JUV-92-011

Technical Evaluation of the Duane Arnold Energy Center Emergency Service Water Technical Specification Change Request

J.U. Valente

August 1992

9210090243 920929
PDR ADOCK 05000331
P PDR

Table of Contents

1 Introduction

At the request of NRC/NRR, Brookhaven National Laboratory (BNL) staff have performed a review of a proposed plant technical specification change submitted by the Iowa Electric Light & Power Company [1]. The submittal is for the Duane Arnold Energy Center (DAEC) and involves the modification of Emergency Service Water (ESW) System flow requirements as they presently exist in DAEC's plant Technical Specifications (TS). These require weekly surveillance testing of the ESW system against strict flow limits which are a function of water temperature, once the river water exceeds 80°F.

In 1990 a Service Water Safety System Functional Inspection determined that the original basis for the TS limits could not be retrieved. As a consequence, DAEC commissioned a re-evaluation of the heat loads on the ESW system. The resulting series of calculations were performed by Bechtel Corp. These are Bechtel designated Task 466 calculations M-001 to M-911. These calculations provide a basis for the DAEC proposal of reducing the flow requirements of the ESW system and reducing the surveillance requirements to once every three months. The licensee purports that the reductions are now possible because of "improved modeling methodology, current design information, and the reduction of component heat loads through the installation of additional insulation."

The scope of BNL's review effort was to determine the validity of the supporting calculations provided by Bechtel. A site visit to the plant by NRC and BNL staff was conducted after a preliminary review of the calculations and requests for supporting documentation (primarily references used in the calculations). The intent was to verify the assumptions that went into the calculations, and familiarize the review team with pertinent as-built conditions. A further benefit of the visit was the interaction with the licensee's engineers.

Before leaving the site, the licensee's personnel were informed by the NRC representative that the submittal was not acceptable in its present form. Key to this finding was the assumption governing the river water fouling factors for heat exchangers and cooling coils. Other concerns involved discrepancies in the assumptions for piping insulation, room temperature stratification, equipment qualification and air cooling flow short-circuiting.

Subsequent to this finding, the review of the calculations continued so that the licensee could be made aware of all BNL/NRC concerns in the event DAEC decided to resubmit their TS change request. What follows is a discussion of these calculations with insights gained from the site visit. This is followed by our conclusions.

2 Emergency Service Water Component Review and Report Layout

The discussion on the ESW components is divided into four sections. In addition, there is a section dealing with control room habitability. Three systems serviced by the ESW represent, according to Bechtel's newly performed calculations, nearly 93% of the total ESW flow requirements at 95°F river water temperature (see Table 1). At this temperature, the three heat exchangers on an emergency diesel (combustion air, jacket water, and lube oil) represent 49% of the projected required ESW flow. The diesel cooling requirements are discussed in Section 3.

Table 1 ESW Flow Requirements (gpm)

Equipment	River Water Temperature	
	95°F	80°F
Diesel Generator Coolers	310	310
Control Room Chiller	190	75
RHR/CS Room Cooler	95	30
RHR Pump Seal Coolers (two)	21	14
RCIC Room Cooler	8	3
HPCI Room Cooler	5	4
RHR Service Water Pump Motor Coolers (two)	4	4
CS Pump Motor Cooler	3	3
Control Building HVAC Instrument Air Compressor	2	2
	638	445

The control room cooler services a number of rooms in the control room building. This control room cooling coil interfaces with the chiller (a refrigeration loop). On a LOCA trip signal the chiller's condenser is cooled by the ESW instead of the normal well water

system. The projected ESW flow requirement of this system is 30% of the total projected ESW flow requirements at a 95°F river water temperature. The control room chillers are discussed in Section 4.

Section 5 of this report discusses ESW flow requirements for the safety related pump room cooling units. These involve those unit coolers servicing the reactor building rooms housing the RHR and Core Spray (CS) Pumps (one room with 2 RHR and 1 CS is considered); the High Pressure Coolant Injection (HPCI) pump; and the Reactor Core Isolation Cooling (RCIC) pump. The RHR/CS pump room is projected to need 15% of the newly estimated ESW total flow requirement. The HPCI and RCIC coolers represent only about 1% each of the estimated ESW total flow.

