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50-313

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 19, 1999

Mr. C. Randy Hutchinson
Vice President, Operations ANO
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT NO. 1 RE: COMPLETION OF THE EMERGENCY COOLING POND LICENSING BASIS REVIEW (TAC M94948)

Dear Mr. Hutchinson:

By letters dated May 15, May 19, and June 7, 1995, Entergy Operations, Inc., (EOI) requested an amendment to the Arkansas Nuclear One, Unit 1 (ANO-1) technical specifications pertaining to operation of the reactor building coolers. During the staff's review of the request, a concern was identified regarding the licensing basis of your ultimate heat sink (UHS). The amendment was approved on its own technical merit; however, the staff was interested in further discussion of your UHS capabilities. By letter dated October 25, 1995, we requested you provide a summary of the licensing basis for the emergency cooling pond at the Arkansas Nuclear One site. You provided a response on February 23, 1996. After review of your response, the staff requested a meeting in a letter dated June 13, 1997. A public meeting was conducted on November 12, 1997, in Rockville, Maryland to discuss the ANO-1 UHS.

Your interpretation of the licensing basis was presented at the November 1997, meeting and a copy of the handout from that meeting is included as an enclosure. Supporting your presentation was a calculation that showed a very low probability of an ANO-1 loss-of-coolant accident concurrent with the failure of Dardanelle Dam. After considerable discussion and review of the available documentation, the staff accepts your interpretation of the design basis for the UHS for the following reasons:

1. actions are being taken to monitor and maintain the integrity and reliability of the Dardanelle Dam, Reservoir, and the plant intake and discharge canals, and

2. there is a very low probability of an ANO-1 loss-of-coolant accident concurrent with the failure of Dardanelle Dam.

You are requested to make appropriate revisions to the Updated Final Safety Analysis Report, eliminating the confusion and conflicting information that currently exists, and include additional information that reflects the importance of the Dardanelle Dam, Reservoir, and the plant intake and discharge canals. You are also requested to assure that appropriate surveillance and maintenance requirements are implemented for maintaining the integrity, reliability, and availability of these features, and that these features are included within the scope of your quality assurance program. The U.S. Nuclear Regulatory Commission reserves the option of inspecting the implementation of your UHS performance monitoring measures in the future. Additionally, inclusion of the Dardanelle Dam, Reservoir, and the plant intake and discharge canals within the design basis of the UHS would subject them to review under Title 10 of the

DFO1

Code of Federal Regulations, Section 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," if an application for license renewal is made in the future.

Due to an administrative oversight, a summary of the November 12, 1997, meeting was not prepared. This letter also serves as the meeting summary to ensure your presentation is available on your docket.

Sincerely,

ORIGINAL SIGNED BY

M. Christopher Nolan, Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-313

Enclosure: as stated

cc: See next page

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Agenda

Introduction.....Rick Lane

Design Review -
Issue Identification.....Charles Turk

ANO-1 Licensing Basis.....Dale James

Seismic Adequacy of
Dardanelle Lock and Dam.....Bill Alumbaugh

Probabilistic Insights.....Dan Williams

Interactions Subsequent to
Initial Licensing.....Dale James

Conclusions.....Charlie Zimmerman

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Design Review - Issue Identification

Ultimate Heat Sink
Service Water System
Containment Cooling

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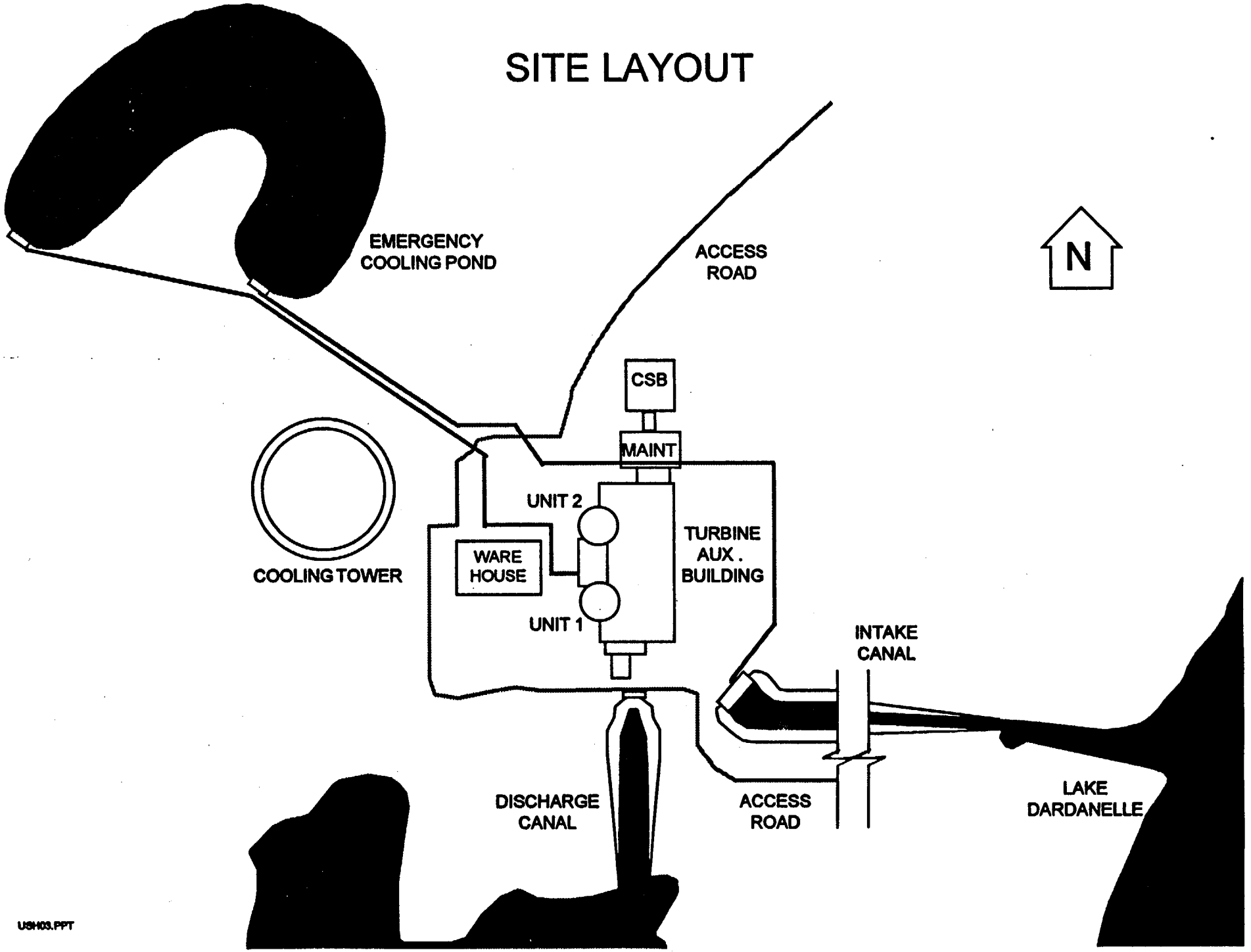
Ultimate Heat Sink

