NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION'S RECOMMENDED BEST PRACTICES FOR LIQUEFIED NATURAL GAS TERMINALS

DRAFT (12/13/05)

INTRODUCTION

Natural gas is becoming a significant source of energy throughout the world and within the United States. As domestic supplies of natural gas decline, the United States has sought to capitalize on overseas production of Liquefied Natural Gas (LNG) and has taken steps to import larger volumes of LNG to meet domestic energy needs.

The importation of natural gas and the construction and operation of LNG terminals are governed by the Natural Gas Act and the Deepwater Port Act (DPA).[1] The Federal Energy Regulatory Commission (FERC), the United States Coast Guard (USCG), and the Maritime Administration (MARAD) have the authority to regulate the importation, licensing, construction, and operation of LNG terminals in State waters (onshore and nearshore) and in Federal waters (offshore). FERC's jurisdiction applies in onshore and nearshore environments, whereas the Coast Guard and MARAD's jurisdiction applies in offshore environments. As lead agencies for the licensing of LNG terminals, the FERC, Coast Guard, and MARAD are required to coordinate their activities and consult with other Federal agencies who have either jurisdictional authority over resources, including living marine resources, within the affected area or who have expertise in a particular matter related to the proposed activity.[2]

The National Oceanic and Atmospheric Administration (NOAA) is one of the Federal agencies involved in assisting the lead agencies in their licensing responsibility. The construction and operation of LNG terminals have the potential to adversely affect marine and coastal ecosystems. NOAA possesses expertise that could prevent or minimize adverse effects to such ecosystems. As described more fully below, NOAA reviews LNG project proposals in both nearshore and offshore environments and provides comments and recommendations designed to minimize adverse environmental impacts on marine resources.

In July 2004, NOAA's National Marine Fisheries Service (NMFS) convened an interagency workshop, with active participation from the National Ocean Service (NOS), to address a number of issues relating to LNG. The objective of the workshop was to: (1) obtain a greater understanding of the potential impacts to the marine environment resulting from an increase in the number of proposed LNG terminals; (2) identify i) the available literature on LNG terminals, ii) data needs, and iii) issues of scientific uncertainty; (3) develop a comprehensive and consistent approach for NOAA's review of LNG applications; and (4) promote collaborative work and increased communication among regulatory agencies and project applicants. One product of the workshop was a "Best Practices" document.

The primary purpose of the Best Practices document is to provide guidance to NOAA staff to ensure consistent reviews of applications and environmental impact analyses of proposed LNG terminals, including their planning, design, siting, construction and operation. In addition, the document may be used to assist Federal agencies and project applicants in the early identification of potential environmental issues that may result from a proposed LNG terminal.

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[1] *See* 15 U.S.C. §717 *et seq*. and 33 U.S.C. §1501 (as amended by the Maritime Transportation Security Act of 2002, P.L. No. 107-295).

[2] *See* 33 U.S.C. § 1504(e); 40 C.F.R. § 1503.1.

The NOAA recommendations, as presented in this document, pertain to planning, design, siting, construction, and operational aspects of LNG terminals. They follow a sequential procedure[3] for mitigating[4] potential LNG terminal impacts on marine and coastal resources (e.g., marine mammals, sea turtles, federally managed fish[5] species, Essential Fish Habitat (EFH), Endangered Species Act (ESA) critical habitat) and ecosystems. This approach provides that all appropriate and practicable steps first be taken to avoid impacts. If avoidance of all impacts cannot be achieved, all efforts to minimize impacts should be undertaken.[6] Once impacts are avoided or minimized, the appropriate agencies must then determine whether compensatory mitigation to offset impacts is necessary.[7]

Primary impacts to coastal and marine resources (including direct, indirect and cumulative impacts) are identified throughout this document as those caused by the mortality or injury of marine organisms due to impingement, entrainment, ship strikes, as well as the impacts associated with the alteration or adverse modification of habitat functions and values. Impacts to nearshore and offshore resources also include impacts to marine and coastal fauna and habitats due to vessel operation, construction or removal of structures, noise generation, dredging, disposal, water use, and the discharge of biocides into the water column. Information about developing impact analysis and monitoring, as well as options and considerations for mitigation of unavoidable impacts from LNG project proposals are also included in this document.

AUTHORITIES

NOAA is responsible for reviewing proposals and providing recommendations to the Coast Guard, MARAD, and FERC on LNG terminals regarding effects on commercial and recreational fisheries, EFH, endangered and threatened species and their critical habitats, marine mammals, National Marine Sanctuaries, and other marine and coastal resources held in trust for the public. Under the Memorandum of Understanding (MOU) Related to the Licensing of Deepwater Ports pursuant to the Deepwater Port Act of 1974, (see Appendix I), NOAA is required to expedite the review process of offshore LNG proposals in coordination with the Coast Guard and MARAD.

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[3] The sequential procedure of avoiding, then minimizing, and, finally, offsetting impacts parallels the approach to mitigation adopted by multiple Federal agencies and departments. For example, the sequential approach is identified in the MOA between the Environmental Protection Agency and the Department of the Army concerning the determination of mitigation under the Clean Water Act Section 404 (b)(1); the National Mitigation Action Plan on wetland mitigation of which NOAA, the Army Corps of Engineers, Environmental Protection Agency, and Departments of Interior, Agriculture and Transportation are signatories; and the Fish and Wildlife Service's mitigation policy.

[4] The term "mitigation" in this document is used as defined by the Council on Environmental Quality's National Environmental Policy Act regulations (40 C.F.R. §1508.20).

[5] The term "fish" in this document is used as defined in the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1802(12)).

[6] Under the Deepwater Port Act, 33 U.S.C. §1503(c)(5), the Secretary of Transportation may only issue a license if he determines that the LNG terminal "will be constructed and operated using best available technology, so as to prevent or minimize adverse impact on the marine environment." The term "avoid" as used in the sequential approach for mitigating impacts is interpreted as being synonymous with the term "prevent" as used in the DPA.

[7] Compensatory mitigation to offset impacts may not be used as a substitute for avoiding and minimizing impacts.

NOAA's participation in the LNG process stems from our responsibilities to manage, conserve, and protect marine and coastal living resources as provided for under the following statutes:

- Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- Endangered Species Act (ESA)
- Marine Mammal Protection Act (MMPA)
- Coastal Zone Management Act (CZMA)
- National Marine Sanctuaries Act (NMSA)
- National Environmental Policy Act (NEPA)
- Fish and Wildlife Coordination Act (FWCA)

More detailed information regarding NOAA's authorities is provided in Appendix I.

GENERAL

This document reflects NOAA's current understanding of LNG issues and serves as guidance to staff to ensure consistent implementation of the agency's responsibilities and to assist Federal agencies and project applicants in identifying potential environmental issues that may result from a proposed LNG terminal. On-going discussions with stakeholders and new data could prompt revisions to this document and to NOAA's views regarding the review of proposed LNG projects.

A. This document will assist NOAA in its evaluation, on a case-by-case basis and as mandated by statute and regulations, of submitted LNG proposals that might affect marine and coastal resources under NOAA's jurisdiction. It also provides future applicants and other federal agencies with information about how NOAA may comment during various phases of a project.

B. This document is intended to assist applicants in complying with NOAA requirements and processes related to LNG projects and to help ensure consistent NOAA review among projects. While NOAA will use the Best Practices document to review LNG projects, this document is not binding on NOAA, other federal agencies or applicants. In addition, NOAA recognizes that alternative means or methods of demonstrating compliance with statutory requirements are acceptable.

C. This Best Practices document is not intended to circumvent, modify or replace applicable Federal law, and does not, in and of itself, satisfy or fulfill any legal obligation of an LNG project applicant.

D. This document does not substitute or replace any project specific comments that have been or will be provided on an individual LNG project during the application and NEPA review phases.

E. NOAA notes that the Memorandum of Understanding Related to the Licensing of Deepwater Ports calls for participating agencies to recommend "any additional information necessary . . . to evaluate the application's impacts upon the agency's programs and areas of responsibility." With regard to the Coastal Zone Management Act (CZMA), the Department of Commerce

has a potential adjudicatory role for proposed LNG projects. An adjudication would arise if a coastal state (with a federally approved coastal management program) were to object to a proposed project and the applicant filed an appeal with the Secretary of Commerce. The substantive issues that may be considered in deciding an appeal, and for which information would be required, are: (1) is the project consistent with the objectives of the CZMA; and (2) is the project necessary in the interest of national security. Additional details concerning these grounds can be found at 15 C.F.R. § 930.121, 122. Consequently, NOAA's recommendations about LNG project information needs pursuant to the CZMA are limited, in order to avoid prejudging issues that are initially decided by the state (*see, e.g.,* 15 C.F.R. §§ 930.60, 930.62) or might be considered in an adjudicatory proceeding (*see generally* 15 C.F.R. part 930, subpart H).

