U.S. NUCLEAR REGULATORY COMMISSION

ENVIRONMENTAL STANDARD REVIEW PLAN

5.3.1.1 HYDRODYNAMIC DESCRIPTIONS AND PHYSICAL IMPACTS OF INTAKES

REVIEW RESPONSIBILITIES

Primary—Organization responsible for the review of hydraulic information

Secondary—None

I. AREAS OF REVIEW

This environmental standard review plan (ESRP) directs the staff's description of intake hydrodynamics and analysis and assessment of predicted physical impacts caused by the flow field induced by the water intakes.

The scope of the review directed by this plan should include consideration of the spatial and temporal distribution of the surface-water body flow field and the physical effects of the flow field induced by intake system operation. The review should be in sufficient detail to describe intake hydrodynamics to the extent necessary for subsequent assessment of predicted intake system impacts to aquatic biota. In addition, the reviewer should assess potential intake system physical impacts (e.g., bottom scouring, induced turbidity, silt buildup, and alteration of thermal stratification patterns) and evaluate how these impacts should be treated in the licensing process. When necessary, the reviewer should identify and evaluate alternative designs, practices, or procedures that would mitigate or avoid predicted adverse impacts.

Review Interfaces

This section describes the types of interfaces needed with other staff. Interfaces require coordination primarily with the lead for hydrology, and to a lesser extent with the leads for alternatives and cumulative impacts. The reviewer for this ESRP should obtain input from and provide input to the reviewers for the following ESRPs, as indicated:

- ESRP 2.3.1. Obtain descriptions of the hydrology of the region surrounding the proposed plant site (specifically, the hydrology of the surface water bodies that would be affected by the intake system).

- ESRP 2.4.2. Obtain descriptions of the baseline aquatic ecology for the surface water bodies in the area surrounding the proposed plant site that would be affected by the cooling system intake system.

- ESRP 3.1. Obtain descriptions of the layout of the proposed plant (specifically, the layout of the main water bodies, including locations of all intakes and discharges).

- ESRP 3.3.1. Obtain descriptions of the expected water use of the proposed plant.

- ESRPs 3.4.1 and 3.4.2. Obtain descriptions of the cooling system of the proposed plant.

- ESRP 5.2.2. Provide input related to potential water-use restrictions caused by operation of the intake system.

- ESRP 5.3.1.2. Obtain input regarding the potential for impacts of the induced hydrodynamic flow field to aquatic biota including biota with behaviors or life stages that can potentially be impacted by flow fields (which will be used to determine the appropriate extent of the hydrodynamic description required for the environmental impact statement [EIS]).

- ESRP 5.3.2.1. Obtain descriptions of the physical impacts to surface-water bodies caused by the discharge system of the proposed plant (if the same water bodies are used for intake to the cooling system).

- ESRPs 5.3.1.2 and 5.3.2.1. Provide a description of the intake system hydrodynamic flow field.

- ESRP 5.4.1 and 5.4.2. Provide a description of changes in hydrodynamics that might change radiation pathways and dose to the public for a range of water conditions.

- ESRP 5.8.1. Provide a summary of the physical impacts related to the presence and operation of the intake system.

- ESRP 5.10. Provide a list of measures and controls to limit adverse impacts that have been identified and evaluated for consideration in the licensing process.

- ESRPs 6.3 and 6.6. Provide input regarding the need for and possible limitations on any monitoring activities as a result of the presence or operation of the cooling intake system.

- ESRP 9.4. Provide a list of adverse physical impacts that could be mitigated or avoided through alternative intake system designs or operational procedures, and assist in determining appropriate alternatives.

- ESRP 10.1. Provide a summary of the unavoidable adverse physical impacts that are predicted to occur as a result of intake system operation.

Data and Information Needs

The type 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 anticipated magnitude of the potential impacts. The following data or information should be obtained:

- bathymetry and substrate characteristics in the vicinity of the intake structure(s) (from ESRP 2.3.1)
- maps depicting station layout with respect to the water body, including locations of all intakes and discharges (from ESRPs 3.1 and 3.4.2)
- intake flow rates and velocities as a function of plant operating conditions (from ESRP 3.4.2)
- detailed drawings of the intake structure(s), including the relationship of the structure to the water surface (normal and minimum levels) (from ESRP 3.4.2)
- ambient current patterns in the vicinity of the proposed intake structure(s) (from ESRP 2.3.1)
- descriptions of other intake system design and performance characteristics affecting hydrodynamics (e.g., horizontal and vertical approach velocities, through-screen velocities, geometry of intake canals, submerged riprap) (from the environmental report [ER])
- descriptions of spatial and temporal alterations of the ambient flow field and of any other physical hydrologic effects induced by intake-system operation (from the ER).

