WOOLPERT

QUALITY ASSURANCE REPORT

Lidar and Concurrent Imagery Collection, Processing, and Shoreline Mapping Along the Louisiana Coastline

Prepared For:

National Oceanic and Atmospheric Administration

NOAA Contract: 1305M220DNCNL0065

NOAA Task Order: LA2208-TB-C

Woolpert Project Number: 10010368.00

Revision	Date	Written	Project Manager	Distributed to	Comments
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1. Introduction

Woolpert were contracted by the National Oceanic and Atmospheric Administration's National Geodetic Survey (NOAA NGS) to provide topographic and bathymetric lidar data, and digital imagery for project LA2208-TB-C: Louisiana Shoreline. All data were acquired using Wolpert's Leica Chiroptera 4X (CH4x) system to meet the requirements of the project.

Details of the survey, data processing, quality control (QC), and product creation are provided in detail within this report.

1.1 Survey Area

The project areas cover approximately 280 square miles of topographic and bathymetric lidar and digital imagery collection along the Gulf coast of Louisiana. Roughly ten square miles of LAS processing area was appended to the original project boundary in areas where good bathymetric returns were seen outside the original AOI.

The project area was split into three processing sections (West, Central, East) containing survey blocks, allowing flight lines to be planned in the most efficient manner. Lidar data was collected to support 100% coverage to meet IHO Order 1b specifications. The dataset was processed in three discrete sections (see Figure 1) and was delivered as one comprehensive area comprising 4319 500 x 500m tiles.

Table 1. Survey Blocks

Area	Area (mile^2)	Survey Block(s)
West	142	BL01, BL02, BL03, BL04, BL05, BL06, BL07, BL08, BL09, BL10, BL11, BL12, BL13, BL14, BL15
Central	46	BL16, BL17, BL18, BL19, BL20, BL21, BL22, BL23, BL24, BL25, BL26, BL27
East	91	BL28. BL29. BL30, BL31. BL32

Figure 1. LA2208 Project Area.

2. Lidar Data Acquisition

All lidar data was acquired using a Chiroptera 4X (CH4x) sensor. The CH4x sensor was mounted in a Leica PAV100 gyro-stabilized mount integrated with a NovAtel SPAN GNSS and LCI-100C IMU. Real time navigation and GNSS/IMU data logging was provided by Leica FlightPro software. Lidar data was logged on the Airborne Hydrography, AB (AHAB) operator console.

The sensor was installed in the aircraft prior to the project. A full calibration flight was collected over Stennis International Airport (HSA) on October 1st, 2022, prior to mobilization for survey operations. The collection of the project data was conducted over 14 flights from October 4, 2022, to October 21, 2022.

2.1 Mobilization

The CH4X sensor was installed in a Cessna 404 (N7079F) (**Figure 2**).

Figure 2. Mobilized Aircraft N7079F

2.1.1 Aircraft Offset Survey

Physical mounting offsets between the GNSS antenna, IMU, and gyro-stabilized mount were determined through a combination of manual measurements and iterative processing in NovAtel Inertial Explorer software.

Manual measurements were taken from the GNSS antenna to the reference point on the IMU in the CH4x sensor head. These measurements were added to the known offset between the IMU reference point and the rotation center of the gyro-stabilized mount to calculate the preliminary offset between the GNSS antenna and sensor reference point. This preliminary value was then used to seed the post-processing software which, through an iterative computation, used the dynamic accelerations and rotations during flight to refine the offsets. Once the solution converged, the final offsets were entered into the flight management software and used in subsequent post-processing of the GNSS/IMU data for final trajectories.

Final offsets, shown in the Leica reference frame, are presented in **Table 2**.

Table 2. Aircraft Offsets

Sensor Head	Lever Arm	X (forward)	Y (right)	Z (down)
CH4x (Topographic and Shallow Channel)	Reference to GNSS Antenna L1 Phase Center	0.007 m	-0.022 m	-0.958 m
	Reference to IMU	-0.022 m	0.007 m	0.958 m
	Reference to IMU Rotation	0°	180°	0°

2.1.2 System Calibration Checks

Field calibration of the CH4x system was carried out to eliminate systematic errors by calculating corrections for boresight errors, scanner angle errors, remaining IMU angle errors, and any necessary internal timing errors. To verify or compute the field calibration, the lines shown in **Figure 3** were flown.