- For ANO the ultimate heat sink complex consists of
  - Dardanelle reservoir with single intake and discharge canals
  - The Emergency Cooling Pond (ECP) with single supply and return lines for each unit

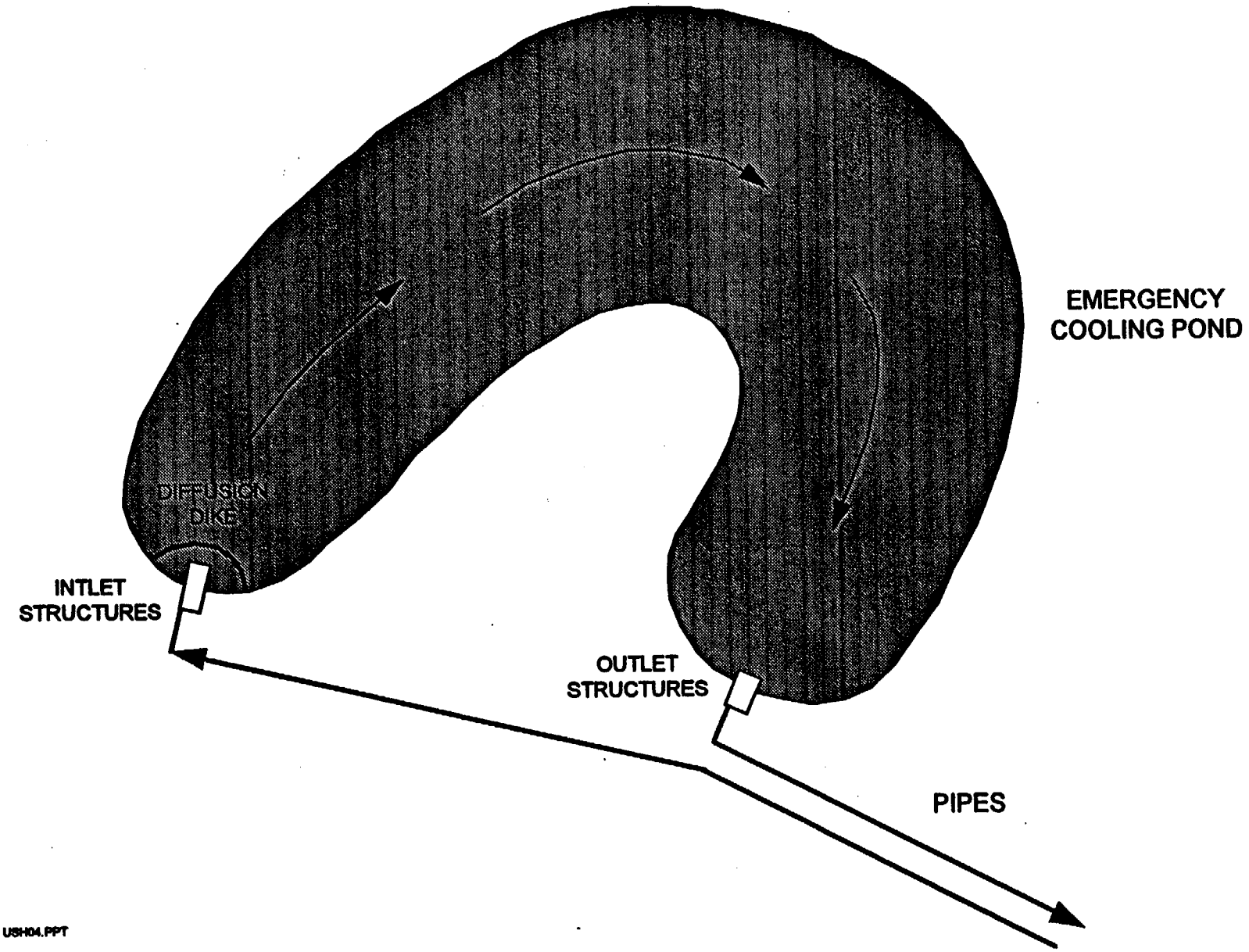
- The design is in conformance with the licensing basis requirements as described in FSAR

