ENVIRONMENTAL STANDARD REVIEW PLAN

FOR ES SECTION 5.3.2.2 COOLING SYSTEM IMPACTS - DISCHARGE SYSTEM: AQUATIC IMPACTS

REVIEW INPUTS

Environmental Report Sections

2.2 Ecology
3.4 Heat Dissipation System
5.1.3 Effects of Operation of Heat Dissipation System: Biological Effects

Environmental Reviews

2.3.1 Hydrology
2.3.3 Water Quality
2.4.2 Aquatic Ecology
3.6.1 Wastes Containing Chemicals or Biocides
5.3.2.1 Cooling System Impacts - Discharge System: Physical Impacts and Thermal Plume Description

Standards and Guides

Rivers and Harbors Act of 1899
Federal Water Pollution Control Act Amendments of 1972
Fish and Wildlife Coordination Act of 1958
Marine Sanctuaries Act of 1972
Coastal Zone Management Act of 1972
Endangered Species Act of 1973
40 CFR Part 122
40 CFR Part 432
National Pollution Discharge Elimination System, Federal Register, Vol. 39, Part III, 1974
EPA/NRC/FWS 316(a) Technical Guidance Manual
Memorandum of Understanding Between NRC and Army Corps of Engineers, 1975
Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"
Second Memorandum of Understanding Between NRC and EPA, December 1975
Applicable State water quality standards

Other

The site visit
Responses to requests for additional information
Consultation with local, State, and Federal agencies

108 171

REVIEW OUTPUTS

Environmental Statement Sections

5.3.2.2 Cooling System Impacts - Discharge System: Aquatic Impacts

Other Environmental Reviews

5.10	Measures and Controls to Limit Adverse Impacts (Operation)
6.5.2	Environmental Measurements and Monitoring Programs: Aquatic Ecology
9.3.2	Alternative Circulating Water Systems
10.1	Unavoidable Adverse Environmental Impacts
10.2	Irreversible and Irretrievable Commitments of Resources

I. PURPOSE AND SCOPE

The purpose of this environmental standard review plan (ESRP) is to direct the staff's description, quantification, and assessment of potential thermal, physical, and chemical stresses to aquatic organisms that may occur as a result of plant cooling system discharges to receiving water bodies. The principal objective of this section is the prediction and assessment of impacts to "important"* aquatic populations in the vicinity of the station.

The scope of the review directed by this plan will include the analysis of alterations to the receiving water body resulting from plant thermal, physical, and chemical discharges in sufficient detail to predict and determine the nature and extent of potential impacts to aquatic ecosystems. If an impact is adverse, the reviewer will identify and analyze alternative design, location, or operational procedures that could mitigate or avoid the environmental impact.

II. REQUIRED DATA AND INFORMATION

The kinds of data and information required will be affected by site- and station-specific factors, and the degree of detail will be modified according to the anticipated magnitude of the potential impact. The following data or information will usually be required:

*See definition of "important" in ESRP 2.4.1.

A. THERMAL

1. Predicted changes in the thermal regime of the receiving water body resulting from the discharge of heated water, including (1) maps of the thermal plume configuration, (2) the effects of depth, tide, currents, and winds on the thermal plume, and (3) predictions of ambient and discharge temperatures on a seasonal basis (from ESRP 5.3.2.1).

2. Resident and migratory aquatic species (as identified in ES Section 2.4.2) and their diel and seasonal abundance in the discharge area and receiving water body (from ESRP 2.4.2).

3. Data on tolerances of susceptible "important" aquatic species to abrupt changes in temperature (from the ER and general literature).

B. CHEMICAL

1. Expected concentration, flowrates, and release frequency of chemicals to be released to the receiving water body from the condenser discharge or cooling tower blowdown, including discharges from sanitary waste systems, from laundry discharge systems, or from any other nonradioactive waste stream discharged from the plant via the cooling system (from ESRP 3.6.1).

2. Ambient concentrations of chemicals (including dissolved gases) in receiving water bodies (from ESRP 2.3.3).

3. Tolerances of the "important" aquatic species identified in ES Section 2.4.2 to acute and chronic exposure to chemicals in the plant discharge (from the ER and the general literature).

