U.S. NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL STANDARD REVIEW PLAN

9.4.1 HEAT DISSIPATION SYSTEMS

REVIEW RESPONSIBILITIES

Primary—Organization responsible for the review of hydrology information

Secondary—None

I. AREAS OF REVIEW

This environmental standard review plan (ESRP) directs the staff's analysis of alternatives to the applicant's proposed heat dissipation system. This includes evaluating these alternatives, in comparison with the proposed system, to identify those systems that are environmentally preferable to the proposed system. Environmentally preferable alternatives should be compared with the proposed system on a benefit-cost basis to determine if any such system should be considered as a preferred alternative to the proposed system.[(a)]

The scope of the review directed by this plan should be limited to alternative heat dissipation systems considered feasible for construction and operation at the proposed plant site and that (1) are not prohibited by Federal, State, regional, or local regulations, or Native American tribal agreements, (2) are consistent with any findings of the Federal Water Pollution Control Act (FWPCA), commonly referred to as the Clean Water Act (CWA), and (3) can be judged as practical from a technical standpoint with respect to the proposed dates of plant construction and operation. This review should also include the investigation of alternatives proposed by other reviewers to mitigate impacts associated with construction and operation of the proposed heat dissipation system.

(a) The review of environmentally preferable alternative heat dissipation systems should include both environmental and economic considerations. The activities of and information from two or more reviewers may be needed to conduct this portion of the review.

This plan provides the methodology for reaching staff conclusions with respect to the environmental preference of alternative heat dissipation systems, and for environmentally preferable systems and conclusions regarding any such systems having a better benefit-cost balance than the proposed system.

Review Interfaces

The reviewer for this ESRP should obtain input from or provide input to the reviewers for the following ESRPs, as indicated:

- ESRPs 2.2.1, 2.3.1, 4.1.1, 4.3.1, 5.1.1, and 5.3.3.2. Obtain input from the reviewers for these ESRPs to develop the comparative land-use and ecological impact data with regard to heat dissipation systems.

- ESRPs 2.3, 4.2.2, 4.3.2, and 5.2.2. Obtain input from reviewers to develop the comparative water-quality and water-use data.

- ESRPs 2.7 and 5.3.3.1. Obtain input from the reviewers to develop comparisons, which may be based on verified applicant supplied data or on independent staff estimations of atmospheric effects.

- ESRPs 2.3.1, 4.2.1, and 5.2.1. Obtain input from the reviewers for assistance in comparing each alternative heat dissipation system with the effects of the proposed system.

- ESRPs 2.5, 3.1, 5.8.1, and 5.8.2. Obtain input from the reviewers when comparing the aesthetic impacts and potential recreational benefits of each alternative system with those of the proposed system.

- ESRP 3.3.1. Obtain plant water consumption data to be used in the evaluation of impacts using component alternatives.

- ESRPs 4.1.3 and 5.1.3. If proposed construction or operation of the heat dissipation system may result in adverse impacts to historic properties, obtain information regarding alternative systems or locations that may be taken into consideration as a means to avoid the impacts.

- ESRPs 4.4.1 through 4.4.3. If socioeconomic impacts from construction of the heat dissipation system appear to be adverse, consider alternative systems or locations to avoid the impacts.

- ESRPs 4.6 and 5.10. Provide a list of those measures and controls to limit adverse heat dissipation system impacts that were developed as a result of this environmental review.

- ESRP 9.4.2. Obtain input from the reviewers when an alternative heat dissipation system would involve the use of intake or discharge systems that would be substantially different from the proposed system.

- ESRPs 10.1 through 10.4.3. Provide data and information to the appropriate reviewers to permit the inclusion of any such alternatives in the final evaluation of the proposed action when suggested consideration of an alternative heat dissipation system is determined to be environmentally preferable.

- Interface with the Environmental Project Manager (EPM). Obtain input from the EPM when an alternative heat dissipation system appears to be environmentally preferable and meets regulatory requirements.

