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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-4023

AQUATIC ENVIRONMENTAL STUDIES FOR NUCLEAR POWER STATIONS

A. INTRODUCTION

Regulatory Guide 4023 (RG 4023) provides technical guidance for aquatic environmental studies and analyses supporting decisions related to nuclear power stations by the U.S. Nuclear Regulatory Commission (NRC) regarding major Federal actions and compliance with the National Environmental Policy Act of 1969, as amended (Ref. 1). For purposes of RG 4023, the term “aquatic” encompasses freshwater, estuarine, and marine environments. RG 4023 addresses wetlands containing submerged aquatic vegetation (SAV) but does not address wetlands also containing emergent vegetation. Instead, RG 4.11, Revision 2, “Terrestrial Environmental Studies for Nuclear Power Stations” (Ref. 2), addresses such wetland features, along with the terrestrial environment. Although the NRC is issuing separate RGs addressing terrestrial and aquatic environmental studies, it recognizes that aquatic and terrestrial ecological issues often overlap and are often interrelated.

RG 4023 defines general objectives for aquatic analyses but does not provide stepwise instructions or technical protocols. Analysts using RG 4023 should apply professional judgment when identifying analytical methods appropriate to each decision and collecting associated data. Various agencies and universities are continually refining aquatic ecology protocols and developing new approaches to benefit achievement of regulatory objectives. Analysts should contact appropriate Federal and State regulatory agencies and search recent scientific literature for specific data collection protocols and analytical processes. Analysts should justify the methods they select.

RG 4023 focuses on aquatic analyses for authorizations, permits, and licenses for new nuclear power stations under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 3). However, RG 4023 is also applicable to the two-step licensing process in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities” (Ref. 4). RG 4023 also is useful in identifying the more limited studies and analyses needed for nuclear reactor operating license renewal under 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants” (Ref. 5), and portions may be relevant to nuclear reactor power uprates as well as decommissioning. RG 4023 also may prove useful in planning studies to support nuclear fuel cycle facilities or other actions requiring an NRC license or permit.

In addition to this RG, the NRC addresses aquatic analyses in guidance documents designed to aid applicants in preparing multidisciplinary environmental information for applications, including RG 4.2, “Preparation of Environmental Reports for Nuclear Power Stations” (Ref. 6), and RG 4.7,

"General Site Suitability Criteria for Nuclear Power Stations" (Ref. 7). RG 4023 provides focused guidance on aquatic environmental studies and analyses supporting the broader environmental objectives in these other regulatory guides. Like other NRC RGs, this RG addresses information that the NRC uses in making regulatory decisions. It does not necessarily cover all of the aquatic environmental information required to comply with other Federal, State, or local laws and regulations.

The NRC issues RGs to describe the methods that the NRC staff considers acceptable for use in implementing specific parts of the agency's regulations, to help explain techniques that the NRC staff uses in evaluating specific problems or postulated impacts, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with them is not required.

This RG contains information collection requirements covered by 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions" (Ref. 8), which the Office of Management and Budget (OMB) approved under OMB control number 3150-0021. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. This RG is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

B. DISCUSSION

Background

The NRC is issuing this guide to describe objectives and suggested topics for inclusion in aquatic analyses, in support of applications to site, construct, or operate a nuclear power station, as well as license renewal and power uprate applications. Aquatic analyses occur in areas such as nuclear power station siting support, baseline investigations, identification of important species and habitats, impact analyses, monitoring, and decommissioning. The applicant should use best professional judgment to develop and justify the objectives of aquatic studies, spatial and temporal coverage, level of detail, and methods of data collection.

Aquatic Siting Support

Aquatic ecology is one of multiple technical disciplines involved in the site selection (screening) process required to license (or issue an authorization or permit for) a new nuclear power plant (under 10 CFR Part 50 or 10 CFR Part 52). The discussion of site selection procedures in RG 4023 is limited to aquatic ecological issues. The presence or absence of aquatic ecological resources contributes to screening an initial region of interest (ROI) to identify candidate areas, candidate areas to identify potential sites, potential sites to identify candidate sites, and candidate sites to identify alternative sites and a proposed site. Analysts can find information relevant to the site-selection process in the Electric Power Research Institute's (EPRI) "Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application" (Ref. 9), and RGs 4.2 and 4.7. Aquatic ecology is also a factor in evaluating alternative energy sources and alternative heat dissipation systems.

Site Selection

As mentioned above, NRC guidance for the site selection process, including aquatic ecology considerations is available in RGs 4.2 and 4.7. Analysts primarily use reconnaissance-level information and published data to identify aquatic ecology resources for site selection. Each step in the site selection

process increases the level of detail used to identify sensitive aquatic ecology resources (e.g., freshwater mussels) and special aquatic sites, further narrows the field of possible sites, and increases confidence in how well the resulting field of sites avoids sensitive resources. The ROI may be screened initially at a coarse scale (e.g., 1:250,000) to identify candidate areas that best exclude areas dedicated to ecological management (e.g., national wildlife refuges, critical habitat for Federally listed species, important habitat for State-listed protected species, designated essential fish habitat (EFH), and State sanctuaries, reserves, preserves, wildlife, or natural areas), as well as other sensitive and important aquatic habitats such as estuaries. Those candidate areas may then be screened more closely by overlaying a polygon approximating the size of a nuclear reactor site showing protected species and smaller aquatic areas that were indiscernible at the coarser scale. Analysts may reposition the polygon multiple times over the map to identify a suite of candidate sites for further investigation.

Applicants should then compare candidate sites using specific qualitative and quantitative criteria. Criteria may include numbers of known occurrences of Federally or State-listed species; scientific reports or professional judgment on the amount and quality of freshwater, estuarine, or marine habitats; distance from aquatic habitats; and other pertinent species or habitat attributes. Applicants may score criteria and compare candidate sites using composite scores. Scoring criteria should reflect information that is as uniform in detail and accuracy as possible among candidate sites. Analysts should review scores for possible biases derived from differing quality of available data. For example, the number of known occurrences of Federally and State-listed species may vary from site to site depending on how well analysts in each geographic region have characterized them in the past. Analysts should justify the criteria selected and criteria scoring schemes.

Analysts may identify a final suite of alternative sites, including a proposed site, by comparing candidate sites based on potential siting, construction, and operational impacts to the aquatic resources. The analysis normally requires further differentiation of candidate sites by conducting additional screening at a higher confidence level, using more detailed site-specific data currently available or developed from onsite verification surveys. Such analysis also would consider potential impacts from siting, building, maintaining, and operating transmission lines. Analysts may also score and compare construction impacts (e.g., disturbance of high-quality habitats and proximity to protected species) and operation impacts (e.g., biota affected by water withdrawal and discharge).

The evaluation of alternative sites provided to meet NRC staff needs may partially overlap with U.S. Army Corps of Engineers (Corps) requirements under Section 404 of the Clean Water Act (CWA) (Ref. 10). Analysts may find it efficient to evaluate aquatic resources at alternative sites following an integrated approach that simultaneously achieves the requirements for both the NRC and the Corps. Analysts should contact the appropriate regional Corps district office to acquire information about local application of the Corps guidelines for site selection.

Energy Alternatives

Aquatic ecology is one of multiple technical disciplines involved in evaluating whether alternative energy sources requiring new generating capacity are competitive with the proposed energy source. RG 4.2 identifies alternative energy sources requiring new generating capacity. Nuclear, coal, natural gas, and a combination of alternatives are the most commonly considered alternative energy sources for new baseload power generating capacity; these alternative energy sources are normally compared under the assumption that they would be developed on the proposed site. However, green energy alternatives, such as wind power, solar power, and others, are becoming more efficient and should be considered when possible. For the purposes of this comparison, analysts would develop the combination of alternatives on the proposed site unless otherwise stated. No specific aquatic ecology evaluation criteria reflect competitiveness between the alternative energy sources and proposed source.

