DESCRIPTION

This work shall consist of furnishing, installing, operating, monitoring, maintaining, and removing an Isolation Casing and Bubble System (ICAB system) to attenuate underwater noise generated by driving piles. All work specified herein shall be performed in accordance with the contract documents and as directed by the Engineer.

MATERIALS

The ICAB system shall be fabricated of components selected by the Contractor to meet the requirements of the specification and approved by the Engineer.

CONSTRUCTION DETAILS

1. Design. The design of the ICAB system shall be submitted within one week of contract award. The ICAB system shall consist of an isolation casing, which isolates its interior from dynamic forces present in the water column, and an air bubble curtain system operating within the casing. The isolation casing consists of a rigid sheath, of larger diameter than the pile being driven, that penetrates into the river sediment at the bottom and extends through the water column and above the water surface at the top, thereby mechanically isolating the pile from river flow. The air bubble curtain system consists of an air compressor(s) providing oil-free compressed air in sufficient volume and pressure to self-purge water from the bubblers and maintain the required bubble flux for the duration of pile driving, supply lines to deliver the air, distribution manifolds or headers, and perforated aeration pipes. Any framing or other appurtenances necessary to facilitate the transport and placement of the system, keep the aeration pipes stable, and provide ballast to counteract the buoyancy of the aeration pipes in operation shall be designed so as to avoid direct contact with the pile being driven. The following represent the minimum design requirements for the ICAB system:
   a. The isolation casing shall consist of corrugated metal pipe, steel pipe or pile sections, HDPE pipe sleeve, or other material, that is of sufficient rigidity to ensure that the interior areas will be mechanically isolated from river flow at all times and is approved by the Engineer.
   b. The isolation casing shall be sufficiently massive or supported by structural elements such that it will remain stationary and not deflect under all river flow conditions to be encountered during pile driving.
   c. The inner diameter of the isolation casing shall be sufficiently large such that the pile being driven does not directly contact the casing itself or any of the submerged air bubble curtain equipment at any time.
   d. The bottom of the isolation casing shall be in contact with and embedded into the mudline for its full circumference. Direct hydraulic connection between the area within the isolation casing and the river water column will not be permitted under any circumstance. If obstructions in the riverbed interfere with full seating of the isolation casing, such obstructions shall be removed.
e. Any hardware interior to and connected to the isolation casing that is meant to guide, align, or otherwise come in contact with the pile being driven must be constructed of material that will not transmit vibration.

f. The height of the isolation casing above mean high water shall be sufficient to ensure that no water will be expelled from the noise attenuation system while in use.

g. The air bubble curtain system shall be constructed such that the pile being driven is completely engulfed in bubbles over the full depth of the water column at all times during pile driving with an impact hammer, or as otherwise specified by the Engineer.

h. The ICAB system shall consist of a ring of horizontal perforated aeration pipe within the isolation casing and surrounding the pile being driven in multiple heights. The lowest tier of perforated aeration pipe shall be in contact with the river bed, but the system shall be designed to prevent the aeration pipes from sinking into the river bed. An additional tier of aeration pipe shall be provided at midheight of the water column, as measured at Mean Low Water at the location of the pile being driven.

i. The inner most edge of the aeration pipe shall be no further than 2 feet from the pile casing.

j. The ICAB system’s air supply shall be designed to provide a steady, constant flow rate of at least 40 standard cubic feet of air per minute per linear foot of aeration pipe (scfm/lf), discharged at a water depth of 25 feet, and the discharge rate shall be capable of variation between 15 and 40 scfm/lf.

k. The aeration pipe shall be fabricated with three rows of 1/16-inch diameter bubble release holes. The bubble release holes in each row shall be spaced 1.0 inches apart. One row of bubble release holes shall be situated at the crown or apex of each aeration pipe. Each of the other two rows of bubble release holes shall be offset, from the crown of each aeration pipe, by 30 degrees.

l. Compressed air system gauges shall be provided in accordance with the following:
   i. Pressure gauges shall be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
   ii. Flow meters shall be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet.
   iii. Gauges shall be installed so as to be accessible to the Engineer. The Contractor shall keep a continuous log of all gauges when the system is operating. The Contractor shall maintain a graphical plot showing the variation of the gauge readings with time.
   iv. Operating values for pressure and flow rates will be established by the Contractor. And approved by the Engineer during the driving of the first pile segment. If the pressure or flow rate in any gauge falls below 90% of its operating value, the Contractor shall cease pile driving operations until the problem is corrected to the satisfaction of the Engineer.
   v. Air pressure and air flow gauges shall be calibrated prior to use in the bubble curtain system. Gauges shall be accurate to within 2 percent of the range.
m. The design, installation, maintenance, monitoring, operation and removal of the ICAB system shall take into account the site conditions and the requirements of pile installation. Factors to be taken into account include: anchoring, moving, and dismantling the system; configuration of river bed; water velocity; water-surface conditions; air and water temperatures; and positioning of pile and pile-driving equipment relative to the ICAB system and its components. Water velocity at the site is expected to vary in direction due to changes in tidal flow. The design of the ICAB system shall ensure that the system’s bubble flux extends from river bed to the water surface.

