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SUBJECT: Forwards response to NRC 980601 RAI re GL 96-06 w/regard to water hammer & two-phase flow assessments associated w/post-accident operation of drywell air coolers.

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August 28, 1998
NMP1L 1353

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

RE: Nine Mile Point Unit 1 — Docket No. 50-220 — DPR-63
Nine Mile Point Unit 2 — Docket No. 50-410 — NPF-69

Subject: ***Request for Additional Information Regarding Generic Letter 96-06 Dated June 1, 1998 Concerning Nine Mile Point Units 1 and 2 (TAC Nos. M96836 & M96837)***

Gentlemen:

On February 7, 1997, Niagara Mohawk Power Corporation (NMPC) submitted to the NRC its response to Generic Letter 96-06 for Nine Mile Point Units 1 and 2 (NMP1 and NMP2). On December 16, 1997, NMPC revised the commitments made in that earlier response. On June 1, 1998, the NRC forwarded a Request for Additional Information (RAI) to NMPC concerning NMPC's February 7, 1997, submittal. The attachments to this letter provide the requested information with regard to water hammer and two-phase flow assessments associated with post-accident operation of drywell air coolers for NMP1 (Attachment 1) and NMP2 (Attachment 2).

Sincerely,

John T. Conway
Vice President Nuclear Generation

JTC/KLL/sc
Attachments

xc: Mr. H. J. Miller, NRC Regional Administrator
Mr. S. S. Bajwa, Acting Director, Project Directorate I-1, NRR
Mr. B. S. Norris, Senior Resident Inspector
Mr. D. S. Hood, Senior Project Manager, NRR
Records Management

ATTACHMENT 1

NMP1 RESPONSE TO GL 96-06 RAI

Request for Information #1

Discuss specific system parameter requirements to be maintained to assure that water hammer will not occur in the RBCLC System (RBCLC makeup tank level requirements, temperature requirements, etc.), and state the minimum margin to boiling that will exist for the worst-case scenario, including consideration of measurement and analytical uncertainties. Describe and justify reliance on any non-safety related instrumentation and controls for assuring that water hammer will not occur and explain why it would not be appropriate to establish Technical Specification requirements for maintaining these parameters.

Required Response # 1

The two key parameters for assuring that no water hammer occurs in Reactor Building Closed Loop Cooling (RBCLC) piping are (1) static head due to RBCLC fluid and (2) post-accident drywell temperature. The static head is provided by a 2,000 gallon capacity makeup tank located in the Turbine Building at floor elevation 351'-0". Makeup to the tank is provided automatically from the Condensate Transfer System through a level control valve. The tank is also provided with a level indication and high/low level alarms in the Control Room. The normal tank level is maintained by the level control valve between 4 feet and 8 feet from the bottom of the tank. The tank low level alarm set point is 3 feet above the bottom of the tank. The level at which the saturation temperature of RBCLC fluid at the highest point in the drywell would equal the conservatively assumed peak accident drywell temperature of 281 degrees F is approximately 5 feet below the low level alarm set point. Peak drywell temperature based on a reconstituted analysis is about 270 degrees F. The water level in the makeup lines, at which a saturation temperature of 270 degrees F will be reached at the highest location of RBCLC piping inside the drywell, is about 24 feet below the low level alarm set point. Due to the fact that a large margin exists, tank level measurement uncertainty was not explicitly considered in determining the adequacy of static head.

Drywell temperature measurement or analytical uncertainty is not a factor in preventing water hammer because a conservatively high drywell peak temperature was assumed for the calculation of saturation pressure. The actual analyzed temperature based on the reconstituted analysis is about 270 degrees F. The drywell temperature is at maximum only for a short duration and is below 250 degrees F within the first 100 seconds of the accident, and therefore, the bulk temperature of the RBCLC fluid inside the drywell is expected to be significantly less than the conservatively assumed peak drywell temperature. Based on these facts, margin to boiling for RBCLC piping inside the drywell under post Loss of Coolant Accident (LOCA) conditions, although not explicitly calculated, is considered to be substantial.