Instead, aquatic resources potentially affected by each energy alternative typically are described and compared at a coarse level of resolution (e.g., use of previously disturbed versus undisturbed habitat), including quantified data when possible.

Heat Dissipation System Design Alternatives

Aquatic ecology is a factor in assessing whether a heat dissipation system design alternative is environmentally preferable to the proposed system. Heat dissipation systems for new facilities normally include closed-cycle systems or systems that use an off-channel reservoir because a once-through system would lack compliance with CWA regulations (Ref. 11). A closed-cycle system usually uses one or more mechanical draft wet cooling towers, natural draft cooling towers, hybrid wet/dry cooling towers, or spray ponds. A cooling system can use an off-channel reservoir or cooling pond, with or without assistance of a cooling tower, as long as the water usage rates comply with the CWA. Regardless of the type of closed-cycle system, closed-cycle cooling consumes much more water than once-through cooling. Water consumption, or loss, is an impact that must be addressed, usually including predictive modeling, particularly in locations where water availability is a concern. Beyond CWA requirements, no specific aquatic ecology regulatory criteria are used commonly to compare the alternative heat dissipation systems with the proposed system. Instead, aquatic resources potentially affected by each alternative typically are described and compared at a coarse level of resolution (e.g., general habitat types (e.g., freshwater, estuarine, marine, soft-substrate, hard-substrate) that would be affected by siting, building, or operating the heat dissipation system), including quantitative data when possible.

Sources of Information

Some information sources useful for identifying aquatic ecological resources in a project study area include:

- topographic maps (7.5-minute) from the U.S. Geological Survey and other online mapping products
- EFH mapper from the National Marine Fisheries Service (NMFS)
- National Wetland Inventory Maps (they include water features in addition to wetlands)
- State (e.g., Natural Heritage Program) and Federal (e.g., NMFS or FWS) data on potential occurrence of threatened, endangered, and other protected species and habitats
- State Coastal Zone Management plans
- fishery management plans from NMFS and the regional fishery management councils
- coastal and marine spatial plans from the National Oceanic and Atmospheric Administration (NOAA) and the regional planning bodies
- nautical charts
- remote sensing data from Landsat and SeaWiFS imagery from the National Aeronautics and Space Administration (NASA)
- data on marine protected areas (MPAs) from the National Marine Protected Areas Center

- Federal, State, and private land use and land cover maps
- existing and projected future land use maps from the local planning and zoning offices
- Federal, State, and local landings data
- Academic studies of local ecology from nearby institutions
- Other environmental documents (e.g., Environmental Impact Statement, Environmental Assessment, Biological Assessment, Biological Opinion, Essential Fish Habitat Assessment) from nearby facilities

Aquatic Environmental Baseline Investigations

Aquatic environmental baseline investigations inventory and characterize freshwater, estuarine, and marine flora, fauna, and habitats in potentially affected areas on and in the vicinity of a proposed site, including associated offsite rights-of-way for features such as transmission lines or pipelines. Baseline investigations provide more detailed information than needed for the analysis of alternative sites, form a basis for assessing potential impacts to aquatic resources, provide data useful for determining the environmental integrity (e.g., habitat and function) of the site in an ecoregional context, and serve as a foundation for related monitoring and mitigation required by Federal, State, or local agencies. The level of detail should be roughly proportional to the anticipated magnitude of potential impacts and the amount of information needed to evaluate the significance of the impacts. The spatial extent of potential building and operation impacts can extend beyond the proposed property limits to encompass areas potentially affected by site-related activities, such as surface or ground water drawdown, noise, pressure changes, scour and erosion, stormwater runoff, dredged or excavated material disposal, water discharge plumes, and cooling tower drift. Studies of aquatic resources within the area of building and operation (plus a reasonable buffer based on the imprecision of design data) generally should be more detailed than for peripheral areas. The spatial extent and detail of baseline investigations may have to be expanded to account for cumulative impacts properly and to address the concerns of interested Federal, State, Tribal, local, and private organizations.

The detail needed for baseline investigations may be less for proposed sites that have been partially developed (e.g., sites within an existing nuclear power plant property or a property with other energy production facilities) if the site has undergone past ecological investigation. However, generally, ecological data should be collected recently enough to allow an accurate assessment of existing conditions and potential impacts (i.e., after any anthropogenic or natural disasters that may have altered habitats). To describe the current condition of aquatic resources analysts may use descriptive field information gathered during previous environmental reviews, if updated and augmented, as necessary, with current field investigation data and supplemented with an analysis of new and significant information. The updated data collection needs to address habitats lost, degraded, and created by building existing facilities (e.g., loss of nearshore habitat during creation of an intake structure) and natural processes or anthropogenic activities that have taken place since collection of the earlier data. If the analyst uses historic data for comparisons or descriptive purposes, the analyst should justify why such a method is appropriate and scientifically acceptable.

Because baseline investigations form the foundation for subsequent analyses and monitoring, they should be initiated as early as possible and be broad enough to support anticipated subsequent studies. Analysts performing aquatic baseline investigations should follow accepted scientific design methods and

seek input from interested Federal, State, Tribal, local, and private organizations when initially designing the investigations. Some baseline investigations commonly useful for NRC-licensed activities include the following:

- aquatic habitat identification
- aquatic habitat mapping
- aquatic habitat description
- community and population studies
- water availability studies
- instream flow studies
- functional assessment of streams and other water bodies
- sampling of biota near intake and discharge locations
- identification of important species and habitats
- targeted species surveys.

Aquatic baseline studies may be prepared as standalone reports or presented initially within an environmental report (ER, see RG 4.2) or another broadly scoped environmental document. Analysts may combine closely related baseline studies into single reports. For example, they can present aquatic habitat identification, mapping, and descriptions that fit together logically in a single report. Biota survey reports can be prepared separately, together, or combined with an aquatic habitat survey report and map.

Applicants may be able to draw upon existing scientific literature to obtain some of the necessary baseline data. Aquatic ecological baseline studies may already have been prepared to support other projects on or near the site. Web sites, databases, or other information sources that Federal, State, or local agencies or conservation organizations maintain also may contain useful data. Analysts should use professional judgment to evaluate the applicability or possible obsolescence of the data. NRC staff will critically examine analyses using data that are more than two years old or data that do not accurately reflect existing conditions particularly if environmental conditions have changed in the past two years.

Aquatic Habitat Identification

Analysts should identify and describe aquatic habitats on the proposed site and adjoining property, as well as along any new or existing transmission line or pipeline corridors affected by the proposed action. The area of potential effects can extend beyond the proposed site to encompass habitats potentially affected by surface water drawdown or groundwater depletion (including dewatering for construction required to relieve pressure on temporary cofferdams during installation of intake/refill structures); thermal discharge; discharge of contaminants; siltation, noise, and pressure changes from in-water building activities; erosion, runoff, and sedimentation; cooling tower drift; habitat modification and loss; disposal of dredged material; and other activities. For cumulative effects, analysts should define geographic scale based on aquatic ecological parameters chosen according to the zone of influence while taking into account factors such as species migration routes (including those of diadromous species), upstream and downstream activities, locations of dams on waterways, and tidal influence. For example, a watershed scale may be appropriate.

Analysts should identify aquatic habitats according to applicable Federal, State, Tribal, regional, and local nomenclature systems. Analysts also should identify and assess such habitats if they occur within the vicinity of the proposed and alternative sites. Table 1 lists some protected aquatic habitats and statutory bases for protection. In addition to the statutes included in Table 1, analysts should heed Executive Orders that address aquatic habitat protection. When including marine or estuarine waters, the special habitats in Table 1 are marine protected areas (MPAs), per Executive Order (EO) 13158 (Ref. 12),

dated May 31, 2000. The MPA EO requires Federal agencies to "avoid harm to the natural and cultural resources that are protected by an MPA." Similarly, pursuant to the Coral Reef Protection EO 13089 (Ref. 13), dated June 11, 1998, analysts should identify any impacts on coral reef ecosystems and propose ways to "protect and enhance the conditions of such ecosystems." For projects that affect coral reef ecosystems, analysts should propose "measures needed to research, monitor, manage, and restore affected ecosystems."

