Attachment D to
ISO New England
Planning Procedure No. 4
## Attachment D

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1 PURPOSE

Project cost estimates are a key component of the regional system planning process and provide a basis for key decisions to address both regional and local transmission system upgrade needs. The purpose of this document is to provide consistent cost engineering terms and definitions and a standardized approach to cost estimating in the region.

This document also outlines the active review and reporting of cost estimates throughout the project life cycle from the planning and design to the construction phase. The proposed process covered in this document will improve the ability for transmission owners in the region to provide common estimates, increase project costs transparency and provide regular information about the transmission investments made in the region and their impact to rates.

This document complements the current regional planning process and provides additional level of detail to the project cost estimate review and validation. These guidelines have been assemble with the collaboration of the New England Transmission Owner and will serve as supporting document to the existing planning procedure.
2 TERMS AND DEFINITIONS

2.1 Cost engineering definitions

Cost Estimate: A prediction of quantities, cost, and/or price of resources required by the scope of an asset investment option, activity, or project. As a prediction, an estimate must address risks and uncertainties. Estimates are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes. Cost estimates are determined using experience and calculating and forecasting the future cost of resources, methods, and management within a scheduled time frame.

- **Base Estimate:** The Base Estimate is the original estimate (without contingency) in any estimate class (A, B, C or D). The Base Estimate will not change while the project is in the particular estimate class and all cost adjustments will be based on this estimate. For a Base Estimate to change the project will need to be moved to a differed Estimate Class

- **Escalation:** The provision in actual or estimated costs for an increase in the cost of equipment, material, labor, etc., over that specified in the purchase order or contract due to continuing price level changes over time. Inflation may be a component of escalation, but non-monetary policy influences, such as supply-and-demand, are often components.

- **Contingency:** An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually excludes:
  - Major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project;
  - Extraordinary events such as major strikes and natural disasters;
  - Escalation and currency effects.

Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended.

**Project:** Based on commonly used Project Management terminology, Project’s definition is as follow: “A temporary endeavor with a specific objective to be met within the
prescribed time and monetary limitations and which has been assigned for definition or execution” (AACE / PMI). Regional Transmission projects are typically defined by the transmission owner as a result of the solution study. Projects are broken down by components in the RSP listing (Lines & Substations) but are typically permitted and reviewed as a whole for efficiency and resource/costs savings.

- **Project Scope:** The sum of all that is to be or has been invested in and delivered by the performance of an activity or project. In project planning, the scope is usually documented (i.e., the scope document).

- **Project Element:** The breakdown of the Project into a subset. Examples of project elements would be transmission lines, substation, switching stations, underground transmission lines etc.

- **Change in Scope:** A change in the defined deliverables or resources used to provide them.

- **Right of way cost:** All costs associated with the acquisition of new right of way including easements, land purchases, and associated agent, surveying (relative to land acquisition) and recording fees (as defined by FERC 350 account definition).

- **Level of Project Definition:** This characteristic is based upon percent complete of project definition (roughly corresponding to percent complete of engineering). The level of project definition defines maturity or the extent and types of input information available to the estimating process. Such inputs include project scope definition, requirements documents, specifications, project plans, drawings, calculations, learning’s from past projects, reconnaissance data, and other information that must be developed to define the project.

### 2.2 Project planning stage ii

The RSP (Regional System Planning) project list identifies regulated transmission solutions proposed in response to the needs identified in a RSP or Needs assessment conducted pursuant to Section 4.1 of Attachment K of the Open Access Transmission Tariff (OATT). The RSP Project List identifies the proposed regulated transmission solutions separately as either a
Reliability Transmission Upgrade or a Market Efficiency Transmission Upgrade. Every project evolves through various stages of development. These stages are as follow:

- **Concept**: Projects that are being considered by its proponent as a potential solution to meet a need identified by the ISO in a Needs Assessment or the RSP, but for which there may be little or no analysis available to support the transmission project. A project charter is developed at this stage.

- **Proposed**: A regulated transmission solution that (i) has been proposed in response to a specific need identified by the ISO in a Needs Assessment or the RSP and (ii) has been evaluated or further defined and developed in a Solutions Study, as specified in Section 4.2(b) of Attachment K of the OATT, such that there is significant analysis that supports a determination by the ISO, as communicated to the Planning Advisory Committee, that the proposed regulated transmission solution would likely meet the need identified by the ISO in a Needs Assessment or the RSP, but has not received support by the ISO under Section I.3.9 of the Tariff.

- **Planned**: A Transmission Upgrade that has been approved by the ISO under Section I.3.9 of the Tariff.

- **Under Construction**: A Transmission Upgrade that has received the approvals required under the Tariff and engineering and/or construction is underway.

- **In-Service**: A Transmission Upgrade that has been placed in commercial operation and control jurisdiction turned over the local control center.

### 2.3 Examples of Contingency & Scope Change

The variance to the cost estimate baseline falls into the two categories defined in section 2.1, contingency or scope changes. Contingency typically reflects the risks associated with some of the project elements. These risks are identified, quantified and a cost is associated with these risks. Scope changes on the other hand accounts for project costs incurred as a result of changes to the project itself. The following list gives a few examples of each of these cost categories.