4. Tolerances of "important" aquatic species to acute and chronic exposure to dissolved gases (from the ER and the general literature).

108 173

C. PHYSICAL

For the area potentially affected by the plant discharge: (1) hydrological data on surface water flow, littoral drift, currents, tides, salinity, temperature and temperature distribution, characteristics of the mixing zone, scouring, siltation, turbidity, depths, wind effects, and temperature changes in the receiving body on a seasonal basis and (2) the alterations to those parameters caused by plant operation (from ESRPs 2.3.1 and 5.3.2.1).

III. ANALYSIS PROCEDURE

Discharge system impacts on aquatic biota may result from the effects of thermal, chemical and physical alterations to the receiving water body. Major alterations are usually confined to a limited discharge area (the mixing zone), whereas lesser alterations may extend over a larger portion of the receiving water body. Adverse effects on biota which are transported through, migrate through or are attracted to the mixing zone may be acute or chronic and impacts may be reflected as changes in the populations of "important" species and in the structure and function of the ecosystem.

The basic steps in the analysis procedure for this ESRP are (1) to identify the susceptible "important" aquatic species, (2) to identify those alterations of receiving water body characteristics that may affect the aquatic biota, and (3) to determine and assess the levels of potential biological impacts.

The reviewer will accomplish the first two steps of the review process through consultation with the reviewers identified in Part II of this ESRP. This consultation will identify (1) those "important" aquatic species potentially affected by operation of the plant discharge system, and (2) those alterations to receiving water body characteristics that could affect those species. This consultation will establish the depth and extent of the review: i.e., the species identification and the magnitude of the receiving water body alterations will establish the areal bounds of the review and the degree of importance associated with each potential impact.

In the third step, the reviewer will consider the biological effects of thermal, chemical and physical alterations to the receiving water body on the identified "important" aquatic species, including combined effects (e.g., thermal plus chemical effects) and the potential for gas bubble disease. Particular attention should be given to the relationship of these stresses to life history requirements, e.g., growth, reproduction, migration. The Federal Water Pollution Control Act (FWPCA) Amendments of 1972, Section 316(a), require that discharge system operation must ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving water body. Responsibility for making this determination (or for reassigning the responsibility) rests with the Environmental Protection Agency (EPA). Working through the NRC Environmental Project Manager, the reviewer will coordinate the following analysis with the EPA or with those agencies responsible for the FWPCA Section 316(a) determination. Particular attention will be given to the prediction of impacts and the identification of measures and controls to mitigate or avoid them. This coordination will be guided by the provisions of the Second Memorandum of Understanding between the NRC and EPA, dated December 1975.

The following analysis procedure is organized by specific impacts of thermal, chemical and physical alterations. For each of the listed parameters, the reviewer will analyze impacts for the parameter when considered alone and the impacts for the parameter when combined with other parameters. The review will be based on the habitat types described in Appendix A to this ESRP.

A. Thermal Effects

The reviewer will consider the following parameters:

1. Maximum sustained temperatures for each season that are consistent with maintaining desirable levels of productivity.

2. Maximum levels of metabolic acclimation to warm temperatures that will permit return to ambient winter temperatures should artificial sources of heat cease.

3. Temperature limitations for survival of brief exposures to temperature extremes, both upper and lower.

4. If spawning or nursery areas are affected, restricted temperature ranges for various stages of reproduction, including (for fish) gonad growth and gamete maturation, spawning migration, release of gamete, development of the embryo, commencement of independent feeding by juveniles, and temperature required for metamorphosis, emergence, and other activities of early life stages.

5. Thermal limits for diverse compositions of species of aquatic communities, particularly where nuisance growths of certain organisms create reduction in diversity, or where important food sources or chains are altered.

6. Thermal requirements of downstream aquatic life where upstream warming of a cold-water source will adversely affect downstream temperature requirements.

Considering the above parameters, the reviewer will identify the most thermally intolerant "important" species expected to be affected.

