REPORT OF
PRECONSTRUCTION SURVEY AND VIBRATION MONITORING SERVICES

LSU MEDICAL CENTER
NEW ORLEANS, LOUISIANA

PSI FILE NUMBER 251-950114

PREPARED FOR

STANLEY GROUP
721 GOVERNMENT STREET
SUITE 302
BATON ROUGE, LOUISIANA 70802

January 13, 2010

BY

PROFESSIONAL SERVICE INDUSTRIES, INC.
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Information To Build On
Engineering • Consulting • Testing

October 26, 2009

Stanley Group
721 Government Street
Suite 302
Baton Rouge, LA 70802

Attn: Mr. Brant Richard, P.E.

Re: Preconstruction Survey and
Vibration Monitoring/ Engineering Services
LSU Academic Medical Center
New Orleans, Louisiana
PSI Report No. 251-950114

Dear Mr. Richard:

Professional Service Industries (PSI) is pleased to submit the following Report relative to our recently completed pre-construction survey and vibration monitoring/engineering services for the above referenced project.

We appreciate the opportunity to perform this pre-construction survey and look forward to continued participation during the demolition and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

Mark Carlson, M.S.C.E., M.S. Mng. E., P.E.
Chief Engineer

Steven P. Kenley
Senior Vice President

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PROJECT AUTHORIZATION

Professional Service Industries, Inc. (PSI) has completed a pre-construction survey of the area surrounding the proposed LSU Medical Center. The report includes the results of the survey and provides recommendations for threshold limits for ground motions to be considered by the structural engineer during demolition of the existing structures and during construction of the new development. Our services were conducted in general accordance with PSI Proposal No. 251-900250, dated June 19, 2009.

SCOPE OF SERVICES

Based on the aforementioned proposal, the scope of services includes the following:

- *A video survey and still photographs of the exterior of structures as observed from public easements/sidewalks including:*
  Structures along one block west of South Galvez Street between Canal Street and Tulane Avenue.
  Structures along one block south of Tulane Avenue between South Galvez and I-10
  Structures along one block north of Canal Street between I-10 and South Galvez Street
  Structures along one block east of I-10 between Tulane Avenue and Canal Street

- *A vibration survey along the project boundaries. This includes the use of multiple seismographs set at various locations during the day for a period of five days to establish baseline vibration levels due to vehicular traffic and other non-construction vibration sources near remaining sensitive structures in the vicinity of the project site.*

- *Provision of recommendations for vibration levels based on AASHTO guidelines and local practices by the USACE and other local government agencies.*

- *Development of protocols for on-site vibration monitoring during demolition of the existing structures and construction of the proposed Medical Complex.*

- *Development of a protocol for stop work and recommendations for reducing vibration, as necessary.*

PROJECT BACKGROUND

The project site encompasses fifteen (15) blocks of residential and commercial properties which will be demolished to accommodate the proposed LSU Medical Center. The project is bounded by Canal Street to the north, I-10 to the east, South Galvez Street to the west, and Tulane Avenue to the south. More specifically, the historic and other key structures that are situated within close proximity to the project site include:

- *St. James AME Church located at 222 North Roman Street*
- *St. Louis Cemetery No. 2 located at 1600 St. Louis Street*
- *Charles Orleans House located at 1800 Canal Street*
- *McDonough School No. 11 located at 2001 Palmyra Street*
- *Charity Hospital located at 1532 Tulane Avenue*
- *Sister Stanislaus facility located at 450 South Claiborne Avenue*
- *St. Joseph Roman Catholic Church located at 1802 Tulane Avenue*

- *McDonough School No. 30 located at 2228 Gravier Street*
- *Falstaff Brewery located at 2600 Gravier Street*
- *Dixie Brewery located at 2401 Tulane Avenue*
- *Pan American Building located at 2400 Canal Street*
- *Deusches Haus located at 200 South Galvez Street*
- *St. John's Evangelical/Lutheran Grace United Methodist Church located at 2001 Iberville St.*

A historic property (Charles Orleans House), which is located within the construction zone at 1800 Canal Street, will remain in place during construction and could sustain some damage due to construction activity induced vibrations if it is located in the vicinity of any pile driving operations. This Engineering Report is intended to develop base line vibration levels in the development area and suggest controls for the upcoming construction activities (which by definition in this report includes all demolition activities, pile driving, and all other general construction activities that result in ground motions being generated as a direct result of the work in the interest of health, and safety of employees and the public, as well as the protection of nearby historic and other key structures).