In section 6 calculations on the ESW flow requirements for the RHR pump seal cooler are discussed. These requirements are quite small in comparison to those addressed in the preceding sections, accounting for about 3% of the total projected ESW flow requirements at 95°F river water temperature.

Section 7 contains a discussion of control room habitability and single failure criteria. (These issues are closely tied to the chiller system.) Finally, Section 8 contains our conclusions.

3 Diesel Cooling Requirements

Each emergency diesel has three heat exchangers which rely on ESW cooling water. These are the combustion air, lube oil, and jacket water heat exchangers. The ESW flows on the tube side and cools the three heat exchangers in series. The shell flow path is baffled and the design flow varies from 400 to 500 gpm [2] at diesel rated kw output of 3250 kw. As can be seen in Table 1, the estimated ESW flow requirement at 95°F river temperature is 310 gpm. Calculation #466-M-009 is the governing calculation for this effort. It is supported by calculation #466-M-001 and 466-M-003. The latter of these calculates the heat load on the heat exchangers for diesel operation adjusted for a design continuous load of 2850 kw. The diesel vendor's supplied rated specifications for the diesel is 3250 kw. The three emergency diesel heat exchangers are a major

load for the ESW system, requiring 49% of the projected ESW flow at 95°F river water temperature.

3.1 Calculation Methodology

One wishes to establish the unit conductance (U) between the tube and shell side fluids for various ESW flows and river water temperatures. This involves the convective film heat transfer coefficients on the tube's inside and outside surfaces as well as the heat resistance afforded by the tube material and any fouling on the inside and outside tube surfaces. Since convective heat transfer correlations for forced flow inside tubes is well established, as is the tube conductance, the approach in obtaining U concentrates on determining the convective heat transfer coefficient on the shell side. Data sheets are supplied by the vendor for clean (no fouling) conditions, giving the total heat transfer capacity of the heat exchangers with the related fluid conditions (tube's inside and outside fluid mass flow and temperature). Then using the Log Mean Temperature Difference (LMTD) approach for heat exchangers, the preparer is able to establish the shell side convective heat transfer coefficient for the given ESW flow conditions. This is checked against the shell side convective heat transfer correlation being employed. Once this is done, the preparer is now able to determine the effective unit conductance for various ESW flows and river water temperatures, since the heat load on the heat exchangers remains fixed. Estimates are made for the fouling factors under service conditions.

3.2 Assumptions

Calculation M-003 lists the vendor supplied heat loads on the heat exchangers for the rated (3250 kw) and design continuous rating (2850 kw) conditions. We take no issue with using the 2850 kw value for the ESW study.

Calculation M-009 assumes fouling factors that are not realistic for DAEC service. In particular, the use of a fouling factor of 0.0005 (tube and shell) to determine required ESW flow is non-conservative. These values are more representative of sea water cooling than DAEC's river water. Indeed, based on the Handbook of Heat Transfer [3], the fouling factor values for river water should be 0.003 if the flow is 3 ft/s or less and 0.002 at greater than 3 ft/s. The

recommended values for engine lube oil and engine jacket water are 0.001 [3]. Lowering the ESW flow to below about 400 gpm reduces ESW flow velocity through the tube to less than 3 ft/s, and hence raises its fouling factor from 0.002 to 0.003. Both of these are greater than the factor employed in the calculation. It is of interest to note that the heat exchanger vendor used fouling factors of .002 - .003 for shell side water and .006 - .007 for shell side oil in some of the specification sheets [4].

During the site visit, DAEC personnel stated that test results indicate lower loads on the heat exchangers at 2850 kw operation then that supplied by the vendor. However, it should be understood that this could be greatly affected by the environmental conditions in which the diesel operates. At DAEC, the diesels are housed in rooms which could have relatively low ambient temperatures. The piping to the heat exchangers appeared to lack insulation. Hence, the lower than expected observed load on the heat exchangers may be more attributed to the environmental conditions at the time of the tests (especially if conducted at less than summer design temperature) than any conservatism in the design.