Considering such factors as (1) areal extent of the plume, (2) percent of unaffected area, (3) species behavior, habitat and life history requirements, and (4) physical concentrating factors, the reviewer will quantify the magnitude of potential thermal impacts to the aquatic ecosystem.

B. Chemical Effects

The reviewer will consider the following parameters:

1. Acute toxicity

2. Chronic toxicity

3. Accumulation

4. Biomagnification

5. Sublethal and behavioral effects.

The reviewer will consider species in the vicinity of the station and their life stages susceptible to chemicals released. Bioassays for important chemicals such as copper, chlorine or related components, and scale inhibitors under site-specific conditions may need to be performed by the applicant.

The reviewer will compare the concentrations of chemicals at the discharge points with concentrations of the same chemicals in ambient waters. Dilution and mixing of chemical discharges should be considered and estimates of concentrations at various distances from the release point obtained. The effects of variable environmental and plant operation conditions on injury or mortality of suspectible organisms need to be assessed, as well. The potential for bioconcentration, biomagnification, and interacting effects for certain chemicals may need to be determined.

Considering worst and average conditions, the reviewer will determine the biological losses from chemical stress based upon plume configuration, including time and concentration. The reviewer will determine if losses of either resident or migratory species will occur given proposed specifications for chemical releases.

C. Physical Effects

The reviewer will consider the following parameters:

1. Reduction in density, species composition, and community structure of the benthos.

2. Loss or alteration of habitat.

3. Alteration of migratory pathways.

The reviewer will consider the effects of scouring, siltation and increased turbidity of important species in the vicinity of the discharge. Effects associated with loss or alteration of habitat and the resultant potential reduction in species composition and community structure will be noted.

The reviewer will consider altered current patterns, current velocity and littoral drift, and their potential effects on habitat loss or alteration.

The reviewer will consider all of the above effects as they might affect or alter migratory pathways.

IV. EVALUATION

Evaluation of each identified impact will result in one of the following conclusions:

- The impact is minor and mitigation is not required. When impacts are of this nature, the reviewer will accept construction and operation of the discharge system as proposed.

- The impact is adverse but can be mitigated by specific design or procedural modifications that the reviewer has identified and determined to be practical. For these cases, the reviewer will consult with the project manager and the reviewer for ES Section 9.3.2 for verification that the reviewer's recommended modifications are practical and will lead to an improvement in the benefit-cost balance. The reviewer will prepare a list of verified modifications and recommended measures and controls to limit the corresponding impact. These lists will be provided the reviewer for ES Section 5.10.

- The impact is adverse, cannot be successfully mitigated, and is of such magnitude that it should be avoided. When impacts of this nature are identified, the reviewer will inform the reviewer for ES Section 9.3.2 that an analysis and evaluation of alternative designs or procedures is required. The reviewer will participate in any such analysis and evaluation of alternatives

that would avoid the impact and that could be considered practical. If no such alternatives can be identified, the reviewer will be responsible for providing this information to the reviewer for ES Section 10.1.

The reviewer's evaluation of discharge system impacts to aquatic biota will require consultation and coordination with those agencies responsible for the determinations specified in Section 316(b) of the Federal Water Pollution Control Act (FWPCA). Following the procedures described in the Analysis section of this ESRP, the reviewer will coordinate the evaluation of identified impacts and recommendations for any identified measures and controls to limit (or avoid) these impacts with the appropriate agency responsible for the FWPCA Section 316(a) determination. When consulting with the EPA or with agencies of States having NRC/State memoranda of understanding, the reviewer will ensure that the staff analyses, evaluations and recommendations are consistent with the details of these memoranda and will serve the environmental impact statement needs of these agencies. The reviewer will also ensure that any recommendations for measures and controls to limit (or avoid) impacts are consistent with the Section 316(a) determination.

The reviewer should also review other legislation pertinent to the problems of thermal and various chemical discharges into water bodies. Some of those considered most important are listed in the Standards and Guides section of this plan. Quantitative information by which the reviewer may develop acceptable criteria for evaluating discharge system impacts are contained in the EPA document entitled Water Quality Criteria, 1972. Of particular importance in establishing standards for chemical discharge are the FWPCA Amendments of 1972, the National Pollution Discharge Elimination System (NPDES) permit issuing program of EPA, and individual State water quality standards. Review of these standards will serve the reviewer by pointing out those design alternatives and operational practices which are potentially detrimental to the environment.