PRE-CONSTRUCTION MONITORING ISSUES

The following Section describes *critical issues* that are recommended by PSI to be addressed for the successful management of ground motions and/or appurtenant damage induced by excessive peak particle velocities (PPV's) as the result of construction activities:

Public Awareness

Letters should be sent and personal contact should be made with residents, institutional operators, and business establishments that are within the construction area and near enough for ground vibrations from construction activities to be easily perceptible. This contact must be made prior to the beginning of any construction activities. The Contractor is required to furnish the Engineer with a list of those contacted prior to the construction activities and include on that list all pertinent information as required by the Engineer.

Permanent Displacement

A line (location) and grade (elevation) survey should be performed by a surveyor licensed by the State of Louisiana. It should establish control and gradelines to detect movements along the exterior faces of the key buildings. This survey should be conducted on all buildings situated within a 100 foot radius of the specific construction locale where the work is specifically being performed and all historic buildings or structures within a 500 foot radius.

All control lines and grades must be referenced to existing benchmarks which must be established far enough from the construction site to be preserved for all surveys. Reference points are generally taken at a distance greater than 750 feet from the subject site (from where the construction activities are actually being performed) such that they are well beyond the construction zone. Tilting of the nearest walls of structures will be established by measurement with a portable tiltmeter or other suitable method.

Buildings included in this survey are those that could experience permanent deformation because of their proximity to the construction activities. The amount of deformation expected, therefore needs to be quantified as such measurements must be made at intervals determined by the Engineer, but at least once a month.

Existing Building Cracks

Permanent deformation of buildings should be monitored with crack monitoring gauges. The type of gauges must be determined by type of potential distress (plaster cracks, movement, etc.). A minimum of six (6) crack monitoring gauges should be placed on strategic structures within a radius of 100 feet from the nearest construction activities operations, and on buildings or structures of particular concern (such as historical monuments and buildings) within a radius of 500 feet from specific construction activities.

Surveys and gauge readings are generally obtained weekly. The report should summarize the survey and crack opening data. The area monitored by surveys and gauges will be 500 feet out from the proposed construction activity.

PRE-CONSTRUCTION SURVEY

Vibration Baseline Survey

A pre-construction vibration survey was undertaken by PSI between September 15 and September 29, 2009 prior to the initiation of any activity at the site. The survey was conducted using an Instantel Blastmate III vibration monitors. The Blastmate III monitor records the vector sum of the wave velocity in inches per second. The survey was generally conducted near selected occupied structures surrounding the proposed medical complex. The objective of the vibration survey is to establish baseline ground motions caused by vehicular traffic (buses, cars, trucks, trolleys, and non-construction vibration sources) near the remaining sensitive structures surrounding the project site. These vibration levels will be compared to vibrations induced during construction and may be used to set threshold limits for vibration induced damage.

A review of the vibration monitoring data generally indicates peak particle velocities (PPV) ranging from 0.0282 ips to 0.271 ips. The latter vibration level was caused by an RTA bus and a truck trailer passing concurrently near the northwest corner of 300 Claiborne Avenue.

The results of the baseline field monitoring are presented in Appendix A. A summary of the peak particle velocity values recorded during the survey is presented in Table 1.