The tank level control and alarm instrumentation are non-safety related. The tank level control valve fails open on loss of air or power. Makeup to the Closed Loop Cooling (CLC) tank is provided by the Condensate Transfer pumps which are powered by power boards 161B and

171B. These power boards are supported by the diesel generators. The Condensate Transfer pumps are automatically supplied power from the diesel generators in less than 1 minute after a Loss of Offsite Power (LOOP). Therefore, it is highly unlikely that the makeup to the RBCLC system will be lost concurrent with the first few minutes of initiation of a Design Basis Accident (DBA) LOCA event when maximum post LOCA drywell temperature is reached. In the unlikely event that makeup is lost, disruption of makeup to the CLC tank for a few minutes after LOOP or loss of makeup to the CLC tank due to any other reason will not immediately render the RBCLC system inoperable due to the low RBCLC system makeup requirement. Tank inventory ensures that sufficient time is available to restore makeup to the CLC tank by operator actions based on the low tank level alarm response procedure.

The RBCLC system is not a NMP1 Technical Specification required system. None of the RBCLC System parameters have any Technical Specification limits and, since there is a substantial margin against boiling in RBCLC piping inside the drywell which could lead to water hammer, it is not considered necessary to establish Technical Specification limits for RBCLC system static head.

Request for Information #2

Question 2 is directed to Nine Mile Point Unit 2 (NMP2), and is not applicable to NMP1.

Request for Information #3

Implementing measures to assure that water hammer will not occur, such as maintaining system static pressure or prohibiting post-accident operation of the affected system, is an acceptable approach for addressing the water hammer concern. However, all scenarios should be considered to assure that the vulnerability to water hammer has been eliminated. Confirm that all scenarios have been considered, including those where the affected containment penetrations are not isolated (if this is a possibility), such that the measures that have been established are adequate to prevent the occurrence of water hammer during (and following) all postulated accident scenarios.

Required Response #3

The NMP1 design does not include automatic isolation of the RBCLC from the drywell coolers on receipt of a containment isolation signal. A single check valve is provided on the RBCLC supply to the drywell coolers and a motor-operated valve (MOV) is the isolation valve on the return line. As discussed in our 120-day response to Generic Letter (GL)96-06 dated February 7, 1997, the RBCLC containment isolation MOVs are normally open, and no procedure steps require their closure. Per the Response to NRC Question 1 above, prevention of water hammer in the drywell cooler piping is based on static pressure of the RBCLC fluid, not system isolation.

Rupture of RBCLC piping, or another passive failure with the potential to result in rapid loss of RBCLC inventory, is not postulated concurrent with a DBA at NMP1. Therefore, consistent with the NMP1 Licensing Basis, no such scenario is considered with respect to GL 96-06 issues.

Request for Information #4

For those scenarios where the potential for two-phase flow has not been eliminated, explain to what extent two-phase flow conditions will exist following accident conditions and provide the following information:

a. *Identify any computer codes that were used in the two-phase flow analyses and describe the methods used to bench mark the codes for the specific loading conditions involved (see Standard Review Plan Section 3.9.1).*

b. *Describe and justify all assumptions and input parameters (including those used in any computer codes), and explain why the values selected give conservative results. Also, provide justification for omitting any effects that may be relevant to the analysis (e.g., fluid structure interaction, flow induced vibration, erosion).*

c. *Provide a detailed description of the "worst case" scenario for two-phase flow, taking into consideration the complete range of event possibilities, system configurations, parameters (e.g., temperatures, pressures, flow rates, load combinations), and component failures. Additional examples include:*

   - *the consequences of steam formation, transport, and accumulation;*
   - *cavitation, resonance, and fatigue effects; and*
   - *erosion considerations*

   Licensees may find NUREG/CR-6031, "Cavitation Guide for Control Valves," helpful in addressing some aspects of the two-phase flow analyses. (Note: it is important for licensees to realize that in addition to heat transfer considerations, two-phase flow also involves structural and system integrity concerns that should be addressed).

d. *Determine the uncertainty in the two-phase flow analyses, explain how the uncertainty was determined, and how it was accounted for in the analyses to assure conservative results.*

e. *Confirm that the two-phase flow loading conditions do not exceed any design specifications or recommended service conditions for the piping system and components, including those stated by equipment vendors.*

   Confirm that the system will continue to perform its design-basis functions as assumed in the safety analysis report for the facility, and that the containment isolation valves will remain operable.

Required Response #4

Because two-phase flow with the potential for water hammer in the RBCLC drywell cooler piping is precluded, this question is N/A with respect to NMP1.