For plants located in States lacking definitive water quality standards, the reviewer will use the EPA document, Water Quality Criteria, 1972 (or its successor), in the evaluation of impacts resulting from discharge system operation.

A. For thermal discharges, these evaluations include:

1. Growth of aquatic species will be maintained at levels necessary for sustaining actively growing and reproducing populations if the maximum weekly average temperature in the zone inhabited by the species at that time does not exceed one-third the range between the optimum temperature and the ultimate upper incipient lethal temperature of the species, and the temperatures above the weekly average do not exceed the criterion for short-term exposures.

2. Important species should be protected if the maximum weekly average temperature during winter months in any area to which they have access does not exceed the acclimation temperature (minus a 2°C safety factor) that raises the lower lethal threshold temperature of such species above the normal ambient water temperature for that season, and the criterion for short-term exposures is not exceeded. This recommendation applies where cold shock may occur, for example, low velocity areas of water diversions, canals, and mixing zones.

For short-term exposure of a given species to extreme temperatures, the following formula should not be allowed to increase above unity when the temperature exceeds the incipient lethal temperature minus 2°C. This relationship

$$\frac{\text{time}}{10^{[a+b(\text{temp} + 2^\circ)]}}$$

should hold unless there is justifiable reason to believe it is unnecessary for maintenance of populations of the species. The basis for application of this modified resistance-time formula is found in Appendix II-C of Water Quality Criteria, 1972, Section III, pages 161-162. This recommendation applies to all locations where species requiring protection may be exposed, including areas within mixing zones and water diversions such as power plant cooling system.

3. After the specific limiting temperatures and exposure times have been determined by studies tailored to local conditions, the reproductive activity of selected species will be protected in areas where 1) temperature regimes required for gonad growth and maturation are preserved, 2) no temperature differentials are created that block spawning migrations, although some delay or advancement

of timing based upon local conditions may be tolerated, 3) temperatures are not raised to a level at which necessary spawning or incubation temperatures of winter spawning species cannot occur, 4) sharp temperature changes are not induced in spawning areas, either in mixing zones or in mixed water bodies (the thermal and geographic limits to such changes will be dependent upon local requirements of species, including spawning microhabitat, e.g., bottom gravels, littoral zone, and surface strata), 5) timing of reproductive events is not altered to the extent that synchrony is broken where reproduction or rearing of certain life stages is shown to be dependent upon cyclic food sources or other factors at remote locations, and 6) normal patterns of gradual temperature changes throughout the year are maintained.

4. Nuisance growths of organisms may develop where there are increases in temperature or alterations of the temporal or spatial distribution of heat in either the receiving water bodies (e.g., rivers, lakes) or in onsite cooling ponds. Some nuisance conditions may be created by operation of cooling ponds which may not affect receiving water body biota, but which may affect the esthetic quality of the site and vicinity. The reviewer will consider such factors (e.g., odors from algal or macrophyte growth and decomposition) in making this evaluation. There should be careful evaluation of all factors contributing to nuisance growths at any site before establishment of thermal limits based upon this response, and temperature limits should be set in conjunction with restrictions on certain other factors, e.g., eutrophication.

B. For chemical discharges, these evaluations include:

1. The possible environmental effect of certain chemicals, like chlorine (hypochlorite), chlorination by-products, other biocides, and scale and corrosion inhibitors may require special consideration.

2. Alternatives to the biocide treatment of condenser tubing should also be evaluated.

C. For physical effects, these evaluations include:

1. Potential loss or alteration of unique habitat

2. Potential effects of altered migratory pathways

3. Potential effects of biotic changes.

V. INPUT TO THE ENVIRONMENTAL STATEMENT

This section of the environmental statement should be planned to accomplish the following objectives: (1) public disclosure of predicted impacts of discharge system operation to aquatic biota, (2) presentation of the basis for the staff's review and analysis, and (3) presentation of staff conclusions and recommendations.