SITE LAYOUT



USH03.PPT

EMERGENCY COOLING POND



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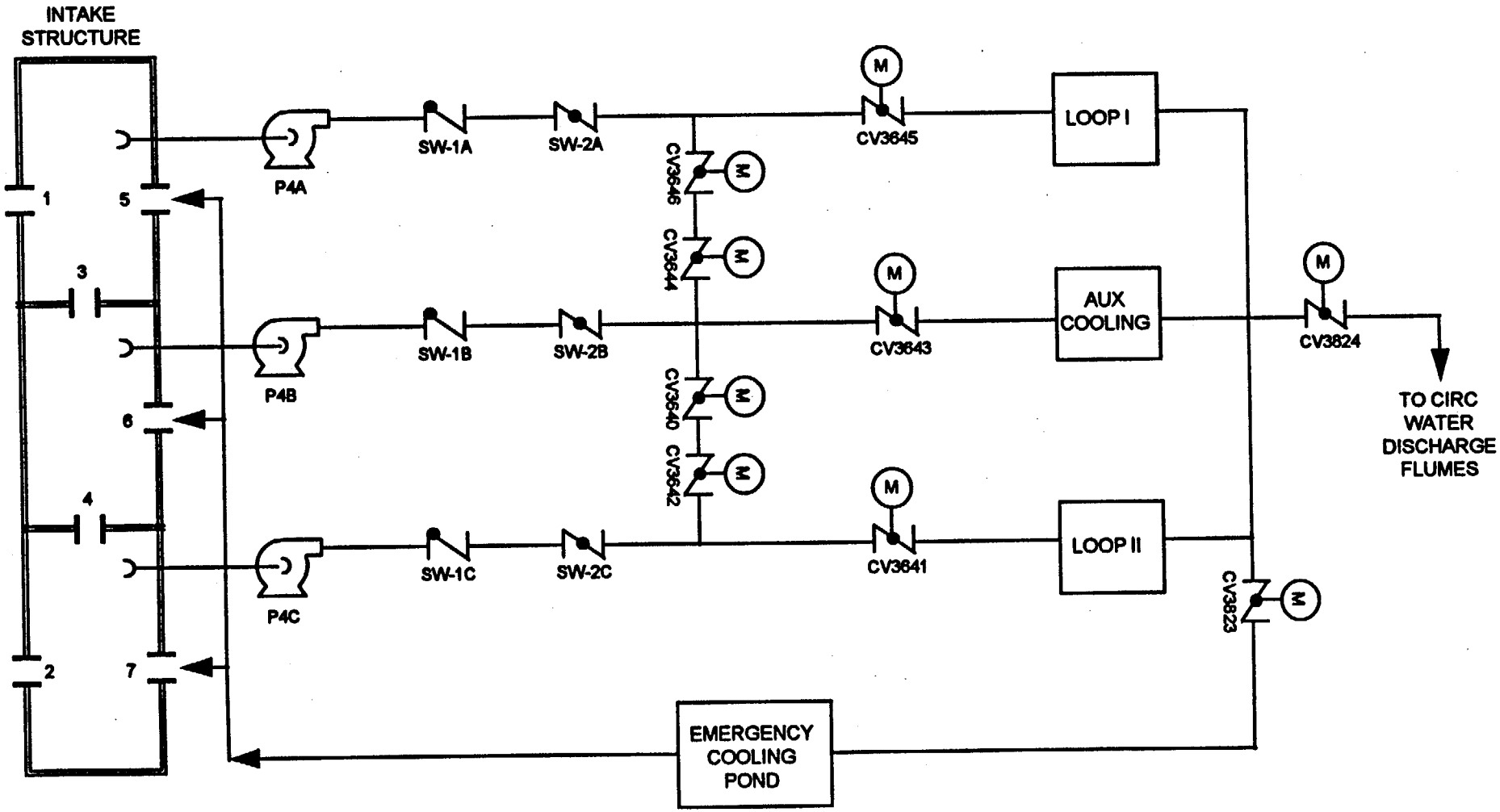
Service Water System

- Two redundant 100% trains of cooling water for vital and non-vital equipment
- Supply is provided by either water source (lake or ECP) through a multiple sluice gate arrangement
- This design provides a single discharge flow path to either the ECP or the lake
- The service water systems and UHS design have been extensively reviewed in three separate SSFIs since 1989

ANO-1 SERVICE WATER SYSTEM

(Simplified)



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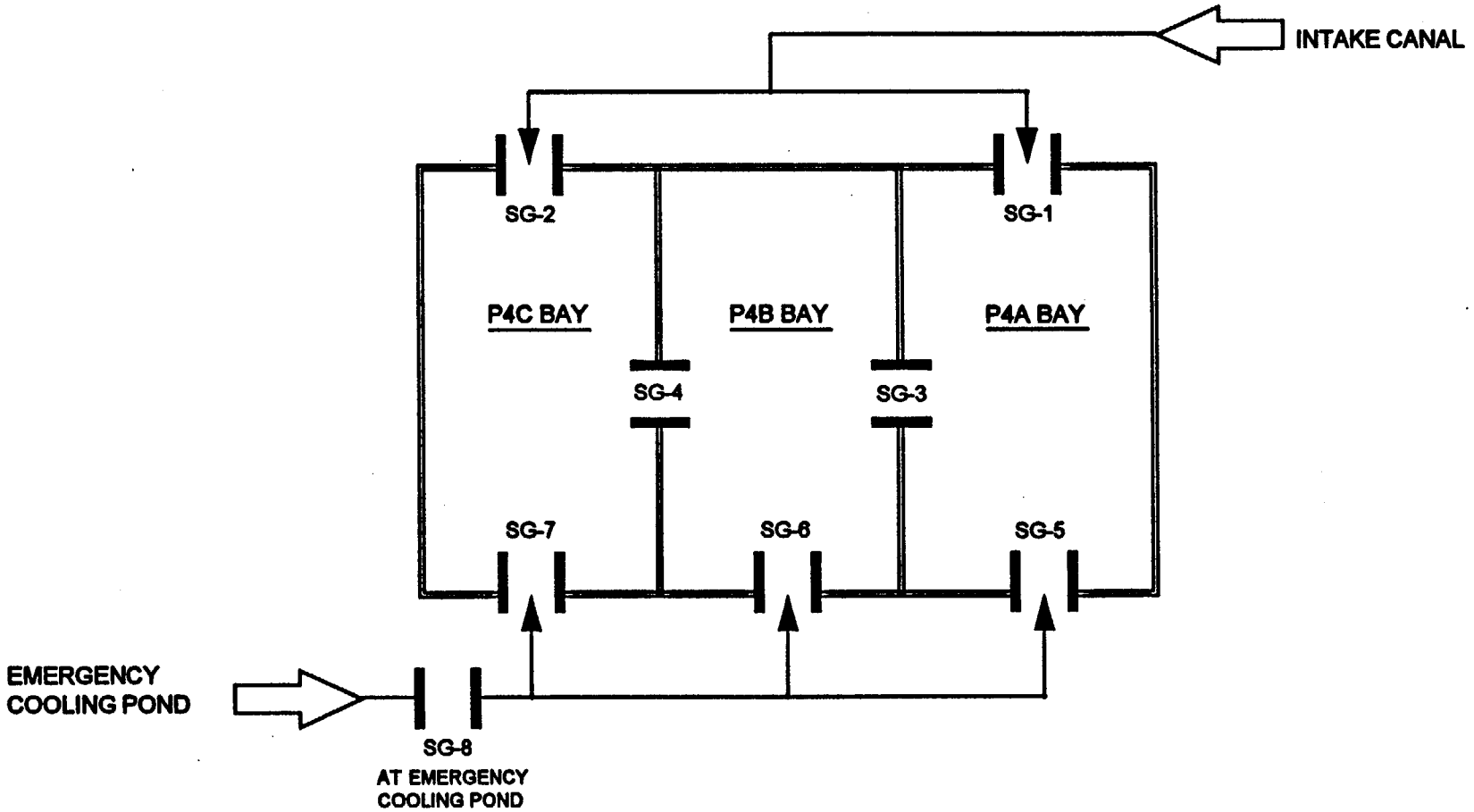
INTAKE STRUCTURE SLUICE GATE ARRANGEMENT