Data and Information Needs

The kinds of data and information needed will be affected by site- and station-specific factors, and the degree of detail should be modified according to the practicality of adapting the potential alternative to the proposed site. The following data or information should be obtained:

(1) proposed heat dissipation system and for each potential alternative as follows:

- land-use requirements (from ESRP 3.1 and the environmental report [ER])
- water-use requirements (from ESRP 3.3.1 and the ER)
- operating and maintenance experience for similar units (from the ER and the general literature)
- capital, maintenance, and operating costs (from the ER and the general literature)
- effect on generating efficiency (from the ER and the general literature)
- predicted thermal and physical effects, e.g., thermal plume, scouring (from ESRPs 5.3.1.1 and 5.3.2.1 and the ER)
- predicted atmospheric effects, e.g., fogging, icing, drift (from ESRP 5.3.3.1 and the ER)
- predicted operating noise levels (from ESRP 5.8.1 and the general literature)
- predicted aesthetic effect, e.g., visual plumes (from the ER)
- predicted recreational benefits (from the ER)

(2) site and vicinity land use, current and projected (from ESRP 2.2.1)
(3) site and vicinity hydrological data (from ESRP 2.3.1)
(4) site and vicinity water use, current and projected (from ESRP 2.3.2)
(5) site and vicinity water-quality criteria (from ESRP 2.3.3)
(6) site and vicinity ecological data (from ESRP 2.4)
(7) site and vicinity meteorological characteristics (from ESRP 2.7).

II. ACCEPTANCE CRITERIA

The analysis of alternative plant heat dissipation systems is a necessary step in the environmental impact statement (EIS) process. The acceptance criteria for this analysis are based on the relevant requirements of the following:

- 10 CFR 51.71with respect to the need to discuss alternatives in the environmental analysis

- 10 CFR 51, Appendix A, discussing alternatives to the proposed action
- Fish and Wildlife Coordination Act of 1958
- Marine Sanctuaries Act of 1972, as amended
- Marine Mammal Protection Act, as amended
- Coastal Zone Management Act of 1972, as amended
- Federal Water Pollution Control Act
- 40 CFR 122 and 125 with respect to National Pollutant Discharge Elimination System (NPDES) permit conditions
- Magnuson-Stevens Fishery Conservation and Management Act
- Rivers and Harbors Appropriation Act of 1899
- Endangered Species Act of 1973, as amended.

Regulatory positions and specific criteria necessary to meet the regulations as identified above are as follows:

- Regulatory Guide 4.2, Rev. 2, *Preparation of Environmental Reports for Nuclear Power Stations* (NRC 1976), with respect to alternative systems designs.
- LIC-203, Revision 1, *Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Impacts* (NRC 2004), with respect to NRC compliance with the Coastal Zone Management Act, the Endangered Species Act, and the Fish and Wildlife Coordination Act.
- The "Memorandum of Understanding between the Corps of Engineers, U.S. Army, and the NRC for the Regulation of Nuclear Power Plants," 40 FR 60115, provides guidance with respect to the NRC exercising the primary responsibility in conducting environmental reviews and in preparing EISs for nuclear power stations. The Corps of Engineers should be consulted regarding (1) coastal erosion and other shoreline modifications, (2) siltation and sedimentation processes, (3) dredging activities and disposal of dredged materials, and (4) location of structures affecting navigable waters.
- Federal, State, regional, local, and affected Native American tribal regulations, on water use, air and water quality, effluent discharge, and land use.

Technical Rationale

The technical rationale for evaluating alternatives to the applicant's heat dissipation systems is discussed in the following paragraph:

> The consideration of alternatives is the essence of the NEPA process. The review conducted under this ESRP section contributes to the consideration of alternatives by addressing alternative means of heat dissipation to determine if there is an obviously superior method in terms of environmental impacts and economic costs when compared to the proposed system.

III. REVIEW PROCEDURES

The principal objectives of this analysis are (1) to provide assistance to the reviewers for ESRP Chapters 4.0 and 5.0 concerned with construction or operational heat dissipation system impacts in identifying and verifying means to mitigate adverse impacts associated with the proposed heat dissipation system, and (2) to identify and analyze reasonable alternatives to the applicant's proposed system to the extent needed to rank them, from an environmental standpoint, as preferable or inferior to the applicant's proposed system.

