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Waterford 3

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A4.05
PR

October 30, 1998

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Request for Additional Information Regarding
Response to Generic Letter 96-06

Gentlemen:

On January 28, 1997, via Letter Number W3F1-97-0017, Waterford 3 provided the requested response to NRC Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions." On July 29, 1998, the NRC requested additional information on the Waterford 3 response to this GL.

The requested information is provided in the attachment to this letter. If you have any questions regarding this RAI response, please contact Mr. M.K. Brandon at (504) 739-6254 or me at (504) 739-6242.

Very truly yours,

E.C. Ewing
Director
Nuclear Safety & Regulatory Affairs

ECE/DAY/ssf
Attachment

cc: E.W. Merschoff (NRC Region IV), C.P. Patel (NRC-NRR),
J. Smith, N.S. Reynolds, NRC Resident Inspectors Office

1/1

A072

Response to the Request for Additional Information Regarding Response to Generic Letter 96-06 for Waterford Unit 3 (TAC NO. M96883)

ITEM 1

Provide a detailed description of the "worst case" scenarios that were identified, taking into consideration the complete range of event possibilities, system configurations, and parameters. For example, the complete range of temperatures, pressures, flow rates, load combinations, and component failures should be considered consistent with the design basis of the plant. Describe the minimum margin to boiling that will exist.

RESPONSE

Waterford's original response identified the LOCA and Main Steam Line Break (MSLB) as worst case scenarios. Further analysis identified the MSLB as the limiting event. As discussed in the Waterford 3 FSAR (Section 6.2), the worst case containment temperature excursion at Waterford 3 occurs as the result of a 7.87 ft^2 Main Steam Line Break (MSLB) occurring at 102% power. (FSAR Figure 6.2-8b) The temperature occurring ~17 seconds into this event was utilized for this evaluation. The assumptions described in the FSAR Section 6.2.1.1.3 produce the most severe MSLB containment temperature transient. A conservative prediction of consequences is assured by determining upper and lower bounding values of containment initial conditions, geometric parameters, and thermodynamic properties, and by applying these values in the manner producing maximum temperature results. The minimum margin to boiling is described in item 4.

ITEM 2

Identify any computer codes that were used in the waterhammer and two-phase flow analyses and describe the methods used to validate and bench mark the codes for the specific application and loading conditions involved.

RESPONSE

The conclusion on page 2 of Attachment A of Waterford's response to GL96-06 dated January 28, 1997 indicated that neither waterhammer nor two-phase flow issues are a concern for Waterford 3. No computer codes or programs were used in performing this evaluation.

ITEM 3

Describe and justify all assumptions and input parameters (including those used in any computer codes) that were used in the waterhammer and two-phase flow analyses, and provide justification for omitting any effects that may be relevant to the analyses. Confirm that these assumptions and input parameters are consistent with the existing design and licensing bases of the plant. Any exceptions should be explained and justified.

RESPONSE

The conclusion on page 2 of Attachment A of Waterford's response to GL96-06 dated January 28, 1997 demonstrated margin to saturation in the CCW system, therefore no concern for waterhammer or two-phase flow exists and no analysis to determine the magnitude and effect of waterhammer was performed.

ITEM 4

The January 28, 1997, response indicated that the main steam line break (MSLB) provides the worst-case temperature excursion in containment. After 17 seconds, the temperature is about 375° F at 44 psia. EOI indicated that the partial pressure of steam is less than 23 psia and the corresponding saturation temperature is 235° F. EOI concluded that the condensed steam (at 235°F) will coat the outside surface of the fan cooler tubes and because the saturation temperature for CCW is about 269° F (due to surge tank elevation), boiling will not occur in the CCW system. Discuss what effect the bulk containment temperature will have on the fluid film that coats the fan cooler tubes and on CCW temperature. Describe the bounding CCW temperature that will be reached, and explain why this temperature is assured to be conservative.

RESPONSE

Waterford's evaluation for the timing of the start of CCW flow in 17 seconds corresponds to a LOOP condition. However, the worst case MSLB containment temperature response used in our evaluation is calculated assuming off-site power is available. This analysis conservatively uses containment temperatures calculated with off-site power available. Off-site power allows the continuation of reactor coolant pump flow. This maximizes the rate of primary to secondary heat transfer and maximizes the rate of mass/energy release. This condition along with the other assumptions used results in the maximum containment temperature. Actual containment temperatures for a MSLB concurrent with a LOOP will be lower.