II. ACCEPTANCE CRITERIA

Acceptance criteria for the hydrodynamic physical impacts at the proposed plant sites are based on the relevant requirements of the following:

- 10 CFR 51.45 with respect to ERs and the analysis of potential impacts contained therein
- 10 CFR 51.75 with respect to descriptions of the environment affected by the issuance of a construction permit, early site permit, or combined license
- 10 CFR 51.95 with respect to the preparation of supplemental environmental impact statements (EISs) in support of the issuance of an operating license
- 33 CFR 322 with respect to definition of activities requiring permits
- Clean Water Act with respect to Section 316(b) and Section 401
- 40 CFR 122 and 125 with respect to National Pollutant Discharge Elimination System (NPDES) permit conditions
- Rivers and Harbors Appropriation Act of 1899
- Federal, State, regional, local, and affected Native American tribal water laws and water rights.

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

- Compliance with environmental quality standards and requirements of the Clean Water Act, is not a substitute for and does not negate the requirement for NRC to weigh the environmental impacts of the proposed action, including any degradation of water quality, and to consider alternatives to the proposed action that are available for reducing the adverse impacts. If an environmental assessment of aquatic impacts is available from the permitting authority, the NRC will consider the assessment in its determination of the magnitude of the environmental impacts in striking an overall benefit-cost balance. When no such assessment of aquatic impacts is available from the permitting authority, the NRC (possibly in conjunction with the permitting authority and other agencies having relevant expertise) will establish its own impact determination.

- Regulatory Guide 4.2, Rev. 2, *Preparation of Environmental Reports for Nuclear Power Stations* (NRC 1976), provides guidance on the format and content of ERs including hydrology, water-use, and water-quality issues.

- LIC-203, Revision 1, Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Impacts (NRC 2004), with respect to NRC compliance with the Endangered Species Act.

Technical Rationale

The technical rationale for evaluating the applicant's hydrodynamic descriptions and physical impacts is discussed in the following paragraph:

> The EIS should include an analysis that considers the environmental effects of the operation of the proposed cooling water intake system and the alternatives and mitigation measures available for reducing or avoiding adverse environmental effects, as well as any environmental benefits that may result from the proposed action. Following the acceptance criteria listed above will help ensure that the environmental impacts of the proposed cooling water intake system are considered with respect to matters covered by such standards and requirements.

III. REVIEW PROCEDURES

The reviewer's description of intake hydrodynamics should be linked to the environmental descriptions provided by ESRPs 2.3.1 2.3.2, 2.3.3, 3.3, and 3.4 to ensure that water body characteristics affecting intake hydrodynamics are described in sufficient detail to allow prediction of the flow field induced by the operation of the intake system. The reviewer's analysis of physical impacts of intake system operation should be linked to the environmental descriptions and impact analyses of ESRPs 2.4.2, 5.3.1.2, 5.3.2.1, 5.4.1, and 5.4.2 to ensure that those environmental factors most likely to be affected are described in sufficient detail to permit assessment of the predicted changes or impacts. The extent of the description of intake hydrodynamics and analysis of physical impacts should be governed by the magnitude of potential intake system impacts to aquatic biota.

Intake-Hydrodynamic Description

The reviewer should take the following steps to develop a description of the intake hydrodynamics:

(1) Conduct a simple independent hydrodynamic analysis (e.g., calculate of the induced potential flow field by standard procedures and prepare an intake system hydrodynamic description.

- The reviewer needs to determine the range of low water surface elevation at the intake. Guaranties of future water commitments from upstream dam operators are necessary to bound the operational conditions for the intake before velocities at the intake can be computed.

- Discuss this with reviewers for ESRPs 2.4.2 and 5.3.1.2 to determine its adequacy for use in predicting intake system impacts to aquatic biota.

- When determined that the induced flow fields would result in only minor impacts on aquatic biota (or that no biota would be affected), this portion of the analysis is complete.

(2) When it is determined that the simple hydrodynamic analysis is insufficient (e.g., the analysis results in predictions of significant adverse impact; there are large populations of "important" aquatic biota in the vicinity of the intake), prepare a detailed independent analysis of intake hydrodynamics consisting of

- a review of any applicant supplied flow field predictions or

- a reviewer prepared prediction of the induced flow field based on modeling procedures.

