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Absolute and Relative Gravity Survey
Part One
Southeastern Louisiana

February - March 2018

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1. Introduction

a. Background

This report presents the results of a gravity survey in support of U.S. Army Corps of Engineers (USACE), New Orleans District and the Center for Geomatics (C4G) at Louisiana State University, Baton Rouge. The survey was conducted by Mr. R. David Wheeler (Team Chief, 575-679-2893), Mr. John Brockmeier, Mr. Jason Gazeley, Mr. Branden Langley, Mr. A. Trent Patch, Ms. Roberta L. Paz, Mr. Daniel Steineman and Mr. Thomas Sandoval of the National Geospatial-Intelligence Agency (NGA). Survey dates were February 26 – March 23, 2018.

b. Points of Contact:

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2. Requirements

Absolute gravity values are requested at twenty (20) locations throughout Louisiana. Seven (7) absolute gravity locations were measured during this deployment. The remaining sites will be measured in the future. The accuracy requirements for this survey were “best achievable”.

3. Procedures

a. Absolute Gravity:

The absolute gravimeters used for this survey, FG5-107 A10-009 and A10-010 were validated prior to deployment to Louisiana at Table Mountain Geophysical Laboratory (TMGO), Boulder Colorado. All gravimeters agreed with known gravity values within the acceptable validation values. A more comprehensive explanation of the location of these absolute stations is given in section 7 **‘Station Descriptions’**.

PHYS AA: in Louisiana, an absolute gravity station, ‘**PHYS AA**’ was established with FG5-107, at the James W. Nicholson Hall, East Annex, Room 33, on the campus of Louisiana State University. Multiple day, independent measurements were made at this absolute station. Gravimeters A10-009 and A10-010 were validated at **‘PHYS AA’**, pre and post deployment and were found to be within acceptable validation values.

HAMM: After validation on **‘PHYS AA’,** A10-009 was deployed to Hammond, Louisiana where multiple day, independent measurements were taken on absolute station **‘HAMM’,** located in the basement of Ralph R. Pottle Music building on the campus of Southeastern Louisiana University.

NOL RESET: A10-009 was then moved to New Orleans, Louisiana where multiple day, independent measurements were taken on absolute station **‘NOL RESET’** which is located in the J. Edgar Monroe Science Complex on the campus of Loyola University.

NSUT RESET: After validation on **‘PHYS AA’** A10-010 was deployed to Thibodaux, Louisiana where multiple day, independent measurements were taken on absolute station **‘NSUT RESET’,** which is located in the H.D. Ellender Hall on the campus of Nicholls State University.

NEW ORLEANS AA: A10-010 was then moved to New Orleans, Louisiana where multiple day, independent measurements were taken on absolute station **‘NEW ORLEANS AA’** which is located in the basement of the Engineering Building Structures Laboratory on the campus of New Orleans University.

BATON ROUGE AA: FG5-107 remained on the campus of Louisiana State University, but was moved to absolute station **‘BATON ROUGE AA’** located in Patrick F. Taylor Hall, where multiple day, independent measurements were taken.

LIGO AA: FG5-107 was then deployed to Livingston, Louisiana where multiple day, independent measurements were taken on absolute station **‘LIGO AA’,** which is located in the high bay clean room of the Laser Interferometer Gravitational-Wave Observatory (LIGO).

b. Relative Gravity:

Relative observations from the established absolute stations were made using a 1-2-3-4-3-2-1 ladder-type loop structure with four Scintrex CG-5 Autograv gravity meters (Serial Numbers 40244, 40245, 40582 and 40687).

Louisiana State University: in Baton Rouge the relative gravity ladder-type loop included relative measurements on gravity stations **‘BATON ROUGE AA’, ‘BATON ROUGE DA’, ‘ERAD 1.5’ ‘PHYS AA’**.

Southeastern Louisiana University: in Hammond the ladder-type loop included relative measurements on gravity stations **‘HAMM’**, **‘HAMM RM1’**, **‘HAMM RM2’** and **‘HAMM RM3’**.

Loyola University: in New Orleans the ladder-type loop structure included relative measurements on gravity stations **‘NOL RESET’**, **‘QUAD RESET’** and **‘INRI RM1’**.

Nicholls State University: in Thibodaux the ladder-type loop structure included relative measurements on gravity stations **‘NSUT RESET’**, **‘NSUT X’** and **‘NSUT Y’**.

New Orleans University: the ladder-type loop structure included relative measurements on gravity stations **‘NEW ORLEANS AA’**, **‘NEW ORLEANS EA’** and **‘NEW ORLEANS FA’**.

LIGO: in Livingston the ladder-type loop structure included relative measurements on gravity stations **‘LIGO AA’**, **‘LIGO BA’** and **‘LIGO CA’**.

Additional Ladder-Type Loops: two other loops were measured, the **‘EAST-LOOP’** consisted of relative observations at absolute gravity stations **‘LIGO AA’**, **‘HAMM’**, and **‘NEW ORLEANS AA’** and the ‘**WEST-LOOP’** consisted of relative observations at absolute gravity stations at **‘LIGO AA’**, **‘PHYS AA’**, **‘BATON ROUGE AA’** and **‘NSUT RESET’**. These were used to further validate the absolute gravity readings.

c. Gravity Gradient:

Relative observations from the ground to a one meter tripod were made using a 1-2-1-2-1-2-1 type loop structure with four Scintrex CG-5 Autograv gravity meters (Serial Numbers 40244, 40245, 40582 and 40687). The loop structure included a gravity gradient measurement at all absolute gravity stations **‘PHYS AA’**, **‘HAMM’**, **‘NOL RESET’**, **‘NSUT RESET’**, **‘NEW ORLEANS AA’**, **‘BATON ROUGE AA’** and **‘LIGO AA’**. The gradient value is used to reduce absolute gravity measurements to the survey monument.

4. Computations and Analysis

a. Absolute Gravity:

‘PHYS AA’: the absolute gravity value was determined from data collected with a Micro-G LaCoste FG5 gravity meter using Micro-G LaCoste **‘G9’** software. Approximately six days of mostly independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.004 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the FG5’s measurement location (approximately 130 centimeters above) to the established gravity monument on the ground.

‘BATON ROUGE AA’: the absolute gravity value was determined from data collected with a Micro-G LaCoste FG5 gravity meter using Micro-G LaCoste **‘G9’** software. Almost four days of mostly independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.004 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the FG5’s measurement location (approximately 130 centimeters above) to the established gravity monument on the ground.

‘LIGO AA’: the absolute gravity value was determined from data collected with a Micro-G LaCoste FG5 gravity meter using Micro-G LaCoste **‘G9’** software. Two days of independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.004 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the FG5’s measurement location (approximately 130 centimeters above) to the established gravity monument on the ground.