TABLE 1
MAXIMUM PEAK PARTICLE VELOCITY (PPV)

Date	Time	Location	Distance from Source	Max PPV (ips)	General Comments
9/15/09	5:34 AM	1801 Canal Street	11'	0.0727	Due to traffic movement and background
9/15/09	12:41 PM	NE Corner of 1800 Canal Street	5' to 30'	0.119	Due to speeding dump truck
9/16/09	6:46 AM	SE Corner of 1901 Canal Street	4' to 20'	0.0497	Due to traffic movement
9/16/09	10:52 AM	NE Corner of 1800 Canal Street	5' to 30'	0.128	Due to traffic movement
9/17/09	5:09 PM	SW Corner of 2021 Canal Street	4'	0.0572	Due to traffic movement

TABLE 1
MAXIMUM PEAK PARTICLE VELOCITY (PPV) ***(continued)***

9/17/09	11:11 PM	SE Corner of 2201 Canal Street	5' to 50'	0.0906	Due to traffic movement
9/18/09	10:30 AM	16' off SW Corner of 2025 Canal Street	4'	0.0746	Due to traffic movement
9/18/09	1:00 PM	SE Corner of 239 and 241 Galvez Street	5' to 20'	0.102	Due to traffic movement
9/21/09	3:06 PM	SE Corner of 335 Galvez Street	5' to 30'	0.0416	Due to traffic movement
9/21/09	2:45 PM	NE Corner of 1820 Tulane Avenue	25'	0.0332	Due to traffic movement
9/22/09	2:24 PM	SE Corner of 2201 Tulane Avenue	5' to 40'	0.0758	Due to traffic movement
9/22/09	6:51 AM	NE Corner of 1900 Block of Tulane Avenue	10'	0.0775	Due to traffic movement
9/23/09	8:28 AM	NW corner of 2000 Tulane Avenue	10'	0.2100	Due to semi-truck passing by
9/23/09	4:12 PM	NE Corner of 2200 Tulane Avenue	5' to 50'	0.1350	Due to semi-truck passing by
9/24/09	1:29 PM	NW Corner of 2104 Tulane Avenue	12'	0.0501	Due to traffic movement
9/24/09	2:59 PM	NE Corner of 2122 Tulane Avenue	5' to 50'	0.1400	Due to semi-truck passing by
9/25/09	10:27 AM	NW Corner of 1630 Canal Street	10' to 20'	0.0292	Due to traffic movement
9/28/09	8:17 AM	NW Corner of 300 Claiborne Avenue	20'	0.2710	Due to RTA bus and semi-truck
9/29/09	4:42 PM	SW Corner of 1661 Canal Street	15' to 25'	0.0282	Due to traffic movement

Existing Structures Condition Survey

A cursory condition survey was undertaken for the existing commercial and residential buildings situated within about one (1) block surrounding the construction site. This preliminary survey documents the existing exterior conditions of these buildings as observed from public easements and sidewalks.

The survey includes general documentation of above-grade accessible areas and visible exterior as viewed from the grade level. It details (by videotape and/or photographs) the existing condition and include walls, sidewalks, and areas of buildings highlighting existing damage. Photographic documentation of each building was also provided to supplement the video survey. It must be emphasized that this survey was not all inclusive nor does it satisfy industry standards for a complete, in-depth condition survey of all of the structures.

The results of the conditions survey of the structures are included in Appendix B of this document. This information includes DVD format videos of the subject structures and numerous still-photographs.

PEAK PARTICLE VELOCITY

By definition, the *peak particle velocity* (PPV) is the maximum rate of change of position (displacement) with respect to time as measured on the ground surface. The velocity amplitudes are given in units of inches per second (ips), zero to peak amplitude. The *frequency* of vibration is the number of oscillations that occur in 1 second. The frequency units given are in hertz (cycles per second).The *dominant frequency* is usually defined as the frequency at the maximum particle velocity, which will be calculated visually from the seismograph strip chart for the half cycle that has its peak, the maximum velocity.