Public disclosure may be accomplished by a brief summary of discharge system operation, thermal and physical conditions in the receiving water body as affected by plant discharges, and the chemicals added to the plant discharge. ES Sections 3.4.2, 5.3.2.1, and 3.6.1 should be referred to for further descriptive information. The aquatic biota and their habitats that will be exposed to discharge system impacts should also be described. This section should be understandable to a nontechnical reader. Extensive descriptive material should be incorporated by reference and not duplicated in the ES.

The staff's analysis may be provided by referencing the aquatic biota descriptions of ES Section 2.4.2, and describing in brief detail the effects on biota that are "important" and susceptible to thermal, chemical, or physical impact. Types, life stages, and relative abundance of impacted "important" biota should be described, along with specific aspects of proposed discharge system operation responsible for impacts to these biota. This section should provide estimates of survival from these discharge system impacts, and estimates of the relative or absolute losses to the impacted populations.

Staff conclusions should evaluate the significance of losses to the populations of "important" species, including a determination as to whether or not these losses will constitute an adverse impact that should be mitigated or avoided. This section may include a summary of staff coordination with agencies having responsibilities under the FWPCA. Any studies or environmental investigations performed by these agencies that address discharge system impacts should be described or referenced.

The reviewer will provide inputs or ensure that inputs will be made to the following ES Sections:

A. Section 5.10. The reviewer will supply the reviewer for ES Section 5.10 with a list of applicant commitments and staff recommendations for measures and controls to limit adverse discharge-system aquatic impacts.

B. Section 6.5.2. The reviewer will provide the reviewer for ES Section 6.5.2 with a discussion of any required preoperational baseline monitoring programs necessary to assess impacts of discharge system operation.

C. Section 9.3.2. The reviewer will provide the reviewer for ES Section 9.3.2 with a list of adverse impacts of discharge system operation that could be mitigated or avoided through alternative system design, location, or operation. The reviewer will assist the reviewer for ES Section 9.3.2 in determining appropriate alternatives.

D. Section 10.1. The reviewer will provide the reviewer for ES Section 10.1 with a summary of the unavoidable adverse impacts to aquatic biota that are predicted to occur as a result of discharge system operation.

E. Section 10.2. The reviewer will provide the reviewer for ES Section 10.2 with a summary of irreversible and irretrievable commitments of aquatic resources that are predicted to occur as a result of discharge system operation.

VI. REFERENCES

1. Water Quality Criteria, 1972, Committee on Water Quality Criteria, National Academy of Sciences and National Academy of Engineering, Ecological Research Series, Washington, D.C., EPA-R3-73-033, 1973.

2. Guidelines for Developing or Revising Water Quality Standards, Environmental Protection Agency, Washington, D.C., 1973.

3. C. D. Becker, J. A. Strand, and D. G. Watson, "Aquatic Ecology, Part 6," Environmental Impact Monitoring of Nuclear Power Plants, Source Book of Monitoring Methods, Atomic Industrial Forum, Inc., Washington, D.C., 1975.

4. J. R. Brett, "Some Principles in the Thermal Requirements on Fishes," Quart. Rev. Bio. Vol. 31, no. 2, pp. 75-87, 1956.

5. W. A. Brungs, "Chronic Effects of Constant Elevated Temperature on the Fathead Minnow (Pimephales prolelas, Rafinesque)," Trans. Amer. Fish Soc., Vol. 100, no. 4, pp. 569-664, 1971.

6. J. Cairns, Jr. and K. L. Dickson, eds., "Biological Methods for Assessment of Water Quality," Symposium, Seventy-fifth Annual Meeting, American Society for Testing and Materials, Philadelphia, PA, 1973.

7. D. E. Noll, "The Influence of EPA Guidelines on Treatment of Power Plant Wastes," Industrial Water Engineering, Vol. 12, no. 6, pp. 19-25, December 1975/January 1976.

8. J. Clark and W. Brownell, "Electric Power Plants in the Coastal Zone: Environmental Issues." American Littoral Society, Highlands, NJ, 1973.