2. **Working Drawings.** Within two weeks of contract award, the Contractor shall submit working drawings for the ICAB system to the Engineer for approval in conformance with the provisions in “Design,” of these specifications. The working drawings shall be fully coordinated with all other working drawings to be provided by the Contractor. The working drawings shall provide complete details of the ICAB system, including mechanical and structural details. Working drawings shall be signed by a Mechanical Engineer who is registered in the State of New York. Working drawings shall include the following:
   a. Details of anchorage components, air compressors, supply lines, distribution manifolds, aeration pipes, isolation casing, and any related appurtenances.
   b. Details of proposed means of isolating noise-producing systems on the pile-driving barge
   c. Independently checked design calculations for the ICAB system.
   d. ICAB system materials list shall include the manufacturer, model number, description, and standard of manufacture for each component.
   e. Manufacturer's descriptive data and catalog cuts for all products proposed for the ICAB system, including air compressors.
   f. Calculations showing pressure loss in the piping system and estimated flows from the most removed orifice of the aeration piping.

3. **Noise Attenuation.** Hydrophones (deployed, maintained and operated by others) employed to confirm the expected level of noise reduction will be positioned approximately at mid-water column depth and approximately 33 feet [10 meters] from the pile being tested.

4. **In-Situ Test.** Prior to driving any test pile, conduct an in-situ test of the ICAB system to demonstrate its capability to deliver compressed air in the quantity required by this specification. The test shall demonstrate the operating capability of the noise attenuation system through at least four on/off cycles. For the purposes of the In-Situ Test, an on/off cycle shall consist of a continuous period of at least ten minutes of air flow, followed by a continuous period of at least five minutes with no air flow and no visible bubbling at the water surface. Provide the Engineer the opportunity to observe the in-situ tests. Pile driving shall not be initiated unless the Engineer concurs that the testing demonstrates the ICAB system can achieve the required air delivery rate and can be successfully cycled.
5. **Operating Requirements.** The ICAB system shall be operated in accordance with these specifications, and as indicated on the project drawings.
   a. Operation of noise attenuation systems as required by these specifications shall not interfere with navigability of the Hudson River.
   b. At those times when the ICAB system is being tested for its noise attenuation capability, no other piles shall be driven except the pile where the test is being conducted.
   c. The pile driving operation shall be acoustically isolated from the pile driving barge. This isolation shall be such that noise from the pile driving operation is not transmitted through the barge to the water column. Padding and avoidance of metal-to-metal contact shall be ensured. Air compressors, where utilized, shall be mounted on rubber pads or other sound isolating devices, in order to decrease the sound transmitted from the compressors to the water column.
   d. Furnish to the Engineer boats, laborers, and equipment to enable inspection of ICAB system as they are installed, once fully installed, and at such other times as requested by the Engineer.
   e. Provide the Engineer sufficient secure space, on the barge supporting the pile driving equipment, to set up underwater noise monitoring equipment and to operate such equipment when the ICAB system is being tested.
   f. Operate the ICAB system at the locations shown on the drawings.
   g. In addition to the recording of pile driving data as specified elsewhere, record and provide to the Engineer, within 24 hours of the completion of driving of each test pile, the following information:
      i. On/off status of the ICAB system during driving.
      ii. A time-history of all air pressure readings and airflow measurements recorded throughout the test period at the air inlet to the ICAB system, and at each point where pressure is being recorded.
      iii. Adjustments made to the operation of the ICAB system based on feedback provided by the Engineer.
      iv. Pile driving time-history for each test pile driven with the ICAB system installed, including total number of blows, energy per blow, blows per inch, and depth of pile embedment.
   h. The ICAB system will be operated in various modes during pile driving in order to assess effectiveness of the system to attenuate underwater noise. Generally, for each section of pile, this will involve pile driving with the system turned off and at two different air flow rates. Unless otherwise approved by the Engineer, Contractor shall operate the ICAB system as specified herein and on the drawings. Sequencing and duration of the On/Off cycles are based on pile length. Each pile shall be driven and monitored in no more than two segments. Each segment will be monitored in two cycles, each one-half of the segment length. Within each cycle, the ICAB system shall be turned off for the first one-third of the cycle (based on length), operated at a flow rate of 22 scfm/lf for the next one-third of the cycle, and operated at a flow rate of 35 scfm/lf for the last one-third of the cycle. When turning the ICAB system on, pile driving shall stop temporarily stop until the bubble flux visible at the water surface has stabilized and then remained steady for at least two minutes, after which pile driving may resume.
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When changing the air flow rate, pile driving shall temporarily stop until the bubble flux visible at the water surface has stabilized and then remained steady for at least two minutes, after which pile driving may resume. When turning the ICAB system off, the pile driving shall stop temporarily until no bubbles are observed at the water surface for at least two consecutive minutes, after which pile driving may resume.

i. Confer with the Engineer at the completion of the first pile installation. The Engineer will provide the preliminary acoustic monitoring results obtained during driving. If the Engineer concludes, based on monitoring results, that the requirements of these specifications are not being met, modify the operation of the ICAB system so as to improve its noise attenuation performance. Do not initiate driving any additional piles unless the Engineer concurs that the modifications proposed can reasonably be expected to improve the noise attenuation system performance.

j. Completely remove the ICAB system at the completion of the project, which will remain the property of the Contractor.

METHOD OF MEASUREMENT
This work will be measured on a lump sum basis.

BASIS OF PAYMENT
The lump sum price bid shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work.