Some examples for transmission project contingency are:
- Field condition design adjustment (e.g. field conflict)
- Incremental change to cost estimate (e.g. unit price increase) excluding general escalation.
- Estimating variances (e.g. quantity, equipment)
- Design development and changes within the original scope (e.g. pole placement less than 50ft)
- Market & vendor variations (e.g. price delta between vendors)
- Reasonable environmental condition or customer request adjustments (e.g. avoiding stream)
- Weather impact on construction (limited to minor delays of few days or less)
- Permitting requirements (e.g. working hour restrictions, rare plants and species protection measures)

Some examples for transmission project Scope changes are:
- Substation site relocation
- Design criteria change
- Currency effects
- Regulatory & permitting project definition changes (e.g. undergrounding transmission or distribution lines, Army Corps of Engineer construction requirements)
- Project re-Routes or relocation from the original Scope
- Changes to the project to accommodate compliance measures (Environmental, Land impact mitigation)
- Significant project delays (cost incurred through the escalation cost and the carrying charges for the project, including capital interest)
- Major schedule changes
3 **COST ESTIMATING PROCESS**

3.1 **Development of the cost estimate**

The development of initial cost estimates takes place early in the regional planning process to allow for alternative comparison as well as alternative cost/benefit evaluation. As the project goes through its life cycle, different grade of estimates are developed and released. The different types of estimates are:

- Order of Magnitude Estimate
- Conceptual Estimate
- Planning Estimate
- Engineering Estimate
- Construction Estimate

The level of detail in the estimate will increase as the project develops. The level of project definition also varies depending on the stage of the project. The following shows the expected level of definition on various project phases and the corresponding estimate types:

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Level of Project Definition</th>
<th>Estimate Class</th>
<th>Estimate Type</th>
<th>Regional Review</th>
<th>RSP Listing Target Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Initiation</td>
<td>0% to 15%</td>
<td></td>
<td>Order of Magnitude</td>
<td>Need Approval (RSP Listing)</td>
<td>-50% to +200%</td>
</tr>
<tr>
<td>Proposed Project</td>
<td>15% to 40%</td>
<td>A</td>
<td>Conceptual Estimate</td>
<td>CRC Review / Retain Proposed Solution</td>
<td>-25% to +50%</td>
</tr>
<tr>
<td>Planned Project</td>
<td>40% to 70%</td>
<td>B</td>
<td>Planning Estimate</td>
<td>PPA Approval</td>
<td>-25% to +25%</td>
</tr>
<tr>
<td>Final Project Design</td>
<td>70% to 90%</td>
<td>C</td>
<td>Engineering Estimate</td>
<td>CRC Review / TCA Approval</td>
<td>-10% to +10%</td>
</tr>
<tr>
<td>Under Construction</td>
<td>80% to 100%</td>
<td>D</td>
<td>Construction Estimate</td>
<td></td>
<td>-10% to +10%</td>
</tr>
</tbody>
</table>

Table 1: Cost Estimate types per project phase (From AACE definition & customized for Transmission Project)

3.1.1 **Cost estimate components**

**Base Estimate Development**

The project estimate depends on the level of project definition as well as the type of estimate being developed. At a minimum the cost estimate should be broken down by project elements (e.g. line segments, substations etc...). The estimate shall conform to the template as described in section 4 of this document. The following information and level of details should be provided at the different project stages of the estimate development process:
• **Concept project:** Cost broken down by project elements (lines, substations, etc...). Analogous cost estimating practices may be used to develop conceptual stage estimates (using similar past projects as a reference).

• **Proposed Project:** Project characteristics should be refined (e.g. line mileage, major equipment specifications, etc...) so to achieve a project level of definition sufficient to achieve the level of accuracy targeted. Some preliminary engineering, field recognition may be necessary to refine project knowledge.

• **Planned Project:** One line diagrams and preliminary design with proposed project location and equipment specifications need to be developed in order to increase the level of project definition. These requirements are already in place to enable Proposed Plan Application (PPA) approval and for the ISO-NE to authorize the project to proceed.

• **Transmission Cost Allocation (TCA):** For TCA approval final design should be developed to achieve the +/- 10% accuracy level targeted. Detail estimate should be developed and broken down by the following cost categories:
  - Material
  - Labor
  - Right of way costs
  - Engineering, Permitting (Including administrative & legal cost)
  - Financing cost (AFUDC & Interest Costs)
  - Escalation (using Handy Whitman or similar)
  - Contingency

At a minimum the project scope of work shall be developed and provided with the estimate (See reporting template for details in section 4 of this document)

**Escalation**

At each of these stages costs should be calculated and the estimate expressed in year-of-expenditure dollars to reflect escalation. This can be done by assigning an inflation rate per year for the different project cost elements. The selected year-of-expenditure should reflect a realistic scenario, taking into account project planning and permitting durations, as well as construction timeframe. Inflation rates may be different for specific cost elements (e.g. substation vs.
transmission lines). Handy Whitman is a custom tailored index for the utility industry which updates are released twice a year. This index follows the Uniform System of Accounts as defined by the Electric Code of Federal Regulations (Title 18) and is used by the utility companies for tax preparation and depreciation purposes. Despite its historical basis it does provide accurate trends that may be used to anticipate inflation rates. Estimates should clearly specify how inflation is considered in the estimate and clearly state that the estimate is expressed in year-of-expenditure dollars. Multiple sources may be used for determining the inflation rate, including other nationwide and local references.