Request for Information #5

Confirm that the water hammer 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. Also, confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.

Required Response #5

Because two-phase flow with the potential for water hammer in the RBCLC drywell cooler piping is precluded, this question is N/A with respect to NMP1.

Request for Information #6

Explain and justify where engineering judgment was used in lieu of calculations in the analysis of the RBCLC System.

Required Response #6

The RBCLC System at NMP1 has two piping sections which penetrate the drywell as is discussed in the response to Issue 1A and 1B in the February 7, 1997, GL 96-06 response. The RBCLC piping section which supplies the drywell coolers enters through penetration X-12B and exits through penetration X-13B. The RBCLC piping section which supplies the recirculation pump coolers enters through penetration X-157 and exits through penetration X-156. Both piping sections are considered safety related pressure boundaries since these piping sections are not isolated from the safety related loads under LOCA conditions. NMPC's GL 96-06 response addressed the potential for two-phase flow in both sections of RBCLC piping.

The determination that no boiling would occur in RBCLC piping supplying water to the drywell coolers which could potentially lead to water hammer is based on straightforward comparison of piping elevations to determine the required static head required to maintain the saturation temperature above that of the peak drywell temperature due to a DBA LOCA. This determination was based on analysis of existing configuration of RBCLC piping and not on engineering judgment.

The evaluation of the potential for two-phase conditions in the RBCLC piping which supply cooling to the recirculation pump seals was considered as part of the two-phase flow evaluation. The Station Blackout (SBO) Qualification testing of the NMP1 recirculation pump seals

determined that natural circulation and boiling heat transfer in the recirculation pump coolers provides significant cooling to the seals under loss of RBCLC pump cooling to the seals. The SBO testing of the seals was performed using a full scale pump seal cooler mockup and the simulation of the RBCLC piping and RBCLC system head. These SBO tests demonstrated that the boiling in the pump coolers remains localized and that adequate natural circulation flow develops to prevent any vapor void formation. Engineering judgment was applied to confirm that these tests were applicable to the LOCA conditions in two respects: 1) Natural circulation will develop in the RBCLC piping, and 2) The potential for localized two-phase conditions in the pump coolers did not lead to the potential for hydrodynamic loads. NMPC discussed the RBCLC recirculation seal cooler piping and the potential for two-phase conditions in the piping post-LOCA for completeness because of the NMP1 specific RBCLC piping system interrelationship.

Request for Information #7

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

Required Response #7

The attached sketch provides all the requested information except lengths of piping runs. Complexity of RBCLC piping inside the drywell does not allow inclusion of piping lengths in the simplified sketch. Piping isometrics can be provided if more detail than shown on the simplified sketch is desired.