Many aquatic habitats are highly valuable because of existence of protective mechanisms, particularly from an ecosystem rather than species-specific perspective. For example, high productivity areas are integral to the integrity of a local ecosystem's food web. EO 13158 does not cover some *de facto* MPAs, such as shipping lanes or the aquatic portion of an exclusion area for a nuclear power station, but these still warrant inclusion in environmental analyses and studies. Analysts should identify, describe, and assess all such valuable aquatic habitats if they occur within the vicinity of the proposed or alternative sites. Typically, analysts identify and describe aquatic habitats according to salinity, bathymetry, rugosity, substrate, flow rate and current patterns, nutrient load, turbidity, SAV, biotic community, biodiversity, tidal influence, temperature, dissolved oxygen, and other parameters appropriate for a particular site. For some assemblages or populations, analysts identify aquatic habitats based on importance for particular activities, species, or life stages. These instances include nursery grounds, breeding grounds, feeding grounds, and spawning or pupping grounds. Designations of EFH and habitat area of particular concern (HAPC), which is a discrete subset of EFH, often are based on species-specific activities and requirements.

The degree of habitat description within differing geographic areas can vary. Thus, analysts should select the tool or combination of tools that provides a description of the habitat resolution adequate to identify habitat impacts and to quantify impacts, where necessary. The analyst should contact or meet with other Federal and State agencies (e.g., NMFS and the U.S. Fish and Wildlife Service (FWS) or a State's department of natural resources) and use their online tools. For example, each NMFS region has an EFH mapper online, which identifies EFH that the proposed action may affect. Remote sensing data, including satellite imagery, and geographic information systems (GIS) are very useful tools for analyzing extents and adjacency of aquatic habitats and potential impacts.

Table 1. Protected Aquatic Habitats

HABITAT TYPES	STATUTES	IS NRC CONSULTATION REQUIRED?	WHAT IS PROTECTED?	AGENCIES
Critical habitat	Endangered Species Act	Yes	Important habitat for Federally listed species	NMFS or FWS or both
Essential fish habitat (EFH), Habitat area of particular concern (HAPC)	Magnuson–Stevens Fishery Conservation & Management Act	Yes	Important habitat for Federally managed fish and shellfish species and their prey	NMFS
National Monument	Antiquities Act (Presidential proclamation)	No, but the agency with jurisdiction may be a coordinating or cooperating agency for National Environmental Policy Act (NEPA) purposes	Public natural area with historic or scientific interest	NPS, NOS, USFS, FWS, and BLM
National Park, National Water Trail, National Seashore, National Lakeshore, National Preserve, etc.	All National Park System units, except National Monuments (see above) have individual pieces of designating legislation	No, but the agency with jurisdiction may be a coordinating or cooperating agency for NEPA purposes	Varies by type and legislation	NPS
National Wild and Scenic River	Wild and Scenic Rivers Act	No	Natural, cultural, and recreational values of rivers	Varies
National Marine Sanctuary	National Marine Sanctuaries Act	No, but the agency with jurisdiction may be a coordinating or cooperating agency for NEPA purposes	Marine areas with special national significance	NOS
National Wildlife Refuge	National Wildlife Refuge System Administration Act and individual legislation	No	Fish, wildlife, and plant resources	FWS
National Estuarine Research Reserve	Coastal Zone Management Act	No	Vital coastal and estuarine resources	NOAA/State partnership

HABITAT TYPES	STATUTES	IS NRC CONSULTATION REQUIRED?	WHAT IS PROTECTED?	AGENCIES
Tribal refuge	Tribal (varies)	No	Varies according to Tribe; some joint refuges with FWS	Tribe (and FWS for some)
State scenic river, park, reserve, refuge, conservation area	Varies	Perhaps, as per Fish and Wildlife Coordination Act	Varies by site and state	Appropriate State agency
Coastal zone habitats vary by state and location	Coastal Zone Management Act	No*	Varies according to State's enforceable policies	NOAA and State agency
Special aquatic sites, aquatic resource of national importance	Clean Water Act	No, but the agency with jurisdiction may be a coordinating or cooperating agency for NEPA purposes*	Sanctuaries and refuges, wetlands, mudflats, vegetative shallows, coral reefs, riffle and pool complexes	EPA and/or ACE
Intake area, discharge area, outfall, etc.	Clean Water Act	No, but the agency with jurisdiction may be a coordinating or cooperating agency for NEPA purposes*	Dependent on site-specific parameters such as intake velocity, pollutant discharge concentrations, etc.	EPA, ACE, or delegated State agency (or both); FERC
Local special habitats	Varies	No	varies	County or municipal authority (or both)

* Applicant must obtain permit, approval, etc. from the appropriate agency before the NRC can issue authorization, permit, or license.

AGENCY-RELATED ACRONYMS:

DOI: Department of the Interior
BLM: Bureau of Land Management (within DOI)
NOAA: National Oceanic and Atmospheric Administration
NMFS: National Marine Fisheries Service (within NOAA)
NOS: National Ocean Service (within NOAA)
ACE: U.S. Army Corps of Engineers
NPS: National Park Service (within DOI)
EPA: U.S. Environmental Protection Agency
USFS: U.S. Forest Service (within Department of Agriculture)
FWS: U.S. Fish and Wildlife Service (within DOI)
FERC: Federal Energy Regulatory Commission

Aquatic Habitat Mapping

Analysts can best map and understand habitats using GIS based on recent sampling results, site reconnaissance, field surveys, literature, data from appropriate agencies, and remote sensing data. Community composition, water quality, substrate, bathymetry, salinity, flow rate, presence of SAV, and other descriptors mentioned above could be shown on a comprehensive map. Map detail should generally focus on areas of potential aquatic impact, particularly including the extents of direct and indirect effects (e.g., the extent of the thermal discharge plume under various operating and receiving water body conditions, and increased runoff resulting from new impervious surfaces). The analyst will need to adjust the level of detail to meet the anticipated complexity of impact assessment and to address the concerns of various interested agencies and organizations. Table 2 provides an example of how aquatic habitats might be mapped for a new reactor-licensing project under 10 CFR Part 52.

Habitat maps should be scaled and created from georeferenced GIS geodatabases or data layers. Maps should include a title, date, revision number, north arrow, scale, and legend identifying each habitat type and other mapped features. Maps should show features such as existing topography, roads, water features, and buildings, as necessary, to provide general spatial orientation.

Aquatic Habitat Description

Aquatic habitat type should be identified. Types of aquatic habitat include, but are not limited to, freshwater lake or reservoir, freshwater river or stream, tidal river or stream, estuary (usually including bays and sounds), and open ocean or marine environment. Freshwater or saltwater wetlands typically are described with the terrestrial environment as outlined in RG 4.11. However, information on the presence of adjacent wetlands can also be useful to an evaluation of aquatic habitat quality. As noted previously, most aquatic habitats are best described by several characteristics that include, but are not limited to, salinity, tidal range, substrate, presence of SAV, flow rate, temperature, dissolved oxygen, energy regime, bathymetry, rugosity, stream order, geomorphology, floodplain size, quality of riparian zone, and biotic community types. Such characteristics should be described in detail and include spatiotemporal extents, patterns, gradients, and shifts.