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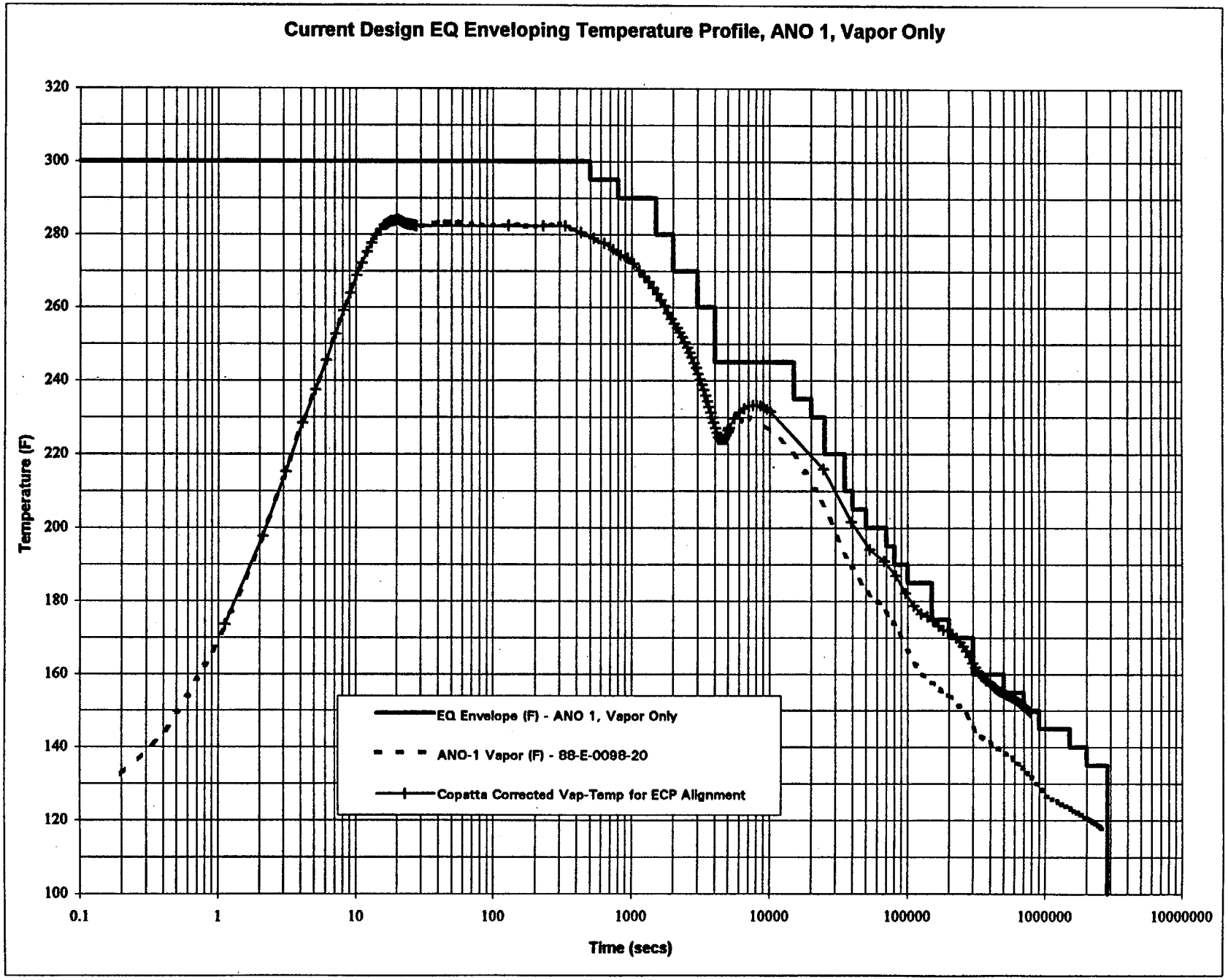
Containment DBA Analysis

- The limiting accident for reactor building design was established as the 5 ft^2 hot leg break LOCA
- The limiting single failure was established as the loss of one diesel generator
- 85° F service water was used in the original analysis and the ANO-1 SAR indicated that Lake Dardanelle was the assumed source
- For environmental qualification, licensees were permitted to use "approved FSAR profiles"