Following the MSLB event that results in the worst containment temperature response, the containment temperature rises from an assumed initial temperature of 120°F, (maximum allowed per Technical Specification) to about 375°F in 17 seconds. Following the break, the steam in containment will condense on the CFC coil tubes containing much colder CCW. The condensation process will create a liquid film on the tubes that can reach a maximum temperature equal to the saturation temperature corresponding to the steam partial pressure in the containment. The heat transfer process from the containment atmosphere to the CCW in the CFC tubes is primarily due to condensation of steam on the tubes and convection/conduction processes from the liquid film on the tubes to the CCW water inside the tubes. A temperature gradient exists across the film from the surface temperature of the CFC coils to the temperature at the free surface. The maximum temperature of the film at 17 seconds is the saturation temperature based on a partial pressure of the steam 23 psia, i.e. 235°F. This film represents a thermal resistance to heat transfer.

As long as the liquid film coats the coils, the temperature of the CCW inside the tubes can be no greater than 235°F. If the entire liquid film reaches saturation temperature, the liquid film may start to evaporate and may result in a dry tube surface if no additional condensation occurs to replenish the liquid film. This is considered unlikely in the high humidity environment of containment. If the CFC tube surface dries up, the convection heat transfer from the potentially superheated steam could cause the CCW water temperature to increase above the CCW saturation temperature. The condensate film coating the CFC coils is not expected to dry out due to the following:

- The CCW in the tubes is initially subcooled by approximately 150°F. Thus, a large temperature change is required within a short period of time to reach saturation in the CCW.
- Since a LOOP is assumed for this analysis, the CFC fans are coasting down during the 17 seconds. Therefore, as the temperature is increasing, less air is drawn through the fan cooler which decreases the heat transfer rate.
- A conservative estimate of how much heat is added to the CCW in the coils and the resulting bulk CCW temperature rise was performed. From the containment temperature analysis, the highest CFC heat removal rate during the initial 17 seconds was applied to the total mass of CCW water in the CFC for the entire 17 seconds. The resulting CCW temperature rise (approximately 85°F) was well below the margin to saturation. This temperature rise conservatively does not credit the reduced heat transfer rate due to the CFC fans coasting down or the resulting CCW water temperature increase.

Based on the above, the condensation process will continue and a liquid film will be maintained on the CFC tubes. Therefore the CCW water in the CFC coils is not expected to reach saturation during the initial 17 seconds of the event. After the initial 17 seconds, the CCW flow is restored providing a continuous flow of cool water.

The restoration of an out of service CFC sometime after the accident initiation was considered. In this case, a longer time is available for the stagnant CCW water temperature to increase to containment temperature. For the LOCA event (FSAR Figure 6.2-4), the maximum containment temperature reached is approximately equal to the saturation temperature of the CCW water (269°F) and occurs about 5 minutes after the start of a LOCA. This temperature is a peak temperature and is maintained for only a very short period of time on the order of a few seconds. Furthermore, the maximum liquid film temperature for a LOCA (saturation temperature at the maximum steam partial pressure) is 261°F, which is less than the CCW saturation temperature. The short time period combined with the CFC fan not running will limit how much heat can be transferred into the CCW water. The containment temperature is below the saturation temperature of the CCW water for the remainder of the event. Therefore the CCW water is not expected to reach saturation during the entire event. For the MSLB event, the containment temperature is above the saturation temperature of the CCW water for approximately ninety seconds. The maximum liquid film temperature is above the CCW saturation temperature for a shorter period of time. Once the containment temperature drops below 269°F, the containment atmosphere is incapable of increasing the CCW water above its saturation temperature because it is at a lower temperature. The short time period combined with the CFC fan not running will limit how much heat can be transferred into the CCW water. Therefore, if CCW flow is restored sometime after the MSLB or LOCA initiation, it is not expected that waterhammer or two-phase flow will be a concern.

The CCW supply to the RCPs and CEDM was also considered since they are also inside containment. Upon a Containment Spray Actuation Signal (CSAS) the containment isolation valves to these coolers are shut, isolating the CCW flowpath. These flowpaths need to be manually restored if cooling flow is desired. At the time the flowpaths would be restored, it is expected the containment temperatures will have been reduced to much lower levels as previously described. Therefore, waterhammer or two-phase flow is not a concern.