a. 2 x Line A over mixed terrain with flat or gentle slopes and features such as peaked roof buildings (1 x each direction)
b. 1 x Line B offset + 50% from Line A in one direction
c. 1 x Line C offset - 50% from Line A in the same direction as Line B
d. 2 x Line D orthogonal to previous lines (1 x each direction)

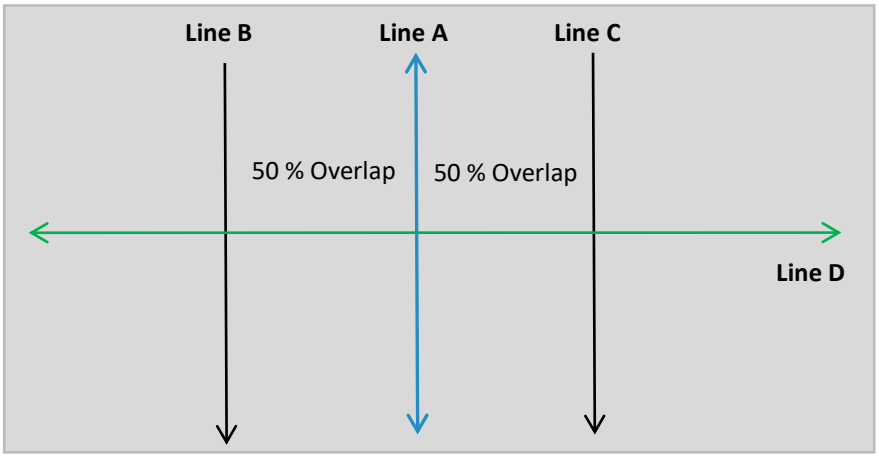

Figure 3. Schematic of CH4x Calibration Lines

A set of calibration lines were acquired at 800 m, 500 m, and 400 m altitude. All sets of lines were used to calibrate and verify the topographic lidar, while the 500 m and 400 m lines were used for the bathymetric lidar.

Calibration values were calculated using the automatic calibration routine within the Leica Lidar Survey Studio (LSS) software. This utility first identified patches or areas of gentle slope within the overlap region of all the lines to use for calibration. Patch selection prevented areas of vegetation, side of cars, or buildings from being used in the calibration process. Next, the utility compared the front side and back side of the elliptical scan within the same line, as well as comparing all lines to each other, to identify suitable calibration parameters such that data within the patches match. The procedure was iterative and continued until the best possible solution wass computed.

Calibration for each channel (topographic and shallow) was done independently. Topographic and shallow channel calibration was computed using the 500 m altitude lines. The 800 m and 400 m lines were then used for verification of the derived values' accuracy.

At each step of the calibration process, quality assurance was conducted to ensure values being calculated were valid. This was done using the Leica LSS Quality Control Utility. Two types of checks were performed. First, the front scan was compared to the back scan for every line. Next, a single line was chosen as a baseline and was compared to every other line. As expected, the average errors from both of these checks were small. Additionally, the data was visually reviewed. In particular, suitable features were studied to ensure lines from different directions show structures in the same position, verifying horizontal accuracy was maintained. These tests all provided assurance of relative accuracy.

Results from the calibration verification checks are provided in following **Table 3**. Results are good and indicate that calibration was successful. Calibration values computed were used for the entire project.

Table 3. Calibration QA Results

Test		Topographic 800 m	Topographic 500 m	Topographic 400 m	Shallow 500 m	Shallow 400 m
Front to Back Scan Comparison	Average Error (m)	-0.0014	0.0001	0.0101	-0.0002	-0.0067
	Std. Dev. of Error	0.0003	0.0005	0.0007	0.0009	0.0007
Line to Line Comparison	Average Error (m)	-0.0028	-0.0067	-0.0028	-0.0028	-0.0001
	Std. Dev. of Error	0.0008	0.0008	0.0024	0.0010	0.0014

Woolpert acquired a detailed set of ground truth data over the apron at the Stennis International Airport. The ground truth was acquired using Trimble R7 GNSS receivers and Real Time Kinematic (RTK) survey techniques.

Ground truth is not used within the automatic calibration routine. However, a comparison to the lidar data was used to verify absolute accuracy. Results presented in **Table 4** show data is well within required accuracy specifications.