‘HAMM’: the absolute gravity value was determined from data collected with a Micro-G LaCoste A10 gravity meter using Micro-G LaCoste **‘G9’** software. Almost three days of mostly independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.011 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the A10’s measurement location (approximately 71 centimeters above) to the established gravity monument on the ground.

‘NOL RESET’: the absolute gravity value was determined from data collected with a Micro-G LaCoste A10 gravity meter using Micro-G LaCoste **‘G9’** software. Over five days of mostly independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.011 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the A10’s measurement location (approximately 71 centimeters above) to the established gravity monument on the isolated pier.

‘NSUT RESET’: the absolute gravity value was determined from data collected with a Micro-G LaCoste A10 gravity meter using Micro-G LaCoste **‘G9’** software. Almost four days of mostly independent observations were taken at the station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.011 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the A10’s measurement location (approximately 71 centimeters above) to the established gravity monument on the ground.

‘NEW ORLEANS AA’: the absolute gravity value was determined from data collected with a Micro-G LaCoste A10 gravity meter using Micro-G LaCoste **‘G9’** software. Almost five days of mostly independent observations were taken at station. A weighted mean of this observation was calculated at the station. The absolute precision term was 0.011 mGal. Using the Scintrex CG-5 relative meters, a gradient value (microGal/centimeter) at the absolute site was determined. This gradient was applied to the absolute gravity value to relocate it from the A10’s measurement location (approximately 71 centimeters above) to the established gravity monument on the ground.

b. Relative Gravity:

A dynamic drift value is computed from the observations at the initial control station (**‘PHYS AA’**) for each meter. This is applied to the individual observations, linearly; by time. The relative gravity value for each station was determined from data collected with the CG-5 meters. The output from these meters is automatically corrected for static drift and earth-tide effects. The delta gravity value of the observations from each meter is then processed with NGA proprietary GravNet 3.1 software. These deltas are then applied to the absolute station to determine the gravity value at each measured relative gravity station. The relative precision terms were between 0.005 mGal and 0.013 mGal for all stations.

c. Gravity Gradient:

A dynamic drift value is computed from the observations at the initial control station (**‘PHYS AA’**) for each meter. This is applied to the individual observations, linearly; by time. The relative gravity value for each station was determined from data collected with the CG-5 meters. The output from these meters is automatically corrected for static drift and earth-tide effects. The delta gravity value of the observations from each meter is then processed with NGA proprietary GravNet software. This delta is the gravity gradient. The relative precision terms were less than 0.005 mGal for all gradients.

5. Corrections to Absolute Gravity

a. Earth Tide and Ocean Loading

Earth Tide and Ocean Loading corrections (effects of lunar-solar attraction and tidal parameters) are applied to each drop. The '**G9**' software accommodates two Tidal Correction methods, ETGTAB and Berger. Within each it is possible to incorporate an ocean loading model. This collection utilized the ETGTAB for the earth tide model and the Schwiderski ocean tidal model. For more advanced information regarding the tide models visit http://www.ecgs.lu, or Dr. Oliver Francis at (oliver@ecgs.lu).

b. Polar Motion

Polar Motion corrections, defined as changes in the centrifugal acceleration due to the variation of the distance of the earth's rotational axis from the gravity station, are applied to each drop. The daily final polar motion coordinates (post-processed) were obtained from the International Earth Rotation Service (IERS), Bulletin B, found at http://www.usno.navy.mil.

c. Transfer Height

The transfer height at the observed absolute stations was 0.000 meters. This means that the gravity value is reported at the survey monument at ground level. The nearest observed gradient is used to transfer the observed gravity position to the transfer height. The observed gravity position is a known point made up of a fixed internal instrument height (71.90 cm for A10-009, 71.40 cm for A10-010 and between 130.52 cm and 130.82 cm for FG5-107).

d. Barometric Pressure

The observed gravity is normalized to the nominal air pressure at the station by applying a correction based on the observed atmospheric pressure during each drop of every set.

6. Gravity Results

Absolute Gravity Values at Survey Monument				Gradient	
STATION NAME	**Louisiana Locations**	**ADJUSTED GRAVITY milliGal**	**PRECISION TERM milliGal**	**GRADIENT milliGal per meter**	**PRECISON TERM milliGal per meter**
PHYS AA	**Louisiana State University**	979333.528	0.004	-0.285	0.001
BATON ROUGE AA	**Louisiana State University**	979333.179	0.004	-0.305	0.005
LIGO AA	**Livingston**	979350.716	0.004	-0.301	0.001
HAMM	**SE Louisiana State University**	979351.280	0.011	-0.253	0.001
NOL RESET	**Loyola University**	979311.888	0.011	-0.292	0.002
NSUT RESET	**Nicholls State University**	979306.873	0.011	-0.313	0.001
NEW ORLEANS AA	**University of New Orleans**	979317.068	0.011	-0.247	0.003

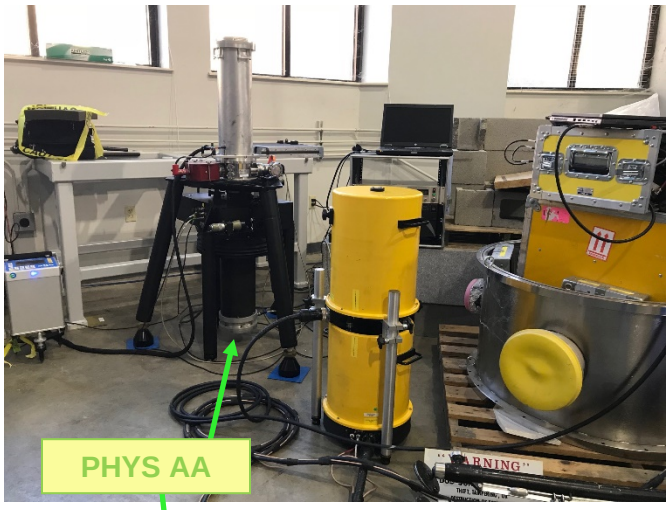
Relative Gravity Values			
STATION NAME	**Louisiana Location**	**ADJUSTED GRAVITY milliGal**	**PRECISION TERM milliGal**
Baton Rouge DA	**LSU**	979333.441	0.005
ERAD 1.5 M	**LSU**	979333.215	0.005
LIGO BA	**Livingston**	979350.782	0.005
LIGO CA	**Livingston**	979350.848	0.005
HAMM RM1	**SE Louisiana State Univ**	979350.445	0.011
HAMM RM2	**SE Louisiana State Univ**	979350.539	0.012
HAMM RM3	**SE Louisiana State Univ**	979350.540	0.012
QUAD RESET	**Loyola University**	979312.259	0.011
INRI RM1	**Loyola University**	979312.446	0.012
NSUT X	**Nicholls State Univ**	979306.880	0.011
NSUT Y	**Nicholls State Univ**	979307.112	0.011
NEW ORLEANS EA	**University of New Orleans**	979316.464	0.011
NEW ORLEANS FA	**University of New Orleans**	979316.463	0.012