ITEM 5

Explain and justify all uses of "engineering judgement" that were credited in the waterhammer and two-phase flow analyses.

RESPONSE

"Engineering judgements" are described in item 4 above.

ITEM 6

Discuss specific system operating parameters and other operating restrictions that must be maintained to assure that the waterhammer and two-phase flow analyses remain valid (e.g., surge tank level, temperature, pressure), and explain why it would not be appropriate to establish Technical Specification requirements to acknowledge the importance of these parameters and operating restrictions. Also, describe and justify use of any non-safety related instrumentation and controls for maintaining these parameters.

RESPONSE

As discussed in the initial response, surge tank level would be the primary operational parameter needed to be maintained in order for the analyses to remain valid. To be conservative, the elevation at the bottom of the surge tank is used to calculate the pressure (and saturation temperature) at the CFC coils. Therefore, in this analysis, the tank is assumed to be completely empty. Surge tank volumes are normally maintained by a non-safety related make-up supply at greater than 70% of tank capacity (~3 ft. above tank bottom). A safety related make-up supply is also available if needed. The design of the surge tank provides for train separation and system volume changes. The tank's capacity ensures that the tank inventory will not be depleted by ruptures of non-seismic CCW piping before the non-essential piping is automatically isolated.

Safety related level controls, interlocks and alarms are provided to assure that tank level is maintained. All surge tank level instrumentation and controls are safety related. In addition, Technical Specification (TS) 3/4.7.3 addresses the availability of the CCW system by requiring both trains to be operable. If the surge tank level could not be maintained, the CCW makeup system as a supporting system to CCW would be declared inoperable. Per the TS definition 1.17 of operability, the CCW system would be declared inoperable and the action statement for this TS would be entered. Therefore, Technical Specification requirements to acknowledge the importance of these parameters and operating restrictions already exist.

ITEM 7

Implementing measures to prevent waterhammer and two-phase flow conditions, such as establishing and maintaining system overpressure requirements, is an acceptable approach for addressing these issues. However, all scenarios must be considered to assure that the vulnerability to waterhammer and two-phase flow has been eliminated. Confirm that all scenarios have been considered, such that the measures that have been established are adequate to address the waterhammer and two-phase flow concerns during (and following) all applicable accident scenarios.

RESPONSE

The measures discussed in Item 6 provide assurance that the CCW surge tank is at required design levels to maintain system pressure and assure that piping, such as the CFC piping, remains full when a portion of the system is isolated or CCW pump(s) are not in operation. All scenarios were considered when selecting the worst case containment temperature described in item 1. As discussed in item 4, following the initial event, if the CFC is later restored to service, waterhammer should not be a concern.

ITEM 8

Confirm that the waterhammer and two-phase flow analyses included a complete failure modes and effects analysis (FMEA) for all components (including electrical and pneumatic failures) that could impact performance of the cooling water system and confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.

RESPONSE

From our evaluation that demonstrates margin to saturation in the CCW system, no concern for waterhammer or two-phase flow exists. Therefore, no analysis to determine the magnitude and effect of waterhammer was performed. The FMEA analysis for the CCW system (FSAR table 9.2-4) was reviewed and no additional information is required.

ITEM 9

Describe the uncertainties that exist in the waterhamner and two-phase flow analyses, including uncertainties and shortcomings associated with the use of any computer codes, and explain how these uncertainties were accounted for in the analyses to assure conservative results.

RESPONSE

From our evaluation that demonstrates margin to saturation in the CCW system, no concern for waterhammer or two-phase flow exists. Therefore, no analysis to determine the magnitude and effect of waterhammer was performed. The engineering judgement used to conclude that waterhammer or two-phase flow was not a concern employed a conservative approach regarding inputs such as CCW surge tank level and maximum containment temperatures. The use of these conservative assumptions bound any uncertainties in these inputs.

ITEM 10

Provide a simplified diagram of the affected system, showing major components, active components, relative elevations, lengths of piping runs, and the location of any orifices and flow restrictions.