There are bypass lines for the shell side fluids (diesel fluids) around the heat exchangers. One would assume the bypass functions is used to assure the cooled diesel fluids return within a given temperature tolerance. Thus, increasing the bypass reduces the heat removed and allows the diesel fluids to return at a higher temperature. If in establishing the tube outside heat transfer coefficient (ht_o) for the diesel heat exchangers, no bypass was assumed but bypass existed, the velocity of the diesel fluid would be overestimated and so would ht_o, since ht_o should be proportional to approximately the square root of the velocity. Since ht_o is proportional to "U", the effect could be a lower predicted ESW flow than required. Also of particular concern is the effect on the baffling's efficiency on the shell side due to any bypass.

3.3 Calculation Details

The vendor's data sheets on the heat exchangers are used to establish a shell side heat transfer coefficient for clear tube conditions. For the air cooler heat exchange in calculation M-001 version 1, an error is made in using the vendor's data. The calculation uses rev 1 of the data sheets [4] for the clean unit conductance of 622 Btu/hr.ft^2.°F but uses rev 0's value for the heat

transfer of 2,769,000 Btu/hr instead of rev 1's value of 2,795,000 Btu/hr. Further, the value used for the shell side flow area (0.314") must be a derived value, and the review team could not determine how it was attained since the data sheet does not supply the shell diameters. The preparer, in checking his results, found a convergence within about 10% on the shell side film heat transfer correlation against vendor data to be acceptable. The review team believes that this should have been translated into an uncertainty in the required ESW flow.

3.4 Summary of Findings

The fouling factors employed on both surfaces of the tubes need to reflect the service conditions that exist. In establishing the design condition parameters, the use of the vendor supplied data sheets should be consistent. That is, the unit conductance and heat transfer should be from the same sheet. If the preparer finds that his calculations show a convergence only within 10% on the shell side film heat transfer correlation, this should be translated into a safety factor for the ESW flow requirements.

4 Control Room Chiller Cooling Requirements

The Chiller Water System (CWS) is a dual loop system with one loop normally operating. Each loop contains a separate condenser, compressor, evaporator, chiller water heat exchanger, and control room building cooling coil.

In normal operation, the freon of the chiller is cooled in its condenser by well water. However, on a LOCA signal the emergency diesels start and ESW is supplied to cool the chiller condenser. Both the chiller water heat exchanger and the control room air cooler remain on-line during a LOCA. The chiller compressor is capable of supplying 200 hp (509,440 Btu/hr) to the refrigeration loop.

If off-site power is lost, chilled water flow into and out of the chiller water heat exchanger is isolated. The compressor is reduced to 75 hp (191,040 Btu/hr), and the control room cooling coil remains on-line.

The calculations being reviewed for this task involve 466-M-003, M-007, and M-008. In terms of projected ESW flow requirements, the demands of the chiller system, servicing only essential loads, are second only to the diesels (see Table 1), requiring 30% of the projected ESW flow at a 95°F water temperature.

4.1 Calculation Methodology

The basic approach of determining an overall unit conductance for the condenser utilizing known data points is employed. Since the data points are not specifically for the DAEC condenser, the Wilson Method [5] is used to adjust the supplied data to the specific DAEC coil. The preparer then goes on to determine the necessary ESW flow for different river water temperatures knowing the condenser's unit conductance and the design load on the condenser. The design load is based on the Control Room cooling coil design capacity and the refrigerant compressor's work.

4.2 Assumptions

Supporting heat load calculation M-003 assumes that 100% of the compressor work must be removed by the condenser. This is a conservative assumption, since some of the work would appear as heat lost to the ambient air.

It should be noted that calculation M-007 is used to determine the required ESW flows to the chiller condenser when only the control room cooler and the refrigerant compressor are the loads to the condenser. Calculation M-008 determines the heat load to the control room cooler by examining the human, equipment, lighting, heat transmission, and solar loads to the room serviced by this cooler, but no fresh air intake is assumed. Calculation M-003 simply assumes that the heat load to the cooler is that of the cooler's design which would include fresh air intake loads. Calculation M-007 uses the data from M-003 and not M-008. It should also be noted that calculation M-008 lacks administrative control since there is no reviewed sign-off.