BEST PRACTICES

The following sections of this document identify and discuss NOAA's best practices regarding (i) planning and coordination (ii) design, (iii) siting, (iv) construction, (v) operation, (vi) impact analysis, (vii) monitoring, and (viii) mitigation of LNG terminals. These best practices are intended to provide guidance to NOAA staff when evaluating LNG project proposals. While these recommendations may apply to any LNG terminal, additional issues of concern could be identified depending on the specifics of a proposal.

I. Planning and Coordination

During the pre-application and application phases of LNG project proposals, coordination activities should be undertaken with as many resource agencies at the same time as possible. Maximizing the agencies in attendance at any meeting reduces the likelihood of conflicting recommendations and affords all parties the opportunity to facilitate clarification of issues. Discussions at this planning stage should focus on assessing NOAA's potential role in the licensing process.

A. NOAA should assess its potential role in the environmental review of LNG proposals as soon as practicable, after a prospective applicant, applicant, or action agency requests NOAA's involvement in connection with the project under development. If NOAA determines it has a role, it will:

    1. Identify NOAA contacts for the proposed project.

    2. Meet with prospective applicants, applicants, other state and federal agencies, or the action agency when requested by such groups to identify areas of potential concern and to assess the need for and availability of NOAA resources to address issues related to the proposed LNG project.

    3. Identify environmental issues and concerns related to the proposed LNG project that need to be addressed in order for the lead action agency to meet its obligations.

B. NOAA should identify any relevant alternatives, analyses, or mitigation to the action agency to help ensure a comprehensive NEPA document is developed. Recommendations regarding specific alternatives and analyses are included in the remaining sections of this document.

II. Design of LNG Terminals

LNG terminals receive, store, and convert LNG to a gaseous state for distribution. The vaporization process requires a heat source, which, in turn, relies on one or more either open or closed-loop heat exchanger systems within a regasification unit. The type of regasification system used to convert LNG to natural gas influences the type and magnitude of effects on marine and coastal resources.

An open-loop system can draw in large quantities of warm water (approximately 100 to over 200 million gallons per day) to heat the LNG and then discharge the cooled water back into the environment. The primary concerns associated with an open-loop system include: the volume of water intake; damage and mortality of impinged and entrained organisms; generation of thermal plumes; discharge of treated water; and generation of noise in the marine environment.

In contrast, a closed-loop system is a self-contained heating system that uses a mixture of water and ethylene-glycol to heat the LNG. Some of these systems use local water supplies for the operation of the vessel's main condenser. Closed or semi-closed systems use no water or lesser amounts than open-loop systems. They are needed in areas where and when natural water temperature precludes open-loop systems due to reduced thermal transfer efficiencies. While a closed-loop system may also affect the marine environment (e.g., through increased vessel activity, and activities related to the construction and operation of terminals), it eliminates entrainment and impingement impacts to marine species as well as thermal and chemical water pollution associated with the open-loop LNG regasification processes.

Due to operational differences, as described above, the use of open-loop systems, compared to closed-loop, substantially increases the degree of impact on the marine environment. The intake of large quantities of seawater could result in significant impacts on a large number of marine organisms (including fish eggs and larvae, some of commercial importance) through impingement and entrainment (NOAA/NMFS Memorandum, Southeast Fisheries Science Center, 2004). NOAA is particularly concerned that the use of open-loop systems will result in the loss of significant numbers of fish, particularly larvae and eggs. Some fish species that could be affected are already at low population levels and any additional impact could prevent or unnecessarily delay rebuilding or recovery of their populations.

A memorandum from the NMFS Southeast Fishery Science Center providing information on the potential impacts of open-loop LNG terminals on fish species in the Gulf of Mexico (February 18, 2004), identified the following concerns:

- Locating LNG terminals in shallow water increases the proportional area of impact (i.e., in shallower waters, a larger area would be affected) and would be especially damaging to fishery resources because of the high concentration of eggs and larvae of fishery species in inshore locations.

- The estimated mortality of billions of fish eggs and larvae per year due to impingement and entrainment indicates that mortality caused by an LNG terminal could have significant effects on certain fish stocks. Furthermore, the uncertainties and variability surrounding the survival of eggs and larvae, their patchy distribution and other related issues are significant matters to be assessed for a proposed terminal utilizing an open-loop system.

- In addition to the mortality of fish eggs and larval fish and crustaceans, all phytoplankton and zooplankton found in the water passing through an LNG terminal are likely to be killed. These organisms are the base of the food web for many species in estuarine systems, and negative impacts on the estuarine food web should be expected.

- The temperature of discharged water is likely to slow the development of fish eggs and larvae, and may reduce the survival of these life stages.

Although the operational design of proposed LNG terminal projects is often determined before applicants seek input from NOAA on project impacts, NOAA staff should recommend during the pre-application phase or early in the review process the use of a closed-loop regasification system. NOAA has determined the use of closed-loop system to be the best available technology and a best practice for avoiding or minimizing impacts on the marine and coastal environment. In the event a closed-loop regasification system is not utilized, other methods of regasifying LNG that are proposed for consideration should provide protection to the marine environment that is equal to that of the closed-loop system.

Particularly for onshore and nearshore terminals, NOAA recommends employing closed-loop systems designed to use waste heat from existing power plants or other industrial facilities. These systems, by using waste heat from nearby facilities, do not require the combustion of additional hydrocarbons to gasify LNG, thereby reducing potential air pollution impacts (EPA 2004).

III. Siting of LNG Terminals

LNG terminals can be sited either onshore, nearshore or in offshore locations. Onshore terminals are located on land, nearshore are those located within state waters, and offshore terminals are deepwater ports located beyond State seaward boundaries[8]. Although the location of LNG projects is often determined before applicants seek NOAA input on project impacts, during the pre-application phase or early in the review process NOAA staff should consider providing the following recommendations regarding NEPA analyses and alternatives:

A. Coordination of the lead action agencies should occur at the earliest possible time with NOAA and prior to conducting site resource evaluation surveys needed for NEPA documentation. Surveys should include information comparing and contrasting the relative marine and coastal resource impacts of possible LNG sites. Site selection should consider and include information and analysis regarding: EFH, its location, functions, and values as well as its availability; local fishing activity; the federally-managed fish species that may be affected; the presence of National Marine Sanctuaries and National Estuarine Research Reserves; potential cumulative impacts; endangered/threatened species and their critical habitat; and the possibility of interconnecting with existing facilities (e.g., location of existing pipelines, heat sources, and other viable infrastructure) that the applicant could potentially utilize.

B. The prospective applicant or the lead action agency (USCG, MARAD, and FERC) should provide a reasonable range of alternate locations for the siting of the LNG terminal as part of the NEPA analysis. The analysis should be comprehensive to allow for a meaningful comparison among the sites.

[8] *See* Deepwater Port Act. 33 U.S.C. §1502(9) and Natural Gas Act 15 U.S.C. § 717b(e)(2).

The following additional recommendations should also be considered when reviewing the siting of a LNG terminal. These recommendations have been prioritized by using the sequential procedure for mitigating potential LNG terminal impacts on marine and coastal resources, which first includes avoidance and then minimization of impacts.

Avoidance of impacts

A. Generally, NOAA expects that LNG terminals, particularly open-loop systems, located offshore would have fewer impacts on marine and coastal resources than nearshore terminals, which may have intake structures closer to more sensitive areas and zones of high productivity such as tidal estuarine passes (Section XIX, Guidelines from NOAA/NMFS Southeast Regional Office 2000; NOAA/NMFS Memorandum, Southeast Fisheries Science Center 2004). NOAA recommends that LNG terminals (especially open-loop systems) be sited as far offshore as possible, in locations of lower biological productivity, and away from sensitive habitats and migration routes of economically important fish species and their forage, marine mammals or listed species.

B. Select sites for LNG terminals and associated pipeline networks to avoid/minimize both construction and operation impacts on ESA critical habitat (e.g., right whale critical habitat), EFH, estuarine passes, fishing areas, designated recreational zones, National Estuarine Research Reserves, National Marine Sanctuaries, and other specially designated zones. A list of habitats, both nearshore and offshore, that should receive special attention in connection with the siting of an LNG terminal is provided in Appendix II of this document.

Minimization of impacts

C. Select sites for LNG terminals near existing deepwater channels to minimize the need for additional dredging activities for incoming and outgoing vessel transportation. The dredging and the disposal of dredged material can cause substantial impacts on many marine and coastal organisms and their habitats (Hanson et al. 2003). Vessel passage in confined waterways can induce erosion of shoal water areas, resuspend sediment from the channel bottom and destabilize the sediment/water interface expanding the sediment/water nephloid layer in the bow and wake wave wash zone.

D. Select sites for LNG terminals in a manner that maximizes the use of existing viable infrastructure such as existing pipeline networks and other industrial facilities that may provide waste heat, thereby reducing the need to use seawater for warming the LNG.

E. Select sites that minimize conflicts with current activities such as recognized aquatic resource congregation, spawning, nursery or aquaculture farming areas, areas where fishing gear is deployed, navigation channels, fairways and separation zones, as well as recreational and research use areas.