Current Design EQ Enveloping Temperature Profile, ANO 1, Vapor Only
320
300
280
260
240
220
200
180
160
140
120
100
Temperature (F)
0.1
1
10
100
1000
10000
100000
1000000
10000000
Time (secs)
EQ Envelope (F) - ANO 1, Vapor Only
ANO-1 Vapor (F) - 88-E-0098-20
Copatta Corrected Vap-Temp for ECP Alignment

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NRC Position

- NRC position as stated in June 13, 1997 letter
  - The Dardanelle Reservoir along with the ECP make up the ultimate heat sink (UHS) complex
  - Dardanelle Reservoir is the UHS for normal operation only
  - Dardanelle Reservoir is not on Q list and not a Class I structure
  - Only ECP can be credited for accident mitigation

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NRC Position

- The ECP must be able to perform accident mitigation function assuming the worst-case single failure consistent with the design basis of the plant
- Questioned operability of the UHS and compliance with environmental qualification requirements

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Entergy Position

- The ECP and Lake Dardanelle make up the UHS complex at ANO
- UHS design consistent with NRC guidance at the time ANO-1 was licensed
- The UHS complex is capable of performing accident mitigation function assuming the worst-case single failure consistent with the ANO-1 licensing basis
  - ECP is credited for accident mitigation when the assumed single failure is the loss of Lake Dardanelle

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Implication of NRC Position

- The NRC proposed position imposes an additional single failure not currently assumed in the design and licensing basis of the UHS
- If required, a single failure of the ECP supply or return line would be unacceptable
- In addition, significant EQ program impact would result
  - Re-evaluation of all EQ components inside the RB
  - Possible requalification testing or replacement of components
- Other impacts

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ANO-1 Licensing Basis

Ultimate Heat Sink
Service Water
Containment Cooling

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ANO-1 Licensing Introduction

- The application for a construction permit for ANO-1 was filed 30 years ago
- Regulatory framework in 1967 considerably different
  - Fewer and less prescriptive regulatory requirements
  - Fewer and less prescriptive regulatory guidance documents
  - Details of the licensing bases established off the docket
- Non-docketed communication with Atomic Entergy Commission (AEC)

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ANO-1 Licensing - Construction Permit

- Arkansas Power & Light (AP&L) submitted application for construction permit for ANO-1 on November 24, 1967
  - No specific regulatory guidance existed for UHS
- ANO-1 Preliminary Safety Analysis Report (PSAR) only credited Lake Dardanelle as heat sink
- In January 1968, AEC requested AP&L to consider a dam failure based upon position that no single failure shall render plant unsafe
- AP&L performed studies which showed Dardanelle Dam would maintain structural integrity following maximum earthquake (Supplement 2 of PSAR)

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ANO-1 Licensing - Construction Permit

- Following further discussions with the AEC, the PSAR was modified (Supplement 3) noting
  - Considering the most conservative assumptions, there is sufficient time after dam failure to shut down the power generation and start to operate an emergency cooling water supply
  - Emergency reservoir would be capable of maintaining safe shutdown for extended period of time without makeup and would withstand the maximum earthquake

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ANO-1 Licensing - Construction Permit

- Correspondence dated August 3, 1968 noted emergency reservoir would have 30 day cooling water supply
  - Size based upon decay heat initially being removed by steam generators and normally available condensate

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ANO-1 Licensing - Construction Permit

- ANO-1 construction permit issued on December 6, 1968 establishing initial licensing basis
  - PSAR provided documentation of the seismic adequacy of the Dardanelle Dam and the intake and discharge canals to the plant
  - Emergency reservoir designed for the unlikely event of the complete loss of the Dardanelle Reservoir
  - No mention in the PSAR of concurrent accident and loss of Lake Dardanelle
- Construction of ANO-1 begins in earnest

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ANO-2 Licensing

- September 10, 1970 ANO-2 submits construction permit
  - ANO-2 PSAR consistent with ANO-1 revised PSAR
- November 1970 conversations with AEC indicate ANO-2's access to the ECP under emergency conditions is necessary
- March 2, 1971 series of questions transmitted to ANO-2 associated with the service water system
  - Requested detail on ECP capacity, pump capability, and piping size
  - Include all possible modes for both units including an accident on either unit
  - Provide basis of manual sluice gate operation
- April 1971 ANO-2 amended its PSAR to show an ECP maximum temperature of 120° F for a normal shutdown of one unit and a design basis accident in the other unit

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ANO-2 Licensing

- April 19, 1971 AP&L submitted application for ANO-1 operating license
  - The FSAR described the ECP as the revised ANO-1 PSAR had
- During meetings in July 1971 on ANO-2's licensing AEC provided insights into new safety guide on UHS
  - 30 day supply assuming safe shutdown of one unit and accident in the other
  - Complex capable of withstanding single failure
  - ECP with no above ground structures and redundant pipelines would be sufficient, or
    - ECP and Lake Dardanelle sufficient provided
      - Dardanelle dam and intake canal can be shown to be capable of withstanding 1/2 DBE
      - ECP capable of withstanding most severe natural phenomena, DBE, and other credible events

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ANO-2 Licensing

- During September 1971 meeting on ANO-2 licensing, the temperature difference between the containment coolers and shutdown cooling heat exchanger and the ECP maximum temperature was discussed
  - Maximum ECP temperature not reached for 3 to 4 days after DBA
  - Containment coolers not credited when peak containment pressure and temperature reached
- AEC concerned with second pressure peak
  - Noted only slight increase in pressure for second peak following recirculation
  - Agreed words would be added to the PSAR

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ANO-2 Licensing

- ANO-2 PSAR Amendment 15 dated November 10, 1971 noted effects of using higher ECP temperature
  - Section 14.11.4.2 Design Basis Accident Results

    Following sump water recirculation, a second pressure peak occurs. The magnitude of the second pressure peak varies by about 9% (14.8 psig to 16.2 psig) between the two service water temperature extremes of 95° F and 120° F. The actual pressure transient curve resulting from the use of the cooling pond for DBA cool down will lie between these two curves, since the initial pond temperature will be at or below 95° F and will heat up to 120° F after about 2 days of pond operation