Descriptive detail generally should be greater in areas of likely aquatic impact than for the surrounding areas. Other descriptive information may be useful when describing aquatic habitats, including the following:

- Presence of invasive species. Executive Order 13112, "Invasive Species," dated February 3, 1999 (Ref. 14), defines invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." The National Invasive Species Information Center maintains a list of known invasive aquatic plant and animal species, such as water hyacinth (*Eichhornia* spp.) and Asian clam (*Corbicula fluminea*). In compliance with the National Environmental Policy Act (NEPA) and in the spirit of the Nonindigenous Aquatic Nuisance and Prevention Control Act of 1990, as amended (Ref. 15), the analyst should describe the effects of building and operation on populations of invasive species. (Note: Keep in mind that any biocides used to control or prevent invasive species may harm indigenous species and their habitats. Such effects should be described.)

Table 2. Example Approach to Habitat Mapping for a New Reactor Project

AREA OF COVERAGE	EXAMPLE LEVEL OF DETAIL FOR AQUATIC HABITAT MAPPING
Areas subject to in-water activities, such as proposed intake structures, discharge outfalls, barge slips, dredging activities, pipelines, transmission towers	Map spatial extent of in-water building impacts in proximity to important habitat. Include impacts such as pressure effects, noise, turbidity, runoff, drawdowns and dewatering associated with temporary cofferdam installations, etc. Show temporal progression of impacts through map series, if appropriate.
Areas subject to habitat modification, conversion, or fragmentation as a result of building activities	Spatially explicit depiction of areal extent of proposed habitat disturbance, modification, conversion, fragmentation, or removal. Include type of substrate removed (cobble, sand, silt, clay, etc.) and delineation of depth of disturbance, including quantified estimate of removal or disturbance of infauna and epifauna at levels of individual, population, and species, as appropriate. Also include map depicting proposed structures in place. Identify all important aquatic habitats on such maps.
Areas subject to crossing by a transmission line, railroad spur, bridge, causeway, or pipeline right-of-way or access road to such right-of-way	Spatially identify locations of aquatic habitats subject to overhead, tunnel, or other crossings of transmission lines, railroad spurs, bridges, causeways, pipelines, access roads, or other features related to the proposed power plant. Include siting of transmission towers if they are adjacent to or within aquatic or wetland habitats.
Areas subject to indirect building impacts such as runoff, noise, or atmospheric deposition	Map potential impacts to aquatic habitats located downstream or downgradient from short- and long-term building activities. For example, building in uplands could increase sediment and nutrient loads to aquatic habitats through runoff and other such nonpoint sources.
Areas subject to direct and indirect operational impacts, such as entrapment; impingement; entrainment; thermal, chemical, and physical effects from discharge; and other pollution (e.g., in-water noise)	Map the areal extent of anticipated impacts during varying operational and seasonal conditions. For example, map the three-dimensional hydraulic zone of influence from cooling water intake operation, and map the three-dimensional spatial extent of the discharge plume to determine type of species and proportion of population as well as habitat that would be adversely affected.
Areas not subject to direct impact but for which information is needed to understand the spatial context and connectivity of affected areas	Map existing conditions in the vicinity of the proposed and alternative sites. Contextual maps facilitate impact analysis and regional quantification. Additionally, identification of important local and regional habitats is critical for proper cumulative impact analysis and potential mitigation activities.

- Disease vectors, pests, or nuisance species. Describe which species occur in the vicinity of the proposed and alternate sites, transmission lines, and pipelines. Also, if any such species do not yet occur in the vicinity but are anticipated to spread to the area within 40 years, describe the scenario. Examples include etiologic agents, including thermophylic bacteria (e.g., *Vibrio* spp.), thermophylic amoebas (e.g., *Naegleria fowleri*), and harmful algal blooms (e.g., *Karenia brevis*); biofouling organisms, such as invasive nuisance species such as the Asian clam and zebra mussel (*Dreissena polymorpha*); potential intake-clogging biota, such as water primrose (*Ludwigia* spp.), water hyacinth, and hydrilla (*Hydrilla* spp.) as well as jellies (e.g., pink comb jelly (*Beroe ovata*)), anchovies (e.g., bay anchovy (*Anchoa mitchelli*)), cownose rays (*Rhinoptera bonasus*),

and other animals; habitat degraders or modifiers, including nutria (*Myocastor coypus*) and North American beaver (*Castor canadensis*); and invasive species, including lionfish (*Pterois volitans* and *P. miles*), that alter trophic cascades.

- Connectivity and biogeography information. A habitat description should indicate whether the habitat serves, served historically, or may serve in the future as a migration corridor for highly migratory, diadromous, potadromous, or oceanodromous species. Additionally, connectivity also is represented on smaller or various spatial scales, including post-settlement adult movement patterns, larval dispersal, or motile host species carrying larvae of invertebrates that have sessile adult stages. Examples include adult reef fish that move within a system of patch reefs, corals that spawn pelagic larvae near oceanic currents, and host fish species that transport mussel larvae within a river system.

- Existing natural and anthropogenic effects. Past or ongoing natural and anthropogenic processes have altered many aquatic habitats and populations. An analyst should determine the environmental integrity (i.e., habitat and function) of a site in an ecoregion context. Examples of natural processes include formation of oxbow lakes, flash floods, tide-driven salinity changes, and some harmful algal blooms. Examples of anthropogenic effects include increased eutrophication, overfishing, pollution, dredging, and tidal restrictions.

- Recent or ongoing ecological or biological studies or management on and in the vicinity of proposed and alternative sites. The description for aquatic habitat should note whether the habitat is the site of ecological investigations or management actions (and what agency or organization is conducting such activities), including discussion of other water uses and conflicts per cross reference to hydrology reviews. If these exist, impacts to the habitat could simultaneously affect the studies or programs. Additionally, data and results of such studies or programs may provide valuable information for the nuclear power project's aquatic review. For example, NMFS, FWS, and State agencies prepare habitat conservation plans for select habitats. Such plans and agency representatives should be primary resources for habitat descriptions and impact analyses, as applicable. Also, applicants should provide and consider FERC license conditions (i.e., seasonal flow requirements) if a hydropower facility is in the vicinity of the proposed or alternative sites.

Flora and Fauna Surveys

Tabular lists of observed aquatic species greatly enhance habitat descriptions. Analysts should identify the majority of aquatic species in the area of potential impacts. Generally, analysts should focus on the higher trophic levels because they are integrators of the lower trophic levels. Field surveys are best conducted when flora and fauna are most readily detected and identified. For example, diadromous fish species may occur in a river during certain times of year when they are migrating to or from the ocean. Various life stages of many aquatic species are present only seasonally. Sampling should be conducted in representative years during all seasons and at a frequency necessary to determine the distribution and abundance of important species. Because sampling frequency should be twice the frequency of the targeted event, sampling should be conducted at least twice per season for any aquatic system (Carney, R.S., Ref. 16). Additionally, analysts should follow appropriate sampling protocols as directed by other Federal, State, and local agencies. Data describing biophysical parameters, such as water temperature, dissolved oxygen, pH, and salinity, should be collected concurrently with biotic sampling. The sampling method should be designed comprehensively enough to describe benthic assemblages, including epifauna and infauna, biota in different stream habitats (i.e., riffle v. pool areas), and invertebrate and vertebrate communities in the water column and near the surface in intertidal, nearshore, and offshore environments in the vicinity of the proposed site. Sampling location, taxa targets, timing, and duration should be

designed according to site-specific characteristics and per Federal, State, or local sampling methods and protocols as available.