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	PHYS AA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana – East Baton Rouge	Baton Rouge
LATITUDE	LONGITUDE	ELEVATION
30° 24' 45.716" N	91° 10' 44.291" W	10.295 meters (NAVD88)
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze survey disk	NGA	PHYS AA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
Disk position/Disk elevation	C4G	C4G-NGA 2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
LA VRS(NAD 83)/Leveling	g = 979,333.528 ± 0.004 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Louisiana State University, Baton Rouge, LA in the James W. Nicholson Hall East Annex basement room 33. To reach the mark from the south stairs entrance to the basement of Nicholson Hall Annex, turn right and proceed 13.1 meters along hall (drinking fountain on the right), turn left and proceed 22.9 meters into lab, turn left 24.4 meters toward west wall to the mark on the right, 1.4 meter south of the northeast-southwest row of windows, 4 meters northwest of the northwest corner of a large support pillar and 4.3 meters east of a circuit breaker box on west wall. Station is a 6 cm bronze NGA disk countersunk into the concrete floor. For access contact J. Anthony Cavell, CFedS Surveyor / Research Specialist, Center for GeoInformatics, Louisiana State University 225-578-4525

DIAGRAM/PHOTOGRAPH



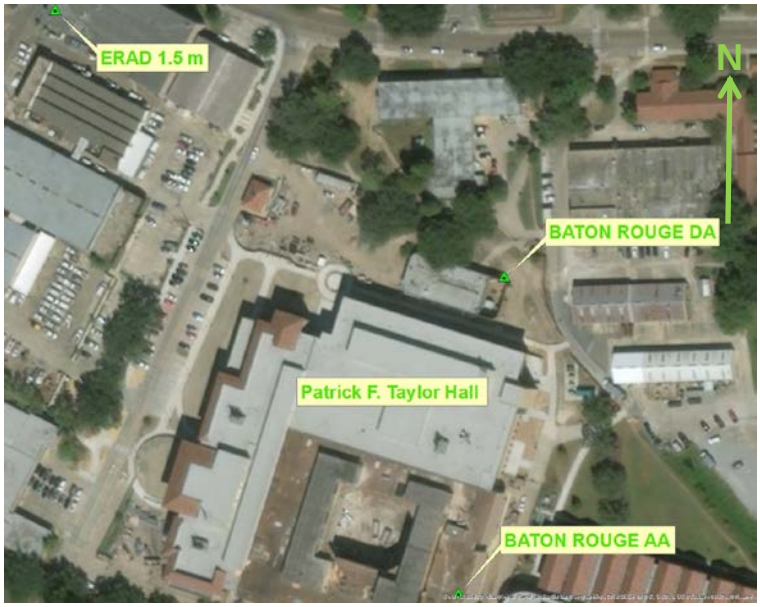
DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

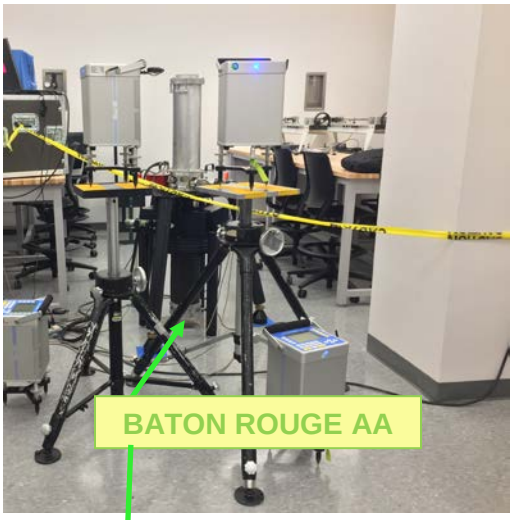
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	Baton Rouge AA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - East Baton Rouge	Baton Rouge
LATITUDE	LONGITUDE	ELEVATION
30° 24' 26.2" N	91° 10' 45.9" W	6.5 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
2 cm brass plug	NOAA-NGS	Baton Rouge AA 2002
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	Winester(NGS-06)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979333.179 ± 0.004 mGals (NGA, 03/2018)	

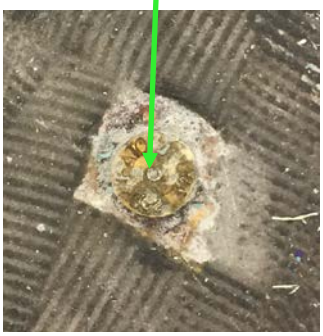
DESCRIPTION/CONTACT

The station is located at Louisiana State University, Baton Rouge, LA in the Patrick F. Taylor Hall. Station is on ground level in Materials Engineering Testing Laboratory, classroom 1322 near the southeast corner of the building. It is 7.7 meters northwest of the southeast wall, 4.4 meters northeast of the southwest wall, 4.0 meters southwest of the northeast wall, 3.1 meters southeast of the northwest wall, 0.5 meter south of a support pillar and about level with the concrete floor. For access contact J. Anthony Cavell, CFedS Surveyor / Research Specialist, Center for GeoInformatics, Louisiana State University 225-578-4525

DIAGRAM/PHOTOGRAPH







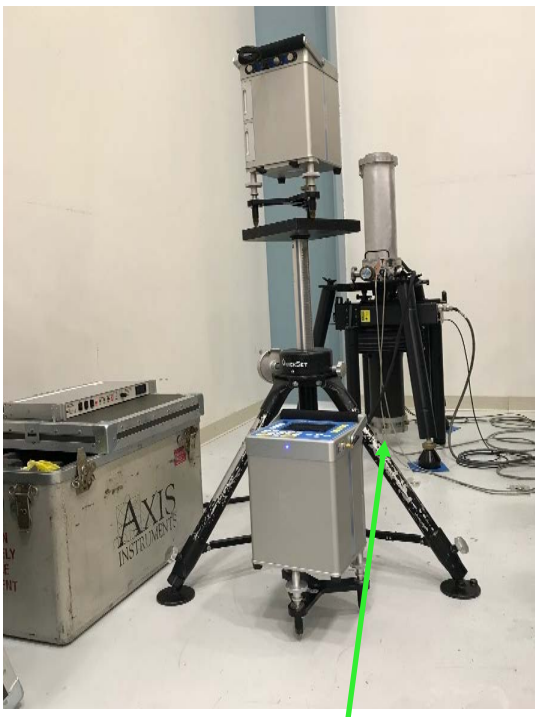
DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