The capacity of the control room cooler is based on an inlet air temperature of 84.5° dry bulb temperature (DBT) or 67° wet bulb temperature (WBT). This gives a relative humidity of about

40%. One might expect that for operator comfort the control room may be maintained below this DBT. The coil's heat removal capacity is a function of its condensation capability, and this does not appear to be considered in M-007.

As stated in 4.1, calculation M-007 employs the Wilson method [5]. This assumes the freon in the condenser has a condensing fluid film coefficient which is held constant over normal operating ranges. This assumption translates into requiring the Log Mean Temperature Difference (LMTD) and the fluid flow rate (freon) to be held constant.

If used appropriately in the calculation, this would seem to be a reasonable assumption. The condenser manufacturer provided unit conductances [6] for operation of the chiller at various ESW flow rates. Unfortunately, this was done for a condenser different from the one installed at DAEC. Instead of requesting a revised series of calculations from the vendor, the data was used in the calculation to establish a shell side (freon side) heat transfer coefficient for the incorrect condenser. This became part of the overall condenser unit conductance in the Wilson method approach. Then, before applying it to the DAEC condenser, it was corrected for tube inside and outside surface areas.

Another assumption made was that the fin type of the DAEC condenser was the same as for the condenser for which information was received from the vendor. Again, the review team believes this information should have been verified.

The ESW required flows were determined using a fouling factor of 0.001. As discussed in Section 3.2 of this report, this is too low for the ESW water. We believe 0.003 to be more realistic.

4.3 Calculation Details

For the Wilson method to have a reduced uncertainty, it is important that the freon flow rate and condenser LMTD be held nearly constant. The calculation lacks documentation to confirm this.

With respect to the freon flow rate being constant, the vendor's supplied data and the DAEC condenser freon flows should be compared to assure that the Wilson constraint on freon flow rate is satisfied. In doing this, one should assure the correct condenser load from the vendor is used with the appropriate freon flow rate. The referenced data [7] supplied by the vendor assumes an evaporator load of nearly 120 tons. The heat load on the condenser for the DAEC specific case was 859,200 Btu/hr or only ≈ 72 tons, and only 668,000 Btu/hr or less than 60 tons is evaporator load. The true load on the condenser assumed in the vendor's calculations [6] used to generate the supplied normalizing data points needs clarification.

4.4 Summary of Findings

The calculation is presently unacceptable. Confirmation through in-field inspection of actual condenser components may be required. The two constraints which need to be adhered to for use of the Wilson method (i.e., constant freon flow and LMTD) have not been confirmed to be true. Control room cooling coil capacity may be affected by its condensation capability for the air thermodynamic conditions assumed. We were not able to confirm if condensation capability was considered. The fouling factor employed is non-realistic for the service conditions.

5 Pump Room Coolers: HPCI, RCIC, RHR/CS Pump Rooms

The Bechtel task 466 calculations associated with these cooling coils are M-002, M-003, M-005, and M-006. The RHR/CS pump room coolers are predicted to need more ESW flow than the HPCI and RCIC room coolers combined. The proposed ESW flow requirements can be found in Table 1. For the purposes of this review, there is sufficient similarity in the pump room cooler calculations that we will combine our discussion of the three (four if one considers both RHR/CS rooms) air cooling systems.

The HPCI, RCIC, and RHR/CS pump room cooling systems consist of unit coolers in rooms which are presumed to be isolated from their surroundings during a LOCA. There are some through wall penetrations with draft activated louvers. (Based on our site visit, these louvers appeared to be in need of maintenance.) The rooms in question surround the torus room. Typically the rooms are about 20 - 30 feet in height with the heat sources (steam turbines,

electric motors, pumps, and most of the piping) located at the lower elevations, and the cooling coils at the upper elevations. The cooling coils are enclosed in unit coolers consisting of filters and air handlers with exhaust ducts. The cooled air is typically exhausted close to the unit coolers. That is, there is a minimum of exhaust duct work. The floor areas of the RCIC and the two RHR/CS rooms are each about 600 to 800 ft^2 while that of the HPCI room is closer to 1500 ft^2.