IV. Construction of LNG Terminals

The following information should be considered by NOAA when providing recommendations on the construction of LNG terminals. Although the protective measures identified below were developed for specific regions, they should be considered when addressing offshore LNG siting and construction issues around the country, as appropriate.

A. Conservation measures have been developed in the past to protect sensitive resource areas in the Gulf of Mexico from outer continental shelf (OCS) petroleum development activities. These measures resulted from an EFH consultation between NMFS Southeast Regional Office and Minerals Management Service (July 1, 1999). Recommendations include, but are not limited to: 1) avoiding damage or disturbance to live bottoms; 2) requiring a spill response plan from all owners and operators of OCS handling, storage, or transportation facilities; and 3) controlling and removing pollution in order to avoid risks to EFH and associated fisheries.

B. Regarding the installation of new linear pipelines and the performance of any associated dredging activity, consider the recommendations provided in both the document, "Non-fishing impacts on EFH and recommended conservation measures" (Sections 4.1 and 4.10, Hanson et al. 2003), and the guidelines developed in the NOAA/NMFS Southeast Regional Office 2000 (Section XIV). Recommendations include, but are not limited to: (1) aligning crossings along least environmentally damaging routes; (2) avoiding the construction of permanent access channels; and (3) where possible, storing and containing excavated materials on uplands or barges. The use of scientifically based seasonal "construction windows" should be used to minimize loss of habitat functions and values and the resources that might be harmed or displaced by the installation activities. Recent advances in the use and management of subsea blasting should be employed as needed to minimize the effects of underwater noise to living marine resources. In addition, the use of subsea plows to bury pipelines has greatly reduced the specific alignment and collateral damage to the seafloor and greatly reduced the recovery time. Alternative installation technologies such as plowing, hydro-jetting and directional drilling should be discussed in any "alternatives" discussions.

C. Intense and prolonged exposure to noise may result in the masking of biologically significant sounds, changes in hearing sensitivity, hearing loss, increase fish egg mortality, and changes in marine animal behavior (Southall 2005). Efforts to minimize noise from construction and operation activities should be considered, particularly if sensitive marine and estuarine resources (e.g., fish, marine mammals, turtles) are either present or likely to be present. For example, pile driving work could be scheduled when spawning adults, as well as larval and juvenile stages of MSA-managed or ESA-listed species are not present. Pile driving and subsurface demolition of structures is a source of resource displacement and its effects have been documented (Sonalysts, Inc 1996). Pile driving pulse energies can be reduced using an air bubble curtain or air-filled cofferdam (Thorson 2004). The Department of the Navy in cooperation with NOAA has investigated a variety of sound energy releases in relationship to vessel testing and communications (Department of the Navy 1998 and 2001). The use of vibratory or boring systems to set piles has been shown to greatly reduce or eliminate shock wave releases associated with pile driving using the "drop hammer" technology (Sonalysts, Inc. 1996). Compressor sound has been reported along underwater pipelines, although the extent and impact of this sound has not been fully explored.

V. Operation of LNG Terminals

The operation of LNG terminals may affect coastal and marine resources in a variety of ways. In order to prevent or minimize impacts, NOAA will examine the following issues.

A. LNG terminals will likely cause an increase in vessel traffic as a result of transport operations. The increase in vessel traffic may result in sediment resuspension and deposition, increased noise, and vessel strikes, thereby affecting coastal and marine resources. NOAA encourages operators

of LNG terminals to recommend to LNG carrier operators the following approaches for reducing potential adverse impacts:

1. When applicable, use existing navigation channels for transportation to minimize the need for additional dredging.

2. Use operational measures to minimize sediment resuspension from increased vessel transportation. Some of these measures could include minimizing the number of vessel trips to and from a terminal and routing vessel traffic through deeper waters/channels as well as speed restrictions and the use of shallow draft tugboats.

3. At the May 2004 Marine Mammals and Shipping Symposium (Southall 2005), methods to address the potential impacts of vessel noise on marine organisms were discussed. Maintaining efficiency of ships could reduce the amount of acoustic energy they emit. For any new vessels or those that may be refurbished, NOAA encourages incorporation of quieting technologies that may also serve to improve efficiency or performance.

4. Coordinate with the U.S. Coast Guard Marine Safety Office, and notify vessel operators of applicable area-specific strategies for the protection of marine mammals and turtles.

5. To minimize vessel collision with ESA-listed species, marine mammals, and other marine resources, the applicants will be provided with outreach products on the vulnerability of species to ship strikes. These materials should then be distributed to vessel operators. Vessels involved in either construction activities or LNG transportation could be routed around or undertake movement restrictions in areas where such species are known to occur, in order to minimize the potential for disturbance and ship strikes. Furthermore, observers could be utilized to monitor and facilitate avoiding such species, as appropriate.

B. The use of non-technological operational strategies could be employed to minimize impacts. For example, dredge shipping channels at times when habitat loss, entrainment, noise disturbance, and other impacts on resident and migratory marine species would be minimized. (For more information on the application and the process for establishing environmental windows, see the document entitled “A process for setting, managing, and monitoring environmental windows for dredging projects”; Committee for Environmental Windows for Dredging Projects, 2001).

C. If LNG operation impacts associated with water withdrawal are not avoided or minimized by using a closed-loop system, the following recommendations for minimizing (or reducing) impacts from facilities operating in an open-loop mode should be considered:

1. Minimize water utilization as a heat source, for example, by using heat-recovery from turbine-generated exhaust or other practices.

2. Withdraw water when and where the impacts of entrainment and impingement of marine organisms will be minimized (e.g., off temporal and spatial abundance peaks).

3. Avoid lighting on the import terminal and water intake in areas of larval fish settlement and recruitment, sea turtle hatchling occurrence, marine mammal (e.g., seal) presence, or other biota concentrations that may be attracted to light.

4. Use specialized technology to minimize impacts of water intake structures and their operation on marine organisms. Examples include the use of multiple and mobile intakes that would facilitate appropriate modifications in the depth and location of seawater intake, wedge wire screens, exclusion devices, automatic larvae and egg detectors, specific bio-fouling products and practices (i.e., use of less harmful chemicals and minimal concentrations), and discharge diffusers.

5. Use hydraulically engineered, positive barrier screens (see http://swr.nmfs.noaa.gov/hcd/expert.htm for more information) to minimize entrainment of fish and aquatic organisms. Additional fish protection technologies may also be considered to enhance the effectiveness of the overall entrainment reduction system. Determining appropriate fish protection technologies may include pre-design entrainment experimentation on water diversion of the same magnitude, and in the same location, as the proposed LNG intake. It is important that any experiments be conducted in such a way that collection, identification, and enumeration of species are possible.

6. Use water intake velocities (generally less than 0.5 feet per second) to minimize impingement impacts of juvenile and adult marine organisms.

7. Where possible, avoid the use of aqueous biocides (e.g., sodium hypochlorite) and toxic coatings to control biofouling and implement least damaging antifouling alternatives. If the use of biocides cannot be avoided, minimize their discharge through the use of minimum effective concentrations, reduced application schedules and/or targeted application, pre-treat effluent before discharge, and promote effluent diffusion to minimize water contamination and potential impacts to marine organisms.

8. Water temperatures within the discharge plume should not a) severely influence the distribution of organisms (even sub-lethal temperature changes can affect physiology and behavior negatively); b) exceed the thermal tolerance of plant and animal species living in the receiving water body, and c) provide suitable habitat for non-native invasive organisms (warm power plant discharges have been known to promote proliferation and survival of injurious tropical shipworms in temperate latitudes). The use of multiple water discharge points and orientations is recommended to maximize mixing and minimize ambient water temperature change.

9. Locate water discharge points at an appropriate distance from the seafloor to minimize sediment suspension, scouring, and impact to benthic organisms.

VI. Impact Analysis

To ensure the adequate evaluation of impacts on NOAA's trust resources, NOAA will consider the following when reviewing biological, economic, and cumulative impact analyses within environmental review documentation (e.g., NEPA and consultation documents). The best practices identified below are intended to guide NOAA staff and, depending on specific project characteristics, may not be applicable to all LNG projects.

Biological analyses should include:

A. A list of direct, indirect, and cumulative biological effects resulting from physical, chemical, and biological changes on the environment, including a comprehensive and detailed analysis of potential impacts. Biological effects associated with LNG terminals could arise from construction activities, water intake, thermal pollution, discharges, pipe laying, dredging, vessel operations, etc.. Depending on the specific project, impact estimates may include:

    1. The extent of impacted EFH, ESA critical habitat, and other marine and coastal habitats;
    2. Impacts on fisheries production;
    3. Population-level impacts of MSA-managed species taking into account their interrelationships at both the habitat and the food web level;
    4. Impacts to listed and protected species, individual and population-level;
    5. Impacts to national marine sanctuary resources and;
    6. Impacts to National Estuarine Research Reserves.