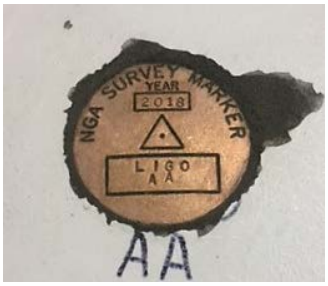
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	LIGO AA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Livingston	Livingston
LATITUDE	LONGITUDE	ELEVATION
30° 33' 49.6" N	90° 46' 33.0" W	19.0 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze survey disk	NGA	LIGO AA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA 2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979350.716 ± 0.004 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at the Laser Interferometer Gravitational-Wave Observatory (LIGO), north of Livingston, Louisiana. Station is located in southwest corner of the High Bay-Clean Room facility. Station is a 6 cm bronze NGA disk countersunk into the concrete floor. It is 1 meter north of the south wall and 1 meter east of the west wall. For access contact Tim Nelson, Facilities Team Lead, 225-686-3120.

DIAGRAM/PHOTOGRAPH





LIGO AA

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	HAMMOND AA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Tangipahoa	Hammond
LATITUDE	LONGITUDE	ELEVATION
30° 30' 47.4" N	90° 28' 03.0" W	9 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm survey disk	NIMA (NGA)	HAMM 2002
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	Winester(NGS-06)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979351.280 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Southeastern Louisiana University, Hammond, LA in the Ralph R. Pottle Music Bldg. (built 1990). Enter north-northeast side of bldg. to hallway's first door on right, which is a stairwell. At bottom of stairwell, go south-southeast into 4 m by 4 m, electrical room and station (under northeast portion of the auditorium). It is in the northwest corner, 1.1 m southeast of northwest wall and 0.9 m northeast of southwest wall. 6 cm disk is epoxied to concrete floor and stands proud of floor by 13 mm. For access contact Ben Norman, Music and Performing Arts, 985-549-5039.

OTHER STATION DESIGNATIONS: NN 962, DOD 0013-0, GSS 118O02

PID: DH4226

DIAGRAM/PHOTOGRAPH

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

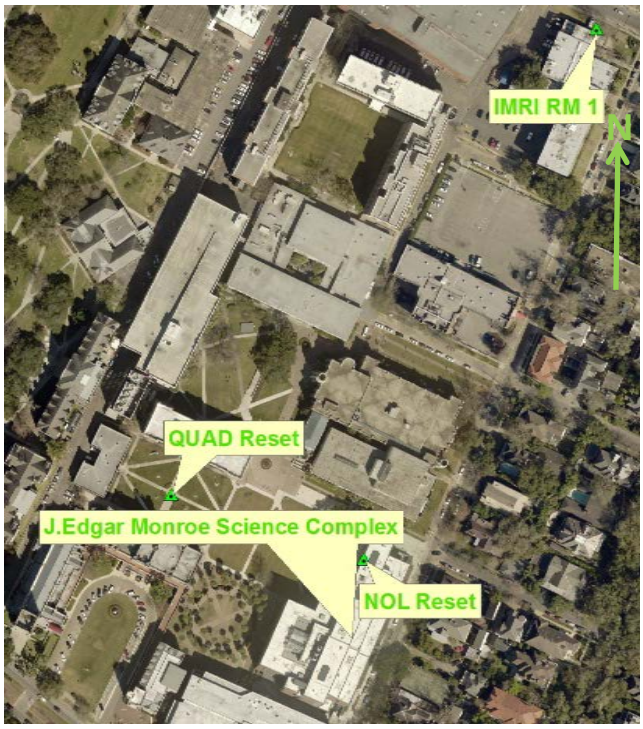
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	NEW ORLEANS NOL Reset
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
29° 56' 04.8" N	90° 07' 12.5" W	1.8 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
9 cm brass gravity disk	NOAA-NGS	NOL Reset 2017
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	Winester(NGS-91)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979311.888 ± 0.011 mGals (NGA, 03/2018)	

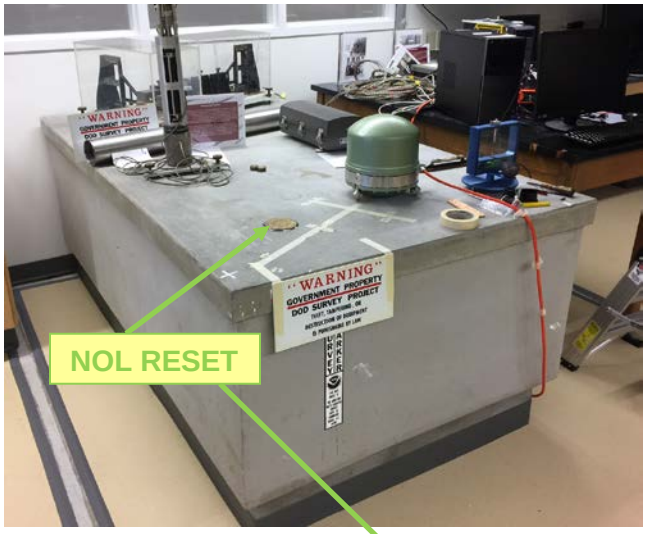
DESCRIPTION/CONTACT

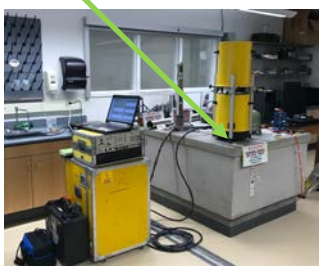
The station is located at Loyola University in New Orleans, LA in the J. Edgar Monroe Science Complex building. Station is at the north-northeast end of the building on the ground level, in Physics lab room 153, an interior room housing a seismic pier. Station is at the west-southwest corner of the seismic pier (2.2 meters by 1.25 meter by 0.87 meters high), 0.3 meters from the corner, 13.4 meters northeast of exterior door, 6.7 meters east-southeast of west wall and 13.3 meters north northeast of south-southwest wall. Original disk was removed and the current “NOL Reset” disk is epoxied as near as possible in the original’s location. For access contact Dr. Martin McHugh, Associate Professor of Physics, 504-865-2451.

