

Acoustic and/or Vibration Monitoring System

The Contractor shall provide all services and deliverables as required, described, and detailed herein, and shall meet all service and delivery timelines as specified by this Contract. The Contract Term shall be for three years with two additional one-year options to renew. The Contractor shall provide building vibration monitoring services as described below.

A. GENERAL SPECIFICATIONS

A.1. Definitions.

- a. Building means the James K. Polk building located at 505 Deadrick Street, Nashville, Tennessee 37243.
- b. Monitoring System means a continuous vibration and/or acoustic monitoring system with associated sensors and any mounting hardware installed and maintained by the Contractor.

A.2. Description of Work.

- a. The Contractor shall provide a Monitoring System for the 18-story James K. Polk Building in downtown Nashville that will continually monitor the existing post-tensioned truss anchorage and roof framing systems for acoustic anomalies and/or unusual floor vibrations.
- b. The Contractor's services shall include assembly, deployment, testing, maintenance, data collection, and reporting unusual events to the State for further evaluation.
- c. The Monitoring System shall be capable of detecting and pinpointing the source of the anomalous vibrations or acoustic anomalies within a five foot radius of the sensor(s). The Monitoring System shall at all times function independently of the State's network and shall include a broadband device such as a cellular modem to relay information to the offsite storage area.
- d. The Contractor shall provide a minimum sixty (60) month warranty on the installation, the materials required for the installation, and the service life of the monitoring equipment.
- e. The Contractor shall provide personnel on site to monitor the installation, setup, and initial testing of the equipment.
- f. The Contractor shall include all fees necessary to provide continuous data collection and report unusual events to the State for a period of no less than 60 months.
- g. The Contractor shall remain aware of the unique structural qualities of the Building as follows:

- i. The structural steel columns and beams at the outer perimeter are suspended from the ends of triangular trusses at the roof level. These trusses extend from a post-tensioned concrete roof deck located over the central rectangular cast-in-place concrete core of the building.
- ii. The five structural drawings in Attachment A illustrate the framing details at the top of the structure where the Monitoring System shall installed.

A.3. Submittals.

- a. The Contractor shall submit to the State and maintain the following information:
 - i. The manufacturer's data for anchors, electrical boxes, and associated wiring, and all equipment (including computers, monitors, modems, relevant software, etc.).
 - ii. Shop drawings for the entire Monitoring System (including power supply, data acquisition and monitoring system; wiring diagrams; point-to-point diagrams; mounting details; computer logic diagrams for the proposed acquisition and monitoring software; and schematic diagrams). The Contractor shall submit all drawings to the State for approval prior to fabrication.
 - iii. Sample reports that demonstrate the presentation of reporting.
 - iv. An operational and maintenance manual for the Monitoring System, which shall include the manufacturer's literature, operation instructions, control diagrams, wiring diagrams, maintenance instructions and requirements, manufacturer's parts list, complete list of parts and supplies, and operating diagrams.

A.4. Storage and Handling.

- a. The Contractor shall handle all components carefully to prevent damage and shall replace all damaged components at no cost to the State.
- b. In the event that any components are damaged, the Contractor shall remove those components from the site within 24 hours.
- c. The Contractor shall store all system components in a clean dry space and per manufacturer recommendations and/or directions.

B. MONITORING SYSTEM SPECIFICATIONS

B.1. The Monitoring System may, at the Contractor's option, include the following:

- a. A total of 16 single-axis accelerometers, such as, PCB 353-B33, Endevco Isotron 43A,

or an equivalent product, may be set to record each event that exceeds a preset trigger threshold and may be mounted at the following locations:

- i. At the core structure roof level slab, attach eight accelerometers to the underside of the concrete slab shown in Attachment A, Figure 1 (one at each corner, one at the middle of both long sides, and two in the middle region of the slab).
 - ii. At the perimeter of the building roof level, attach eight accelerometers to the underside of the deck as shown in Attachment A, Figures 2 and 3 (one at each corner and one at the middle of each side).
- b. Remote access to the Monitoring System, which would be maintained through a self-contained cellular modem. The modem can either be a combination of gateway and modem, such as a Novatel USB551L in a Cradlepoint router or equivalent product, or a self-contained system, such as an Airlink Raven XE by Sierra Wireless or equivalent product.

B.2. The Contractor may propose, in addition to or instead of the system described in B.1., an acoustic Monitoring System or an alternate vibration Monitoring System. The data acquisition system should scan all sensor channels simultaneously at a minimum rate of 10 kHz and trigger to capture waveform files with a minimum duration of one second. An example of a suitable system is a National Instruments cRIO Model 9064 chassis with four NI-9234 C-series modules. Another option is a National Instruments CompactDAQ chassis with National Instruments Model NI-9234 C-series modules controlled by a laptop computer or any equivalent product.

B.3. The Monitoring System shall include a means of notifying the State of any vibratory or acoustic anomalies within a five (5) minute period. The Monitoring System shall be capable of identifying the source location of the anomaly so that it can be evaluated by qualified personnel.

B.4. The Contractor's install process shall include but not be limited to the following.

- a. The installation shall include furnishing and installing the wiring suitable for the temperature, conditions, and locations.
- b. The Contractor shall ensure that any conduit for electrical wiring shall be corrosion-resistant and approved for electrical use.
- c. Upon completion of installation of all wiring, the Contractor shall ensure that all cabling electrical boxes and equipment are properly grounded in accordance with the 2014 National Electrical Code (NEC).

C. FIELD QUALITY CONTROL

- C.1. Prior to energizing the Monitoring System, the Contractor shall check the installed wires, cables, and transmission media for electrical continuity and for short circuits.
- C.2. The Contractor shall implement acceptance testing on site prior to the completion of the installation process. The Contractor shall outline acceptance testing methods in the installation manual and shall supply the results to the State.
- a. Codes and Standards:
- i. The Contractor's testing shall conform to the International Electrical Testing Association Acceptance Testing Standard.
 - ii. The Contractor shall ensure the Monitoring System complies with all applicable local electrical code requirements for Metro Nashville, Davidson County, and with the 2014 National Electrical Code (NEC) as applicable for installation.
 - iii. The Contractor shall ensure the mounting of the anchors, fasteners, hangers, supports, and equipment for the Monitoring System complies with the National Electrical Contractors Association's "Standard for Installing and Maintaining."
- C.3. The Contractor shall test all power circuits. The receptacles shall be tested for continuity, grounds, shorts, and impedance with a circuit analyzer. The supply conductors shall be given a continuity test and an insulation test.
- C.4. The Contractor shall inspect all cable and system components at the project site to ensure all components are not damaged.
- C.5. Once the Monitoring System is installed, the Contractor shall test to verify:
- a. There is an appropriate signal quality,
 - b. The trigger thresholds are set appropriately so that everyday operations within the building will not trigger notice of a normal event, and
 - c. All remote communications are operational.
- C.6. The Contractor shall ensure that the Monitoring System delivers the following metrics at all times:
- a. Continuous monitoring with a service level agreement minimum uptime of 99.99%
 - b. Weekly reports on system activity

- c. Critical reports delivered within five (5) minutes of an observed anomaly.
- d. Best practice maintenance for as per manufacturer recommendations for the system.
- e. The Contractor shall deliver software updates or hardware repairs for critical bugs within 15 days and normal patching and firmware upgrades from stable releases.