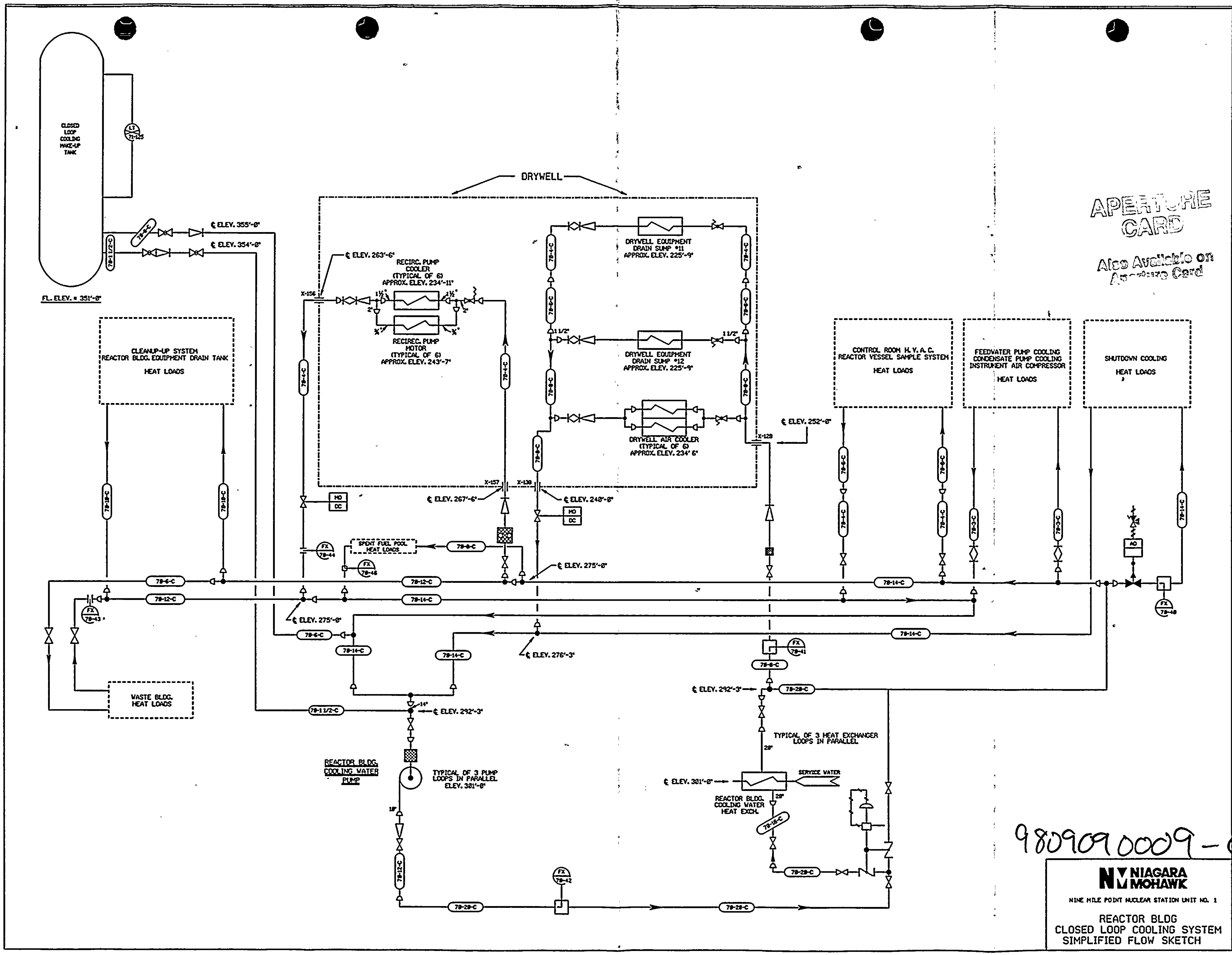
Request for Information #8

Describe in detail any modifications that have been made (or will be made) to system design or operating requirements to resolve the water hammer and two-phase flow issues.

Required Response #8

Since there is no potential for water hammer in the drywell coolers or in the RBCLC piping supplying cooling water to the drywell coolers due to two-phase flow, and since the heat removal function of the RBCLC System is not credited for post LOCA decay heat removal, no modifications were required for resolution of water hammer and two-phase concerns.

Furthermore, RBCLC return piping from the drywell, beyond the drywell penetrations, was also reviewed for two-phase flow concerns. An engineering assessment has been performed which demonstrates that the process fluid temperature will remain below the saturation temperature in the piping outside the drywell, therefore, no modifications were required for the RBCLC piping outside the drywell.



NIAGARA MOHAWK

NINE MILE POINT NUCLEAR STATION UNIT NO. 1

REACTOR BLDG
CLOSED LOOP COOLING SYSTEM
SIMPLIFIED FLOW SKETCH

<u>ATTACHMENT 2</u>

NMP2 RESPONSE TO GL 96-06 RAI

<u>Request for Information #1</u>

Question 1 is directed to Nine Mile Point Unit 1 (NMP1), and is not applicable to NMP2.

<u>Request for Information #2</u>

For the small break scenario, describe the minimum time required for operators to initiate RBCLC flow in order to prevent steam formation, and explain how this action will be assured. Although the EOPs have been revised to eliminate the potential for water hammer following a large break loss of coolant accident, explain how water hammer will be avoided after drywell temperature drops below 250 degrees F (steam pockets that have been formed are not expected to dissipate very readily).