OTHER STATION DESIGNATIONS: DOD 0577-6, IGB 08290, NHO 112.07

DIAGRAM/PHOTOGRAPH







DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	THIBODAUX NSUT Reset
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - LaFourche	Thibodaux
LATITUDE	LONGITUDE	ELEVATION
29° 47' 26.0" N	90° 48' 18.1" W	2.6 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
2 cm brass plug	C4G	NSUT Reset 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	Winester(NGS-06)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979306.873 ± 0.011 mGals (NGA, 03/2018)	

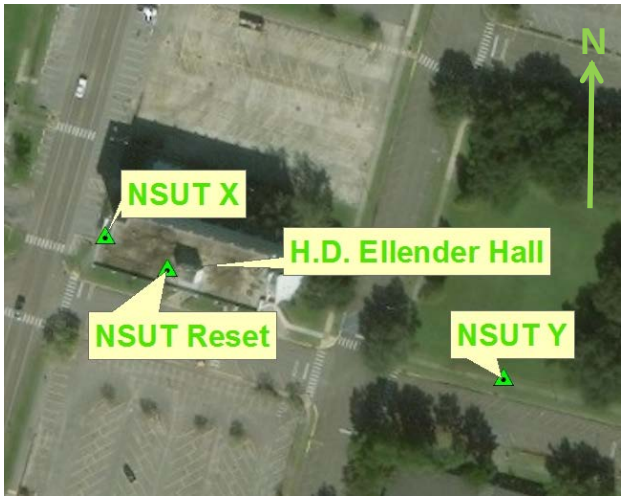
DESCRIPTION/CONTACT

The station is located at Nicholls State University in Thibodaux, LA in the H.D. Ellender Hall. Station is on ground level, in the Study Room/Computer Lab, opposite Room 103, about 14 m west-northwest of the reception area, in the southwest corner of the room, 0.80 m east-southeast of west-northwest wall and 0.72 m north-northeast of south-southwest wall. Room was tiled since last visit and the disk was presumed to have been removed at that time. A new 2 cm disk stamped “NSUT Reset 2018” is countersunk into the tile and located as close as possible to the previous location. To access contact is Dr. Balaji Ramachandran, Head/Associate Professor/Geomatics Program Coordinator, 985-859-5727.

OTHER STATION DESIGNATIONS: NN 964, DoD 3982-4, GSS 082O05

PID: DH4243

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

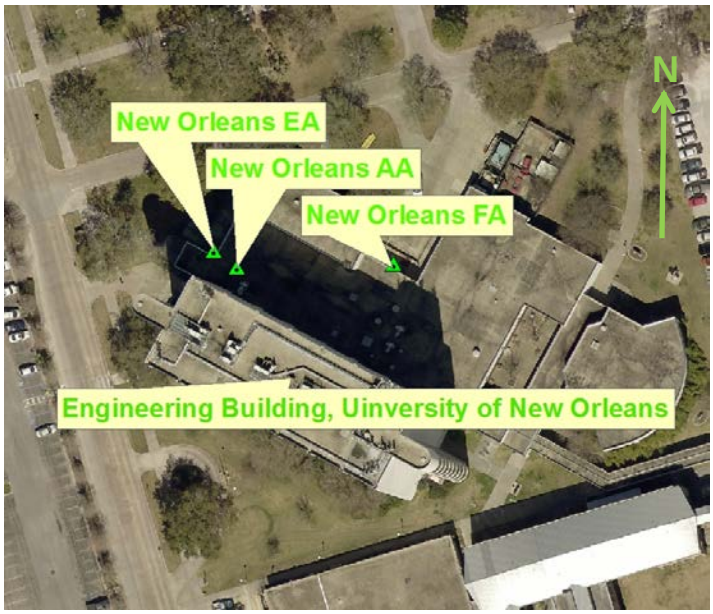
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Station	NEW ORLEANS AA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
30° 01' 30.6" N	90° 04' 07.7" W	-2.255 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
2 cm brass gravity plug	NOAA-NGS	US AGN 1989
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Disk Elevation	ArcMap/NGS Levels	Winester(NGS-91)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
1st Order Levels	g = 979317.068 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

Station is located at University of New Orleans in New Orleans, LA in the Engineering building. Station is at the northwest end of the northeast section of the single floor section of the Engineering building. It is in the basement (Room 136B) of the Structures lab (Room 136). Station is in the west corner of room 136B, 1.04 meters northeast of the southwest wall and 1.54 meters southeast of the northwest wall. 2 cm plug is epoxied into the concrete floor. To access contact, Bryon Landry, Engineering Safety Officer/Technician, UNO, 504-616-6232.

OTHER STATION DESIGNATIONS: NN 670, DoD 0577-A

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	BATON ROUGE DA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana – East Baton Rouge	Baton Rouge
LATITUDE	LONGITUDE	ELEVATION
30° 24' 30.5" N	91° 10' 45.3" W	7.5 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
9 cm brass gravity disk	NOAA-NGS	BATON ROUGE DA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979,333.441 ± 0.005 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Louisiana State University, Baton Rouge, LA, 35.5 meters north of the northeast corner of Patrick F. Taylor Hall. Station is a 9 cm brass NGS disk countersunk into the concrete sidewalk. It is approx. 0.5 meters south of a low (0.5 meter) brick wall. For information, contact J. Anthony Cavell, CFedS Surveyor / Research Specialist, Center for GeoInformatics, Louisiana State University, 225-578-4525.

DIAGRAM/PHOTOGRAPH

N

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	ERAD 1.5m
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana – East Baton Rouge	Baton Rouge
LATITUDE	LONGITUDE	ELEVATION
30° 24' 34.1" N	91° 10' 52.4" W	9 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
5 cm brass disk	C4G	ERAD
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979,333.215 ± 0.005 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Louisiana State University, Baton Rouge, LA, on the northeast corner of the loading dock on the west side of the Engineering Research and Development (ERAD) building. Station is a 5 cm brass C4G disk countersunk into the concrete. It is approx. 0.5 meters west of the west wall of the ERAD building and approx. 0.5 meters south of the north edge of the loading dock. For information, contact J. Anthony Cavell, CFedS Surveyor / Research Specialist, Center for GeoInformatics, Louisiana State University, 225-578-4525.

DIAGRAM/PHOTOGRAPH

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	LIGO BA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Livingston	Livingston
LATITUDE	LONGITUDE	ELEVATION
30° 33' 50.1" N	90° 46' 29.6" W	18.1 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze survey disk	NGA	LIGO BA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979,350.782 ± 0.005 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at the Laser Interferometer Gravitational-Wave Observatory (LIGO), north of Livingston, Louisiana. Station is located in the sidewalk on south side of the Science Education Center. Station is a 6 cm bronze NGA disk countersunk into the concrete sidewalk. It is 0.5 meter south of the east-west row of windows and 6.4 meters west-southwest of the southeast corner of the building. For access contact Tim Nelson, Facilities Team Lead, 225-686-3120.