Analysts should be generally familiar with the species that could potentially occur in the areas where they will conduct flora and fauna surveys. Thus, analysts should review any existing data and reports describing aquatic biota in the survey area or in nearby areas with similar habitats. Analysts should contact Federal, State, Tribal, local, and private organizations, including academic institutions, to acquire such data. These data may identify aquatic species that could potentially inhabit the subject areas and may help the analyst identify suitable survey methods. Moreover, it would be appropriate to follow previous methodology, if scientifically suitable, for purposes of detecting and analyzing trends. The agencies also may direct the analyst to survey for specific listed species and other species of regional interest and may provide recommended survey timings and protocols specific to such species. For certain species, the agencies may request that uniquely qualified specialists conduct the surveys. Examples of potentially useful sources of information include the following:

- recovery plans that FWS, NMFS, or State wildlife agencies prepared for listed species
- habitat conservation plans that have been approved by FWS or NMFS
- fishery landings data
- government ecological reports
- academic theses and dissertations
- surveys conducted at nearby facilities, such as parks, research reserves, and institutional properties containing habitat types similar to those in the area to be surveyed
- surveys conducted and databases maintained by non-governmental conservation and other organizations
- field guides with range maps indicating species that could potentially occur in a geographic area

Existing inventory data collected from the survey area may serve as a baseline for new field surveys in areas where the habitat has not changed substantially. When supplementing existing data, the analyst should consider the spatial extent, purpose, and techniques of the original data collection. Consideration of these factors may identify certain locations and groups of plants and animals omitted during the original data collection effort that should be surveyed. Existing site-specific data that no longer reflect current conditions (e.g., a habitat has substantially changed or species distribution has shifted) and areas without existing data will require reconnaissance surveys for planning purposes, followed by detailed field surveys. Fauna surveys should employ standard techniques suitable for the detection and identification of the category of wildlife (i.e., mammals, reptiles, fish, and invertebrates) and any life stages of interest. Analysts should choose survey methods appropriately based on targeted species and life stage to be assessed. They should list each observed species in a table. For each species, the table should provide, at a minimum, the scientific name, common name, habitat location(s), and observation date. The table also should include a description of abundance when possible. The text should explain the data collection methods used. A map should depict habitat coverages and sampling sites.

Other field observations useful in evaluating the suitability of aquatic habitats for aquatic biota include the following:

- presence of preferred prey or other food source
- presence of SAV and refugia
- extent and type of substrate
- current flow rate
- stream channel morphology
- pH
- water temperature
- depth
- turbidity
- rugosity
- dissolved oxygen
- salinity or conductivity
- nutrient concentrations (e.g., nitrogen and phosphorus)

Summary of Common Useful Aquatic Environmental Baseline Data

Table 3 summarizes some of the types of aquatic baseline environmental data commonly helpful in supporting NRC licensing actions. The table provides separate information for new reactor licensing (including early site permits, limited work authorizations, construction permits, operating licenses, and combined licenses), relicensing of existing reactors (also termed license renewal), power uprates, and decommissioning. The text discusses the data in more detail.

Table 3. Types of Aquatic Environmental Baseline Data and Utility for Reactor Licensing/Permitting, Relicensing, Power Uprates, and Decommissioning

<table>
<tr><th rowspan="2">DATA TYPE</th><th colspan="4">DATA UTILITY</th></tr>
<tr><th>LICENSING/ PERMITTING</th><th>OPERATING LICENSE RENEWAL</th><th>POWER UPRATE</th><th>DECOMMISSIONING</th></tr>
<tr><td>Land cover and land use data (various scales and sources)</td><td>• Site selection
• Habitat impacts at the proposed site</td><td>Habitat impacts from operation and refurbishment</td><td>Habitat impacts from equipment upgrades or operation at higher power output level</td><td>Impacts to habitats in and outside operational areas caused by large component removal, material storage, and site remediation (e.g., disposal of contaminated soils, shipping, refurbishment of rail lines, barge unloading facilities, demolition of buildings)</td></tr>
<tr><td>Reconnaissance-level data on species and habitats</td><td>• Site selection
• Impacts to species and habitats at the proposed site</td><td>Impacts to species and habitats from refurbishment and operation</td><td>Impacts to species and habitats from equipment upgrades or operation at higher power output level</td><td>Impacts to species and habitats in and outside operational areas caused by large component removal, material storage, and site remediation (e.g., disposal of contaminated soils, shipping, refurbishment of rail lines, barge unloading facilities, demolition of buildings)</td></tr>
<tr><td>Previously collected data describing aquatic habitat and species at the proposed site (i.e., studies supporting existing power units or other industrial facilities. Also research or baseline studies for other purposes, including previous or withdrawn COL or other NRC applications). Such data may be obsolete for purposes such as project impact analysis but may be useful for cumulative impact analysis</td><td>• Possible partial substitute for field surveys at the proposed site if the accuracy or reusability of old data is verified in the field
• Survey method design to augment old data at the proposed site
• New and old data used to analyze impacts over time to habitats and species</td><td>Impacts to species and habitats from refurbishment and operation</td><td>Impacts to species and habitats from equipment upgrades or operation at higher power output level</td><td>Impacts to species and habitats in and outside operational areas caused by large component removal, material storage, and site remediation (e.g., disposal of contaminated soils, shipping, refurbishment of rail lines, barge unloading facilities, demolition of buildings)</td></tr>
<tr><td>Current species and habitat data collected onsite</td><td>Impacts to species and habitats</td><td>Impacts to species and habitats</td><td>Impacts to species and habitats</td><td>Impacts to species and habitats</td></tr>
</table>

DATA TYPE	DATA UTILITY			
	LICENSING/ PERMITTING	OPERATING LICENSE RENEWAL	POWER UPRATE	DECOMMISSIONING
Site-specific Federally and State-listed species and critical habitat occurrence data from current field investigations	Impacts to Federally and State-listed species and critical habitat	Impacts to Federally and State-listed species and critical habitat	Impacts to Federally and State-listed species and critical habitat	Impacts to Federally and State-listed species and critical habitat
Site-specific Federally and State-managed species and EFH data from current field investigations	Impacts to Federally and State-managed species and EFH	Impacts to Federally and State-managed species and EFH	Impacts to Federally and State-managed species and EFH	Impacts to Federally and State-managed species and EFH
Distribution of various life stages of species in project area; projected intake flow rates	Impacts to aquatic biota caused by impingement, entrainment, and entrapment	Impacts to aquatic biota caused by impingement, entrainment, and entrapment	Impacts to aquatic biota caused by impingement, entrainment, and entrapment	Impacts to aquatic biota caused by discontinued water withdrawal
Distribution of various life stages of species in project area; projected discharge flow rate, extent of thermal plume, and discharged pollutants	Impacts to species and habitats caused by water discharge	Impacts to species and habitats caused by water discharge	Impacts to species and habitats caused by water discharge	Impacts to aquatic biota caused by discontinued water discharge

Identification of Important Species and Habitats

Aquatic environmental impact analyses for the NRC generally emphasize species and habitats meeting one or more importance criteria established by the agency (Refs. 6 and 17). Since the 1970s, the NRC has used such criteria commonly to address ecological impacts in NRC environmental documentation. Baseline data and natural resource agency consultations should form the basis for identifying specific important species and habitats. The following are criteria the NRC uses at this time to identify important species and habitats:

- *Federally listed threatened or endangered species and designated critical habitat under the Endangered Species Act of 1973, as amended (ESA)* (Ref. 18). The NRC encourages informal consultation with the agencies responsible for administration of the ESA, and the NRC will conduct ESA Section 7 consultations, as appropriate. For most Federally listed aquatic species, either NMFS or FWS maintains ESA responsibilities; however, for some species, such as sea turtles, NMFS and FWS share ESA responsibilities.

- *Species that are proposed or are candidates for Federal listing as threatened or endangered and a habitat that is proposed for designation as critical habitat.* For listed threatened or endangered species, informal consultation with NMFS or FWS is the best source of information.

- *State-listed threatened or endangered species and species otherwise considered rare or protected in the State (in contrast to widespread, abundant, and stable species)*. Informal consultation with State agencies is appropriate. State natural heritage programs may provide a listing of Federally listed species and State-listed and rare species that occur within specified areas. The NRC encourages the use of databases, but direct communication with State regulators is still preferred. Impacts from facilities near State borders can extend to neighboring States; therefore, the NRC encourages consultation with all States whose resources may be affected. The NRC will consult with State agencies as appropriate as required by the Fish and Wildlife Coordination Act, as amended (Ref. 19). For sites near the Canadian or Mexican borders, consultation with appropriate foreign agencies may be appropriate.