The depth of the analysis should be governed by the nature and magnitude of proposed heat dissipation system impacts predicted by the reviews of ESRP Chapters 4.0 and 5.0. If adverse impacts are predicted, the reviewers should coordinate in identifying and analyzing means to mitigate these impacts. The proposed system with any verified mitigation schemes (i.e., measures and controls to limit adverse impacts) should be the baseline system against which alternative heat dissipation systems are compared. The nature and adversity of the remaining unmitigated impacts for this baseline system should establish the level of analysis required in the review of alternative systems. This should permit staff evaluation and conclusions with respect to the environmental preference of these alternatives. When no adverse impacts have been predicted for the proposed system and the system will comply with the requirements of the CWA, the reviewer should conclude that there are no environmentally preferable heat dissipation-system alternatives.

When environmentally preferable alternatives have been identified, the review should be expanded to consider the economic costs of any such alternative. This analysis should be done in consultation with appropriate ESRP 10.4 reviewers. Assistance from these reviewers should be requested to establish the economic-cost data to be used to develop a benefit-cost comparison with the baseline (proposed) heat dissipation system.

The reviewer should consider the following classes of heat dissipation systems (additional systems, e.g., a combined tower/pond system, may be considered when site-specific conditions suggest that such a system would be environmentally preferable to the proposed system):

- once through systems

- closed cycle systems:
  - mechanical draft wet cooling towers (including circular towers)
  - natural draft cooling towers (including fan assisted towers)
  - wet dry cooling towers
  - dry cooling towers
  - cooling ponds
  - spray ponds.

The reviewer should consider these alternatives for construction and operation at the applicant's proposed site. The analysis should include intake- and discharge-system environmental impacts (and economic costs) when these systems would need to be substantially different than those associated with the proposed heat dissipation system.

The reviewer should conduct an initial environmental screening of each alternative heat dissipation system to eliminate those systems that are obviously unsuitable for use at the proposed site. Factors to be considered in this initial screening are land use (e.g., site size and terrain), water use (e.g., availability of cooling water), and legislative or regulatory restrictions. Economic factors should not be considered in this initial screening. Working through the EPM, the reviewer may consult with appropriate Federal and State agencies when needed to conduct this screening. The reviewer may also consult (through the EPM) with the appropriate administrative agencies to screen those alternatives that will not meet CWA requirements. The reviewer may establish other justifiable environmental bases for rejection of a given alternative. When the reviewer rejects an alternative, that alternative needs no further consideration other than the preparation of the reasons and justification for the rejection.

The following procedure for developing the analysis of alternative heat dissipation systems considers both environmental and economic-cost factors. In following this procedure, the reviewer should initially consider only the environmental factors and should repeat the procedure for economic factors only for those alternatives shown to be environmentally preferable by the evaluation procedures of this ESRP. The analysis of those alternative heat dissipation systems not eliminated by the initial screening process should be based on the environmental and economic factors shown in Table 9.4.1-1. The reviewer should prepare a similar table for the heat dissipation systems under consideration, comparing each of the environmental and economic cost and benefit factors with those of the proposed heat dissipation system. Information for this table may be presented either in terms of absolute environmental and economic costs and benefits or as incremental costs and benefits referenced to the proposed system. Additional factors may be included when needed on a site- or system-specific basis. Preparation of this table should involve the following:

(1) Land Use—Determine (1) the onsite land-use requirements of each system, (2) the practicality of heat dissipation system construction and operation within the specifics of site area, terrain, and the impacts of social and economic land-use costs, (3) the extent to which any system is sited on or results in modifications to the floodplain,[a] (4) any relevant wetlands or critical habitat issues, and

(a) See ESRP 2.3.1 for a definition of the floodplain.

(5) the impacts to terrestrial biota associated with system construction and operation. The reviewer should consult with the reviewers for ESRPs 2.2.1, 2.3.1, 4.1.1, 4.3.1, 5.1.1, and 5.3.3 to develop the comparative land-use and ecological impact data.