5.1 Calculation Methodology

A computer code was employed to perform these calculations. It is Bechtel's designated PC version of ME201 (DASHCC). Details regarding the code were not provided. Based on the limited information available, the reviewers have reconstructed the methodology as follows. The approach taken by the preparer is to use a design point for which as much data as is available can be used. As indicated in Assumptions, Section 5.2, there are four unknown parameters. These are: air flow rate, fouling factor, exit air wet bulb temperature, and the calculated number of coil rows. The code user inputs the first two of these as initial guesses. The third is calculated by the code, once the code user stipulates that the coil only performs sensible cooling of the air, and the inlet WBT and DBT along with the exiting DBT are supplied as code input from design criteria. With the total air to coil surface area furnished as code input from vendor supplied data, the code will output the number of tube rows, as well as the cooling capacity of the coil. The coil cooling capacity is a known value that the code user matches.

In an iterative manner, the user then varies the air volume flow to match the coil's known at capacity the known conditions, while fixing the fouling factor and stipulating only sensible air cooling. Initially, the number of tube row allowed to vary. Once a match to the coil's capacity is obtained, the code's calculated number of tube rows is held constant for the ESW flow study.

The number of tube rows has thus been established based on matching the code's prediction of heat removal capacity at the investigated design point to the code user's estimate of the air flow over the coil, the fouling factor, and the assumption of only sensible air cooling. The code user now goes about determining the required ESW flow through each coil for various ESW coil inlet

temperatures, each time assuring that he is matching the air cooling capacity previously determined in calculation 466-M-003, and employing a fouling factor of 0.0005.

By this approach, the preparer has essentially established an active coil surface area with an air flow rate. These parameters are determined by the number of actual tube rows calculated by the code for the supplied air flow. Together with the stipulation of only air sensible cooling, these parameters help determine the air to coil heat transfer rate. But the degree of true condensation on the coils is a function of how cool the coils are, as well as the air flow and moisture content of the air. In determining the required ESW flow for different ESW temperatures, the relationship of the coils efficiency, based on the degree of condensation afforded by the different coil temperatures, is lost in this approach. The exhaust air's WBT, and hence the degree of condensation vs. sensible cooling are not supplied by the vendor.

The approach appears to lack sufficient design point characterization and it may be necessary to determine the true air flow rate over the coils by examining the air handler. The number of tube rows are known and should be used in the calculation. This would leave only the exit WBT and fouling factor to be matched. To establish the design point, a communication with the vendor may be necessary. If this is unsuccessful, then in-situ testing to establish a new design point may be necessary.

5.2 Assumptions

The calculations assume no condensation of the air-vapor mixture since they state only sensible cooling is used. Realistically the amount of condensing which will occur is a function of the true relative humidity (RH), coil temperature, and volumetric flow over the coils. If condensation did occur, it is likely that the coils would have better heat transfer coefficients on the air side of the coils. Not knowing whether condensation was assumed by the vendor in establishing the coil's capacity could invalidate the design condition which the preparer uses to determine some missing design data, including the number of cooling coil rows.

The number of cooling coil rows could have been made a parameter that was known, i.e., an input parameter. Instead, it appears as a derived parameter tied to establishing the design point for the coils. The air mass flow is also assumed because of incomplete data.

Finally, the fouling factors assumed for the ESW flow in the calculations (0.0005) is too low for the service conditions which would demand a value of 0.003 for flow velocities less than 3 ft/s.

5.3 Calculation Details

The computer code ME201 (DASHCC) was verified by showing that the results one would obtain by performing a sample problem by hand match the results the code would supply. However, since the hand check was done using the correlations in the code [8], this method of verification only checks that the algorithms in the code were correctly programmed and the code correctly installed. We do not know whether the correlations themselves were validated. This should have been done for safety related applications.

During our field visit, the HPCI coil was examined and found to have 14 rows (vertical to air flow) of 8 tubes each. In the computer code used by the preparer for the calculation, 14 rows were input, but the code determined the number of tubes. A design point value of 6.65 rows was calculated by the computer code. This discrepancy appears to have been known by the preparer, but it remains unclear why this remained an unmatched parameter for the calculations.