Table 4. Calibration Ground Truth Comparisons

	Topographic	Shallow
Average dZ (m)	-0.0026	0.0015
Root Mean Square (m)	0.0129	0.0091

2.2 Survey Operations

For ease of operations and data management, the survey area was split into survey blocks. Actual flight lines flown, including start and end date and unique line ID, are provided in the trajectory database included with the project deliverables in SHP format.

A summary of the daily operations is shown in **Table 5**. Detailed Flight Logs for each day are provided in **8.1 Flight Logs**. Collection was based out of the New Iberia Airport (KARA).

Forty-six cross lines were acquired across the areas of interest during the survey for quality purposes. Crosslines were planned perpendicular to main scheme survey lines and used to verify the relative accuracy of the data where bottom coverage allowed.

Table 5. Summary of Daily Operations

Flight	Engine Time	Airtime	Flown km | %		Reflown km | %		Comments
2022-10-04A	3:38:00	03:08:00	100.9	2.03			East
2022-10-06A	6:00:00	5:32:00	340.5	6.86			East
2022-10-07A	6:02:00	5:27:00	511.1	10.29			West
2022-10-08A	5:43:00	5:18:00	437.4	8.81			West
2022-10-09A	5:57:00	5:30:00	416.2	8.38			West
2022-10-10A	3:29:00	2:59:00	256	5.16			West
2022-10-11A	5:16:00	4:52:00	538.7	10.85			West
2022-10-13A	5:17:00	4:50:00	491.2	9.89			West
2022-10-14A	5:57:00	5:21:00	214.8	4.33	20.4	0.41	Central
2022-10-15A	6:09:00	5:34:00	453.5	9.13			Central
2022-10-18A	6:28:00	5:45:00	577.9	11.64			Central
2022-10-19A	5:36:00	4:56:00	315	6.34			East
2022-10-20A	4:52:00	4:20:00	115.2	2.32			Central, East
2022-10-21A	4:02:00	3:25:00	100.9	2.03			East

2.2.1 The Chiroptera 4X

All lidar data was acquired using a CH4x sensor. The system provides denser data than previous traditional bathymetric lidar systems. It is unique in its ability to acquire bathymetric lidar, topographic lidar, and 4-band digital camera imagery simultaneously.

The CH4x provided 300 kHz topographic data and effective 140 kHz shallow bathymetric data. 4-band 80 MP digital camera imagery was also collected simultaneously with the sensor's RCD-30 camera.

The bathymetric and topographic lasers are independent and do not share an optical chain or receivers, so they are optimized for their specific function. As with any bathymetric lidar, maximum depth penetration is a function of water clarity and seabed reflectivity. The CH4x is designed to penetrate to 1.5 times the secchi depth. This is also represented as Dmax = 2.44/K, where K is the diffuse attenuation coefficient, and assuming K is between 0.1 and 0.3, a normal sea state, and 15% seabed reflectance.

Both the topographic and bathymetric sub-systems use a palmer scanner to produce an elliptical scan pattern of laser points with a degree of incidence ranging from ± 14° (front and back) to ± 20° (sides), providing a 40° field of view. This has the benefit of providing multiple look angles on a single pass and helps to eliminate shadowing effects. This can be of particular use in urban areas, where all sides of a building are illuminated, or for bathymetric features such as the sides of narrow water channels or features on the seafloor, such as smaller objects and wrecks. It also assists with penetration in the surf zone where the back scan passes the same ground location a couple of seconds after the front scan, allowing the areas of whitewater to shift.

The bathymetric laser is a diode pumped class 4 laser which operates in the green spectrum. Full waveform data is acquired for every pulse. The topographic laser operates in the infra-red spectrum at 1064 nm. Up to 4 returns per pulse are acquired from each lidar.

For this project, the flight parameters shown in **Table 6** were used to provide 100% coverage. Flight parameters used exceed the requirements for the survey to meet IHO Order 2b.

Table 6. CH4x Survey Flight Parameters

Topographic PRF (kHz)	300
Topographic Points per m^2	>12
Shallow Bathy PRF (kHz)	140
Shallow Bathy Points per m^2	5.6
Swath Width (m)	290
Flight Line Sidelap (%)	20
Altitude (m)	400
Survey Speed (knots)	125

During acquisition, flight lines were shown on a pilot's display, and the aircraft was controlled by the pilot at all times. The CH4x system includes a NovAtel SPAN GNSS system with an LCI-100C IMU for aircraft position and orientation. One IMU is in the main Chiroptera sensor head, which includes the topographic channel, shallow channel, and RCD30 camera. Data from this IMU is also used in real-time by the PAV100 gyro-stabilized mount to compensate for deviations in pitch and roll. Aircraft bank angles were restricted to 20° to avoid any potential GNSS dropouts. No flights were planned if the PDOP was expected to go above 3.0.

