we determine if planned maintenance should continue based on risk, or if our maintenance plans need to be altered because of additional risk incurred due to changing plant conditions. The risk associated with removing a service water-to-saltwater heat exchanger from service can be compared with the risk associated with removing a containment air cooler from service using this method. Because of the amount of equipment affected when the Saltwater System is removed from service, the risk for that activity is approximately four times the normal plant risk. This creates a medium risk condition for the plant (a risk level of ≥ 3 times normal is considered a medium risk). Removal of one containment air cooler, however, results in an insignificant increase in the normal plant risk. In addition to using a Level 1 probabilistic risk assessment (core melt frequency) to evaluate this condition, we also evaluated the likelihood of a radioactivity release from the Containment. This evaluation determined that the change in the likelihood of a radioactivity release from the Containment associated with the removal of up to two containment air coolers from service is a low risk event (< three times normal risk). These relative levels of risk are considered when determining the appropriate plant response to adverse environmental conditions.

In addition to reviewing the risk, we also evaluated the deterministic effects of removing a containment air cooler from service on our Containment response analysis. Each containment air cooler was originally designed to provide one-third of the total heat removal capability needed to maintain the containment atmospheric pressure within the containment design pressure. Additionally, each Containment Spray was originally designed to provide 50% of the total heat removal capability needed to maintain the containment design pressure. The design of these systems was intended to provide a significant amount of redundancy for the containment cooling function. The limiting case for Calvert Cliffs Containment response analysis assumes that one train of Emergency Core Cooling System fails at the beginning of the accident. This results in a limiting condition in which two containment air coolers and one Containment Spray provide the post-accident cooling function.

When we take a service water header out-of-service to clean it, bullet it, or because environmental conditions have rendered it inoperable, we enter the appropriate Technical Specification Action statement. Likewise, if we isolate a containment air cooler, we enter the appropriate Technical Specification Action statement. This specified Action statement time is a temporary relaxation of the single failure criterion, which, consistent with overall system reliability considerations, provides a limited time to make the system Operable. Therefore, for the limited time that we place the plant in this condition, we assume that no single failure occurs for the limiting condition defined in the Technical Specifications. This assumes that the Operable train of service water responds to the accident and functions as assumed. Likewise for the containment air cooler, we assume the full complement of containment response equipment is available (except one containment air cooler). Therefore, for the period of time that we are in Action statements, the plant remains within the previously approved licensing basis.

Short-Term Action

If the Chesapeake Bay increases above 86°F this summer without substantial macrofouling of the heat exchangers, we can choose between bulleting a heat exchanger on demand, reducing power, or isolating a containment air cooler. It should be noted that the Chesapeake Bay has exceeded 85°F during only one summer in our operating history (1995).

Currently, bulleting is scheduled to be performed four times during the year on each heat exchanger. Two of those four bulletings have been scheduled for the summer months to provide maximum benefit during high temperature operation. These scheduled bulletings are intended to restore the affected heat exchangers to their baseline condition. However, if Bay temperature is expected to increase above the operable curve conditions for a heat exchanger, more frequent bulletings could be scheduled. These more frequent bulletings would reduce the fouling in the heat exchanger below the design valve. Therefore, for a limited time period, additional margin can be credited. As noted above this is a medium risk evolution.

Given the historically short duration of temperature excursions in the Chesapeake Bay (three to six hours), reducing power must be carefully considered. First, we need to predict the temperature excursion so the power reduction can precede it. In addition, the time required to maneuver the plant to the lower power (~six hours) exceeds the typical duration of a temperature excursion. This alternative was used in 1995 when the Bay temperature was expected to remain high for several days.

If a service water train were declared inoperable, we would enter the service water Technical Specification Action statement. We could then choose to isolate a containment air cooler from the Service Water System and enter the Action statement for a containment air cooler out-of-service. It is the easiest condition to enter, requiring the fewest equipment alignments by Operations personnel. In addition, the plant can be restored to its previous status quickly. Under these circumstances, isolating one containment air cooler is likely to be the safest of the alternatives available to us. Final strategy selection will consider this alternative and will be chosen based on the plant and environmental conditions.

If the Chesapeake Bay temperature is approaching 86°F and the heat exchanger delta P has increased, indicating macrofouling has occurred, the following alternatives are available to us to maintain plant operation: cleaning the heat exchanger, bulleting a heat exchanger as needed, or isolating a containment air cooler. Cleaning a heat exchanger will help restore the baseline delta P for the heat exchanger; however, it will not provide enough margin to permit the heat exchanger to remain operable above 86°F. Bulleting a heat exchanger on demand will increase the operating margin; however, it has drawbacks related to plant risk. Isolating a containment air cooler will provide the most margin for continued operation if only one heat exchanger is affected and, as described above, is the safest alternative because it entails the least plant risk. Each of these alternatives will be considered and an appropriate course of action taken based on plant and environmental conditions.

Long-Term Actions

We have currently scheduled replacement of the service water-to-saltwater heat exchangers during the 1998-1999 refueling outages. The new heat exchangers are designed with a margin to encompass these environmental concerns. Specifically, they are designed for a 90°F Bay temperature and the maximum recommended fouling factor. These new heat exchangers are designed to prevent this operational problem from occurring in the future. As part of the design process, we are continuing to test the new design with a side stream monitoring system to learn more about its anticipated operational performance. Installation will require the removal of most of the piping and components from our Service Water Rooms. Two new plate and frame heat exchangers (with inlet strainers to reduce macrofouling) will be used to replace each tube and shell heat exchanger. The new heat exchanger and piping design have been reviewed under the provisions of 10 CFR 50.59, and their operation constitutes an unreviewed safety question. Our request for NRC Staff review was submitted on May 17, 1997, and is awaiting Staff action. We are eager to obtain approval of this modification to allow a greater safety margin in responding to environmental conditions in future summer periods. A meeting on this unreviewed safety question is scheduled with the NRC staff for September 3, 1997.

Should you have questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

PGC/PSF/dlm

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