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ANO-1 Licensing - Operations

- November 1, 1971 as part of the FSAR review, a series of questions (9.2) are transmitted to ANO-1 associated with the service water system
  - Requested detail on ECP capacity, pump capability, and piping size
  - Include all possible modes for both units including an accident on either unit
  - Provide basis of manual sluice gate operation
- These questions represented new requirements for ANO-1
  - To comply will require extensive modification to the service water system

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ANO-1 Licensing - Operations

- The 9.2 series questions are responded to by amendments 22, 25, and 26 (Spring 1972)
  - FSAR section 9.3.2.4 is revised to note the ECP is sized to contain sufficient water for dissipating the total combined heat transferred to the Unit 1 and 2 service water systems as a result of a postulated DBA in one unit and a simultaneous shutdown of the other unit, while limiting the returning plant cooling water temperature to 120° F
  - No revision to the reactor building cooling section of the FSAR
  - Single failure analysis of service water system specifically notes the failure of the Dardanelle Dam as a single failure

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ANO-1 Licensing - Operations

- Safety Guide 27 Ultimate Heat Sink issued March 1972
  - GDC 44 requires that suitable redundancy in features for cooling water system to assure its safety function can be accomplished
  - Describes the combination of features and design requirements necessary to assure the availability of the heat sink. Notes the UHS is that complex of water sources, including necessary retaining structure, and the canals or conduits connecting the sources with, but not including, the cooling water intake structure

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ANO-1 Licensing - Operations

- Safety Guide 27
  - The complex (but not its individual features) must be capable of withstanding each of the most severe natural phenomenon expected, other site related events, reasonable combinations of natural phenomenon and/or site related events, and a single failure of man-made structural features without loss of capability of the sink to accomplish its safety function
  - The UHS shall be capable of providing cooling for 1) safe shutdown of both units, and 2) accident in one unit with safe shutdown and cooldown in the other unit

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ANO-1 Licensing - Operations

- No mention in Safety Guide 27 of part of the complex only being used for normal shutdown and the other part for emergency shutdown
- Requires the complex to be capable of withstanding a single failure - does not mention the assumption of an additional failure
- If an additional failure to that of the Dardanelle Dam were required to be assumed, then the ECP would have to have redundant intake and discharge lines to account for the failure of one of the lines

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ANO-1 Licensing - Operations

- In a May 1972 open issues meeting with AEC, a presentation was made on the design basis of the ECP
  - Various heat loads were analyzed
  - Conservatisms used in deriving pond temperature and water loss
  - AEC questions focused on ECP sizing
  - No record of concerns with FSAR assumptions for reactor building cooling

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ANO-1 Licensing - Operations

- NRC Safety Evaluation Report issued August 14, 1973
- 2.4.6 Cooling Water
  - Found the ECP to be an adequate heat sink for simultaneously shutting down both units in the event of loss of the Dardanelle Reservoir
- 2.5.3 Foundation Engineering
  - Dardanelle Dam adequately reliable secondary source as regards to seismic and static stability

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ANO-1 Licensing - Operations

- 6.2.1 Containment Functional Design
  - Calculated pressure and temperature conditions resulting from any design basis LOCA will not exceed containment structure design conditions
- 6.2.2 Reactor Building Heat Removal System
  - Systems acceptable because of adequate assurance of operability and redundancy
- 9.3.1 Service Water
  - System capable of providing cooling in the event of any single active failure or a single passive failure during post-accident long term cooling - system acceptable

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ANO-1 Licensing - Operations

- 9.3.4 Ultimate Heat Sink
  - Two sources of cooling water available for reactor equipment to use as an UHS - Dardanelle Reservoir and ECP
  - Design meets Regulatory Guide 1.27

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ANO-1 Licensing - Operations

- On May 21, 1974 ANO-1 received an operating license
- ANO-1 met the guidance of Regulatory Guide 1.27 with the UHS complex made up from Lake Dardanelle and the ECP
- Given a design basis accident and the single failure of the Dardanelle Dam, the containment temperature profile presented in the FSAR remains bounding
- A failure in addition to that of the Dardanelle Dam is beyond the ANO-1 licensing basis

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Seismic Adequacy of Dardanelle Lock and Dam

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Purpose

- Provide a summary of the design, construction, and operation of the Corps of Engineers' (CoE) Dardanelle Lock and Dam
- Focus on the seismic equivalency of the lock and dam to that of a nuclear power station

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Areas of Comparison

- Design
- Construction
- Quality control
- Inservice or periodic inspections

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Design Codes

- CoE gravity dam design, EM-1110-2-2200, September 25, 1958
- American Institute of Steel Construction
- American Concrete Institute (ACI-318)
- Approximate CoE construction period 1960 -1965, which corresponds to time period ANO-1 was being designed

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Load Combinations

- Normal operating (pool at top of gate, minimum tailwater, ice)
- Induced surcharge (pool at top of partially open gate, tail water at 60% of pool, ice)
- Flood discharge (all gates open, tailwater at flood elevation)
- Construction with earthquake (dam unwatered, earthquake acceleration in downstream direction)
- Normal operating with earthquake (pool at top of gate, minimum tailwater, earthquake acceleration in upstream direction)

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Seismic Requirements

- Safe against overturning (resultant within the kern)
- Safe against sliding (SF>4.0)
- Allowable stresses **shall not** be exceeded

Note: In nuclear plant design, the facility is not allowed to slide, but the use of overturning and allowable stresses are identical

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Industry Experience

- Design/construction methods were field tested on similar structures in the North Pacific and the North Atlantic divisions of the CoE before design/construction of the Dardanelle Dam

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Site Geology

- Navigable lock socketed into the spadra shale rock formation
- Dam sets on top of 50 - 110 feet thick layer of the harthshorne sandstone formation
- Compressive strengths - 4920 psi to 11,200 psi
- Shear strength - 195 tsf to 334 tsf