<u>Required Response #2</u>

This question consists of two parts: (a) what is the minimum response time for small breaks; (b) how is water hammer precluded if drywell temperature exceeds 250 degrees F, then goes back below 250 degrees F?

a. As stated in our February 7, 1997 response, the heat removal capability of the drywell coolers is not required nor credited in any post-accident mitigation scenario. The automatic isolation of the RBCLC System containment isolation valves prevents boiling during all design basis accidents by maintaining the isolated segment above the saturation pressure. This is described in detail in the February 7, 1997 response. The system is susceptible to boiling only after the isolation signal is manually defeated. As such, post-accident Operator initiation of RBCLC flow is not required to prevent steam formation in the piping network. Steam formation and subsequent water hammer are prevented by restricting the operation of the system during conditions that may induce boiling in the piping network.

   Initiation of the RBCLC coolers is symptom-based as a function of drywell temperature. The administrative limit of 250 degrees F ensures the system is not operated during conditions conducive to boiling. It is not expected nor required that the isolation interlocks be defeated to support operation of the RBCLC coolers for medium to large break scenarios. The system can be initiated during small break scenarios where the drywell temperature increases at a slower rate. Again, system availability during this scenario is not required and has not been credited in the plant design.

b. Attachment 24 to procedure N2-EOP-6 defines the conditions in which the LOCA

isolation signal may be defeated for the RBCLC drywell cooler containment isolation valves (2CCP*MOV265, 2CCP*MOV273, 2CCP*MOV122, 2CCP*MOV124). This procedure has been revised to preclude reopening of the containment isolation valves if the drywell temperature has exceeded 250 degrees F during the event, until an evaluation of drywell and RBCLC parameters concludes that water hammer will not occur.

Request for Information #3

Implementing measures to assure that water hammer will not occur, such as maintaining system static pressure or prohibiting post-accident operation of the affected system, is an acceptable approach for addressing the water hammer concern. However, all scenarios should be considered to assure that the vulnerability to water hammer has been eliminated. Confirm that all scenarios have been considered, including those where the affected containment penetrations are not isolated (if this is a possibility) such that the measures that have been established are adequate to prevent the occurrence of water hammer during (and following) all postulated accident scenarios.

Required Response #3

Isolation of RBCLC from the drywell coolers is accomplished by MOVs 2CCP*MOV265 and 2CCP*MOV273 on the drywell cooler supply piping and 2CCP*MOV122 and 2CCP*MOV124 on the return piping. Containment isolation is single failure proof, and would be achieved in the event of any LOCA/Main Steam Line Break (MSLB) resulting in high drywell pressure or low reactor water level. EOP restrictions on defeating the isolation signal are symptom-based, and are not specific to any scenario. Scenarios involving breaks with insufficient energy release to generate a LOCA isolation signal would not result in water hammer, as described below in the response to Question 6. The combination of a single failure proof isolation scheme and symptom-based EOP guidance covers any postulated scenarios with respect to preventing water hammer in the RBCLC drywell cooler piping.

Request for Information #4

For those scenarios where the potential for two-phase flow has not been eliminated, explain to what extent two-phase flow conditions will exist following accident conditions and provide the following information:

a. *Identify any computer codes that were used in the two-phase flow analyses and describe the methods used to bench mark the codes for the specific loading conditions involved (see Standard Review Plan Section 3.9.1).*

b. *Describe and justify all assumptions and input parameters (including those used in any computer codes), and explain why the values selected give conservative results. Also, provide justification for omitting any effects that may be relevant to the analysis (e.g.,*

fluid structure interaction, flow induced vibration, erosion).

c. *Provide a detailed description of the "worst case" scenario for two-phase flow, taking into consideration the complete range of event possibilities, system configurations, parameters (e.g., temperatures, pressures, flow rates, load combinations), and component failures. Additional examples include:*

- *the consequences of steam formation, transport, and accumulation;*
- *cavitation, resonance, and fatigue effects; and*
- *erosion considerations*

Licensees may find NUREG/CR-6031, "Cavitation Guide for Control Valves," helpful in addressing some aspects of the two-phase flow analyses. (Note: it is important for licensees to realize that in addition to heat transfer considerations, two-phase flow also involves structural and system integrity concerns that should be addressed).

d. *Determine the uncertainty in the two-phase flow analyses, explain how the uncertainty was determined, and how it was accounted for in the analyses to assure conservative results.*

e. *Confirm that the two-phase flow loading conditions do not exceed any design specifications or recommended service conditions for the piping system and components, including those stated by equipment vendors.*

Confirm that the system will continue to perform its design-basis functions as assumed in the safety analysis report for the facility, and that the containment isolation valves will remain operable.

