DESCRIPTION

This work shall consist of furnishing, installing, operating, monitoring, maintaining, and removing a Confined Bubble Curtain System (CBC 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 CBC 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 CBC system shall be submitted within one week of contract award. The CBC system shall consist of an aquatic barrier that shields its interior area from dynamic forces present in the water column, and an air bubble curtain system operating within the barrier. The aquatic barrier extends through the entire water column, eliminating or reducing river currents that would otherwise disrupt or impair the effectiveness of the air bubble curtain. 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, perforated aeration pipes, and a frame. Framing for the aquatic barrier shall 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. The following represent the minimum design requirements for the CBC system:
   a. The aquatic barrier shall consist of material capable of preventing water flow along its entire length, such as plastic sheeting, cloth, or other material proposed by the Contractor and approved by the Engineer. Sufficient rigidity of the barrier to ensure that it will remain in place and not interfere with functionality of the air bubble curtain system and/or the pile being driven may be provided by means of a frame, rings, or other methods proposed by the Contractor and approved by the Engineer.
   b. The aquatic barrier shall be sufficiently 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 interior space contained by the aquatic barrier shall be sufficiently large such that the pile being driven does not directly contact the barrier itself or any of the submerged air bubble curtain equipment at any time.
   d. The bottom of the aquatic barrier shall be in contact with 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 aquatic barrier,
such obstructions shall be removed or the pile relocated (with the Engineers’
permission only).
e. Hardware interior to and connected to both the aquatic barrier and the pile being
driven (if required or proposed by the Contractor) must be constructed of material
that will not transmit vibration.
f. The air bubble curtain system shall consist of a single horizontal tier of perforated
aeration pipes. The perforated aeration pipes shall be in contact with the river
bottom but the system shall be designed to prevent the aeration pipes form sinking
into the river bottom.
g. The single tier of perforated aeration pipes shall consist of rings of three aeration
pipes spaced 1 foot on center. The inner most aeration pipe shall be no further
than 2 feet from the pile casing.
h. The CBC 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.
i. Each 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.
j. 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.
k. The design, installation, maintenance, monitoring, operation and removal of the
CBC 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 bubble curtain system. Water velocity at the site is
expected to vary in direction due to changes in tidal flow. The design of the CBC
system shall ensure that the system’s bubble flux extends from river bed to the water surface during maximum water current conditions and accommodates tidal changes.

2. **Working Drawings.** Within two weeks of contract award, the Contractor shall submit working drawings for the CBC 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 CBC 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 and frame.
   b. Details of proposed means of isolating noise-producing systems on the pile-driving barge.
   c. Independently checked design calculations for the CBC system.
   d. CBC 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 CBC 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 CBC 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 CBC system can achieve the required air delivery rate and can be successfully cycled.

5. **Operating Requirements.** The CBC 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 CBC 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 CBC 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 CBC system is being tested.

f. Operate the CBC 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 CBC 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 CBC system, and at each point where pressure is being recorded.
   iii. Adjustments made to the operation of the CBC system based on feedback provided by the Engineer.
   iv. Pile driving time-history for each test pile driven with the CBC system installed, including total number of blows, energy per blow, blows per inch, and depth of pile embedment.

h. The CBC 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 CBC 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 CBC 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 CBC 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. 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 CBC 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 CBC 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 CBC 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.