(2) Water Use—Determine (1) the water-use requirements of each system, including intake requirements, water consumption, and intake/discharge water quality and quantity, (2) the practicality of this water use within the specifics of water availability and the impacts of present and known future water uses, and (3) the impacts of aquatic biota associated with system construction and operation. The reviewer should compare these data with characteristics of the proposed heat dissipation system. The economic cost of water consumed should be considered when these data are available. The reviewer should consult with the reviewers for ESRPs 2.3, 4.2.2, 4.3.2, 5.2.2, and 5.3 to develop the comparative water quality, water use, and ecological impact data.

(3) Atmospheric Effects—Determine the predicted atmospheric effects of each alternative heat dissipation system (e.g., the extent and magnitude of cooling tower drift) and compare these effects with those of the proposed system. The reviewer should consult with the reviewers for ESRPs 2.7 and 5.3.3 to develop this comparison, which may be based on verified applicant supplied data or on independent staff estimations of atmospheric effects.

(4) Thermal and Physical Effects—Estimate the predicted thermal and physical effects (e.g., thermal plumes, erosion, scouring) of each alternative heat dissipation system, and compare these effects with those of the proposed system. The reviewer should consult with the reviewers for ESRPs 2.3.1, 4.2.1, and 5.2.1 for assistance in making this comparison.

(5) Noise Levels—Estimate operational noise levels for each of the alternatives and compare them with the predicted operating noise levels of the proposed system and with any Federal, State, regional, local, or affected Native American tribal restrictions. The reviewer should consider construction noise levels when these could be significant.

(6) Aesthetics and Recreational Benefits—Compare the aesthetic impacts and potential recreational benefits of each alternative system with those of the proposed system. The reviewer should consult with the reviewers for ESRPs 2.5, 3.1, and 5.8 for assistance in making this comparison.

(7) Operating and Maintenance Experience—Compare operating and maintenance experience of each alternative with the proposed system to develop a projected reliability factor for each system.

(8) Generating Efficiency—Estimate the plant electrical generation efficiency for each alternative heat dissipation system and compare it with the generating efficiency using the proposed system.

(9) Costs—Estimate the capital, operating, and maintenance costs for the proposed system and for each alternative considered. The reviewer should use these figures for economic-cost comparisons.

The reviewer should determine if there are any site-specific factors that might affect the costs of any alternative and factor these additional costs into the comparison.

(10) Other Considerations—When an alternative heat dissipation system will involve the use of intake or discharge systems that would be substantially different from the proposed system, repeat these procedures for both intake and discharge systems. This should supplement the appropriate environmental and economic-cost factors, as needed, to account for any differing intake and discharge system effects. The reviewer should consult with the reviewer for ESRP 9.4.2.

General Considerations

The reviewer should ensure that each heat dissipation system alternative has been described in sufficient detail to enable an effective analysis and comparison of environmental impacts leading to a staff conclusion that the alternative system is environmentally preferable or inferior to the proposed system. For those alternatives determined to be environmentally preferable, the reviewer should ensure that economic-cost data are available in sufficient detail to enable the reviewer to conduct benefit-cost balance and comparisons with the proposed system leading to a final staff conclusion for heat dissipation-system consideration. The reviewer should also ensure that all comparisons are made on the basis of the proposed system as supplemented with those measures and controls to limit adverse impacts proposed by the applicant and concurred with by the staff. For those alternatives eliminated from consideration (1) on the basis of land-use, water-use, or legislative or regulatory requirements, or (2) because it is judged inferior to the proposed system, the reviewer should ensure that adequate documented justification for this action has been prepared.

If a mitigation measure or alternative heat dissipation system is to be considered, determine that the measure or system being evaluated has a lesser overall environmental impact than the proposed system (i.e., is environmentally preferable). When this is true, the economic costs of mitigation or of the alternative could result in an improved project benefit-cost balance. When these criteria are met, the reviewer should verify those mitigation measures proposed by the reviewers for ESRP Chapters 4.0 and 5.0 or should consider an alternative heat dissipation system. The reviewer should be guided by the following general considerations:

- Keep in mind that an environmental review of alternative heat dissipation systems, if conducted in the depth applied to the review of the proposed system, would be expected to find additional impacts and/or increased severity of the impacts already predicted for the alternative. The reviewer should allow for this when evaluating the comparative environmental impacts of each proposed alternative with those of the proposed system.