**Contingency**

Reasonable contingencies should be developed and evaluated for each project cost estimate. Contingency captures uncertainties and cost risks within an estimate. The contingency should adhere to the definition as provided in Section 1 of this document and is dependent on the level of project definition. Some general guidelines for contingency have been developed based on AACE definitions by EPRI and the Department of Energy and are as follow:

<table>
<thead>
<tr>
<th>Estimate Class</th>
<th>Descriptive (AACE / EPRI)</th>
<th>From AACE</th>
<th>From EPRI</th>
</tr>
</thead>
</table>
| A             | Study / Simplified Estimate | 1% to 15% | L: -15% to -60%  
H: +30% to +120% | 30-50% |
| B             | Budget, Authorization or Control / Preliminary Estimate | 10% to 40% | L: -10% to -30%  
H: +20% to +60% | 15-30% |
| C             | Control or Bid / Detailed Estimate | 30% to 70% | L: -5% to -15%  
H: +10% to +30% | 10-20% |
| D             | Check Estimate or Bid / Finalized Estimated | 50% to 100% | L: -5% to -5%  
H: +10% to +10% | 5-10% |

*Table 2: Cost Estimate types and relevance based on level of project definition*

Major and more complex projects may include higher contingency levels based on increased project risks and challenges. Typically, as the project is refined, the contingency should reflect
the shift of contingencies into actual cost categories. Transmission Owners should manage risks and uncertainties to reduce the contingency used. However, per the AACE definition, historically, contingency is expected to be expended and should be included in the estimates.

3.2 Cost Estimate Accuracy & Contingency

Contingency and accuracy should not be confused. Where contingency reflects an amount added to a project cost estimate for project unknown and risks identified, accuracy reflects the probability that the estimate will come within a predefined parameter (e.g. 90% confidence). Accuracy is defined by the width of the bell curve distribution of the cost estimate. Contingency is fully part of an estimate.

As the project evolves thru the RSP, the cost estimate is refined and the accuracy changes as follow:

4 PROJECT COST ESTIMATES UPDATES

4.1 Submission of Project Cost Estimate Updates.

For Projects that are (or will be) a Categories 4 or 5 TCA Application a Project Cost Estimation Update must be submitted at least once a year to the ISO and the RC. The update should correspond with the RSP Project List update and should be sent to TCApps@iso-ne.com. The ISO will review the Cost Estimation Update and will also post the updates on the ISO website at the following address: http://www.iso-ne.com/trans/pp_tca/req/proj_cst_est/index.html. The ISO may also request that the Applicant present the Project Cost Estimate Update at the Planning Advisory
Committee (PAC) up to three times a year. The applicant will be notified at least one meeting before they will be presenting to insure ample time to gather costs information.

4.2 Project Cost Estimate Template

The Project Cost Estimate Template will be used the first time a Project is reviewed. The Project Cost Template will be completed one time and not changed unless the Project estimates class changes. It is not necessary to submit a Project Cost Estimation Change Reporting Template when completing this template.

4.3 Project Cost Estimate Change Reporting Template

The Project Cost Estimate Change Reporting Template will be used to update project costs and completion percentage. This is the template that will be used once a Project Cost Estimation Template has been completed. It is not necessary to update the Project Cost Estimation Template when completing this Template.
PROJECT COST ESTIMATE & SCHEDULE SHEET

Transmission Owner: 
Project Name: 
Estimate Grade: 

1. Project Scope Summary

2. Project Cost Summary

<table>
<thead>
<tr>
<th>Project Cost Summary</th>
<th>PTF</th>
<th>Non-PTF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>6%</td>
<td>10%</td>
<td>17%</td>
</tr>
<tr>
<td>Engineering / Permitting / Indirects</td>
<td>22%</td>
<td>6%</td>
<td>13%</td>
</tr>
<tr>
<td>Escalation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFUDC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contingency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Project Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detailed Cost Summary By Project Element</th>
<th>Material</th>
<th>Labor</th>
<th>Equipment</th>
<th>Indirects</th>
<th>Escalation</th>
<th>AFUDC</th>
<th>Contingency</th>
<th>Total</th>
<th>PTF Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1 Component A (Substation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.2 Component B (Line)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Project Milestone Schedule

Project Initiation
Initial Engineering
Final Engineering
State/Local Siting
Environmental Permitting
Land/ROW acquisition
Long Lead Time Equipment Procurement
Civil Construction
Construction

Project Element 1

Procedure #CRC-001
Project Element 2
Project Element X
Construction complete
Energize/in-service
PROJECT COST ESTIMATE UPDATE SHEET

Transmission Owner: 
Project Name: 
Base Estimate: 
Base Estimate Date: 
Prior Estimate Cost: 
TCA Application #: 

RSP Project ID #’s: 
Estimate Grade: 
PPA Approval: 
Date: 

1. **Project Scope Summary**

2. **Project Update**

3. **Project Cost Summary**

<table>
<thead>
<tr>
<th>Project ABC Components</th>
<th>Base Estimate</th>
<th>Base Estimate With Contingency</th>
<th>Scope Change</th>
<th>Actuals Cost</th>
<th>Project Forecast</th>
<th>Estimated % Completion</th>
<th>Forecast vs. Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>On Track</td>
</tr>
<tr>
<td>Line B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Off Track</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>On Track</td>
</tr>
</tbody>
</table>

**Note:** On track & Off Track are indicators comparing forecasted cost to the baseline estimate for PTF funding in accordance to PP-4.