- *EFH and HAPC*. Federally managed fishery species, including crustaceans and corals, have designated EFH and sometimes HAPC, which are under the jurisdiction of NMFS. EFH includes prey species of the managed species being evaluated. The NRC suggests early informal consultation with NMFS. The NRC will conduct EFH consultations as appropriate per Magnuson–Stevens Fishery Conservation and Management Act, as amended (Ref. 20).

- *Recreationally and commercially valuable species*. Fish species targeted by recreational and commercial fisheries also are important resources to assess. Informal conversation with State game officials could identify species used for consumptive and nonconsumptive recreational and commercial uses.

- *Subsistence species*. Target species of Tribal and nontribal subsistence fishing should be evaluated. The NRC recommends informal consultation with Tribes and State agencies.

- *Species essential to the maintenance and survival of other important species*. Information may be available in scientific literature and from relevant Federal and State agencies. Consideration of habitat requirements and food web relationships is necessary.

- *Species that can serve as biological indicators to monitor the effects of the proposed action on the aquatic environment*. Some species are exceptionally sensitive to impacts and can serve as indicators of otherwise inconspicuous adverse conditions. For example, presence and population trends of diatoms are good indicators of water quality and environmental conditions suitable for other aquatic species.

- *National estuarine research reserves, national parks, state parks, or other marine, estuarine, riverine, or lacustrine protected areas designated as such by State or Federal agencies*. Although not formally designated by Federal or State agencies, lands owned by private conservation organizations, such as The Nature Conservancy, or even privately held preserves also might be important under this criterion.

- *Other habitats the State or Federal agencies have identified as unique or rare or prioritized for protection*. This should include Safe Harbor Agreements and Candidate Conservation Agreements with Assurances between the FWS or NMFS and non-Federal property owners. The NRC recommends informally meeting with agencies such as NMFS, FWS, and State conservation or game agencies. Some States have unique conservation or management agencies, such as the water management districts in Florida, the Critical Areas Commission for the Chesapeake and Atlantic Coastal Bays in Maryland, and the Texas Water Development Board, which works with the various river authorities in Texas. Also, some regions have organizations

that may involve more than one state; examples include the Delaware River Basin Commission and the Susquehanna River Basin Commission. The NRC also recommends informally speaking with interested local agencies, such as county or municipal planning organizations and town conservation commissions.

- *Invasive species*. Invasive species are alien species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health. Invasive aquatic species include, but are not limited to, plant species, such as water hyacinth, and animal species, such as lionfish and zebra mussel. Analysts should use, among other resources, the National Invasive Species Information Center (at www.invasivespeciesinfo.gov) for this analysis.

The baseline studies described in the text sections above should form a generally adequate basis for identifying important species and habitats. However, it may be necessary for analysts to conduct specialized field surveys to establish the presence or absence of certain important species. FWS has established specific field protocols for investigating sites for the presence of some threatened or endangered species and specific qualifications for field surveyors. Analysts can obtain information on suitable methods for surveying other important species from NMFS, FWS, State agencies, or from the scientific literature. Surveys should enumerate or estimate, where feasible, the numbers of individuals observed for Federally listed species, species proposed or that are candidates for Federal listing, State-listed species, and species considered rare by the State.

Aquatic Environmental Impact Analyses

Professional judgment is necessary to determine the types of aquatic environmental impact analyses appropriate to an NRC decision or action. Analysts should consult recent scientific literature and natural resource regulatory agencies for direction in planning impact analyses. This guide cannot anticipate all categories of aquatic environmental impact analyses potentially appropriate to NRC decisions or actions. However, analysts should apply the following general recommendations:

- use best available baseline data, whether collected specifically for the subject activity or available from published sources, agency files, communication with regional experts, or other credible sources

- support findings clearly with data and logic

- use information that is as quantitative as practicable

- implement methodologies or models that are widely accepted by the scientific community, natural resource agencies, and regulatory agencies

- avoid experimental or unproven methodologies, assumptions, or models

- avoid unsupported speculation or opinion.

Habitat Modification Analyses

Intake and discharge structure installation, pipeline installation, dredging, barge slip installation, impervious surface creation, and other site-preparation and building activities result in the modification, conversion, fragmentation, or loss of aquatic habitats. Operational activities, such as water withdrawal, thermal discharge, and discharge of chemical constituents, also can alter aquatic habitats through

processes such as scouring and degradation of water quality. For aquatic habitats, modifications include, but are not limited to, altered current or upwelling patterns, changes in salinity gradients, scouring, temperature changes, eutrophication, discharge of contaminants (e.g., biocides), and altered sediment transport patterns. Analysts should quantify habitat modifications, conversions, fragmentation, and losses by mapping and analyzing the following:

- the spatial extent of the existing aquatic habitats
- site-preparation and building plans for in-water activities
- temporal variation in the occupation of various habitats
- model outputs for water withdrawal and discharge effects (e.g., thermal plume extent, scouring, current alterations).

Distinguishing between permanent and temporary habitat losses and distinguishing among habitat losses attributable to each major project element are both important. Impact analysis usually needs to extend beyond quantifying the areal extent of habitat losses. It should evaluate the effects of habitat losses on the distribution, movement, behavior, feeding, and reproduction of species. Biological monitoring of natural and anthropogenic effects on habitats, as well as species, is an excellent tool that NRC recommends employing to assess accurately dynamic ecology in the vicinity of the project. Analysts should consider the timing of activities and impacts as well as natural diurnal, seasonal, and long-term shifts in aquatic habitat, aquatic assemblages, important life history events, and species distributions synergistically with anthropogenic effects of the planned activities related to site preparation, building, and operation.

Noise and Pressure Effects Analyses

Impact analyses should consider the possible effects of proposed short-term and long-term noise and pressure on aquatic species in the vicinity of the proposed activities. Noise and pressure transience generated by the operation of dredging and pile-driving equipment, for example, can adversely affect the distribution, behavior (including migration, feeding, reproduction, and communication), and even physiology and integrity of certain tissues of aquatic animals in the area. Analyses can compare projected noise levels in aquatic habitats near project sites with species noise tolerance levels reported in the scientific literature. Responses reported in the literature vary widely among species and are a function of sound level (measured in decibels), sound duration, and pattern and frequency of occurrence. If quantitative noise data are not available in the scientific literature, analysts may substitute qualitative evaluations to account for the effects of existing background noise. Similarly, changes in pressure and resulting effects on aquatic species should be analyzed quantitatively and/or qualitatively as appropriate.

Displacement Analyses

Impact analyses should consider how habitat loss and other activities displace aquatic biota from affected habitats to nearby habitats. The receiving habitats may lack the resources or environmental conditions necessary to accommodate the displaced biota, or the displaced individuals may compete for limited resources with individuals in the existing community, resulting in net losses to affected populations. Habitats can optimally support only a certain population level, called the carrying capacity. Once a habitat that receives displaced individuals exceeds its carrying capacity, displaced individuals compete for resources until the population returns to the carrying capacity. When a habitat exceeds carrying capacity, the resulting resource depletion can affect other species, thus disturbing delicate

equilibriums that underlie food chains, ecological communities, and ecosystems. In many areas of the United States, displacing species can lead to indirect impacts in nearby habitats, such as heavy feeding on vegetation or changes in targeted prey species.

A qualitative discussion of possible biotic displacement may be adequate. Analysts should confer with Federal, State, and local resource agencies. Analyses can include a discussion of possible mitigation measures, such as regional habitat improvement projects to accommodate displaced individuals.