B. Any incomplete or unknown information, with a description of its relevance in evaluating reasonably foreseeable significant adverse impacts on the marine environment as stipulated in 40 CFR Section 1502.22 (b).

C. Site-specific impact analysis studies and site development should be considered. For projects considering the use of an open-loop mode, existing site-specific studies addressing entrainment impacts should be used to the extent possible. If site specific studies are not available, NMFS should be consulted to identify acceptable alternative data sets/studies or other impact assessment tools.

D. A description and rationale of the methods used in models that estimate project impacts on living marine resources. This description and rationale should include the assumptions made for the model as well as any verification available for the model itself. NOAA recommends the use of the age-1 equivalency approach, along with sensitivity analyses. This method is considered appropriate for estimating entrainment impacts, given the available data (Final Environmental Impact Statement for the Gulf Landing LLC Deepwater Port License Application, Appendix G, 2005). Where data requirements are met, more complex models such as age-1 equivalent yield and production foregone models are useful.

E. In addition to using the best available information, a description of data uncertainty and variability including uncertainty ranges and appropriate sensitivity analyses should be provided. For example, when applying modeling techniques, varying the egg and larval densities, life stage duration, and life stage mortality rates within realistic ranges is recommended.

Socioeconomic analysis should include:

F. An estimation of potential monetary losses incurred by commercial, recreational, and/or subsistence fisheries and fishing communities from impacts to federally managed marine and coastal species and their habitats. The analysis should address impacts from the proposed project and other existing and foreseeable LNG projects within the same geographic area. Specifically, the socioeconomic analysis should address potential losses in fishing opportunity, reduced harvest, and effects on ports and fishing communities, all of which may suffer as a result of the LNG operations.

Cumulative impact analysis should include:

G. A description of any impacts to other existing marine and coastal uses, such as commercial, recreational, and subsistence fisheries, and aquaculture activities.

H. A description of all sources of impacts (past, present and reasonably foreseeable) on marine and coastal resources present in onshore, nearshore and offshore zones within the vicinity of the proposed LNG terminal. Of particular interest to NOAA is the seafloor disturbance associated with terminal construction and pipe laying, total water utilization in a region from a combination of industrial facilities (such as desalination and power plants), and the associated impacts on the marine environment and fishing communities. Special attention should be given to the cumulative impacts associated with the construction and operation of multiple LNG terminals within an affected region. The area considered for the cumulative impacts analysis should be determined according to particular geographic, environmental, and biological characteristics (e.g., presence/absence of physical or geographic barriers, currents, and highly migratory species), which might affect the propagation of impacts from multiple LNG terminals. For example, in the Gulf of Mexico, while it is appropriate to consider general, ecosystem impacts and impacts to coastal and highly migratory fisheries on a Gulf-wide basis, some important fishery resources also will need to be evaluated at a state or regional scale (e.g., a cumulative impact analysis for species such as red drum, which do not exhibit extensive migratory patterns, should be restricted to a smaller area, e.g., east or west of the Mississippi River delta or adjacent to specific estuarine systems). Information that should be considered in a cumulative impact analysis includes the number of existing, proposed, and planned LNG terminals; their location; project specific details (e.g., open-loop vs. closed-loop system); and fishery resources at risk.

I. Impact area boundaries that are broad enough to consider the propagation effect of pollution plumes (temperature and chemical) and include direct/indirect impacts on living marine resources and habitats. These boundaries could be estimated by using available modeling techniques to map the zone of influence for the intakes and discharges of the LNG terminal.

In addition to any impacts on living marine resources, NOAA may also require an analysis of the impacts of the design, siting, and operation of a project on maritime heritage resources, aesthetics, and other user groups for sites that may or are likely to affect a national marine sanctuary.

VII. Monitoring

Monitoring programs should be developed to: 1) provide baseline information; 2) assess real impacts over time and verify the accuracy of estimated impacts; 3) determine whether adaptive management measures are necessary (e.g., retrofitting or modifying operational modes); and 4) provide the information necessary for the development of successful mitigation efforts. To that end, well designed LNG monitoring plans would:

A. Be hypothesis driven and include hypotheses that allow for application of statistical tests. Each plan should be iterative in design (i.e., state how monitoring activities will collect data, analyze results, advance understanding, and provide guidance for redirection of efforts).

B. Include three phases: pre-construction baseline, construction phase, and post-construction/operational impact assessments. A well-designed, three-phased monitoring program provides both adequate and accurate information on the before-and-after characteristics of the site and its vicinity. Monitoring in each phase is essential for assessing impacts and for evaluating mitigation efforts. Pre-construction or baseline assessments should occur between the application phase and construction phase and should begin as soon as the applicant is authorized to conduct such monitoring by either the Coast Guard, MARAD or FERC.

C. Describe and follow specific and well-established protocols by including:
    1. A defined sampling area, defined sampling objectives, and control or reference sites;
    2. Data collection specifications (e.g., experimental design, methodologies, variables being measured, and time, frequency and sampling duration); and
    3. Data analysis procedures and techniques used (e.g., statistics and modeling techniques).

D. Include comprehensive monitoring to determine the responses of living marine organisms or their habitats to environmental changes associated with the construction and operation of LNG terminals:
    1. Physical (e.g., air-water temperature, tidal stage and flow, current velocities);
    2. Biological (e.g., chlorophyll content, species identification and measurement of some/all of the following characteristics: density, size, weight, age class, sex); and
    3. Chemical (e.g., salinity, dissolved oxygen, biocide concentrations).

E. Be designed in such a way that sampling avoids or minimizes potential take of endangered, threatened, or protected species.

NOAA recommends conducting monitoring related field studies at the earliest possible time, provided an authorization by the licensing agency is not required to start the monitoring program. NOAA also recommends the applicant consult with NMFS on the content and scope of any fishery-related monitoring plan.

An example of a regional LNG monitoring plan developed by the NOAA/NMFS Southeast Regional Office is presented in Appendix III (Southeast Regional LNG Monitoring Plan Considerations 2005). Although this document was developed to monitor impacts on living marine resources from the construction and operation of LNG terminals in the Gulf of Mexico, the list of considerations it provides may be useful when developing LNG monitoring plans in other regions. Local information and considerations included in the Southeast Region document are necessary to ensure adequate monitoring of potential sources of impact and relate to sampling techniques, sampling location and frequency, duration of monitoring, and data analysis. Geographically important information will likely be added as similar plans are developed elsewhere.

VIII. Compensatory Mitigation

Compensatory mitigation[9] should be implemented to offset adverse effects or unavoidable losses to aquatic resources from authorized activities as stipulated under NEPA's implementing regulations [40 CFR Part 1505.2 (c), 1502.14, and 1502.16]. If mitigation is used, it should follow applicable current state, federal and national mitigation guidance (e.g., Mitigation Action Plan for wetland compensation under Section 404 of the Clean Water Act). NOAA's recommended best practices for mitigation include, but are not limited to:

A. A mitigation plan that contemplates the replacement of lost resources and habitat functional values. Mitigation plans should be developed to best compensate for losses on a case-by-case basis, and always in compliance with existing state, Federal, and national guidance on mitigation.[10]

B. A process that allows for adaptive management through retrofitting and uses more effective operational practices to further minimize impacts as new techniques are developed.

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[9] Compensatory mitigation involves activities undertaken to replace functional losses to aquatic resources. Compensating for the adverse impacts to aquatic resources should only be considered after efforts to avoid and minimize adverse impacts have been exhausted and never as a substitute for avoiding and minimizing impacts. Ultimately, the lead Federal agency determines if compensatory mitigation is required, although, NOAA may recommend its use.

[10] At this time NOAA is not aware of specific compensatory mitigation examples that would effectively offset unavoidable impingement and entrainment impacts resulting from LNG terminals. As more information becomes available, NOAA will consider developing specific recommendations for offsetting impingement and entrainment impacts caused by LNG facilities.

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APPENDIX I

NOAA AUTHORITIES

NOAA maintains diverse regulatory and statutory authority over many aspects of LNG licensing. NOAA is responsible for a variety of activities in marine and coastal ecosystems, including managing protected species, managing commercial and recreational fisheries, protecting marine and coastal habitats, and managing designated marine sanctuaries and coastal and restoration activities. The following discussion highlights briefly the statutes and regulations addressing NOAA's primary authority and describes the extent to which NOAA participates in the licensing of LNG terminals.

- **Deepwater Port Act, 33 U.S.C. §§ 1501 *et seq.*** - The Deepwater Port Act (DPA), as amended, authorizes the Secretary of Transportation to regulate and license the ownership, construction, and operation of deepwater ports in waters beyond the territorial limits of the United States. *See* 33 U.S.C. § 1501(a)(1). Deepwater ports include those facilities designed to store, handle or transport oil or natural gas to a State. *See id.* at § 1502(9).