Data were monitored for quality during acquisition using the Operators Console running on the AHAB collection computer. The operator monitored the system status of the scanners and receivers, waveforms, camera images, data coverage, flight lines and the health of the navigation system.

All data was recorded to a removable solid-state hard disk. At the end of each flight, the hard disk was removed and taken to the field office, where data was copied onto backup disks for transmission back to the main processing office. Preliminary data was reviewed daily in the field for quality and coverage.

2.2.2 Positioning

Position and orientation data was acquired in the aircraft using a NovAtel SPAN with LCI-100C IMU. All data was post-processed using NovAtel Inertial Explorer software to provide a tightly coupled position and orientation trajectory solution. Project position data were acquired using Precise Point Positioning (PPP) techniques. Logs for the trajectory processing are provided in **Section 8.2**.

3. Ground Survey Operations

Ground control surveys were conducted to assist with final point cloud calibration and to perform quality assurance checks on the final lidar point cloud.

3.1 Primary Control Points

Woolpert used Precise Positioning Processing techniques to conduct final trajectory processing as described in **Section 2.2.2.**

3.2 Lidar Survey Points

Woolpert established three-dimensional coordinates for 33 Topographic Lidar control points, 1 Bathymetric Lidar check points, 10 vegetated check points, and 20 non-vegetated check points. The points were collected per the flight layout. Further discussion of the processing results is presented in **Section 5.4.3**.