4. **Project Forecast**
5 DOCUMENT REFERENCES

i Source: Copyright 2007, AACE International, Inc., AACE International Recommended Practices, Number 10S-90

ii Source: OATT Attachment K – Regional System Planning
Correspondence

MA Department of Marine Fisheries and National Marine Fisheries Service
March 19, 2013

Marc A. Bergeron  
Senior Project Manager  
Vanasse Hangen Brustlin, INC.  
101 Walnut Street  
P.O. Box 9151  
Watertown, MA 02472

Dear Mr. Bergeron,

Thank you for contacting The Division of Marine Fisheries (MarineFisheries) with an update on the proposed National Grid underground cable submarine and land route alternatives. As we noted in our letter of April 27, 2010, both proposed submarine cable routes would directly impact mapped eelgrass (Zostera marina) meadows. Salem Harbor is an area of particular concern for MarineFisheries and other state and local organizations because of recent declines in eelgrass extent, coupled with decreases in water quality. Eelgrass extent in the harbor declined by 70% from 1995 to 2006[1]. Eelgrass beds are important as nursery habitat for finfish and invertebrates and play a key role in nutrient cycling and sediment filtering. Avoiding further impacts is critical to eelgrass recovery efforts.

As stated in our 2010 letter, Salem Harbor provides essential forage habitat for a variety of fish and invertebrate species including alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), rainbow smelt (Osmerus mordax), American eel (Anguilla rostrata), white perch (Morone americana), Atlantic tomcod (Microgadus tomcod), Atlantic cod (Gadus morhua) and American lobster (Homarus americanus). It is also habitat for the forage, spawning, and early development of winter flounder (Pseudopleuronectes americanus) an important recreational and commercial species currently in decline according to state and federal assessments. Soft shell clams (Mya arenaria) and blue mussel (Mytilus edulis) have been mapped by MarineFisheries within the project footprint.

Through correspondence in early March with Vivian Kimball of your office, I understand that the submarine route alternatives for installation of the cable again include horizontal directional drilling (HDD) and Jet plowing. From a fisheries habitat perspective, HDD will have impacts at the points of entry and exit and at the mid water station, but impacts to the seafloor would be avoided though most of the length of the submarine cable route. Alternatively, Jet plowing will result in disturbance within a larger area beneath Salem Harbor. Jet plowing will increase suspended sediments, causing turbidity and, if not effectively contained, further water quality degradation. Finally, the Jet plow alternative will have the greatest potential to impact eelgrass. Furthermore, as stated in our 2010 letter, the harbor supports shellfish and finfish habitat that may also be impacted. To avoid negative effects to marine fisheries resources, we recommend that National Grid further develop the land based route alternatives, and identify the alternative that will have the least environmental impact.

If you have any questions regarding these comments, please call me at our Gloucester Office (978-282-0308 x. 168)
Sincerely,

Tay Evans
Environmental Review Coordinator

cc.  Vivian Kimball (VHB)
     Ken Chin (DEP)
     Kathryn Glenn (CZM)
     Mike Johnson (NMFS)

References

April 27, 2010

Marc A. Bergeron  
Senior Project Manager  
Vanasse Hangen Brustlin, INC.  
101 Walnut Street  
P.O. Box 9151  
Watertown, MA 02472

Dear Mr. Bergeron,

The Division of Marine Fisheries, (Marine Fisheries), has reviewed the project options proposed by National Grid for the replacements of two 115 kilovolt underground cables located between the Salem Harbor substation and the Canal Street substation in Salem, Massachusetts. Below we provide comments on the marine fisheries resources and habitats at the project site.

Salem Harbor provides essential forage habitat for a variety of fish and invertebrate species including alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), rainbow smelt (Osmerus mordax), American eel (Anguilla rostrata), white perch (Morone americana), Atlantic tomcod (Microgadus tomcod), Atlantic cod (Gadus morhua) and American lobster (Homarus americanus). It is also habitat for the forage, spawning, and early development of winter flounder (Pseudopleuronectes americanus) an important recreational and commercial species currently in decline according to state and federal assessments.

Soft shell clams (Mya arenaria) and blue mussel (Mytilus edulis) have been mapped by Marine Fisheries within the project footprint. Pockets of eelgrass (Zostera marina) have also been mapped by DEP in Salem Harbor, falling within the project footprint. Eelgrass beds are important as nursery habitat for finfish and invertebrates and play a key role in nutrient cycling and sediment filtering.

National Grid is proposing two possible underground options for cable replacement; a land route and a route below Salem Harbor. If the Salem Harbor route is selected as the preferred alternative, a detailed argument for why the land route is not practicable will likely be requested by resource agencies in order to ensure that the project is avoiding and minimizing impacts to marine fisheries resources and habitats.

If you have any questions regarding these comments, please call me at our Gloucester Office (978-282-0308 x. 168)

Sincerely,

Tay Evans  
Environmental Review Coordinator

TE/ko
Marc Bergeron  
Senior Project Manager  
Vanasse Hangen Brustlin, Inc.  
Union Station, Suite 219  
Worcester, Massachusetts 01604  

MAR 18 2013  

Re: 115kV Cable Replacement Project, Salem, Massachusetts, Information Request  

Dear Mr. Bergeron:  

We have received your letter, dated January 22, 2013, requesting information regarding fisheries resources and planning consideration for the proposed submarine cable options within Salem Harbor, in Salem, Massachusetts. The proposed project involves replacing two 115-kilovolt underground cables currently located between the Salem Harbor substation and the Canal Street substation in Salem, Massachusetts. One of the project options involves installing the cables within Salem Harbor via jet plow or horizontal directional drilling (HDD) techniques. We are providing general information relative to our trust resources including essential fish habitat (EFH) and Endangered Species Act-listed species under our jurisdiction in the vicinity of the project.  