  Under the DPA, copies of LNG applications are forwarded to Federal agencies, e.g., NOAA, with jurisdiction over any aspect of a deepwater port application for comment, review or recommendation as to appropriate conditions to be included in a license, and for such other action as may be required by law. *See id.* at §§ 1504 (e) and (f). In addition, Coast Guard regulations related to deepwater ports require an applicant to prepare and submit applications to each agency that requires a permit or license to operate the deepwater port, and also requires the applicant to comply with all applicable Federal, State and tribal environmental statutes. *See* 33 C.F.R. §§ 148.700 and 148.737.

- **Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1801 *et seq.*** -Pursuant to the Magnuson-Stevens Act (MSA), NOAA is responsible for the conservation and management of fishery resources found off the coasts of the United States. NOAA is also responsible for establishing programs to prevent overfishing, rebuild overfished stocks, insure conservation, facilitate long-term protection of essential fish habitats (EFH), and to realize the full potential of the Nation's fishery resources.

  Section 1855(b)(2) of the MSA requires Federal agencies to consult with NOAA, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act." The statute defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity." 16 U.S.C. § 1802(10). NOAA's regulations also define EFH, by adding, among other things, that "'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." 50 C.F.R. § 600.10.

  If any of the lead agencies determine that a proposed LNG terminal may adversely affect EFH, they must consult with NOAA. *See* 50 C.F.R. § 600.920. Adverse effects to EFH are defined as "any impact that reduces the quality and/or quantity of EFH," and may include "site-specific or habitat-wide impacts, including individual, cumulative or synergistic consequences of actions." 50 C.F.R. § 600.810(a). Furthermore, the consultation process allows NOAA to make a determination of the project's effects on EFH and provide Conservation Recommendations to the lead agency on actions that would adversely affect such habitat. *See* 16 U.S.C. § 1855(b)(4)(A).

- **Endangered Species Act, 16 U.S.C. §§ 1531 *et seq.*** – The purpose of the Endangered Species Act (ESA) is to provide a means whereby ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such listed species. Section 7 of the ESA requires Federal agencies to consult with NOAA to insure that "any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or

threatened species or adversely modify or destroy [designated] critical habitat . . . ." 16 U.S.C. § 1536 (a)(2)); s*ee also* 50 C.F.R. Part 400. If a proposed LNG terminal may affect a listed species or designated critical habitat, the agency proposing to issue the license must initiate consultation with NOAA and/or the Fish and Wildlife Service pursuant to section 7 of the ESA. *See* 50 C.F.R. § 402.14.

- **Marine Mammal Protection Act, 16 U.S.C. §§ 1361 *et seq.*** – Pursuant to the Marine Mammal Protection Act, it is generally illegal to "take" a marine mammal without prior authorization from NOAA. "Take" is defined as harassing, hunting, capturing, or killing, or attempting to harass, hunt, capture, or kill any marine mammal. Except with respect to military readiness activities and certain scientific research conducted by or on behalf of the Federal Government, "harassment" is defined as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal in the wild, or has the potential to disturb a marine mammal in the wild by causing disruption of behavioral patterns, including, but not limited to migration, breathing nursing, breeding, feeding or sheltering. *See* 16 U.S.C. § 1362(18)(A) and 50 C.F.R. § 216.3.

  Under the MMPA, NOAA, authorizes the take of small numbers of marine mammals incidental to otherwise lawful activities (except commercial fishing), provided that the takings would have no more than a negligible impact on those marine mammal species and would not have an unmitigable adverse impact on the availability of those species for subsistence uses. An activity has a "negligible impact" on a species or stock when it is determined that the total taking is not reasonably expected to reduce annual rates of survival or annual recruitment (i.e., offspring survival, birth rates). In the event that any aspect of a proposed LNG terminal will result in a "take" the project applicant, or the lead agency acting on behalf of the applicant, would be required to obtain an incidental take authorization in advance from NOAA. *See* 16 U.S.C. §§ 1371 (a)(5)(A) and (a)(5)(D).

- **Coastal Zone Management Act, 16 U.S.C. §§ 1451 *et seq.*** – The goal of the Coastal Zone Management Act (CZMA) is to encourage states to preserve, protect, develop, and where possible, restore and enhance natural coastal resources. The CZMA authorizes NOAA to provide grants to states that are willing to develop and implement a comprehensive coastal management program.

  Approval of a state's coastal management program by NOAA causes the CZMA Federal Consistency provision to apply with respect to any land or water use or natural resource of a state's coastal zone. Thereafter, Federal agency activities having reasonably foreseeable effects on these coastal uses or resources must be consistent to the maximum extent practicable with the federally approved enforceable policies of applicable state coastal management programs. In addition, activities of non-Federal entities which require a federal license or permit and which will have reasonably foreseeable effects on a state's coastal uses or resources must be fully consistent with the enforceable policies of that state's coastal management program. State agencies and local governments applying for federal funding for activities that will have reasonably foreseeable coastal effects must also be fully consistent with the enforceable policies of a state's coastal management program.

  States may also designate National Estuarine Research Reserves. The National Estuarine Research Reserves System is a network of 26 areas representing different biogeographic regions of the United States that are protected for long-term research, water-quality monitoring, education and coastal stewardship. Established by the CZMA, the reserve system is a partnership program between NOAA and the coastal states. NOAA provides funding, national guidance and technical assistance. Each reserve is managed on daily basis by a lead state agency or university, with input from local partners.

  In carrying out the agency's functions and responsibilities under the CZMA, NOAA shall consult with, cooperate with, and, to the maximum extent practicable, coordinate its activities with other interested Federal agencies. *See* 16 U.S.C. § 1456(a)

- **National Marine Sanctuaries Act (Title III of the Marine Protection, Research, and Sanctuaries Act), 16 U.S.C. §§ 1431-1445c-1 -** The National Marine Sanctuaries Act (NMSA) provides NOAA with the authority to protect and manage the resources of significant marine areas of the United States. NOAA's administration of the marine sanctuary program involves designating marine sanctuaries and adopting management practices to protect the conservation, recreational, ecological, educational, and aesthetic values of these areas.

  The NMSA requires any federal agency action inside or outside the boundaries of a National Marine Sanctuary (sanctuary), including issuance of a license or permit, that is likely to injure the resources of a sanctuary to provide the Secretary of Commerce (Secretary) with a written statement describing the action and its potential effect on sanctuary resources. This statement of sanctuary resource impacts must be prepared at the earliest practicable time before final approval of the federal action or federal permit. In no case shall the statement be provided to the Secretary later than 45 days prior to the approval of the federal action. If the Secretary finds that the federal action or permit is likely to injure sanctuary resources, the Secretary will recommend reasonable and prudent alternatives to the proposed action which may include choosing an alternative location for the federal activity or federally permitted activity. The federal agency must promptly consult with the Secretary of Commerce on the recommended alternatives and provide a written explanation if the federal agency chooses not to follow the recommended alternatives provided by the Secretary of Commerce.

  In addition, he NMSA prohibits the destruction, loss of, or injury to any sanctuary resource and any violation of the Act, any regulations, or permits issued pursuant to the NMSA. 16 U.S.C. § 1436. NOAA is required to conduct such enforcement activities as are necessary and reasonable to carry out the Act. *Id.* at § 1437. The NMSA also establishes liability for response costs and natural resource damages for injury to sanctuary natural resources. Under the Act, NOAA may undertake or authorize all necessary actions to prevent or minimize the destruction or loss of, or injury to, sanctuary resources, or to minimize the imminent risk of such destruction, loss, or injury. *Id.* at § 1443(b)(1). Furthermore, NOAA shall assess damages to sanctuary resources. *Id.* at § 1443(b)(2). NOAA is required to use recovered response costs and damages to finance response actions and damage assessments to restore, replace or acquire the equivalent of the injured sanctuary resource, and to manage and improve national marine sanctuaries. *Id.* at § 1443(d). NOAA is also required to conduct research monitoring, evaluation, and education programs as are necessary and reasonable to carry out the purposes and policies of the NMSA. *Id.* at § 1440.

- **National Environmental Policy Act, 42 U.S.C. §§ 4321 *et seq.*** - The National Environmental Policy Act (NEPA) requires Federal agencies to prepare Environmental Impact Statements (EIS) for major Federal actions that significantly affect the quality of the human environment. *See* 42 U.S.C. § 4332 (C). The Council on Environmental Quality (CEQ) regulations implementing NEPA require each lead Federal agency to invite the participation of other affected entities, including Federal, state and local agencies, throughout the NEPA process. *See* 40 C.F.R. Part 1501. Furthermore, after the lead Federal agency prepares a Draft EIS, it is required to "obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards." *See id.* at § 1503.1(a)(1).