Required Response #4

As discussed in our February 7, 1997 response and further clarified in the response to Questions 2 and 3 above, two-phase flow and the resulting potential water hammer is precluded from occurring in the RBCLC drywell cooler piping. Therefore, Question 4 is not applicable to NMP2.

Request for Information #5

Confirm that the water hammer 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. Also, confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.

Required Response #5

Question 5 is not applicable to NMP2 because two-phase flow with potential for water hammer is precluded.

Request for Information #6

Explain and justify where engineering judgement was used in lieu of calculations in the analysis of the RBCLC system.

Required Response #6

The temperature limit established to preclude boiling in the RBCLC coolers is based on pressure considerations established in design calculations. The discussion in the response to Question 2, regarding breaks which do not result in a LOCA isolation signal, is not based on any calculations performed specifically to address Generic Letter 96-06 concerns. The judgment that such breaks would not result in steam formation in the RBCLC piping is based on a qualitative assessment of existing accident response models, considering the temperature and pressure input from design calculations.

One of the diverse means of automatic initiation of the LOCA isolation function is the drywell pressure - high signal, which has a set point limit of <1.68 psig (16.38 psia) and an allowable value of <1.88 psig (16.58 psia), per Technical Specification Table 3.3.2-2. During normal plant operation, the drywell pressure must be maintained between 14.2 psia and 15.45 psia, and the maximum allowable drywell average temperature is 150 degrees F (per Technical Specifications 3.6.1.5 and 3.6.1.6, respectively). With containment integrity intact in accordance with Technical Specification 3.6.1, a significant increase in drywell temperature would have a corresponding increase in drywell pressure, such that a temperature increase on the order of that required to induce boiling in the RBCLC piping (e.g., approximately 100 degrees F), without a high drywell pressure condition, is not credible.

As described in NMP2 Updated Safety Analysis Report (USAR) Section 6C, Humphrey Concern 5.8 considered the possibility of high temperatures in the drywell without reaching the drywell pressure - high limit, due to drywell bypass leakage. In response to this concern, a transient analysis was performed assuming the loss of all drywell coolers. Based on normal heat loads and normal leakage from the RCS, the analysis concluded that the drywell high pressure signal would be generated in approximately one hour, and the maximum drywell temperature was predicted to be 204 degrees F. This analysis, though not performed specifically to address water hammer concerns, illustrates that the drywell pressure-high signal provides protection against high drywell temperatures in response to transients with relatively low energy release rates.