- Ensure that the level of detail provided for each economic, environmental, and social cost estimate is commensurate with the level of importance of the related environmental impact.

- Adjust the economic costs of each alternative system on the basis of equivalent generating capacity.

- The evaluation of alternative heat dissipation systems may include consultation and coordination with those agencies responsible for NPDES administration. The reviewer may coordinate the evaluation of measures and controls to limit adverse impacts, or of alternatives to avoid adverse impacts (with the EPM as liaison), with NPDES administrators. When consulting with the EPA or with agencies of States having memoranda of understanding with NRC, the reviewer should ensure that the staff analyses and evaluations (1) are consistent with the details of these memoranda, and (2) will serve the needs of these agencies.

Measures and Controls to Limit Adverse Impacts

When considering measures provided by the reviewers for ESRP Chapters 4.0 and 5.0 to mitigate adverse environmental impacts predicted for the proposed heat dissipation system, the reviewer's verification of the desirability of the measure should lead to the following conclusions:

- The measure provides the desired mitigation and does not introduce other adverse environmental impacts not predicted for the proposed system.

- The measure will result in an overall benefit-cost balance better than that of the proposed project.

- The measure is not precluded by Federal, State, regional, local, or affected Native American tribal regulations, requirements, or ordinances.

- The measure is consistent with NPDES requirements.

Alternative Heat Dissipation Systems

The initial step in the evaluation of those alternative heat dissipation systems identified by the analysis procedure of this ESRP should be to categorize these systems as environmentally preferable or inferior to the proposed heat dissipation system as modified by measures and controls to limit adverse impacts. The following criteria should be applied to this evaluation:

- When the reviewer determines that the proposed system (with mitigation measures, if necessary) will have no unavoidable adverse impacts and the system will comply with the requirements of the CWA, the reviewer should conclude that there are no environmentally preferable heat dissipation-system alternatives.

- When the reviewer determines that the proposed heat dissipation system will meet CWA requirements, but is predicted to have unavoidable adverse environmental impacts, the reviewer should evaluate the identified alternative systems for potential environmental preference to the proposed system. The scope and extent of this evaluation should depend on the nature and

magnitude of the proposed system's environmental impacts. An environmental review for the alternatives may be needed following the analysis and evaluation procedures of the appropriate ESRP Chapters 4.0 and 5.0. The following criteria apply to this evaluation:

- *Environmental preference will be established* when an alternative can be shown to have no unavoidable adverse impacts and will meet CWA requirements.

- *Environmental preference may be established* when an alternative that meets CWA requirements can be shown to have unavoidable adverse impacts that are less severe in both nature and magnitude than those of the proposed system. Determination of environmental preference under these conditions should involve consultation with the EPM and the appropriate ESRP Chapter 4.0 and 5.0 reviewers. This consultation should result in a joint determination of the status of any such alternative.

- *Environmental inferiority will be established* when an alternative can be shown to have unavoidable adverse impacts that are more severe in both nature and magnitude than those of the proposed system, or that will not meet CWA requirements.

When the reviewer determines that there are environmentally preferable alternatives to the proposed heat dissipation system, the reviewer should conduct those portions of the analysis instructions of this ESRP that deal with the economic costs of the alternative systems.

- When environmentally preferable alternative heat dissipation systems have been identified, the reviewer should ensure that economic cost data have been developed for the alternatives and that these data are adequate for a benefit-cost balancing and comparison with the proposed system. This portion of the evaluation procedure should be conducted with the assistance of appropriate reviewers for ESRPs 10.4.1 through 10.4.3. The reviewer should complete the economic and reliability portions of Table 9.4.1-1. On the basis of the completed table, the reviewer should balance and compare benefits and costs of the environmentally preferable alternative(s) with those of the proposed system. When an environmentally preferable alternative can be shown to have a higher benefit to cost ratio than the proposed system, the reviewer may conclude that the alternative should be considered an alternative to the proposed system. For those cases in which the benefits of the alternative are less than those of the proposed system or if economic costs are greater than those of the proposed system, a tentative conclusion that the alternative is superior lead to consultation with the EPM and with the appropriate ESRP Chapter 4.0 and 5.0 reviewers. If this consultation establishes that the benefit-cost balances of such alternatives are not superior to that of the proposed system, the alternatives should not receive further consideration. When alternatives have significantly decreased benefits or increased economic costs, they should be rejected for any further consideration as alternatives to the proposed systems.