  NOAA maintains jurisdiction and special expertise over marine resources as contemplated by CEQ's regulations. In those instances where NOAA receives a Draft EIS from the lead agencies concerning a proposed LNG terminal, NOAA is required to comment on statements within its jurisdiction, expertise, or authority under the time frame established by the lead agency. *See id.* at § 1503.2. In addition, NOAA's comments should be as specific as possible and may address the adequacy of the statements and/or the merits of the alternatives considered. *See id.* at § 1503.3(a). Finally, when NOAA disagrees with methodologies utilized by the lead agency, it should explain why and propose an alternative methodology. *See id.*

- **Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-666c.** - The purpose of the Act is to ensure that wildlife conservation receives equal consideration, and be coordinated with, other aspects of water resources development. The Act requires Federal departments and agencies that undertake an action, or issue a Federal permit or license that proposes to modify any stream or other body of water, for any purpose including navigation and drainage, to first consult with the U.S. Fish and Wildlife Service, NOAA, and appropriate state fish and wildlife agencies. The Federal and state resource agencies provide recommendations and comments to the Federal action agency that should provide for the conservation of fish and wildlife resources by preventing loss of or damage to the resources. The action agency then must give equal consideration to the conservation of fish and wildlife resources in making water resource development decisions.

  The Department of the Interior, NOAA and state agencies may develop reports that determine the possible damage to fish and wildlife resources and recommend means and measures that should be adopted to prevent the loss of or damage to fish and wildlife resources while allowing for the development and improvement of such water resources. Action agencies must specifically consult with NOAA if their action has potential to adversely affect marine and anadromous fish resources. NOAA responds with comments and recommendations to conserve the fish and their habitat. NOAA fulfills its responsibilities under the Act by consulting with the Army Corps of Engineers on permits and water resource development projects, with the Federal Energy Regulatory Commission in decisions regarding hydroelectric project licensing, and on various other federal actions involving water resources development.

- **Memorandum of Understanding (MOU) Related to the Licensing of Deepwater Ports** - In February 2004, the Department of Commerce (NOAA) became a Participating Agency under the Deepwater Ports MOU. The purpose of the MOU is to establish a framework for cooperation among the Participating Agencies with regulatory responsibilities related to the licensing of deepwater ports pursuant to the Deepwater Port Act of 1974. The MOU emphasizes the importance for the lead agencies (Coast Guard and MARAD), to receive specific information from other Participating Agencies at key stages of project development to foster an efficient procedure to develop documentation that will meet the statutory requirements of all affected agencies.

  The MOU establishes a process to facilitate the timely processing of deepwater port applications in the Exclusive Economic Zone and requires NOAA to: (1) work with applicants, stakeholders and other Federal agencies to identify and resolve issues as quickly as possible; (2) process the necessary authorizations or permits associated with deepwater port licensing; (3) expedite its environmental review required for licensing decisions; and (4) work to build a consensus among governmental agencies.

- **Executive Order No. 13212, 66 Fed. Reg. 28357 (May 18, 2001)** - On May 18, 2001, President Bush signed E.O. 13212, "Actions to Expedite Energy-Related Projects," which sets forth Administration policy that executive departments and Federal agencies take appropriate actions, to the extent consistent with applicable law, to expedite their review of permits or take other actions necessary to accelerate the completion of energy-related projects, while maintaining safety, public health, and environmental protection.

APPENDIX II

The following table provides a list of sensitive nearshore/estuarine and offshore/marine areas (including essential fish habitats, marine sanctuaries, critical habitats, and research reserves) that should receive special attention when reviewing sites for proposed LNG terminals. While the list is not exhaustive, it contains the most dominant habitats that need to be considered. Due to geographical differences in the type, distribution, and dominance of these sensitive habitats, they have been organized by regions.

REGION	HABITAT TYPE	
	Nearshore/Estuarine	**Offshore/Marine**
Southwest	• Salt marsh • Intertidal sand and mudflats • Eelgrass beds • Kelp beds • Rocky hard bottom- nearshore reefs • Soft bottom	• Rocky hard bottom – all rock reefs
Southeast	• Intertidal Marsh • Seagrass • Mangrove • Tidal sand and mud flats • Designated critical habitats for Johnson's seagrass, endangered and threatened sea turtles, Gulf sturgeon, and Northern right whale	• Hard bottom and topographic features including, but not restricted to: - *Shelf-Edge Banks*--East Flower Garden Bank, West Flower Garden Bank, Geyer Bank, Rankin Bank, Elvers Bank, MacNeil Bank, Appelbaum Bank, Bright Bank, McGrail Bank, Rankin Bank, Alderdice Bank, Rezak Bank, Sidner Bank, Ewing Bank, Jakkula Bank, Bouma Bank, Parker Bank, Sackett Bank, Diaphus Bank, Sweet Bank - *South Texas Banks*--Big Dunn Bar, Small Dunn Bar, Blackfish Ridge, Mysterious Bank, Baker Bank, Aransas Bank, Southern Bank, North Hospital Bank, Hospital Bank, South Baker Bank, Dream Bank - *Midshelf Banks*--Claypile Lump, 32 Fathom Bank, Coffee Lump, Stetson Bank, 29 Fathom Bank, Sonnier Bank, 29 Fathom Bank, Fishnet Bank • Designated critical habitat for Northern right whale

REGION	HABITAT TYPE	
	Nearshore/Estuarine	**Offshore/Marine**
Northeast	• Salt Marsh • Eelgrass beds (vegetated shallows) • Intertidal mudflats • Shellfish beds • Shallow water habitats • Fish spawning areas - shallow nearshore (winter flounder) • Anadromous fish runs • Designated critical habitat for Atlantic Salmon in Maine	• Topographic features including, but not limited to: - Offshore banks, ledges, shoals, and canyons - Critical habitat for sea turtles - North Atlantic right whale designated critical habitat in Cape Cod Bay and Great South Channel
	Marine Sanctuaries and Research Reserves	
Southwest	• Channel Islands NMS (California) • Monterey Bay NMS (California) • Gulf of the Farallones NMS (California) • Cordell Bank NMS (California) • Elkhorn Slough NERR (California) • San Francisco NERR (California) • Tijuana River NERR (California)	
Southeast	• Flower Garden Banks NMS (Outer Continental Shelf) • Florida Keys NMS • Gray Reef NMS (Georgia) • Weeks Bay NERR (Alabama) • Grand Bay NERR (Mississippi) • Apalachicola NERR (Florida) • GTM NERR (Florida) • Rookery Bay NERR (Florida) • Sapelo Island NERR (Georgia) • Ace Basin NERR (South Carolina) • N. Inlet-Winyak NERR (South Carolina) • North Carolina NERR	

Northeast	• Stellwagen Bank NMS • Wells NERR (Maine) • Great Bay NERR (New Hampshire) • Waquoit Bay NERR (Massachusetts) • Naragansett Bay NERR (Rhode Island) • Hudson River NERR (New York) • Jacques Costeau NERR (New Jersey) • Chesapeake Bay NERR (Virginia) • Chesapeake Bay NERR (Maryland) • Delaware NERR
	Marine Sanctuaries and Research Reserves
Northwest	• Olympic Coast National Marine Sanctuary • Padilla Bay NERR (Washington) • South Slough NERR (Oregon)
Pacific Islands	• Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve • Hawaiian Islands Humpback Whale NMS • Fagatele Bay NMS
Research Reserves	See http://nerrs.noaa.gov/Reserves.html for a list of all National Estuarine Research Reserves.

APPENDIX III

The LNG monitoring plan considerations document developed by the Southeast Regional Office, Habitat Conservation Division represents a regional example of considerations that should be included in a monitoring plan for monitoring potential LNG impacts to living marine resources and essential fish habitat (EFH). Although this document was developed for its use in the Gulf of Mexico, the list of considerations it provides may be useful when developing LNG monitoring plans in other regions, which will be defined based on the particular conditions and issues of any specific region.

NOAA/NATIONAL MARINE FISHERIES SERVICE
SOUTHEAST REGION
HABITAT CONSERVATION DIVISION

Southeast Regional LNG Monitoring Plan Considerations

This document presents a list of considerations for monitoring plans that would be required as a condition of licensing at liquefied natural gas (LNG) facilities licensed by either the Federal Energy Regulatory Commission (FERC) or the U. S. Coast Guard and the Maritime Administration (USCG/MARAD). This document has been developed by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), Southeast Regional Office, Habitat Conservation Division, with the advice of the Southeast Fisheries Science Center (SEFSC). These monitoring plan considerations are intended to address potential impacts that may occur to living marine resources and essential fish habitat (EFH) as described pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. Impacts to resources managed under other authorities, such as the Endangered Species Act or the Marine Mammal Protection Act, are not addressed in this document. Background information was compiled from: guidance on evaluating cooling water structures (EPA 1977); case studies developed for the 316(b) Phase II regulations (EPA 2002); a 316(b) resource assessment for the Morro Bay Power Plant (Tenera 2001); research presented at an American Fisheries Society symposium on "Fisheries, Reefs, and Offshore Development" (Hernandez and Shaw 2003); and comments provided by the SEFSC on the draft fisheries monitoring plan for the proposed El Paso (now Excelerate) Energy Bridge deepwater LNG terminal (Thompson 2004).