Entrapment, Impingement, and Entrainment Analyses

Cooling water withdrawal adversely affects not only habitats, as mentioned above, but also aquatic species at the individual and population levels through entrapment, impingement, and entrainment. Several factors, including type of cooling system, the design and location of the intake structure, and the amount of water withdrawn from the source waterbody, greatly influence the degree to which organisms become entrapped, impinged, or entrained. Potentially affected species include marine mammals, fish, shellfish, other aquatic invertebrates, and aquatic vegetation. Entrapment occurs when an aquatic organism swims or drifts into an area within the intake structure, often termed a forebay, from which the organism cannot escape to return to the natural aquatic ecosystem. For example, sea turtles often swim under booms or underwater curtain walls into forebays and cannot figure out how to return to the natural water body. Also, intake systems that have forebays fed only through a one-way pipeline from the natural water body often entrap many fish and invertebrates that will never escape unless they enter a fish-return system following impingement (some individuals may not ever be impinged and, therefore, remain entrapped indefinitely). Impingement occurs when the water withdrawal occurs at such a velocity that forces an individual against trash racks, trash bars, intake screens, or some other physical component of the intake structure such that the individual cannot swim, walk, crawl, or otherwise move away from the structure. Impingement can harm or kill an organism through physical abrasion, starvation, exhaustion, asphyxiation, descaling, drowning, or other physical harms. Through-screen velocity is an important factor affecting impingement rates and impingement survivability of fish and shellfish species. However, mitigation measures, such as fish-return systems and modified Ristroph screens, may increase impingement survivability by providing a mechanism to deliver impinged organisms back to the natural water body. Finally, entrainment occurs when organisms pass through all components of the intake structure and enter the actual power plant with the cooling water. Entrained organisms typically are quite small since they pass through even mesh intake screens; usual entrained organisms include eggs, larvae, and spores, the absence of which may affect trophic cascades. Entrainment exposes organisms to many stressors, and the NRC generally assumes complete mortality for entrained organisms.

Susceptibility to these three major types of water withdrawal effects varies by species, life history stage, and individual, as well as by temporal factors. Entrapment is largely a feature of the intake structure design, including the probability that an organism will enter a return system or that an organism is capable of returning to the source or receiving water body. For example, marine mammals would be entrapped rarely because their high intelligence allows them to swim easily around obstacles to return to their natural environment. However, exceptions exist particularly if a marine mammal swims into an intake pipe leading to an embayment or canal from which there is no escape route. Impingement typically affects fish and positively buoyant vegetation more than other biota, and some species are more susceptible than others to impingement. For example, a flat fish, such as a flounder species, typically has a high impingement survivability rate while a torpedo-shaped fish, such as an anchovy species, has a high impingement mortality rate because the morphological differences in body shape profoundly affect the ability of an impinged fish to swim off a screen against the intake withdrawal current. Other factors affecting impingement survivability include fish length, burst speed, and overall health (e.g., diseased, previous injury) of the individual. Analysts base entrainment estimates on estimated abundance of organisms smaller than the mesh size of the intake screen, and, for purposes of analysis, they assume

entrainment results in complete mortality. Impact analyses should discuss the potential effects on populations of migratory, benthic, demersal, pelagic, and floating species. Analysts should take into account species-specific reproductive strategies and fecundities when estimating population trends for species likely to be affected by entrapment, impingement, or entrainment. Analysts should base such reviews on building and operational plans and designs of the intake system as well as spatiotemporal patterns of species presence, distribution, and life histories. In addition to data collection for the proposed project, analysts should also use existing data from studies from co-located or nearby nuclear, fossil, or other units. Other sources of intake operation data may also be appropriate for analysis.

Discharge Analyses

Cooling water discharge can affect aquatic habitats and species in several ways. The distribution, abundance, and richness of species in or near the discharge area should be described, including identification of important habitat requirements (see above section, Identification of Important Species and Habitats). Physical alteration of habitat occurs through scouring and/or other sediment transportation processes as well as removal or relocation of certain substrate components and of SAV that occur in the receiving water body. Although such alterations may be difficult to estimate quantitatively, qualitative analyses should be included when quantitative predictions are not possible. Analysts should evaluate thermal pollution (e.g., heat shock and cold shock) in the context of species' thermal tolerance ranges and lethal temperature thresholds. Aquatic ecological analysts should work closely with hydrologists to determine the locations and physical properties of the dynamic thermal plume. Analysts should model and map the three-dimensional thermal plume under various discharge scenarios and throughout different seasons and water availability scenarios (e.g., droughts) paying particular attention to thermal tolerances of resident species in the immediate area as well as migratory species for which the thermal plume could be a barrier to upstream or downstream movement. Other potential effects that could occur because of the discharge include discharge of contaminants (sometimes including radionuclides), gas supersaturation, low dissolved oxygen concentrations, and stimulation of thermophilic nuisance organisms. Effects should be quantitatively analyzed when possible (otherwise, qualitative analysis is acceptable) to determine impacts on habitat area, habitat quality, species distribution, prey availability, and population size, trends, and stability.

Cooling Tower Drift Analyses

Operation of cooling towers releases plumes of water vapor and droplets of condensed water to the atmosphere. The plume generally travels farther from taller natural draft cooling towers than it does from lower mechanical draft towers. Water circulating through cooling towers never comes in contact with the reactor core; therefore, radioactive contamination in drift is not a concern. However, drift can carry dissolved salts, biocides, and other constituents. Salts originate from makeup (source) water and become concentrated as water evaporates inside the tower. Brackish makeup water is of greater concern than fresh makeup water. Biocides are used to control microorganisms in the water. Aquatic habitat and species in water bodies near cooling towers can be exposed to drift, including salts and biocides. Drift deposition rarely results in a significant effect on aquatic habitats and biota, but analysts should consider conducting an analysis, especially in systems using saltwater for condenser cooling.

Transmission Line Water Crossings

Building, operation, and maintenance of transmission lines and towers can affect aquatic habitat and species where transmission lines cross water bodies. Vehicles, equipment, and vegetation maintenance procedures could introduce chemical contaminants into the water body either directly or

indirectly through runoff; installation, maintenance, and other activities also could increase sedimentation because of increased erosion or stormwater runoff. Analysts should evaluate conditions and potential effects from such activities where transmission lines or towers are near or cross water bodies. The analysis can be qualitative if quantitative assessments are not practicable. Often best management practices are relied upon instead of monitoring programs if no species or habitats warrant intensive monitoring. However, at the request of NMFS or FWS, NRC does require targeted surveys for Federally threatened or endangered species.

Aquatic Environmental Monitoring

Federal, State, and local environmental permits; Biological Opinions issued under the ESA; and other Federal and State regulations that protect rare species provide most aquatic environmental monitoring requirements. NMFS or FWS (collectively referred to as "the Services") issues Biological Opinions that will contain Terms and Conditions that may call for the monitoring of areas containing threatened or endangered species or the evaluation of the success of mitigation actions to relocate or protect those species. The Services or other agencies issuing permits may outline specific monitoring and reporting protocols. If not, the NRC recommends contacting the Services or other responsible permitting agencies for individualized direction regarding:

- seasonal timing of monitoring visits
- field data collection procedures
- sampling approaches (e.g., use of sample quadrats or transects)
- field equipment specifications
- qualifications of field personnel
- reporting requirements

Decommissioning

NUREG–0586, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," Supplement 1, "Regarding the Decommissioning of Nuclear Power Reactors," issued November 2002 (Ref. 21), summarizes the potential impacts of decommissioning nuclear reactors on aquatic environmental resources. Additionally, analysts should consider and evaluate the impacts to EFH during decommissioning. Most potential aquatic impacts would result from discontinued thermal discharge or alteration of shoreline or in-water structures during decommissioning. Other activities that could affect aquatic resources include, but are not limited to, stormwater runoff during removal of contaminated soil, dredging of contaminated or uncontaminated sediment, and modification of barge docks or other support facilities. Decommissioning is not generally expected to result in significant adverse ecological effects when ground or in-water disturbance is limited to the former operational area, but reworking the ground surface could have adverse impacts because of changed surface drainage patterns that may affect aquatic communities. Characterization of ecological conditions before site redevelopment would be helpful when determining how to manage and evaluate ecological resources on decommissioned sites. Many of the same aquatic environmental baseline and impact analyses described above could help support the review of decommissioning impacts affecting aquatic biota and habitat. Analysts should quantify habitat modifications and losses and analyze impacts to important species and assemblages in the vicinity of the site.