General Comments  
The maps enclosed in your letter indicate the two options being considered involve HDD and jet plow, both of which would occur within subtidal and intertidal marine habitats within Salem Harbor. Although details regarding the length of the corridors for each option were not provided in your letter, based upon the maps you provided, it appears the HDD option is considerably shorter than the jet plow option. In addition, the map for the HDD option contains a "mid-harbor platform", although it is unclear if this platform would be removed following the HDD operations or would be a permanent structure. A more detailed description of the proposed activity will be necessary for us to complete our consultations.  

Essential Fish Habitat and Other Fishery Habitats  
Salem Harbor supports living marine resources that provide for valuable recreational and commercial fisheries, as well as species and habitats that are critical to healthy marine and estuarine ecosystems. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act (FWCA) require federal agencies to consult with one another on projects such as this. Although your letter did not identify the federal action agency for the proposed project, we believe that the activities will require an Army Corps of Engineers’ (USACE) permit. You may contact the New England District USACE office in Concord, Massachusetts for information regarding necessary permit requirements and processes. Insofar as a project involves EFH, as this project does, this process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments and generally outlines each agency’s obligations in this consultation procedure.
An EFH Assessment should include at a minimum the following information: 1) a description of the proposed action; 2) an analysis of reasonably foreseeable impacts including secondary and cumulative effects on EFH, Federally-managed species and major prey species; 3) the action agencies views regarding the effects on EFH; and 4) proposed mitigation, as appropriate. Other information that should be contained in the EFH assessment, as appropriate, includes: the results of on-site inspections to evaluate the habitat and site-specific effects; the views of recognized experts on the habitat or the species that may be affected; a review of pertinent literature and related information; and an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH. EFH designations and individual species and life stage requirements are described in a series of source documents published by the National Oceanic and Atmospheric Administration’s Northeast Fisheries Science Center, which are available at the following website: http://nefsc.noaa.gov/publications/tm/.

A number our trust resources use habitats within or adjacent to the proposed project, including a number of life history stages for federally-managed species, as well as habitats that support them. The proposed project area has been identified as EFH for 25 federally-managed species, including pollock, winter flounder, windowpane flounder, Atlantic sea scallop, and bluefish. Additional information on EFH and the consultation requirement can be found on the National Marine Fisheries Service, Northeast Regional Office, Habitat Conservation Division website at: www.nero.noaa.gov/hcd/.

Please note that maps produced by the State of Massachusetts’ Office of Geographic Information (www.mass.gov/mgis/) indicate that eelgrass beds may occur within the identified cable corridors. On-site, underwater eelgrass surveys should be conducted during the summer growing season in order to confirm the presence of this benthic resource and to map the location of the beds within the project area. In addition, this area is known to support a number of shellfish resources, such as soft-shell clam, quahog, and blue mussel. Shellfish resources serve as habitat and prey for some federally-managed species and several species are considered a component of EFH pursuant to the MSA. All efforts should be made to avoid and minimize impacts to these fishery resources, and any unavoidable impacts should be offset through compensatory mitigation.

**Endangered Species Act**
The proposed action is within the range of the following listed species:

- **Gulf of Maine Distinct Population Segment (DPS) of Atlantic sturgeon** Threatened
- **New York Bight DPS of Atlantic sturgeon** Endangered
- **Chesapeake Bay DPS of Atlantic sturgeon** Endangered
- **Carolina DPS of Atlantic sturgeon** Endangered
- **South Atlantic DPS of Atlantic sturgeon** Endangered
- **Shortnose sturgeon** Endangered
- **North Atlantic right whale** Endangered
- **Humpback whale** Endangered
- **Fin whale** Endangered
- **Sei whale** Endangered
Northwest Atlantic DPS of loggerhead sea turtle
Leatherback sea turtle
Kemp’s ridley sea turtle
Green sea turtle

Listed whales and sea turtles also occur seasonally in Massachusetts waters; however, whales and sea turtles would be very rare visitors to Salem Harbor. Additionally, while shortnose sturgeon participate in coastal migrations in some portions of the range, this has not been documented in Massachusetts Bay. As such, we do not expect shortnose sturgeon to be present in the action area.

Section 7(a)(2) of the ESA states that each Federal agency shall, in consultation with the Secretary, insure that any action they fund, authorize, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect listed species must undergo Section 7 consultation. A permit from the USACE is likely to be necessary for the proposed project. As the lead Federal agency, they are responsible for determining whether the proposed action is likely to affect listed species and obtaining our concurrence with their determination. The USACE would submit their determination along with justification for their determination and a request for concurrence, to the attention of the ESA Section 7 Coordinator, NMFS Northeast Regional Office, Protected Resources Division, at the letterhead address above. After reviewing this information, we would then be able to conduct a consultation under section 7 of the ESA.