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Seismic Considerations

- No record of seismic activity in Dardanelle area
- No faults in construction area (confirmed)
- Seismic factors based upon New Madrid earthquakes of 1811-1812 (same as ANO)
- Seismic intensity at site estimated as Level VI based upon 225 mile distance (same as ANO)

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Seismic Considerations

- CoE designed structure considers a 0.1g acceleration compared against normal allowables (same as OBE load case for nuclear design)
- Bechtel analyzed the Dardanelle Lock and Dam components with a 0.2g acceleration and concluded; an ample degree of safety exists with no failure of the structures in the existing configuration (same as SSE load case)

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Design Conservatisms

- Shear and friction do not act concurrently to resist sliding (same as nuclear design)
- Minimum SF>4.0 for resistance against sliding
- High tensile rebar yield set at 40,000 psi
- Hydrostatic head used in design is 6 feet over the top of the gates

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Quality Control

- Preliminary design memorandum, design memorandum, and completion reports are subject to multiple level reviews with official comments (endorsements) and resolution correspondence (similar to ANSI N45.2.11 requirements for nuclear design)
- Comments to be resolved between preparer/ commenter (same as used in nuclear design)

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Quality Control

- Government inspectors on site and controlled by resident engineer
- Quality Control testing facilities on site
- Routine samples controlled by specifications and plans
- Additional testing at inspector's discretion

Note: Similar controls used in nuclear construction

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Construction

- Sound, field tested construction practices utilized
- Construction controlled by plans and specifications with industry codes as applicable

Note: Similar methods used in nuclear construction

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Operation

- Operation and maintenance is controlled by a documented manual of operation with an emergency operation plan including emergency call-out lists (same concept used in nuclear operation)

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Periodic Inspections

- Multi-disciplined inspection team inspects structures on 5 year maximum interval
- Personnel from the local resident office, Little Rock District, Southwest Division
- Team make-up includes engineers, geologist, maintenance, operations

Note: Equivalent concept to maintenance rule inspections at a nuclear plant

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Periodic Inspections

- Last lock inspection (Fall 1995)
- Last dam inspection (March 1996)
- No structural defects identified
- Maintenance items were identified and are being implemented - Fall 1997

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Summary

- Conservative load combinations used
- Conservative type of dam design - gravity dam
- Similar codes, if not identical, were used in the design and construction of the lock and dam and ANO
- New Madrid earthquakes of 1811 - 1812 assumed (same as ANO)
- 0.1 g acceleration used by CoE and ANO
- 0.2 g acceleration evaluated by AE (Bechtel)

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Summary

- Dardanelle Lock and Dam will not exceed normal allowables during the OBE load case
- Dardanelle Lock and Dam will not have any functional failures for a faulted load condition associated with the SSE load case as determined by the Bechtel analyses
- The CoE implemented sound practices in the construction of the lock and dam that were similar, if not identical, to those used during construction of ANO

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Summary

- The CoE had a Quality Control Program that was appropriate for their application at the Dardanelle Lock and Dam
- The lock and dam and ANO are subject to periodic inspections
- Maintenance is performed in a timely manner to preserve the structural integrity at both the CoE lock and dam and ANO

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Conclusion

- 10 CFR Part 100, Appendix A, Sec. I requires SSC's important to safety be designed to withstand the design basis earthquake and remain capable of performing their safety functions
- R.G. 1.27 does not apply seismic design requirements to each feature of the UHS (i.e. both the lake and the ECP)
- Nonetheless, as previously demonstrated, Dardanelle Lock and Dam is capable of meeting the 10CFR100 functional requirements

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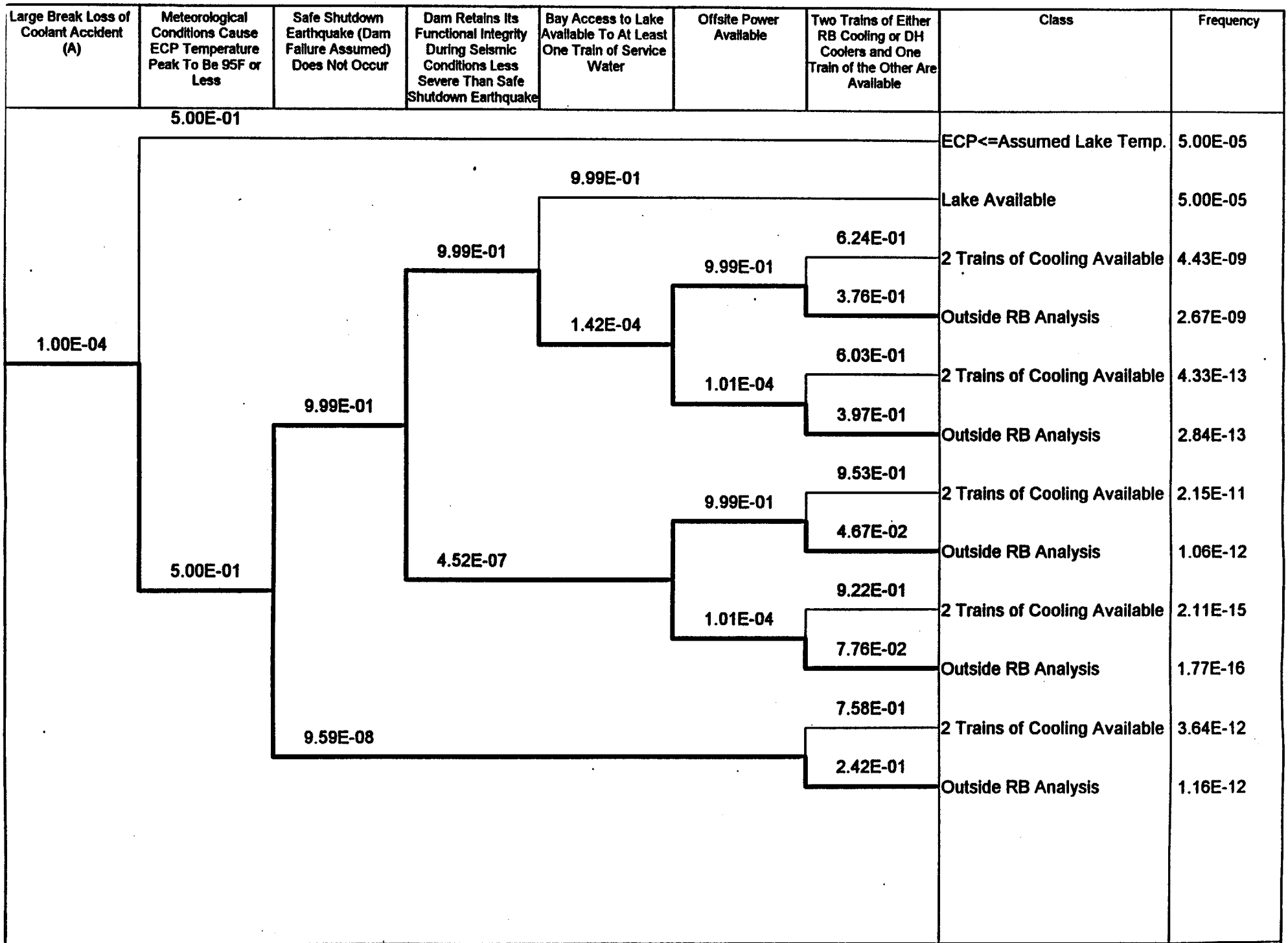
Probabilistic Insights