Request for Information #7

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

Required Response #7

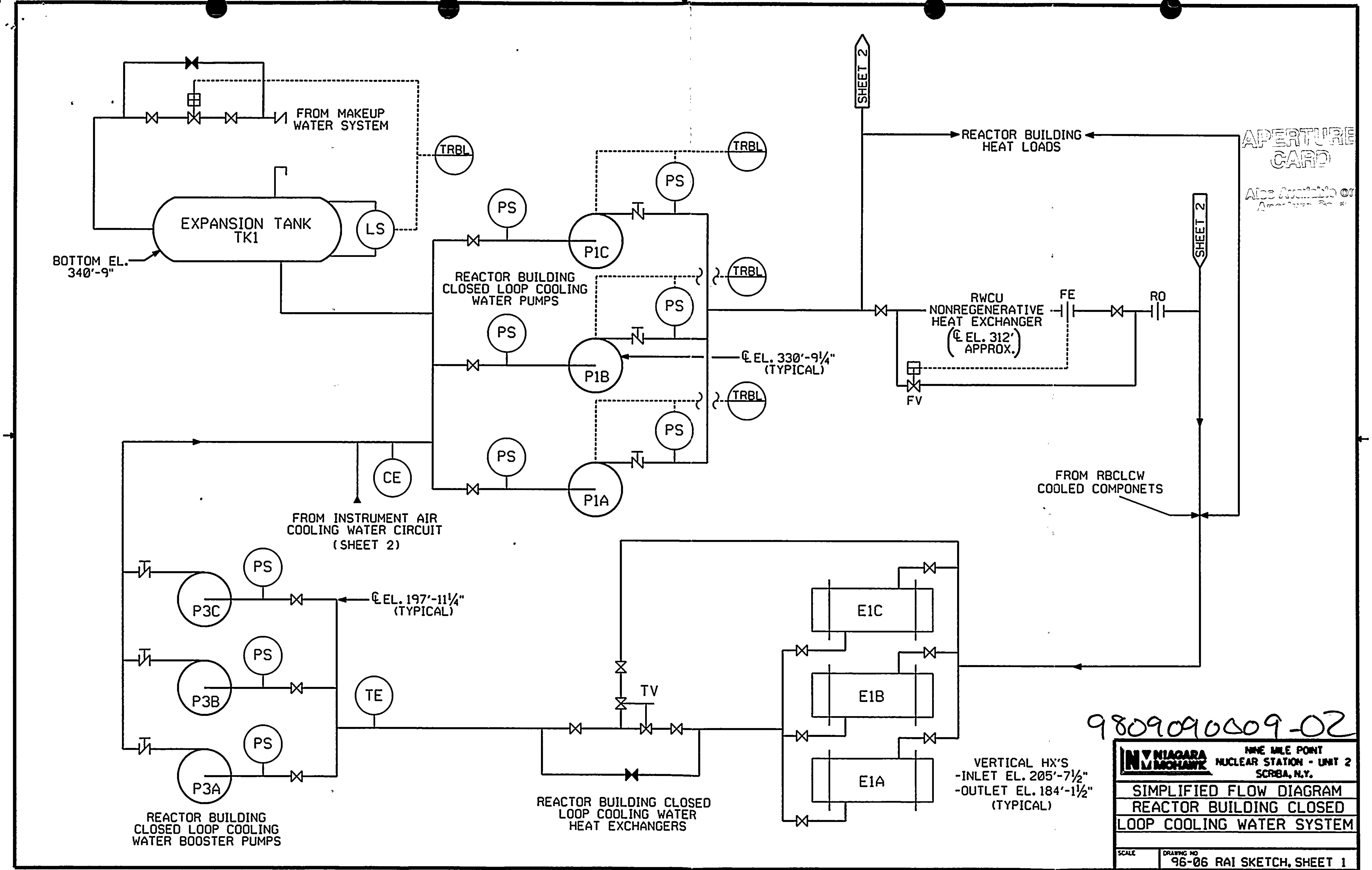
The attached sketch provides all the requested information except lengths of piping runs. Complexity of RBCLC piping inside the drywell does not allow inclusion of piping lengths in the simplified sketch. Piping isometrics can be provided if more detail than shown on the simplified sketch is desired.

Request for Information #8

Describe in detail any modifications that have made (or will be made) to system design or operating requirements to resolve the water hammer and two-phase flow issues.

Required Response #8

As described above in the response to Question 2, changes to procedure N2-EOP-6, Attachment 24, have been implemented to restrict defeating the LOCA isolation signal for the RBCLC drywell cooler containment isolation valves. Specifically, a restriction has been added such that the isolation valves will not be reopened to establish drywell cooling if the drywell temperature has exceeded 250°F during the event, unless an evaluation of drywell and RBCLC parameters concludes that water hammer will not occur. No plant design modifications are required to prevent water hammer from occurring.