Monitoring requirements for LNG facilities are based on the need to determine the impacts of terminal and pipeline installation and operations on resources of concern. For facilities utilizing open-loop regasification systems, those impacts potentially represent direct threats to marine fishery organisms through impingement, entrainment, and water quality changes, as well as indirect threats to those species through EFH degradation and loss. The purpose of monitoring is to determine the level of impacts to marine fishery species and EFH and to identify the need for potential mitigative actions, if monitoring shows impacts to be individually or cumulatively significant.

The following questions are those most necessary to answer via monitoring to determine whether individual or cumulative impacts to marine fishery species and their EFH are occurring as a result of LNG construction or operation. Monitoring data are also needed to identify mitigative actions. Questions 1 through 5 relate to monitoring requirements specific to LNG facilities that utilize an open-loop system (i.e., one that cycles large volumes of ambient water through a heat exchanging device to regasify LNG for transmission).

1. Does entrainment represent a significant impact to marine fishery species, including economically important crustaceans?
2. Are the densities of entrained fish eggs and larvae significantly different (less) than those densities in the natural system adjacent to the terminal(s)?
3. Does impingement represent a significant impact to marine fishery species?
4. What are the physical and chemical characteristics of the discharge plume?
5. Does the discharge plume have a significant impact on benthic marine communities in the vicinity of the terminal?
6. Does the installation of other terminal features (e.g., pipelines, gravity-based structures, etc.) have an impact on EFH?
7. Taken in combination with other LNG proposals and habitat impacting activities, what are the cumulative impacts to EFH and marine fishery resources and the overall health of Gulf of Mexico ecosystems?

Question 1: Monitoring the Impacts to Marine Fishery Species from Entrainment

To accurately assess the impacts of entrainment on the early life stages of marine fishery species, it is important to determine the existing densities of fish and crustacean eggs and larvae (hereafter referred to as ichthyoplankton) at the LNG facility site and the quantity of that ichthyoplankton stock that is subject to entrainment. Therefore, it is necessary to collect reference ichthyoplankton samples near the facility as well as ichthyoplankton entrainment samples directly from the open-loop regasification system.

Sampling Gear
Sampling gear should have known performance characteristics under the conditions in which it is to be utilized. New gear, or gear that has not been tested under the conditions in which it is to be used, should be tested and compared against standard gear under project-specific conditions.

The NMFS recommends using bongo nets or a Tucker trawl with opening/closing mechanisms. A net mesh size of 0.333 millimeter should be used, similar to that used to collect SEAMAP ichthyoplankton samples (Thompson 2004). The mouth of the net must be large enough to filter an adequate volume of water per sample (see below). The minimum mouth diameter of the net should be 0.6 meter. All nets should include flow meters.

Monitoring Duration
While 15 to 25 years is required for many cyclic biological phenomena to become evident, a study of this length may not be feasible, though it may be possible to obtain data from historical studies. The U. S. EPA (1977) has suggested that three years is sufficient for detecting an exceptional/outlier year, though this length of time has been criticized for being too short to understand events in the context of long-term trends.

The NMFS recommends five years as a required minimum initial period for monitoring of LNG entrainment impacts on marine fishery species. At the end of this five-year period, a determination should be made regarding the necessity for additional monitoring and/or modifications to the monitoring protocol. Such a determination, made by the U.S. Coast Guard and the Maritime Administration (USCG/MARAD) in consultation with the NMFS and the applicant, should be based on the analysis and findings of the initial, five-year sampling period.

Sampling Frequency

It is important to design the entrainment monitoring plan such that it captures temporal variability in organism abundance at the seawater intake structure of an LNG facility. Organism abundance may vary over a 24-hour (diel) period, throughout the course of lunar cycles, and from season to season. Many studies have shown that certain species migrate vertically in the water column over a 24-hour period. To accurately assess potential impacts to marine fishery species, it is critical to sample at night as well as during the day to determine the position of fish eggs and larvae in the water column. The monitoring plan should consider and account for differences in expected catch efficiency based on the time of day. Night tows frequently produce larger catches, which may be due to gear avoidance abilities in relation to light level as well as diel differences in abundance. The monitoring plan also should consider and account for differences in ichthyoplankton abundance and expected catch efficiency based on lunar cycles (Hernandez and Shaw 2003). Studies have shown that larval abundance is often higher during the new moon (Rooker *et al*. 1996; Victor 1986), possibly due to increases in spawning and settlement success by minimizing mortality from visual predators (Thresher 1984). In addition, gear avoidance capabilities may be lower during the new moon due to reduced visibility (Rooker *et al*. 1996). The monitoring plan also should capture the entire seasonal cycle of organisms present at the intake structure, as densities of different species and life stages fluctuate throughout the year.

The NMFS recommends 24-hour sampling be conducted, usually on a monthly basis. The recommended frequency of sampling over the diel cycle is at least four times daily: at dawn, mid-day, dusk, and mid-night. Because the location of the proposed terminal could differentially affect various species of concern, the sampling frequency should be adjusted to target those species of concern. For example, for terminals in nearshore waters where red drum are more common and have greater potential impact from terminal operations, sampling should be conducted every two weeks from mid-August to mid-October. Failure to sample at that frequency could mean that the peak of the red drum spawning season and highest densities of eggs and larvae are missed completely, and that all results from that year of sampling would be of little use for that important species. Where platforms are further offshore, the spawning of red snapper or grouper species might be of more concern and therefore targeted for greater sampling frequency.

Concerning the frequency of sampling during each trip, there is often substantial variability in ichthyoplankton data. Such variability would affect the ability to identify significant differences among important variables. Therefore, a power analysis may be necessary to allow for a determination of the number of samples necessary to achieve a specified degree of precision. The discrimination power of the survey should be adequate for the purposes for which the data are intended. Lacking such a power analysis, the NMFS recommends that minimally, all samples be taken in triplicate.

Sampling Locations and Volumes

The density of the ichthyoplankton of some fishery species has been shown to vary with depth. Therefore, the location of the seawater intake in the water column has been identified as a potential mitigative feature reducing entrainment. For this reason, ichthyoplankton reference samples should be taken at different locations in the water column in order to identify species density by depth. The NMFS recommends that oblique bongo or Tucker trawl net tows covering each third (i.e., top, middle, and bottom third) of the water column be employed to collect reference ichthyoplankton samples (Thompson 2004).

Based on tidal cycle and current flows, all ichthyoplankton reference samples should be taken up-current from the intake structure to ensure that monitoring results are not affected by entrainment of fish eggs and larvae resulting from LNG terminal operations. Therefore, the exact location of sampling in relation to

the LNG terminal likely will change daily and seasonally to ensure samples are always taken up-current from the terminal.

The volume of water sufficient for each ichthyoplankton sample is dependent on the actual densities of eggs and larvae in the area surrounding the intake. Sample volume should be determined based on the least dense species/life stage of concern. Initially, as large a sample as can be handled should be collected. The NMFS recommends a target of 500 cubic meters of water be filtered per sample. Such a volume could be filtered during one sampling effort through the use of 1 or more nets, with the samples (and flow meter counts) being combined.

Net Extrusion Analysis
The standard 0.333-millimeter mesh nets employed in ichthyoplankton studies are a compromise used to reduce net clogging and sorting times. However, there is substantial evidence that small fish larvae are extruded through nets of this mesh size. Therefore, the NMFS recommends triplicate plankton tows be collected with a smaller mesh size net (about 0.200 millimeter) for comparison with the 0.333 millimeter net to determine extrusion rates and to derive a gear efficiency factor (Thompson 2004). As with the larger mesh nets, a power analysis should be conducted to determine the appropriate number of samples to be taken. With the exception of mesh size, all other variables must be the same in this sampling effort. These smaller mesh samples will be taken at approximately the same time and with the same frequency and depth as the larger mesh samples. The proposed duration of this portion of the study would be one year, with a determination to be made based on a review of data variability and usefulness as to whether additional sampling efforts using 0.200 millimeter mesh nets are necessary.

Data Analysis
Data collection must be conducive to biostatistical analyses. It is important to determine the means for data reduction and analysis in the early stages of plan design. Standards should be established to consistently report findings (e.g., as number(s) of organisms per unit volume).

The NMFS recommends all ichthyoplankton samples be sorted and identified to species or the lowest possible taxonomic level. This level of identification should be consistent with current analyses of SEAMAP samples, except that larval crustacean data also should be processed similarly to the fish eggs and larvae. All fish eggs should be counted and identified, if possible. Larval stages of economically important crustaceans also should be identified to the lowest possible taxonomic level, counted and data analyzed. The methodology developed by the USCG/MARAD and the NMFS should be used to analyze the monitoring data and extrapolate the results to age-one equivalents and fishery production of the appropriate fishery species. Raw data and all data analyses should be provided annually to the NMFS.