IV. EVALUATION FINDINGS

This review should accomplish the following objectives: (1) description of alternative heat dissipation systems considered and results of the staff's analysis of these alternatives, (2) presentation of the basis for the staff's analysis, and (3) presentation of the staff's conclusions relative to alternative heat dissipation systems.

The input to the EIS should describe (1) those alternatives considered by the staff, (2) those alternatives rejected by the staff as being inappropriate for the proposed site or judged environmentally inferior to the proposed system, (3) the staff's analysis and comparison of potentially environmentally preferable alternatives to the proposed heat dissipation system, and (4) the staff's conclusions related to consideration of alternative heat dissipation systems. Staff contacts with the EPA or with agencies responsible for NPDES determinations should be referenced.

The reviewer should discuss briefly those alternatives rejected because of specific deficiencies and state why each alternative was rejected. The reviewer should also identify those alternatives judged environmentally inferior to the proposed system, and therefore removed from further consideration. The use of a table similar to Table 9.4.1-1 to present the staff's comparison of these potentially acceptable alternative heat dissipation systems is recommended. When the reviewer has concluded that an alternative is environmentally preferable and should be considered as the preferred heat dissipation system, sufficient additional detail should be presented to justify the alternative both environmentally and on a benefit-cost basis.

V. IMPLEMENTATION

The method described in this ESRP should be used by the staff in evaluating conformance with NRC requirements, except in those cases in which the applicant proposes an acceptable alternative for complying with specified portions of the requirements.

VI. REFERENCES

10 CFR 51, Appendix A, "Format for Presentation of Material in Environmental Impact Statements."

10 CFR 51.45, "Environmental report."

10 CFR 51.71, "Draft environmental impact statement—contents."

40 CFR 122, "EPA Administered Permit Programs: The NPDES Pollution Elimination System."

40 CFR 125, "Criteria and Standards for the National Pollutant Discharge Elimination System."

Coastal Zone Management Act, as amended, 16 USC 1451 et seq.

Endangered Species Act, as amended, 16 USC 1531 et seq.

Federal Water Pollution Control Act (FWPCA), as amended, 33 USC 1251 et seq. (also known as Clean Water Act).

Fish and Wildlife Coordination Act Amendment, 16 USC 661 et seq.

Magnuson-Stevens Fishery Conservation and Management Act, 16 USC 1801et seq.

Marine Mammal Protection Act, as amended, 16 USC 1361 et seq.

Marine Protection, Research, and Sanctuaries Act, as amended, 33 USC 1401 et seq.

Memorandum of Understanding for the Regulation of Nuclear Power Plants. 40 *Federal Register* 37110 (August 25, 1975).

Rivers and Harbors Appropriation Act of 1899, 33 USC 401.

U.S. Nuclear Regulatory Commission (NRC). 1976. *Preparation of Environmental Reports for Nuclear Power Stations*. Regulatory Guide 4.2, Rev. 2, Washington, D. C.

U.S. Nuclear Regulatory Commission (NRC). 2004. Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues. LIC-203, Revision 1, Washington, D.C.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Environmental Standard Review Plan are covered by the requirements of 10 CFR Part 51, and were approved by the Office of Management and Budget, approval number 3150-0021.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

Table 9.4.1-1. Screening of Alternative Heat Dissipation Systems

Factors Affecting System Selection	Alternative 1	Alternative 2	Alternative 3
Land-use Onsite land requirements Terrain considerations			
Water use			
Legislative or regulatory requirements			
Is this a suitable alternative heat dissipation system? (Yes/No)			