DIAGRAM/PHOTOGRAPH

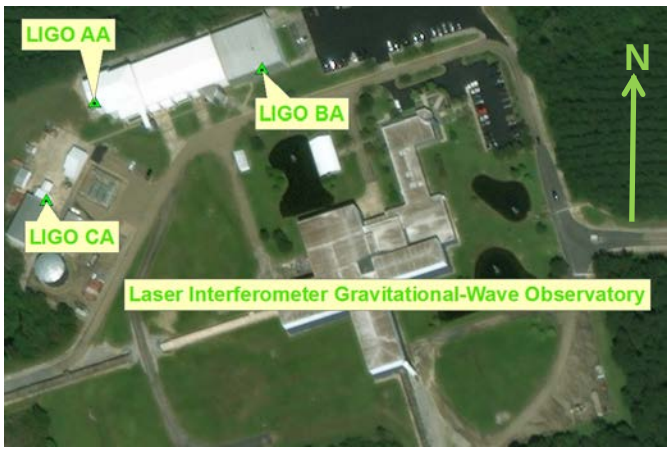
DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	LIGO CA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Livingston	Livingston
LATITUDE	LONGITUDE	ELEVATION
30° 33' 48.0" N	90° 46' 34.0" W	18.1 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze survey disk	NGA	LIGO BA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-2018
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979,350.848 ± 0.005 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at the Laser Interferometer Gravitational-Wave Observatory (LIGO), north of Livingston, Louisiana. Station is located just southeast of a northeast facing garage door for the LIGO maintenance building. Station is a 6 cm bronze NGA disk countersunk into the concrete driveway. It is 0.3 meter east-southeast of the southeast corner of the garage door and 0.8 meters northwest of the east corner of the building. For access contact Tim Nelson, Facilities Team Lead, 225-686-3120.

DIAGRAM/PHOTOGRAPH



LIGO CA

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

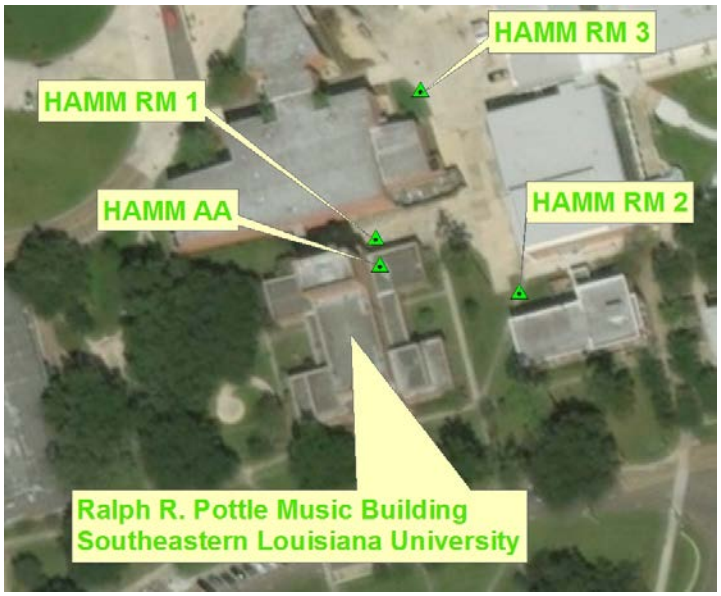
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	Hammond Reference Mark 1
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Tangipahoa	Hammond
LATITUDE	LONGITUDE	ELEVATION
30° 30' 47.6" N	90° 28' 03.2" W	13 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
5 cm survey disk	C4G	HAMM RM1
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979350.445 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Southeastern Louisiana University, Hammond, LA, just north of the northeast side entrance to the Ralph R. Pottle Music Bldg. (built 1990) and next to a large metal grate. It is a 5 cm disk that is countersunk in concrete. For information contact Ben Norman, Music and Performing Arts, 985-549-5039.

Note: The original Hammond Excenter's (HAMM X) location was deemed unfit for occupation due to loss of a stable foundation, HAMM RM1, RM2 and RM3 were established to replace it.

DIAGRAM/PHOTOGRAPH



N

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

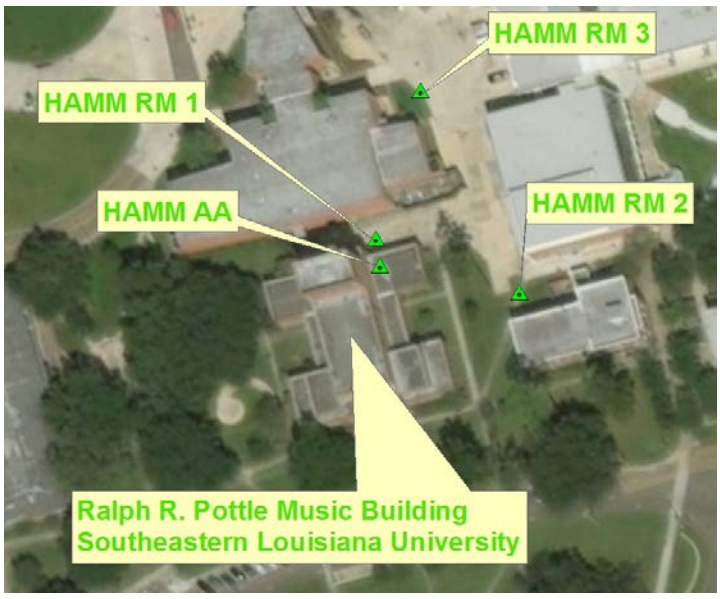
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	Hammond Reference Mark 2
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Tangipahoa	Hammond
LATITUDE	LONGITUDE	ELEVATION
30° 30' 47.3" N	90° 28' 01.5" W	13 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
5 cm survey disk	C4G	HAMM RM2
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979350.539 ± 0.012 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Southeastern Louisiana University, Hammond, LA, east of the Ralph R. Pottle Music Bldg. (built 1990), north of the Charles W. Campbell Hall and south of the Student Union Annex, at a 45 degree bend in a northeast to southwest sidewalk between the buildings. It is a 5 cm disk that is countersunk in concrete sidewalk. For information contact Ben Norman, Music and Performing Arts, 985-549-5039.

Note: The original Hammond Excenter's (HAMM X) location was deemed unfit for occupation due to loss of a stable foundation, HAMM RM1, RM2 and RM3 were established to replace it.