  - Consult with the reviewers for ESRPs 2.4.2 and 5.3.1.2 to determine the extent of the surface-water body to be analyzed.

  - Consult with the reviewers for ESRP 5.3.2.1 and ESRP 5.4.2 to ensure that the area of the water body to be analyzed is sufficient to permit analysis of potential recirculation of discharged cooling water, if applicable.

  - Provide a quantitative description of the induced flow field taking into account the ambient currents.

  - Provide velocity vectors or other descriptors showing the areal extent of the region affected by the induced flow field.

Physical Impacts of Intakes

The reviewer should take the following steps to analyze the physical impacts of the intake system:

(1) Identify and analyze physical changes resulting from intake system operation, including

- shoreline erosion
- bottom scouring
- induced turbidity
- silt buildup
- alterations of stratification patterns.

Staff experience has indicated that the impacts listed above are generally minor. However, impacts to other resources (e.g., aquatic ecology) may be more significant. Impact findings in this ESRP are limited to those not covered in other ESRPs.

(2) Unless adverse impacts have been identified, no further evaluation is required.

The reviewer should ensure that the description of the intake flow field is adequate to serve as a basis for the impact assessment of ESRPs 5.3.1.2, 5.4.1, and 5.4.2. and for providing flow patterns necessary for the assessment of potential heated water recirculation conducted in ESRP 5.3.2.1.

The reviewer should ensure that analyses involving mathematical or physical modeling of intake flow fields are appropriate for the specific situation being modeled, have been verified or shown to be conservative, and are documented and referenced. The reviewer should consider the procedures of Regulatory Guides 4.4, *Reporting Procedure for Mathematical Models Selected for Predict Heated Effluent Dispersion in Natural Water Bodies* (NRC 1974), and 1.125, Rev. 1, *Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants* (NRC 1978), in making this evaluation. However, reviewers should be aware that these documents are dated and may not represent current standard engineering practice in some areas. For analyses involving less detailed procedures than mathematical or physical models, the reviewer should ensure that the procedures used by the applicant were appropriate for the specific situation and were adequately conservative.

For specific physical impacts identified by the "Review Procedures" section, the reviewer should evaluate each impact with regard to water standards and guides or good operating procedures for intake systems. Unless potentially severe impacts have been identified, no further evaluation is required.

IV. EVALUATION FINDINGS

Input to the EIS should contain the following: (1) a physical description of the induced hydrodynamic flow field resulting from operation of the intake system, (2) a description and assessment of physical impacts resulting from intake system operation, (3) the basis for the staff's review and analysis, (4) staff evaluations and conclusions, and (5) the range of environmental conditions considered (meteorological, hydrological, etc). The extent of the hydrodynamic description input to the EIS should be governed by the potential for impacts on aquatic biota (ESRP 5.3.1.2), radiological dose impacts (ESRP 5.4.2), and water quality impacts (ESRP 5.2.3). The extent of the physical impacts to be included should be determined by the results of the "Review Procedures" section in identifying potentially significant changes.

The following information should be included in the EIS:

- hydrodynamic description of the intake induced flow fields, including effects of ambient flow patterns. Tables or figures may be used.
- a description and assessment of the analysis technique used
- the intake flow conditions that may result in adverse impacts on aquatic biota
- a description and assessment of potential physical impacts.

Once the reviewer obtains sufficient information from the applicant in accordance with this ESRP section, then the reviewer should prepare a summary of the hydrodynamic and physical impacts associated with operation of the cooling water intake. The summary should include an impact characterization for each of the impacts using the NRC's SMALL, MODERATE, or LARGE terminology (see the Introduction) and discussion of potential mitigation measures considered, if applicable.

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 51.45, "Environmental report."

10 CFR 51.75, "Draft environmental impact statement—construction permit, early site permit, or combined license."

10 CFR 51.95, "Supplement to final environmental impact statement."

33 CFR 322, "Permits for Structures and Work in or Affecting Navigable Waters of the United States."

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."

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

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

U.S. Nuclear Regulatory Commission (NRC). 1974. *Reporting Procedure for Mathematical Models Selected for Predict Heated Effluent Dispersion in Natural Water Bodies*. Regulatory Guide 4.4, Washington, D. C.

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). 1978. *Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants*. Regulatory Guide 1.125, Rev 1, 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.