Conclusions
We appreciate the opportunity to provide you information regarding our trust resource during early coordination for the National Grid’s cable replacement project in Salem, Massachusetts. Should you have any questions regarding the Section 7 consultation process or ESA issues in general, please contact Julie Crocker at Julie.Crocker@noaa.gov or by phone at (978) 282-8480. Related correspondence or questions on EFH and FWCA consultations should be addressed to the attention of Michael Johnson with our Habitat Conservation Division at the letterhead address above, by email at Mike.R.Johnson@noaa.gov, or by phone at (978) 281-9130.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
For Habitat Conservation

cc: Mary Colligan/Crocker, PRD
Tay Evans, MA DMF
Ken Chin, MA DEP
Robert Boeri, MA CZM
Feasibility Study of Constructing the New S-145 and T-146 Transmission Lines via a Horizontal Directional Drill Installation under the Salem Harbor
Feasibility Study of Constructing the New S-145 and T-146 Transmission Lines via a Horizontal Directional Drill Installation under the Salem Harbor

prepared for

New England Power Company d/b/a National Grid
Waltham, MA

July 2013

Project No. 53411

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri
EXECUTIVE SUMMARY

Burns & McDonnell (BMcD) was requested to conduct an investigation into the feasibility and costs for installing the new S-145 and T-146 circuits under Salem Harbor via a Horizontal Directional Drill (HDD) for the purposes of avoiding a land installation through parts of Salem, MA. In support of this request, BMcD, along with their subconsultant Haley & Aldrich, Inc. (H&A), has prepared this Feasibility Study of Constructing the New S-145 and T-146 Transmission Lines via a Horizontal Directional Drill Installation Under the Salem Harbor. Please note the following clarifications:

- This Feasibility Study is limited to the installation of electrical cables under Salem Harbor via HDD and does not reflect on other electrical cable or HDD projects. All other projects should be evaluated independently on their own merits.
- This Feasibility Study does not compare the installation of the cables via HDD to other potential installation alternatives including underground or overhead cables.
- This Feasibility Study does not identify, or include the cost of obtaining, the environmental, construction and zoning permits required for the installation of electrical cables under Salem Harbor via HDD, nor does it make a determination of the feasibility of acquiring said permits.

In conducting this study, representatives of New England Power Company d/b/a National Grid (NEP), BMcD, and H&A visited the project site to evaluate proposed horizontal directional drill work zones. Based on the electrical and physical installation requirements of the project, the appropriate cable technology for the installation was selected. Available information from internal and external sources was then compiled and reviewed relative to subsurface conditions, including areas of contaminated ground. Additionally, reports prepared for the City of Salem and the US Army Corps of Engineers relative to planned and existing use of Salem Harbor were obtained and reviewed. Finally, utilizing this accumulated information, the following issues associated with this installation were evaluated:

- Work area for drilling and pipe installation
- HDD alignments across Salem Harbor, including potential platform locations.
- Existing geological conditions
- Existing biological conditions in the harbor
- Contamination of existing soil and water in the planned work locations
- Future land uses such as a proposed deep water cruise terminal
- Existing utilities and structure foundations along the proposed alignment(s)
- Street or land-based construction from the HDD end points to the substations
Cost and schedule risks associated with the installation of the harbor crossing via HDD construction

Estimates of probable construction costs for this project alternative.

As this evaluation was performed with regard to technical feasibility only, it does not address permitting or property rights acquisition associated with the HDD installation.

The results of this investigation are summarized below.

**Installation Summary**

NEP seeks to install two 115 kV circuits (the S-145 and the T-146) connecting the Company’s Salem Harbor Substation and its Canal Street Substation. High-Pressure Fluid-Filled (HPFF) cable is recommended for use for this HDD project alternative. An HPFF cable system consists of three cables, one of each phase, installed in a single cable pipe. To meet the required ratings, each circuit will consist of three cables per phase; therefore, six total cable pipes will be necessary for the two circuits for the length of the project. For the HDD portion, each cable pipe would be installed via a single bore from a given launch point to a given receive point, with a minimum separation between each as necessary to achieve the ratings at various points along the HDD alignment.

Each circuit would enter Salem Harbor near the Salem Harbor Power Plant, and exit Salem Harbor at the Palmer Cove baseball field. Due to the subsurface space constraints, the two circuits would be split between two launch locations for the northeastern HDD end points near the Salem Harbor Power Plant. These locations are shown on the figure below as Entry/Exit Point #1 and Entry/Exit Point #2.

Due both to the need for cable pull points, and to the lack of work space at the end points of the HDDs for assembling pipe for long pulls across the harbor, temporary, pile-supported mid-harbor platforms would be needed. Utilizing these platforms, the pipe could be assembled adjacent to land and floated into position for pullback at reasonable lengths. The following figure shows the anticipated alignment, platform locations, and segment identifications:
Segment D would consist of six separate bores for both circuits, Segment A three separate bores for one circuit, and Segment E three separate bores for one circuit. It is possible that further evaluation of subsurface conditions within the harbor could lead to the conclusion that Segment E (the longest segment) is infeasible to construct. In that case, Segment E could be split into Segments B and C, requiring the addition of a second mid-harbor platform. Therefore, either 12 or 15 individual bores would be required to install the two circuits.

Approximately 1.0 to 1.5 miles of land-based construction through City of Salem streets would also be required to bring the S-145 and T-146 circuits from the southwest end of the HDD at the Palmer Cove baseball field to the Canal Street Substation. Due to the width of the corridor necessary to house three parallel steel pipes, the two circuits would follow separate routes for most of the distance between the baseball field and the substation. Shorter land-based cables would also be required within the Salem Harbor Power Plant site to bring the S-145 and T-146 cables from the HDD end point to the substation.

Factors Affecting HDD Feasibility

There are several risk factors that could affect the ease with which the HDD can be completed. First, there is limited information available on the existing geological conditions for the harbor. This increases the likelihood of discovering unfavorable subsurface conditions. Unfavorable subsurface conditions
could lead to potential drill stem or pipe failure or collapse of the bore hole. Either of these results could increase the duration or the cost (or both) of the HDD.