DIAGRAM/PHOTOGRAPH



N

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

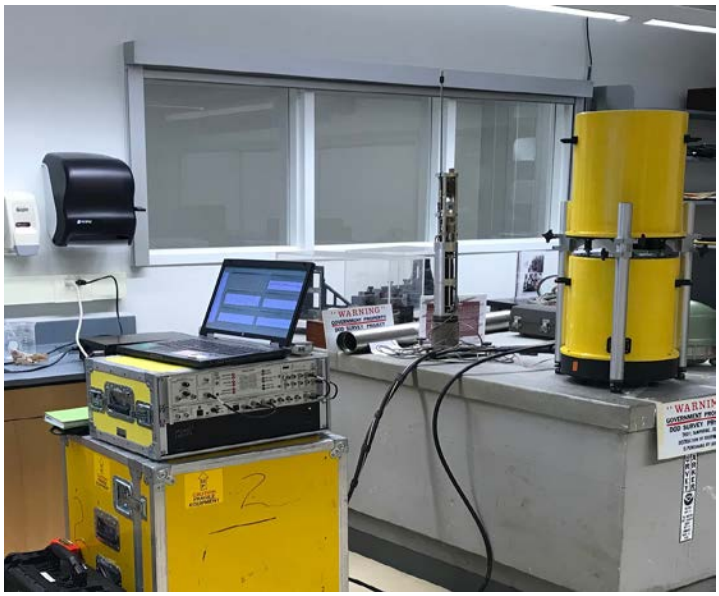
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	Hammond Reference Mark 3
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Tangipahoa	Hammond
LATITUDE	LONGITUDE	ELEVATION
30° 30' 49.0" N	90° 28' 02.6" W	13 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
5 cm survey disk	C4G	HAMM RM3
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979350.540 ± 0.012 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Southeastern Louisiana University, Hammond, LA. It is just east of the Pottle Music Building Annex and west of the Student Union near the east edge of a northwest to southeast line of grass nearest the Pottle Music Building Annex. It is a 5 cm disk that is countersunk in concrete. For information contact Ben Norman, Music and Performing Arts, 985-549-5039.

Note: The original Hammond Excenter's (HAMM X) location was deemed unfit for occupation due to loss of a stable foundation, HAMM RM1, RM2 and RM3 were established to replace it.

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

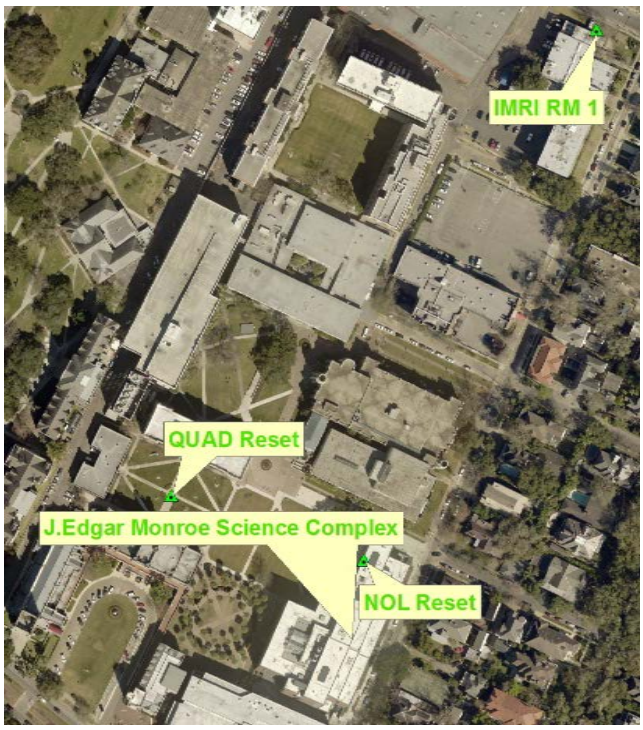
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	NEW ORLEANS QUAD Reset
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
29° 56' 05.99" N	90° 07' 16.55" W	1.645 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
9 cm brass gravity disk	NOAA-NGS	New Orleans Quad Reset 2002
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GPS	NOAA-NGS	Winester(NGS-06)/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
OPUS Solution	g = 979312.259 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

Station is located at Loyola University, New Orleans, LA. It is at the center of the intersection of four sidewalks, known as the Academic Quad, just south-southwest of a silver-colored cyclone-shaped metal bench. It is a 9 cm brass disk countersunk into the concrete sidewalk, 24.8 meters south-southwest of the south-southwest doors of Bobet Hall and 5.7 meters south-southeast of the western fire hydrant. For information contact Dr. Martin McHugh, Associate Professor of Physics, 504-865-2451.

OTHER STATION DESIGNATIONS: NN 673

DIAGRAM/PHOTOGRAPH



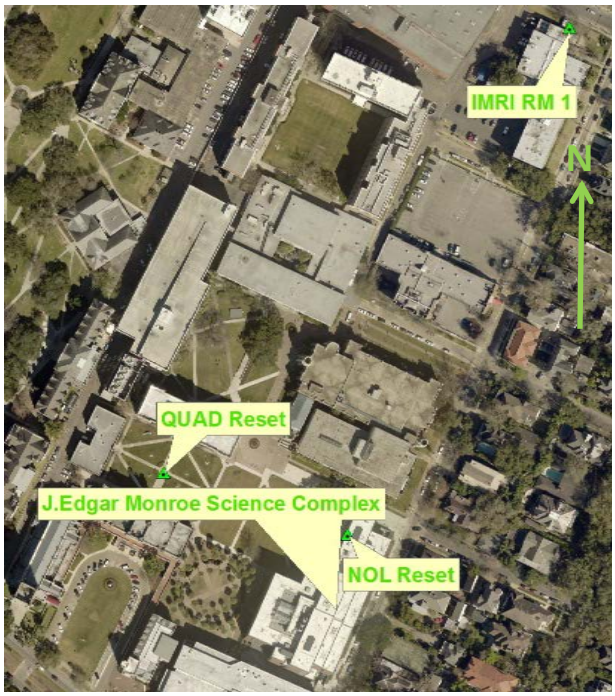
DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	IMRI Reference Mark 1
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
29° 56' 14.6" N	90° 07' 07.8" W	2 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm brass disk	C4G	IMRI RM 1
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979312.446 ± 0.012 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

Station is located at Loyola University, New Orleans, LA. It is on the northwest corner of the loading dock on the northeast side of Mercy Hall at the intersection of Freret Street and Calhoun Street. It is a 6 cm brass disk that is countersunk into the top of the concrete loading dock approximately 0.2 meters southwest of the north edge of the loading dock and 0.5 meters southeast of the west edge of the loading dock. For information contact Dr. Martin McHugh, Associate Professor of Physics, 504-865-2451.