FROM MAKEUP WATER SYSTEM
TRBL
EXPANSION TANK TK1
LS
BOTTOM EL. 340'-9"
PS
P1C
P1B
P1A
REACTOR BUILDING CLOSED LOOP COOLING WATER PUMPS
℄ EL. 330'-9¼" (TYPICAL)
SHEET 2
REACTOR BUILDING HEAT LOADS
RWCU NONREGENERATIVE HEAT EXCHANGER (℄ EL. 312' APPROX.)
FE
RO
FV
CE
FROM INSTRUMENT AIR COOLING WATER CIRCUIT (SHEET 2)
FROM RBCLCW COOLED COMPONETS
P3C
P3B
P3A
℄ EL. 197'-11¼" (TYPICAL)
TE
TV
E1C
E1B
E1A
REACTOR BUILDING CLOSED LOOP COOLING WATER BOOSTER PUMPS
REACTOR BUILDING CLOSED LOOP COOLING WATER HEAT EXCHANGERS
VERTICAL HX'S -INLET EL. 205'-7½" -OUTLET EL. 184'-1½" (TYPICAL)
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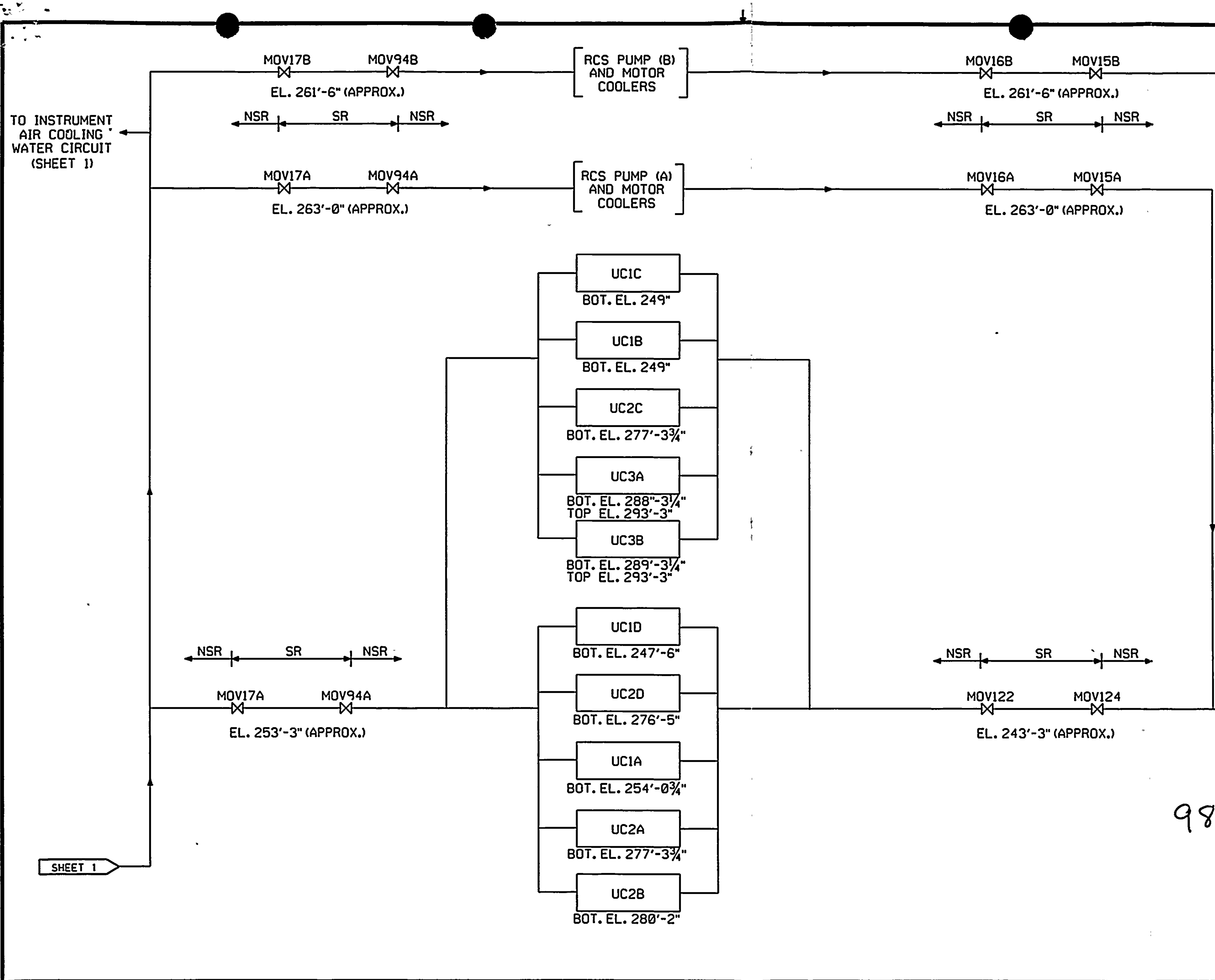
SIMPLIFIED FLOW DIAGRAM REACTOR BUILDING CLOSED LOOP COOLING WATER SYSTEM
SCALE
DRAWING NO
96-06 RAI SKETCH, SHEET 1



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NIAGARA MOHAWK

NINE MILE POINT NUCLEAR STATION - UNIT 2
SCRIBA, N.Y.

SIMPLIFIED FLOW DIAGRAM
REACTOR BUILDING CLOSED
LOOP COOLING WATER SYSTEM

SCALE

DRAWING NO
96-06 RAI SKETCH, SHEET 2