9. C. C. Coutant, "Biological Effects of Thermal Pollution, I. Entrainment and Discharge Canal Effects." CRC Critical Reviews in Environmental Control, Vol. 1, no. 3, pp. 341-381, 1971.

10. C. C. Coutant, "Biological Aspects of Thermal Pollution, II. Scientific Basis for Water Temperature Standards at Power Plants," CRC Critical Reviews in Environmental Control, Vol. 3, no. 1, pp. 1-24, 1972.

11. J. A. Mihursky and V. S. Kennedy, "Water Temperature Criteria to Protect Aquatic Life," A Symposium on Water Quality to Protect Aquatic Life, Spec. Publ. No. 4, Amer. Fish Soc., Washington, D.C., pp. 20-32, 1967.

12. USNRC Regulatory Guide 4.8, "Preparation of Environmental Technical Specifications for Nuclear Power Plants."

ENVIRONMENTAL STANDARD REVIEW PLAN

FOR ES SECTION 5.3.2.2 COOLING SYSTEM IMPACTS - DISCHARGE SYSTEM: AQUATIC IMPACTS

APPENDIX A HABITAT TYPES

A. Rivers and Streams

River currents are often strong and usually unidirectional, carrying heated effluents directly and rapidly downstream. This results in rather narrow and elongated thermal plumes. Buoyancy, as it relates to submerged outfalls, is not generally important because of the relatively shallow depths of most rivers. Heated discharges to low gradient rivers often spread on or near the surface with little mixing. In such situations, benthic organisms are often spared thermal impact. However, phyto- and zooplankton, fish eggs and larvae, insect larvae, and other drifting organisms may enter mixing zones and suffer thermal stress. In winter, fish may be attracted to discharge areas and mixing zones and are then susceptible to cold shock during station shutdown. Migratory fish may avoid mixing zones of elevated temperatures which may impair their upstream or downstream movement.

B. Lakes and Reservoirs

Lake and reservoir currents are generally weak. Temperature patterns of the mixing zone are influenced by the velocity, location, and design of the outfall and water current. Buoyancy of the thermal discharge may be an important consideration in relatively deep lakes. Thermal discharges may affect natural thermal stratification. Since strong unidirectional currents are usually lacking, transport of phyto- and zooplankton, fish eggs and larvae, insect larvae, and other drifting organisms into the mixing zone are of less concern. However, fish may be attracted to discharge areas and mixing zones in winter, depending upon thermal preference. They are then susceptible to cold shock in the event of station shutdown. Mixing zones seldom, if ever, affect migratory

species, but this potential could exist if the discharge is at or near the shoreline.

C. Estuaries

Estuaries are characterized by the presence of both fast and slow currents which may vary directionally with inflowing rivers, tides, and winds. These conditions may greatly affect the configuration of thermal plumes. Buoyancy may not be an important factor if the estuary is relatively shallow. To the extent that the plume reaches the bottom, benthic invertebrates and attached algae and macrophytes may be susceptible, if thermal exposures exceed tolerance limits. Generally, sessile organisms are most susceptible. Planktonic organisms and, in particular, the drifting eggs and larvae of fish are usually abundant and may be vulnerable to the shifting temperature patterns of a mixing zone. Finfish in winter may be attracted to discharge areas and mixing zones where they may be vulnerable to cold shock at station shutdown. Blockage of migratory finfish is a potential if the station is located at the confluence of a coastal river and the estuary.

D. Seacoast

If strong currents prevail, the configuration of the thermal plume will be greatly affected. Depending upon the depth of water in the vicinity of the discharge, wave action may be an important factor. As before, buoyancy would depend upon outfall depth and temperature. To the extent that the plume reaches the bottom or shoreline, benthic and littoral zone organisms would be subjected to thermal stress. Planktonic organisms are seasonally abundant; however, the significance of loss may not be great because of potential replacement by vast populations in unaffected contiguous waters. Adult finfish may be attracted to thermal discharges in winter depending upon thermal preference. Mixing zones in coastal waters usually have little or no effect on migratory finfish and shellfish, but local current pattern alterations may affect planktonic organisms.