C. STAFF REGULATORY GUIDANCE

1. Because precise predictions and assessments of impacts on aquatic ecological systems are not always possible, the NRC recommends reasonable professional interpretations when quantitative prediction is not practicable.

2. Analysts should exercise professional judgment to identify appropriate analytical methods to support NRC licensing actions. Analysts should contact Federal, State, and local regulatory agencies and search recent scientific literature for specific analytical protocols.

3. Baseline investigations should be broad enough, long enough, and completed early enough to support anticipated impact analyses and monitoring that Federal and State agencies might require. These investigations may be prepared as separate reports or presented as part of larger documents such as environment reports. Analysts can combine closely related baseline studies and analyses into single reports.

4. Analysts should label aquatic habitats on maps using standardized or commonly used regional nomenclature when possible. They should describe substrate type, salinity range, tidal range, and dominant benthic and pelagic communities, as applicable.

5. Aquatic environmental impact analyses should focus primarily on species and habitats meeting NRC importance criteria in addition to water availability, current patterns, river flow, tidal flow, and effects of intake and discharge building and operation. Specialists may need to conduct site visits at specific times of the year to determine whether important species are present and, if so, are subject to impact.

6. Analysts should quantify habitat modifications and losses by overlaying the estimated limits of disturbance over a habitat map. Losses of EFH include removal of water from the water column and effects on prey of species that have designated EFH. Analysts should address alterations to critical habitat through the NEPA and ESA processes.

7. The three-dimensional extent of the discharge thermal plume should be mapped on the receiving water body. A narrative explanation should accompany the map and should discuss amounts of scouring and chemical contaminants and other constituents, in addition to heat, anticipated during various discharge scenarios.

8. Analysts should plot estimated salt drift isopleths from cooling towers on a base map showing aquatic habitats as applicable.

9. Other aquatic environmental impact analyses that may be needed to support NRC licensing decisions include the following:

   - entrapment, impingement, and entrainment
   - noise- and pressure-related impacts on aquatic biota
   - surface water availability and hydrology
   - interruptions in species movement and migration patterns
   - introduction and expansion of coverage by thermophilic organisms and invasive species
   - the potential for displaced species to exceed the carrying capacity in nearby habitats

11. Aquatic environmental monitoring required by environmental permits or regulations should be carefully planned with responsible regulatory agencies.

12. Aquatic environmental baseline studies and impact analyses may be necessary for decommissioning activities that disturb habitats outside of the former operational area.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with the Backfit Rule (10 CFR 50.109, "Backfitting") and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily[2] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. The NRC may deem methods or solutions that differ from those described in this RG to be acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this RG for actions that do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments." Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff may discuss with licensees, various actions consistent with NRC staff positions in this regulatory guide, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions ordinarily would not be considered backfitting even if prior versions of this RG are part of the licensing basis of the facility. However, unless this RG is part of the licensing basis for a facility, the NRC staff may not represent to the licensee that the licensee's failure to comply with the positions in this RG constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised RG, and (2) the specific subject matter of this RG is an essential consideration in the NRC staff's determination of the acceptability of the licensee's request, then the NRC staff may request that the licensee either follow the guidance in this RG or provide an equivalent alternative process. Any alternative must demonstrate compliance with the underlying NRC regulatory requirements. The NRC does not consider the provisions in the RG backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

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1 In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

2 In this section, "voluntary" and "voluntarily" mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this RG. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this RG, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to adopt voluntarily this RG to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action that would require the use of this RG. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the RG, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this RG, generic communication, or promulgation of a rule requiring the use of this RG without further backfit consideration.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

Conclusion

The NRC is not imposing this regulatory guide upon current licensees. Existing licensees may use the guide voluntarily. In addition, the NRC is issuing this RG in conformance with all applicable internal NRC policies and procedures governing backfitting. Accordingly, the NRC staff issuance of this RG is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

If an applicant or licensee believes that the NRC is either using this RG or requesting or requiring the applicant or licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in the Implementation section, the applicant or licensee may file a backfit appeal with the NRC. Applicants and licensees should file such appeals in accordance with the guidance in NUREG-1409, “Backfitting Guidelines,” and NRC Management Directive 8.4, “Management of Facility-Specific Backfitting and Information Collection.”

REFERENCES[1]

1. National Environmental Policy Act of 1969, 42 USC § 4321, *et seq.*

2. U.S. Nuclear Regulatory Commission (NRC), "Terrestrial Environmental Studies for Nuclear Power Stations," Regulatory Guide 4.11, Revision 2, Agencywide Documents Access and Delivery System (ADAMS) Accession No. ML113350385.

3. *U.S. Code of Federal Regulations*, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52, Title 10, "NRC Regulations."

4. *U.S. Code of Federal Regulations*, "Domestic Licensing of Production and Utilization Facilities," Part 50, Title 10, "NRC Regulations."

5. *U.S. Code of Federal Regulations*, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," Part 54, Title 10, "NRC Regulations."

6. U.S. Nuclear Regulatory Commission, "Preparation of Environmental Reports for Nuclear Power Stations," Regulatory Guide 4.2, Revision 2, ADAMS Accession No. ML003739519.

7. U.S. Nuclear Regulatory Commission, "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Guide 4.7, Revision 2, ADAMS Accession No. ML003739894.

8. *U.S. Code of Federal Regulations*, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Part 51, Title 10, "NRC Regulations."

9. Electric Power Research Institute, "Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application," EPRI Report No. 1006878, EPRI, Palo Alto, CA, 2002.[2]

10. Clean Water Act of 1977, 33 U.S.C. § 1251, *et seq*.

11. *U.S. Code of Federal Regulations*, "Criteria and Standards for the National Pollutant Discharge Elimination System," Part 125, Title 40, "EPA Regulations."

12. Executive Order 13158, "Marine Protected Areas," May 31, 2000.

13. Executive Order 13089, "Coral Reef Protection," June 11, 1998.

14. Executive Order 13112, "Invasive Species," February 3, 1999, as amended by Executive Order 13286, February 28, 2003.

15. Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, 16 U.S.C. § 4701, *et seq.*

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[1] Publicly available NRC published documents are available electronically through the Electronic Reading Room on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents also can be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or 800-397-4209; fax 301-415-3548; and e-mail pdr.resource@nrc.gov.

[2] Copies of the listed Electric Power Research Institute (EPRI) standards and reports may be purchased from EPRI, 3420 Hillview Ave., Palo Alto, CA 94304; telephone 800-313-3774; fax 925-609-1310.

16. Carney, R.S., "Review and Reexamination of OCS Spatial-Temporal Variability as Determined by MMS Studies in the Gulf of Mexico," OCS Study MMS 93-0041, U.S. Department of the Interior, Minerals Management Service, New Orleans, LA, 1993.

17. U.S. Nuclear Regulatory Commission, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan," NUREG-1555, October 1999, ADAMS Accession No. ML003702019.

18. Endangered Species Act of 1973, 7 U.S.C. § 136, *et seq*.

19. Fish and Wildlife Coordination Act, 16 U.S.C. § 661, *et seq*.

20. Magnuson–Stevens Fishery Conservation and Management Act, 16 USC 1801, *et seq*.

20. U.S. Nuclear Regulatory Commission, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, Supplement 1, "Regarding the Decommissioning of Nuclear Power Reactors," November 2002, ADAMS Accession No. ML023500410.