Large Break Loss of Coolant Accident (A)
Meteorological Conditions Cause ECP Temperature Peak To Be 95F or Less
Safe Shutdown Earthquake (Dam Failure Assumed) Does Not Occur
Dam Retains Its Functional Integrity During Seismic Conditions Less Severe Than Safe Shutdown Earthquake
Bay Access to Lake Available To At Least One Train of Service Water
Offsite Power Available
Two Trains of Either RB Cooling or DH Coolers and One Train of the Other Are Available
Class
Frequency
1.00E-04
5.00E-01
5.00E-01
9.99E-01
9.99E-01
1.42E-04
4.52E-07
9.99E-01
9.59E-08
6.24E-01
9.99E-01
3.76E-01
6.03E-01
1.01E-04
3.97E-01
9.53E-01
9.99E-01
4.67E-02
9.22E-01
1.01E-04
7.76E-02
7.58E-01
2.42E-01
ECP<=Assumed Lake Temp.
5.00E-05
Lake Available
5.00E-05
2 Trains of Cooling Available
4.43E-09
Outside RB Analysis
2.67E-09
2 Trains of Cooling Available
4.33E-13
Outside RB Analysis
2.84E-13
2 Trains of Cooling Available
2.15E-11
Outside RB Analysis
1.06E-12
2 Trains of Cooling Available
2.11E-15
Outside RB Analysis
1.77E-16
2 Trains of Cooling Available
3.64E-12
Outside RB Analysis
1.16E-12

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Interactions Subsequent To Initial Licensing

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Interactions Subsequent To Initial Licensing

- In November of 1988 as a follow-up to a condition of degraded service water flow to the ECP, other discrepancies were identified which affected post LOCA reactor building temperature
  - Assumed lake temperature of 85° F
- Operational restriction imposed not to operate ANO-1 with lake temperatures in excess of 70° F
  - Documented in AP&L letter dated 12/5/1988
- Condition documented in LER 88-22
- Condition discussed in Management Meeting 4/3/1989
  - Analysis completed utilizing 95° F lake temperature

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Interactions Subsequent To Initial Licensing

- Formal results of reanalysis supplied to NRC in letter dated April 14, 1989
  - Consistent with the design basis, the original DBA LOCA containment pressure/temperature analysis, and all subsequent reanalysis submitted to the NRC, have been performed with a constant service water temperature associated with the Dardanelle Reservoir as the ultimate heat sink. The assumed service water temperature was 95° F
- July 19, 1989 submitted post LOCA reactor building temperature profiles and analysis assumptions

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Interactions Subsequent To Initial Licensing

- Summary of previous evaluations noted in NRC SER for Amendment 131 associated with extending operating license date

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Conclusion

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Conclusion

- The ultimate heat sink complex for ANO-1 consists of both the ECP and Lake Dardanelle, either of which are utilized for accident mitigation
- In the event of a LOCA and the single failure of Lake Dardanelle, the plant can be safely shutdown on the ECP and accident analysis assumptions remain bounding
- The reactor building temperature profile from the design basis LOCA, as presented in the SAR, is valid for equipment qualification purposes at ANO-1
- Safety significance of issue well below threshhold where actions would be warranted

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ANO-1 Licensing Time Line

ANO-1 Licensing

November 24, 1967 Application for Construction Permit ANO-1
No mention of ECP in PSAR

December 6, 1968 ANO-1 Construction Permit Issued
ECP for normal shutdown only

April 19, 1971 ANO-1 submittal of application for operating license
FSAR describes ECP for normal shutdown only

November 1, 1971 AEC questions requiring ECP for safe shutdown of one unit and accident shutdown on other unit

FSAR revised to show maximum ECP temperature of 120 F for single failure of dam

Safety Guide 27 issued

ANO-1 Safety Evaluation Report issued

Regulatory Guide 1.27 issued

May 21, 1974 ANO-1 Operating License Issued

1968 1969 1970 1971 1972 1973 1974

ANO-2 Licensing

September 10, 1970 Application for Construction Permit ANO-2
ECP for normal shutdown only

March 2, 1971 AEC questions requiring ECP for safe shutdown of one unit and accident shutdown on other unit

April 1971 ANO-2 PSAR amended to show maximum ECP temperature of 120 F with safe shutdown of one unit and accident shutdown on other unit

November 1971 PSAR Amended to show impact of ECP temperature on containment

September 1971 discussion of impact of ECP temperature on containment

July 1971 AEC insights on UHS Safety Guide