The heat loads determined in calculation 466-M-003 are not representative of as-built conditions in terms of piping and component insulation. There was observed temperature stratification in the equipment rooms cooled by these air coolers and this is not accounted for in the allowable maximum air inlet temperatures to the coolers. Arrangement of the unit coolers in the rooms would appear to allow for air flow short circuiting between the unit coolers' exhaust and intake.

There are two RHR/CS rooms and it is not clear why the proposed ESW requirements do not include both rooms in determining total ESW flow requirements [9].

5.4 Summary of Findings

The calculations are not acceptable in their present form. The calculation appears to have too many unknowns when establishing the design point. Further, the fouling factors used for the ESW in determining the required flow are not in agreement with Reference 3. Finally, the assumptions used in the calculation for piping insulation and flow distributions are not representative of as-built conditions.

6 RHR Pump Seal Cooling Requirements

The RHR pump seals are cooled under emergency conditions using ESW water. A small quantity of nuclear grade water from the RHR pump discharge is passed through a pressure reducing orifice, a cyclone separator, and then to the tube side of a tube and shell heat exchanger before being injected as seal cooling water. ESW flows through the shell side of the heat exchanger. The ESW flow requirements, as shown in Table 1, are only 21 gpm at 95°F. Calculation M-004 is the governing document for establishing this flow requirement.

6.1 Calculation Methodology

The basic approach employed uses pressure drop curves for the orifice and separator to establish the flow to the heat exchanger. This appears acceptable. However, allowing the seal cooling water to return at the seal's equipment qualification temperature limit is overly optimistic. It leaves no margin for the possibility that the seal may be elevated in temperature beyond the seal cooling water temperature due to contact with the NSSS water.

Once the NSSS flow and change in temperature through the heat exchanger are known the required energy removal by the ESW is established. The heat exchanger's unit conductance is then determined using correlations for convective heat transfer on either side of the tubes. Design data was made available giving the heat exchanger's ESW flow and inlet temperature for a given change in temperature of the NSSS seal cooling water.

6.2 Assumptions

Two RHR modes are considered. Operational mode J [10], which is the Minimum Flow Bypass Mode, and mode E [10], which is the normal shutdown mode after Reactor Pressure Vessel pressure relief blowdown to the plant's main condenser. The calculation 466-M-004 discounts mode J because of its short time duration. However, the analysis shows that J mode operation will result in a seal temperature exceeding the 150°F qualification temperature. This discrepancy has not been adequately addressed by the licensee. The mode J alignment [10] which takes suction from the RPV at 135 psig and discharges to the suppression pool should be examined by the licensee to ascertain if the procedures call for RHR pump operation. An RHR pump head is necessary to drive the RHR pump seal water.

Calculation M-004 lacks appropriate administrative controls. All new revision 1 pages of this calculation lack checker's sign-off. The revision is poorly incorporated into the original version of this calculation.

6.3 Calculation Details

Section 7.2 of calculation M-004 is identified as being "not required," but is referenced in Section 7.4 to supply the fouling resistance.

In deriving the shell side film heat transfer coefficient in Section 7.4, preliminary data of Section 7.1 was employed to verify the assumption that the correct ESW flow is 12.4 gpm. The use of this preliminary data of Section 7.1 is inaccurate since Section 7.1 employs what appears to be an incorrect pressure drop assumption across the separator to determine the seal water cooler NSSS flow of 1.5 gpm. Later data employed in revision 1 of the calculation shows a 1.1 gpm seal water flow for the same 147 psi RHR pump head conditions. The problem arises because a shell side film heat transfer coefficient of 359 Btu/hr.ft^2.°F is determined in the original version. This value is carried forward into the revis section of the calculation to verify the newly determined unit conductance.

Fouling factors of 0.0005 for ESW water and 0.0002 for NSSS water were used. We take issue with the ESW values and even that of the nuclear grade water should be justified. The recommended [3] value for distilled water is 0.0005, and this would appear to be acceptable for NSSS use. The ESW water should be assigned a fouling factor of about 0.003 [3] if its velocity is less than 3 ft/s.