In addition, available data suggests that contaminated soils may be present at both the Salem Harbor Power Plant site and the Palmer Cove baseball field, which is located on the site of a capped landfill. Cross-contamination could occur during the HDD if a bore hole were to transmit contaminated ground water to previously uncontaminated areas or underground aquifers. An environmental mitigation plan would decrease, but not eliminate, the likelihood of such cross-contamination.

The HDD process may also result in inadvertent return of drill mud to the surface (frac-out) at unplanned locations (i.e. a location in between launch and receive points). As pressured mud is used to maintain borehole integrity and to remove soil cuttings, success of the drilling operation could be jeopardized.

Because of the long pull length required for this project, HPFF cable is recommended for this installation. However, there is currently only one manufacturer of HPFF cable in the United States. As of the issuance of this report, that manufacturer is quoting lead times of twenty-four to thirty months for new cable orders. Thus, it may be impossible for NEP to obtain the required materials and construct the project before the proposed Footprint Plant expects to come online.

**Cost**

The anticipated cost of the HDD installation, including both HDD and land-based installation of the steel cable pipes plus cable and dielectric fluid installation, is estimated to be $109,640,000 at a tolerance level of +50/-25%. This cost estimate does not include the costs related to improvements needed at the Canal Street and Salem Harbor substations, permitting costs for the cables or substation improvements, or AFUDC and similar costs.

**Schedule**

The total duration of the HDD installation alternative is expected to be approximately fourteen to sixteen months. This includes seven to nine months actual drilling and pipe installation time from a platform (or platforms) in Salem Harbor, concurrent land-based installation, plus the remaining time to pull and splice cables, make final pipe welds around the splices, overboard the platform-constructed splices into the harbor, and disassemble and remove the platforms.

**Long Term Maintenance Issues**

A permanent installation of this type presents several long-term maintenance issues. First, should a cable failure occur along the under-harbor portion, it would be difficult to identify and locate the problem area.
Once the problem area is located, a similar level of effort as the initial construction would be needed in order to remedy the issue. This effort would include the construction of a mid-harbor platform, excavation of the direct-buried splice, pulling of the new cable, and reinstalling the repaired splice back into the harbor. Any leakage of the dielectric fluid from a damaged cable pipe would be released into Salem Harbor.

Additionally, permanent restrictions would be required within the harbor near the location(s) of the mid-harbor platform(s), due to the shallow burial of the cable pipes in those locations. The total trench lengths at the mid-harbor platform(s) are anticipated to be approximately 300 feet long. The permanently restricted areas would be approximately 200 feet wide by 500 feet long at each platform location so to encompass a portion of the HDD-installed pipe as it dives to a deep enough depth below the sea floor to be considered safe from outside impacts. Examples of the type of activities that could be prohibited within this zone would include dredging, exploratory borings, installation of new moorings, use of spud barges, and anchoring of larger ships.

Finally, because HPFF cables would be necessary, there would be regular inspection and maintenance needs for the dielectric fluid pumping plant, as well as the added maintenance procedure to rotate the spare cable reel(s) every three months in order to keep the cable impregnated with the dielectric fluid.

**Summary**

Overall, the project appears to be technically feasible, but with risks, costs, and other considerations as identified and discussed in detail within this document. It should be noted that this analysis is specific to this project only and the various factors associated with it. For other projects that may be proposed for different purposes and/or with different location-specific constraints and considerations, a potential HDD installation would be evaluated based on the unique and particular aspects of those projects, and may yield different results.
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1.0 INTRODUCTION

Burns & McDonnell (BMcD) has teamed with Haley & Aldrich (H&A) to perform a feasibility analysis of a potential Horizontal Directional Drill (HDD) installation under Salem Harbor for the replacement of the S-145 and the T-146 115-kV circuits. This study identifies potential launch and receive points for the HDD, identifies land routes from the HDD launch points to the Canal Street and Salem Harbor Substations, provides cost estimates for the HDD and for on-land construction, and evaluates potential constructability and long term maintenance issues associated with an under-harbor cable.

H&A has investigated the directional drilling and casing installation, and BMcD has evaluated the land portion and overall cable installation. The following document describes BMcD’s and H&A’s methodology and results from this investigation with regard to the feasibility and risk associated with the harbor crossing.
2.0 ELECTRICAL REQUIREMENTS

2.1 CABLE TECHNOLOGY

There are two basic types of cable technology suited for use in underground transmission projects: HPFF cables; and solid-dielectric cables with cross-linked polyethylene (XLPE) insulation. For an HDD installation across Salem Harbor, the most appropriate cable technology is HPFF cables. There are three primary reasons that this technology is superior to other cable technologies for this project: allowable pull length, borehole diameter, and sheath bonding requirements.

2.1.1 Allowable Pull Length

Typically, HPFF cables allow for cable pulls approximately 25 to 50 percent longer than pulls for a comparable XLPE cable. At the time of installation, HPFF cables are individually smaller and lighter than a comparable XLPE cable, because the dielectric fluid that serves as the primary cable insulation is installed after the cables are pulled. The lighter weight of the HPFF cable allows for longer cable length on a reel. Additionally, as all three phase cables are pulled into a single cable pipe as a bundle, the tension during the pull is distributed between the three cables via use of a pulling head attached to all three conductors as shown in Figure 2-1.