RESPONSE

A diagram of the affected system is shown in Figure A. The CCW piping detailed is the return piping from the "A" train CFCs (3C-SA and 3A-SA) located at Floor Elevation +21'. Note that the top of the CFC extends to approximately the +34.5' Elevation. The "B" train CFCs are located lower in containment (Floor Elevation -4') which will increase the saturation pressure for the CCW water inside. A simplified diagram of the entire CCW system is shown in Figure B.

ITEM 11

Describe in detail any plant modifications or procedure changes that have been made or are planned to be made to resolve the waterhammer and two-phase flow issues, including schedules for completion.

RESPONSE

There are no plant modifications or procedure changes required to address this issue.

W3F1-98-0184
Figure A

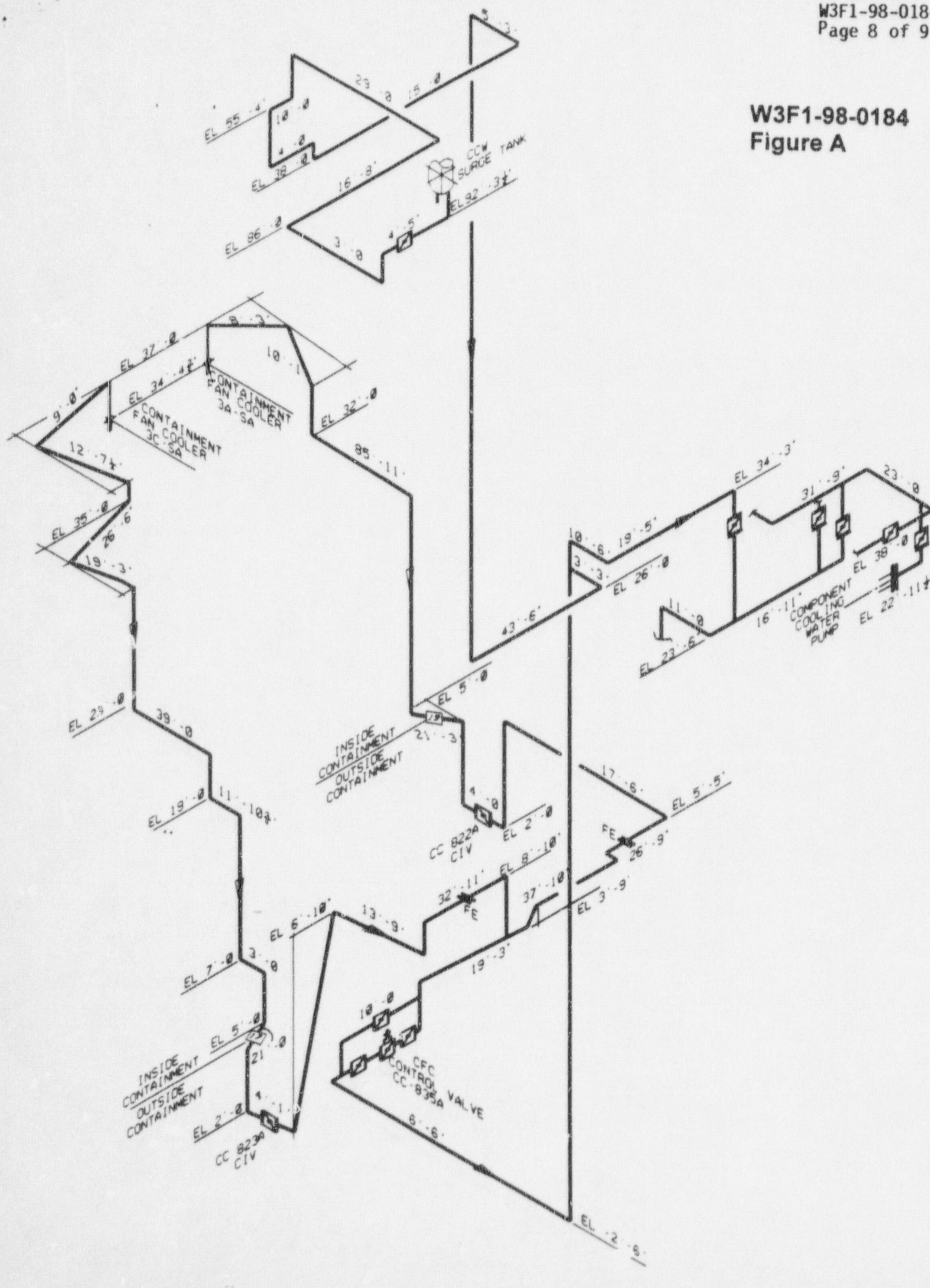
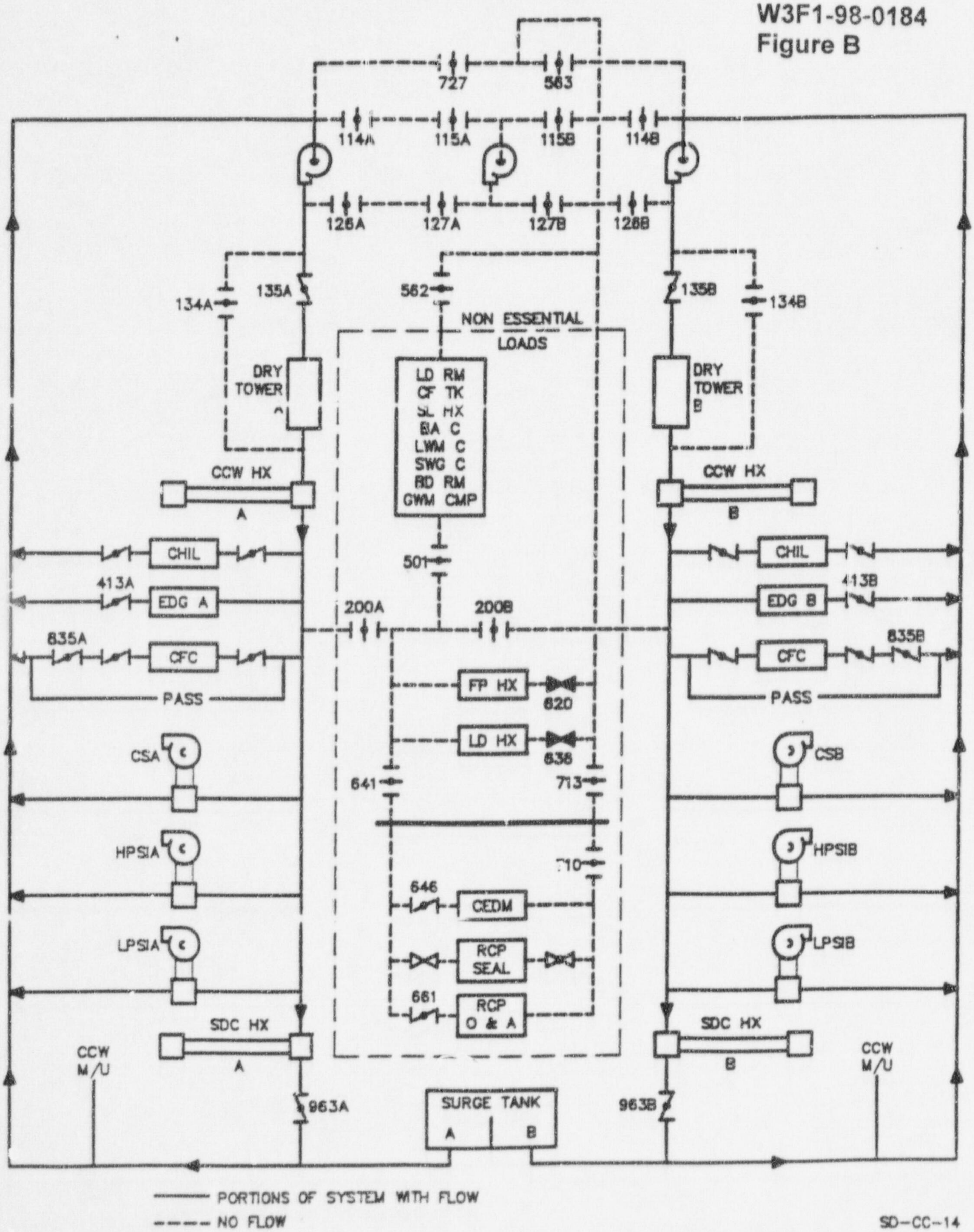


FIG. 14 CCW SYSTEM – CSAS (WITH SIAS) (AB ASSIGNED TO NORM)

(REF. G-160 SH 1-6)

W3F1-98-0184
Figure B



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CCW-000-03

REVISION 1