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

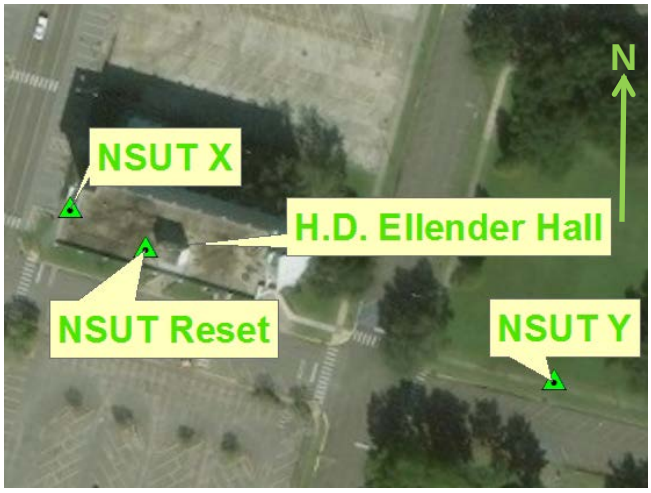
GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	THIBODAUX NSUT X
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - LaFourche	Thibodaux
LATITUDE	LONGITUDE	ELEVATION
29° 47' 26.3" N	90° 48' 17.8" W	2.6 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
9 cm survey disk	NIMA (NGA)	NSUT X 2002
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo map	ArcMap/USGS 1:24000	Winester NGS-06/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979306.880 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

The station is located at Nicholls State University in Thibodaux, LA at the north end of H.D. Ellender Hall. Station is at the exterior stairwell at the east-northeast end of Hall, 30.6 meters north-northeast of the center of Afton Drive, 25.5 meters east-southeast of the center of Audubon Ave., 9.8 meters south-southwest of southwest corner of the Air Handler building., on ground level, underneath a second set of risers, 0.24 meters north-northeast of the south-southwest wall of the stairwell and 0.99 meters west-northwest of the east-southeast side of the risers. The 9 cm brass disk is stamped NSUT X 2002 and is epoxied to concrete landing. For information contact Dr. Balaji Ramachandran, Head/Associate Professor/Geomatics Program Coordinator, 985-859-5727.

OTHER STATION DESIGNATIONS: NN 965, DOD 3982-5, GSS 082O06 PID: DH4244

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	THIBODAUX NSUT Y
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - LaFourche	Thibodaux
LATITUDE	LONGITUDE	ELEVATION
29° 47' 24.946" N	90° 48' 13.258" W	2.21 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
Rod mark	NOAA-NGS	NSUT Y 2006
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
Site position/site elevation	NOAA-NGS	Winester NGS-06/C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Datum NAD 83 (2011)/NAVD 88	g = 979307.112 ± 0.011 mGals (NGA, 03/2018)	

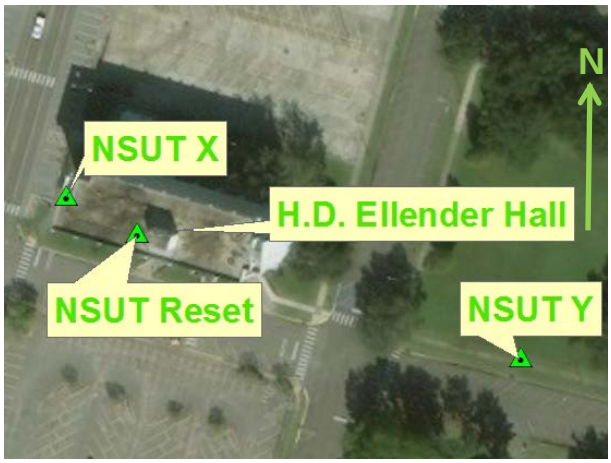
DESCRIPTION/CONTACT

The station is located at Nicholls State University in Thibodaux, LA. Station is in a grassy field between H.D. Ellender Hall and Ellender Library, 0.5 meters north-northeast of the north-northeast edge of sidewalk on north-northeast side of Afton Drive, 18.9 meters northwest of a lamp post, 42 meters east-southeast of Madewood Drive, and 5.5 meters north-northeast of a storm drain on Afton Drive. Rod is accessible through a logo cap and is 15 cm below lawn. Shallow GPS site THIBODAUX NSUT Y is atop tie down ring set in collar. Gravity observations were made on concrete pad 12.2 cm above and 25 cm south-southwest of top of rod mark. Coordinates are those of rod mark. For information contact Dr. Balaji Ramachandran, Head/Associate Professor/Geomatics Program Coordinator, 985-859-5727.

OTHER STATION DESIGNATIONS: NN 937

PID: DN4169

DIAGRAM/PHOTOGRAPH



DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	NEW ORLEANS EA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
30° 01' 30.7" N	90° 04' 07.9" W	1.5 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze disk	NGA	NEW ORLEANS EA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo Map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979316.464 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

Station is located at the University of New Orleans in New Orleans, LA on the north side of the northwest end of the Engineering building. It is 4.6 meters southeast of the northwest entrance to the building, 0.5 meters south of the south edge of a metal garage door. The 6 cm disk is stamped NEW ORLEANS EA 2018 and countersunk into the concrete slab. For information contact, Bryon Landry, Engineering Safety Officer/Technician, UNO, 504-616-6232.

DIAGRAM/PHOTOGRAPH

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018

GRAVITY STATION DESCRIPTION	STATION TYPE	STATION DESIGNATION
	Absolute Excenter	NEW ORLEANS FA
COUNTRY	STATE/PROVINCE – PARISH	CITY
United States	Louisiana - Orleans	New Orleans
LATITUDE	LONGITUDE	ELEVATION
30° 01' 30.6" N	90° 04' 06.4" W	2.0 meters
GRAVITY STATION MARK	AGENCY	INSCRIPTION
6 cm bronze disk	NGA	NEW ORLEANS FA 2018
POSITION/ELEVATION REFERENCE	POSITION/ELEVATION SOURCE	SOURCE DESCRIPTION
GIS map/Topo Map	ArcMap/USGS 1:24000	C4G-NGA-18
POSITION/ELEVATION REMARKS	GRAVITY VALUE/SOURCE/DATE	
Contour interval = 5 feet	g = 979316.463 ± 0.011 mGals (NGA, 03/2018)	

DESCRIPTION/CONTACT

Station is located at the University of New Orleans in New Orleans, LA on the north side of the Engineering building, on a loading dock. It is approximately 3 meters southwest of the northeast edge of the loading dock and, 0.8 meters southeast of the south edge of a set of double doors and 1.1 meters northwest of the north edge of asset of wider double doors. The 6 cm disk is stamped NEW ORLEANS FA 2018 and countersunk into the loading dock. For information contact, Bryon Landry, Engineering Safety Officer/Technician, UNO, 504-616-6232.

DIAGRAM/PHOTOGRAPH

DESCRIPTION BY	AGENCY	DATE
Wheeler	NGA	April 2018