Figure 2-1 HPFF Pulling Head
2.1.2 **Borehole Diameter**

Because three cables are installed in a single cable pipe for an HPFF installation, as opposed to one cable installed in a single conduit for an XLPE installation, the total number and/or size of bore holes required is significantly less for an HPFF installation. For this project, each set of three HPFF cables would be able to be installed in a single 8-inch diameter steel pipe, which would consequently require an approximate 12- to 15-inch-diameter bore hole (bore holes for HDD installations are typically required to be approximately 1.5 times the diameter of the pipe or conduit to be pulled through). This contrasts with an XLPE installation in which individual conduits would be required for each cable of each phase, and therefore require a much larger (24 to 36 inches) bore hole to carry a group of three or six conduits, or, if each conduit were installed in a separate small bore hole comparable to that required for a single HPFF pipe, a larger total number of bore holes.

2.1.3 **Sheath Bonding Requirements**

Conventional land-based XLPE cables use a sheath grounding scheme to minimize circulating currents and maximize ratings. These types of schemes (single point- or cross-bonding) require the installation and maintenance of accessible link boxes, which are typically installed at manhole locations. In a submarine setting, there would be no manholes, and therefore no means of installing and maintaining link boxes. The submarine XLPE cable system therefore would have to employ a multi-point bonding arrangement for grounding. This arrangement would result in increased circulating currents and reduced cable ampacity, and thus require additional cable to meet the ratings requirement. Furthermore, a submarine splice on an XLPE system is not typically done, and would therefore require a custom splice design.

2.2 **AMPACITY REQUIREMENTS**

The new S-145 and T-146 transmission lines are required to achieve a summer normal rating of 300 MVA and a 12-hour summer emergency rating of 400 MVA. The ampacities were calculated based on the following assumptions:

- Maximum conductor temperatures of 85°C (HPFF) under normal operating conditions and 105 ºC under emergency operating conditions
- Emergency calculations completed for a 12-hour duration
- All emergency calculations assume 100% steady state 300 MVA preload before entering emergency conditions, even if this is less than then maximum achievable normal loading of the cables.
• Actual maximum calculated normal ampacity, based on a conductor temperature equal to 85°C, may exceed required normal rating; however, cables operated in this condition will not meet the required emergency rating.

• Load Factor is assumed to be 0.90 for all configurations

2.3 DETERMINATION OF SIZE AND NUMBER OF CABLES REQUIRED

Based on the potential HDD alignments and landfall locations discussed in Section 3.0 of this report, three controlling locations were analyzed as part of this study to determine the size and number of cables required: at the Salem Power Plant, at the midpoint of the alignment under Salem Harbor, and at the ball field west of Palmer Cove. The following assumptions were made regarding the thermal resistivity of the soils (“thermal rho”) and the ambient earth temperatures at these locations, based on previous work in the Northeast United States:

• Thermal rho: 150 ºC cm/W at the ball field; 250 ºC cm/W at the midpoint of the alignment under Salem Harbor; and 220 ºC cm/W at the sea wall.
• Summer ambient earth temperature: 20 ºC at the ball field; 15 ºC at the midpoint of the alignment under Salem Harbor; and 18 ºC at the sea wall.

The three controlling locations are discussed in further detail as follows:

2.3.1 Power Plant Installation Location

At the entrance/exit point south of the Salem Harbor Power Plant, the HDD would need to descend to a depth of approximately 70 feet to pass under a seawall without damaging the existing sheeting and piles. Most of the soil in this area is fill that was used to build up this area of the power plant site. The fill would likely consist of large pieces of broken concrete and large aggregate fill with large void areas in which heat could be trapped. This trapped heat would raise the temperature of the cables and cause a de-rating of the cable. This de-rating impact contributes to the number of cables per phase needed to reach the required ratings.

2.3.2 Harbor Mid-Point Installation Location

The second location that was analyzed was at the mid-point of the harbor, well away from the mid-harbor drilling platform. At this location, the bores would be approximately 60 to 70 feet below the bottom of the harbor. The harbor floor contains a thick stratum of organic matter that can trap the heat below the surface. This trapped heat would raise the temperature of the cables and cause a de-rating of the cable. This organic layer along with the needed depth contributes to the number of cables required per circuit.
2.3.3 Baseball Field Installation Location

The final location analyzed was the point where the bores surface within the ball fields west of Palmer Cove. In this area, the bores are at their shallowest position as they ascend to the surface. The soil in this area has the potential to be best for the bores as it relates to thermal properties. The combination of better thermal properties of the soil and shallow depth leads to a drastic decrease in the required separation of the bores. If the further investigation reveals that this area was once a landfill that contains highly organic soil and large voids, the minimum separation will need to be increased.

2.3.4 Summary Table

Based on the three locations identified above, Figure 2-2 shows the cable size and minimum separation between cables pipes necessary to achieve the ampacity rating required for the project.

**Figure 2-2 Required Duct Bank Cable Ampacity Summary**

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Required Ratings (MVA)</th>
<th>Minimum Separation (edge-to-edge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1 (3500 kcmil HPFF Cable, three cables per phase), Salem Harbor Power Plant</td>
<td>300 Normal, 400 Emergency</td>
<td>30’</td>
</tr>
<tr>
<td>Location 2 (3500 kcmil HPFF Cable, three cables per phase), Salem Harbor Mid-Point</td>
<td>300 Normal, 400 Emergency</td>
<td>35’</td>
</tr>
<tr>
<td>Location 3 (3500 kcmil HPFF Cable, three cables per phase), Ball Field</td>
<td>300 Normal, 400 Emergency</td>
<td>5’</td>
</tr>
</tbody>
</table>