Control of Peak Particle Velocities

Construction activities must be controlled by limiting ground peak particle velocity (PPV). Peak particle velocity is used as the *sole measure* of the level of vibration (ground motion) and should be measured with the instrumentation and methods described in this report. Peak particle velocity must satisfy the following controls:

The peak particle velocity must be less than a specific control limit at the nearest key/historic structure. The type of structure and distance between this structure and the nearest pile will dictate the allowable value as described in Table 2. It must be emphasized that the following criterion is based on local practice within the City of New Orleans and is very conservative relative to that criterion that is typically used by AASHTO and other agencies (such as MSHA or the USBM) elsewhere in the USA. The particle velocity must be recorded in three (3) mutually perpendicular axes with the maximum allowable peak particle velocity being the maximum measure along any of three (3) axes:

TABLE 2
LIMITING SUSTAINED PEAK PARTICLE VELOCITIES

Structure and Condition	(in./sec)
Historic structures	0.25
Residential structures	0.25
New residential structures	0.5
Industrial building	1.0
Bridges	1.0

The limiting PPV values in the above Table may be adjusted based on site specific studies conducted during the test pile program prior to construction.

Historic/ Vibration Sensitive Structures

Thresholds of vibration induced cracking are generally site specific and depend on the type and age of the structure, the frequency of ground vibration, and type of soil supporting the structure. Research by the U.S. Bureau of Mines (USBM) and other investigative groups have established criteria relating the occurrence of structural damage to certain frequencies and level of ground motion. According to the USBM, within the range of four (4) to 12 hertz, the maximum particle velocity recommended to preclude the threshold damage to plaster-on-wood for old structures is 0.5 inch per second (ips) and 0.1 ips established for historic monuments. Furthermore, threshold limit for *sustained* vibration of 0.25 ips has been established and is used in the area by structural engineers including the USACE. This criterion is also necessary to preclude the detrimental effects of settlement that could be induced on adjacent structures as the result of excessive PPV's. The natural soil material underlying much of downtown New

Orleans is comprised of very soft sediment (as the result of its depositional environment from the Mississippi River) and is susceptible to consolidation (settlement) as the result of excessive ground motions. Considering the type of structures adjacent or nearby the proposed construction, this standard will be adopted for this project to limit vibration and minimize its impact on adjacent structures. Other properties of interest such as the St. Louis Cemetery located at St. Louis Street are in excess of about 600 to 800 feet from the site will not be adversely impacted by the construction activities (as traffic-induced vibrating will govern as demonstrated in Table 1 above). Properties situated outside a peripheral limit of 500 feet beyond the foci of the individual construction/demolition activities have been shown to not be adversely influenced by PPV's of the anticipated magnitude *(NCHRP Synthesis 253—Dynamic Effects of Pile Installations on Adjacent Structures; Transportation Research Board). PPV's dissipate (attenuate) significantly over horizontal distance and beyond about 500 feet from the individual construction activities (using the 0.25 ips criterion) are neither perceptible nor damaging to structures. Therefore, no adverse effects on the St. Louis Cemetery are anticipated since truck/bus traffic situated adjacent to the cemetery site already imposes PPV's in excess of those that will be generated by these construction activities.*

Application of the Peak Particle Velocity (PPV) Control/ Stop Work Protocols

If the Contractor exceeds 80 percent of the ground vibration PPV control limit for any single axis during construction activities, the contractor must immediately submit a written Report to the Engineer showing the vibration measurements data and include the corrective action for the next pile to be driven or other construction activity to ensure that the limit will not be exceeded.

If the Contractor exceeds 100 percent of the ground vibration control limit for any single axis during construction activities, the contractor must cease related construction activities and immediately notify the engineer. In addition, a written report should be submitted to the engineer. The Report must provide data and include necessary proposed corrective action to ensure that the specified PPV limit will not be exceeded. Such corrective measures may include the use of open trenches situated between the ground motion source and the key structure that is being monitored (which have been documented to have a dramatic reduction influence on the magnitude of PPV's) or the alteration of specific construction methodologies (such as the pile driving hammer or other characteristics of the driving process) with the intent of reducing PPV's to the tolerable levels outlined in Table 2 above.

FIELD MONITORING OF VIBRATIONS DURING CONSTRUCTION

Test Pile Program

Vibration monitoring during the test pile program is intended to provide guidance for the choice of pile installation techniques for the project within set threshold vibration limits. Since thresholds of vibration induced cracking generally depends on the type and age of the structures, the frequency of ground vibration and the type of soil supporting the structure, a site specific survey is recommended during the test pile program to establish peak particle velocity and distance relationship guidelines for thresholds and enable a better prediction of the vibration intensity on this site using the proposed pile driving hammer. The information gathered during the test pile program can be compared to the baseline vibration survey and threshold limits for vibration induced damage may be set prior to job pile installation.