6.4 Summary of Findings

Overall this calculation appears to lack administrative controls and clarity. Use of data to determine the shell side film heat transfer coefficient and overall RHR seal water cooler unit conductance was inconsistent. The calculation employed overly optimistic fouling factors and may have incorrectly assumed a fully developed pump head across the RHR pump for mode J (Minimum Flow Bypass Mode) operation. Also, failure to satisfy RHR pump seal qualification temperatures during mode J operation was not adequately addressed.

7 Control Room Habitability Considerations

DAEC had a series of calculations performed to determine the habitability of the control room under off-normal conditions. For the loss of the chilled water coolers, two cases were examined. The first involved 100% makeup air from outside, and the second concerned using the Standby Filter Unit for makeup. In this latter case, outside air makeup is only 1000 cfm compared to nearly 16,000 cfm for the former case. In both cases circulating air is maintained within the control building complex, though at a somewhat adjusted distribution.

Unlike the ESW flow requirements for the control room chiller cooling, the heat loads in the control building calculated in 466-M-008 are employed (see Section 4.2 of this report). Calculation M-010 gives the results of the two cases examined and M-011 supplies a validation of the simple computer code employed in M-010.

This computer code is a transient code but lacks the effect of heat slabs. Instead it performs simple mass and energy balances throughout a multiple control volume arrangement. It uses the

capacitance and flow distribution of the air with the sources of energy in each control volume to determine an air heat-up rate.

All three of these calculations lacked administrative controls since they were not signed-off by a reviewer.

The assumptions and approach appear to be on the conservative side, primarily because of the lack of heat slab capacitance consideration. The results of the calculation are somewhat of a concern, however, since in the case of using only standby filter unit makeup air, the control room temperature would rise at a rate of about 2°F per minute. Based on the assumptions used in the calculation, this would continue unabated. This would not allow time for a controlled shutdown of the plant. Therefore, allowing one chiller system to be inoperable during plant operation may need to be restricted.

8 Conclusions

The review team believes that the present calculations do not support the proposed technical specification amendment. Problems were found in the following broad categories:

- Fouling factors. The fouling factors used for the ESW flow requirements appear to be non-realistic for DAEC service use (Sections 3.2, 4.2, 5.2, 6.3).

- Methodology. Some calculations employed an approach which involved too many unknowns (Section 5.2), or did not sufficiently document the calculational results to assure that the approach was adequate, as was the case in employing the Wilson Method (Section 4.2).

- Assumptions. In many cases, assumptions used in the calculations could have been verified and hence removed as assumptions with a request for information to DAEC or vendors (Section 4.2).

- As-built conditions. Our field observations gave us the impression that the calculation preparers did not perform walkdowns or request confirming information from the field (Section 5.4).

  Equipment qualification (EQ). In at least one calculation (RHR pump seal cooling), an argument is made that the EQ Temperature envelope for the seal can be exceeded f-, a short time. Supporting justification for this condition was not addressed (Section 6.2)

- Administrative controls. A revision to one calculation, and all the calculations dealing with control room habitability, lacked checker sign-off (Sections 4.2, 6.2, 7).

- Computer code validation and verification. The documentation for the pump room cooler coil computer code was validated but the review team did not have sufficient documentation to assure verification (Section 5.3).

Within the constraints of this limited review, we have tried to clarify all the problems associated with this calculational series. We have not discussed the distribution of the ESW total flow. Clearly, the appropriate flow to each ESW serviced component would need to be assured, including consideration for uncertainty of flow measurement and variations in intake structure water level.

9 References

1. Mineck, D.L. Letter to J. Murley of 6/28/91 on Docket 50-331.

2. Dwg. 11905649, Colt Industries Heat Exchanger Assembly Vendor Drawing #343M1508A3 of American Standard Industrial Division.

3. Roshenow, W.M., et al., Handbook of Heat Transfer, McGraw-Hill, 1973.

4. Letter, W. Lederhouse (ITT Standard) to J. Olson (Bechtel), dated 8/30/90, (Chron 34605) and Letter, W. Lederhouse to J. Olson, dated 9/05/90, (Chron 34617).