Question 2: Monitoring the Differences in Densities between Entrained Fish Eggs and Larvae and the Natural Environment

Some LNG license applicants have suggested that features such as screen size, flow velocity, and laminar flow reduce entrainment of fishery species. It is thus necessary to determine if fish egg and larval densities are significantly less in entrained waters than source waters. The NMFS recommends entrainment ichthyoplankton samples be taken directly from the open-loop regasification system at a point downstream from the seawater intake point. The mechanism for collecting these samples would depend upon the intake design and internal flow rate, but a system similar to high-speed plankton samplers used on moving ships may have to be designed. Triplicate samples should be collected concurrently with upstream sampling and the same approximate volume of water should be filtered. Data

from those samples should be compared against samples taken during the same date, time of day and at the same depth as the intake pipe.

Question 3: Monitoring the Impacts to Marine Fishery Species from Impingement

It is unclear whether impingement represents a significant impact to marine fishery species. Through the utilization of marine life exclusion devices, relatively low seawater intake velocities (frequently less than 0.5 ft/sec), and other mitigative features, it is possible that most larger life stages of marine fishery species can avoid impingement. However, the degree to which impingement could occur and the potential impacts to marine fishery species resulting from impingement are unknown. Therefore, monitoring of impingement rates for at least a relatively short period of time is justified.

The NMFS recognizes that impingement monitoring of organisms in offshore, deeper waters that can occasionally be turbid may be difficult. However, efforts should be made to quantify the impacts of impingement on fish and crustaceans. In fresh water systems, complete daily counts of impinged organisms may be obtained by collecting organisms from the intake screen backwash material in collection baskets placed over intake structure(s) (EPA 1977). If it is not feasible to sample the entire intake structure due to size, a portion of the structure could be sampled and the results from that area extrapolated to the entire structure(s).

The NMFS is cognizant that the methodology developed for fresh water systems may not be feasible in the marine environment. Methods such as: 1) collecting the impinged species from the backwash coming off a known size of a screen and extrapolating that catch to the entire screen; and/or, 2) using video cameras to record impingement on the screen should be considered. Both methodologies have their drawbacks. As such, the NMFS is willing to leave the development and selection of a specific methodology to the recommendation of the licensee and their experts. Whatever methodology is proposed should be based on samples collected as least as frequently as every two weeks, and should quantify impingement, on a species level, throughout an entire 24-hour period. Those data then should be used to extrapolate impacts to species of concern throughout the year.

At the end of a one-year monitoring period, a determination should be made regarding the necessity for additional monitoring and/or modifications to the monitoring protocol. Such a determination should be made by the USCG/MARAD in consultation with the NMFS and the applicant.

Question 4: Monitoring the Physical and Chemical Characteristics of the Discharge Plume

Water discharged from the open-loop regasification system will be approximately 10 to 20 degrees Fahrenheit cooler than ambient sea water temperatures. This temperature differential makes the discharged water denser than ambient sea water and causes the plume to sink through the water column to the sea floor. Discharged water also will contain biocides, such as sodium hypochlorite or copper. It is necessary to determine how the chemical and physical properties of the discharge plume are altered as the plume moves away from the outfall, as well as the geographical extent of the discharge plume, to determine its potential impact to benthic organisms.

The NMFS recommends that water quality testing be conducted monthly over various tidal conditions to determine the behavior of the discharge plume. Physical and chemical properties of the discharge plume also should be tracked and recorded in a grid pattern at varying distances and water depths from the outfall. The geographic extent of discharge plume monitoring should be determined by the distance required for temperature and the concentrations of chemical additives to become indistinguishable from

ambient seawater levels (using standard analytical techniques). The NMFS recommends that computer generated graphical depictions which show the geographic extent and physical/chemical properties of the discharge plume under various flow and tidal direction/velocity scenarios be developed from the monitoring data. Discharge plume modeling should be conducted until the model has been verified to a high level of predictability for all tidal cycles and seasons. Such a determination should be made by the USCG/MARAD in consultation with the NMFS and the applicant.

Question 5: Monitoring Benthic Impacts Caused by the Discharge Plume

It is possible that the chronic discharge of large quantities of cold water containing biocides would have adverse impacts on the benthic community near the outfall site.

To monitor the impacts of the discharge plume on the benthos, the NMFS recommends collecting sediment grabs with a Peterson dredge or similar sampling equipment at varying distances (approximately every 50 to 100 feet) from the outfall. Triplicate benthic samples should be taken monthly for a year prior to facility construction to determine spatial and temporal variations in the densities of benthos. Because the exact distance and trajectory of discharge plume impact, measured from the outfall pipe will not be known, pre-construction samples should be taken every 45 degrees throughout a 360-degree circle around the platform location. The locations of samples taken should be recorded on a Global Positioning System (GPS) to allow that area to be sampled repeatedly over time. Initially, the geographic extent of benthic monitoring should be larger than the estimated area of impact of the discharge plume.

After the development of the outfall model, the NMFS, in consultation with the applicant, will develop the recommended sampling grid points based on the results of the model. At a minimum, benthic samples should be taken monthly during the preconstruction period and for one year after the LNG facility becomes operational. Samples should be taken annually for an additional five years, to determine the level of short-term and/or long-term impacts to the benthic community. The geographic extent of benthic monitoring after facility operations commence should be determined by the geographic extent of the discharge plume monitoring (i.e., by the distance required for temperature and the concentrations of chemical additives to return to ambient seawater levels). At the end of the 1- and 5-year monitoring periods, a determination should be made regarding the necessity for additional monitoring and/or modifications to the monitoring protocol. This determination should be made by the USCG/MARAD in consultation with the NMFS and the applicant.

Macrobenthos and benthic infauna should be identified to the lowest possible taxonomic level, counted, and weighed. Any notable degradation of benthic communities should be reported with sample data. Both sediment and porewaters from benthic samples should be tested for levels of biocides (e.g., sodium hypochlorite and copper) and their marine by-products (e.g., bromoform), as well as levels of other potential marine pollutants discharged by the facility (e.g., brine solution, petroleum, and lubricants).

Question 6: Monitoring of the Impacts Associated with the Installation of Related Terminal Features

LNG facilities must transport the regasified product to market through pipelines. These pipelines begin at the terminal and may tie-in with other natural gas pipelines located either offshore or onshore. Often, these pipelines are proposed to be constructed on productive water bottoms and/or through wetlands, both of which may be designated as EFH supportive of marine fishery resources. If a pipeline impacts EFH, the NMFS recommends the habitat be restored after the pipeline has been constructed. Alternatively, NMFS may recommend a different pipeline route that would avoid or minimize impacts on EFH.

Monitoring of the pipeline right-of-way (ROW) is necessary to document pre-construction conditions as well as the level of successful restoration and the need for remedial actions. The following constitutes typical monitoring recommendations associated with the installation of pipelines in areas classified as EFH:

1. The licensee should conduct a pre-construction survey of the pipeline ROW and all work areas to document pre-project conditions. The survey should include a GIS analysis using recent aerial photographs of the project area with the pipeline ROW superimposed on the photograph and identify all habitat types using Cowardin codes (Cowardin et al. 1979) or other accepted measures. The survey also should identify elevations of all wetland areas crossed and include a description of major wetland vegetative communities. Where shell reefs may be impacted, the survey should document the geographic extent and productivity of those shell reefs.

2. Ground photographs of those portions of the pipeline ROW which cross marsh should be taken prior to construction and immediately after construction. The photographs should be taken at 500-ft intervals from the center of the ROW with two photographs being taken at each location, one in each direction. GPS should be used during photography such that pre- and post-construction photographs could be taken from the same locations.

3. Following one growing season after construction, the licensee should undertake a post-construction survey similar to that taken prior to construction. The intent of the post-construction survey is to identify areas where pre-construction contours were not successfully restored or where vegetative or shell reef communities did not become re-established.

4. All monitoring information should be provided to the NMFS within 3 months of its development.

Question 7: Monitoring of cumulative impacts of LNG terminals on EFH and marine fishery species.

The analyses of the results of monitoring plans for each individual terminal should be used to estimate the cumulative impacts of LNG operations in the Gulf of Mexico on EFH and living marine resources (with particular emphasis on age-1 equivalents of important fishery species and their forage species). Efforts to apply the results of individual monitoring studies to predict probable cumulative fishery impacts resulting from the operation of other existing LNG facilities should be made. The methodology developed by the USCG/MARAD and NMFS should be used to analyze the monitoring data, develop cumulative impact estimates, and predict the impacts on age-1 equivalents and equivalent yield of the appropriate fishery species. Raw data, all data analyses, and any assumptions necessary to prepare the cumulative impact assessment should be provided to NMFS for review.

Reporting of Monitoring Result

1. Monitoring methodologies, sample locations, monitoring results and analysis, and any resulting recommendations for change of facility operations or monitoring protocols are to be prepared and submitted to the federal licensing agency and the NMFS annually.

2. Annual reports are to be submitted by March 30 and will encompass the previous calendar year (or portion of a year if monitoring was not conducted for an entire 12 month period).

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