Demolition of Existing Structures

Vibration monitoring should be conducted during the demolition of the existing structures, particularly if occupied structures or structures remaining on site are within 200 feet of a demolition site. One or multiple monitors must be set at the nearest possible locations to the structures being monitored provided access is granted.

Job Pile Installation

Two (2) types of pile drivers can be used for this project: namely, impact or vibratory hammers. The Contractor must be aware of the fact that ground vibrations induced by these machines are of a very different nature, and therefore utmost care must be taken in the selection of the equipment and construction method.

The same type of hammer used during the test pile program must be used for installation of the project piles. Pre drilling/jetting techniques may also be used as approved by the Geotechnical Engineer of record and implemented during the test pile program.

FIELD MONITORING OF VIBRATIONS (PPVs)

Recorded Data

Peak Particle Velocity – All three (3) components (longitudinal, transverse, vertical) of particle velocity must be measured on the ground at the location of the nearest and other strategic structures and/or at any locations the Engineer deems necessary for any particular construction activities operations. These measurements must be made on the ground situated adjacent to these key structures as the construction activities are on going.

Construction Activities Log – The Contractor must maintain a construction activities log and must submit Reports to the Engineer on piles driven and vibrations measured. These logs must be in the form specified in the Construction Plan.

Instrumentation

Vibration Monitors – (Seismographs) Vibrations in the form of particle velocities must be monitored by Type I and/or Type II monitors. Type I is a waveform recorder. It provides a particle velocity wave form or time history of the recorded event, sometimes in conjunction with peak event information. Independent chart recorders with separate motion transducers can be used in place of "stand-alone" monitors like seismographs when approved by the Engineer. Type II is known as a continuous peak particle velocity recorder and it provides no waveform and therefore no frequency information. Either Type I or II recorders can be employed for this PPV monitoring.

When the measurement surface consists of asphalt or concrete, the transducers must be bolted to the measurement surface or bonded with high strength adhesive. [The transducer units of most portable seismographs can be removed from the measurement case and installed at an appropriate location on the ground or structure. It is only this transducer unit that needs to be coupled to the surface on which it is sensing vibration]. On other surface the mass of the seismograph and/or transducer package may be sufficient for good coupling. For significant accelerations (greater than 1.0g), adhesive or bolts must be used on all solid surfaces. All transducers on vertical surfaces must be bolted in place. In some locations burying the transducers will minimize air borne noise, while in other situation, sand bags over the transducers can aid with coupling and reducing air borne noise.

Archiving of Reports

Monitoring records are generally kept for a period of at least three years and must include, as a minimum, the following information:

- *All monthly surveys conducted for vibration control purposes, including the preconstruction survey.*
- *The original construction plan, as well as any adjustments made to it during the course of the construction activities.*
- *All monitored data, relative to each and every pile installed. These construction records must contain all information as required and approved in the construction activities plan, including all information concerning the type and characteristics of the monitoring instruments used, their locations and orientations.*
- *All construction records correlated with monitored date.*
- *All weather conditions occurring during the construction activities.*

REPORT LIMITATIONS

This pre-construction survey is a preliminary survey and limited in scope. The condition survey of the structures was conducted from the sidewalks which captured what could be seen from that location. Consequently, some existing conditions may not have been captured in this survey and therefore, a more detailed survey of the structures in question is recommended including mapping existing cracks on structures of concern to better define the current conditions of the structures prior to construction. Furthermore, it is recommended that PSI be retained during the demolition and construction phase to verify conformance with our recommendations and/or make appropriate adjustments to the recommended thresholds, as necessary. The engineer warrants the findings, recommendations, specifications or professional advice contained herein have been made in accordance with generally accepted professional engineering practice in the local area. No other warranties are implied or expressed.