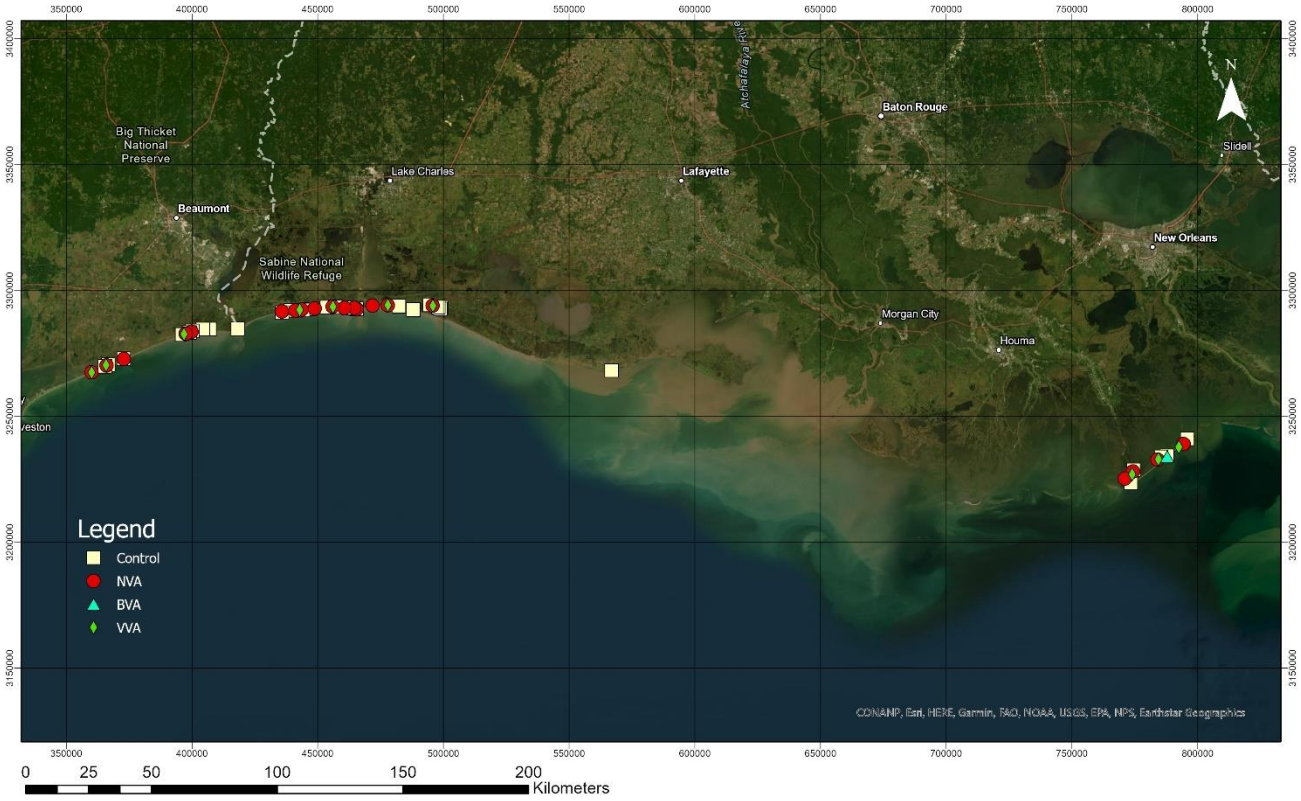

Figure 4. LA2208 Ground Survey Overview

4. Data Processing

Initial data coverage analysis and quality checks to ensure there were no potential system issues were carried out in the field and office prior to final demobilization of the sensor. Final processing was conducted in Woolpert's offices.

In general, data were initially processed in Leica's Lidar Survey Studio (LSS) using final processed trajectory information. LAS files from LSS were then imported to a TerraScan project, where spatial algorithms were used to remove gross noise. Manual review and further QC were conducted in TerraScan prior to product creation.

4.1 Position

Final trajectory data were post processed in NovAtel Inertial Explorer. Lever arms, shown in the NovAtel reference frame, are presented in **Table 2**. Inertial Explorer accounts for the fixed offset between the reference point and IMU and uses a multi-pass algorithm to compute a tightly coupled solution. Trajectory processing logs are provided in **Section 8.2**. Average Forward and Reverse Separation RMS for the project was 0.027m in Easting, 0.014m in Northing, and 0.053m in Height.

Project Datum are provided in **Table 7**.

Table 7. Project Spatial Reference Systems

	Processing Datum	Deliverable Datum - LAS	Deliverable Datum - Products
Name	**ITRF14- UTM 15N & Ellipsoid Heights**	**NAD83(2011)- UTM 15N & Ellipsoid Heights**	**NAD83(2011)- UTM 15N & Geoid 18**
Project Use	Acquisition and Data Processing	Product Delivery LAS	Product Delivery Rasters etc.
Horizontal Datum	ITRF14 (Current Epoch) Equivalent to WGS84	NAD83(2011) UTM Zone 15N epoch:2010	NAD83(2011) UTM Zone 15N epoch:2010
Horizontal Projection	UTM Zone 15N	NAD83(2011) epoch:2010 Ellipsoid, meters	NAD83(2011) epoch:2010 Ellipsoid, meters
Horizontal Units	Meters	Meters	Meters
Vertical Datum	Ellipsoid	Ellipsoid	Geoid 18
Vertical Units	Meters	Meters	Meters

4.2 Imagery

Imagery was acquired simultaneously with the lidar data using the CH4x system. The system includes an RCD30 80MP 4-band RGBN camera, providing raw 16-bit radiometrically-corrected and normalized imagery.

4.2.1 Image Calibration

Field calibration of the RCD30 camera was carried out to eliminate systematic errors by calculating corrections for the principal point offset and misalignment angles (Omega, Phi Kappa). Misalignment angles were essentially the mechanical misalignment of the IMU and the camera sensor axes.

Leica's HxMap was used to finalize the camera calibration. It uses orthogonal lines flown in both directions over an area containing buildings and features, such as painted lines. In this case, orthogonal lines A and D (**Figure 3**) from the calibration flight were used.

HxMap has an automated point matching (APM) feature that identifies the same point in overlapping images and automatically iterates to compute final misalignment and principal point offset (PPO) parameters, which are provided in **Table 8**.

Table 8. RCD30 Camera Misalignment and PPO Parameters

Parameter	X	Y	Z
Lever Arms (m)	0.000	-0.115	0.166
Rotation (deg)	0	0	90
Misalignment (deg)	0.019813	0.023424	0.036451
PPO (mm)	-0.0061	-0.0105	N/A

4.2.2 Image Processing

Imagery data collected with the RCD30 camera were extracted from the raw compressed airborne format to 8-bit 4-band (RGBN) images using Leica's HxMAP software. 8-bit processed data were used to manage data volumes, without significant reduction in data quality. Individual images were rectified by HxMAP using a 1m resolution Digital Elevation Model (DEM) created from the lidar data.

Rectification was accomplished using direct georeferencing (making use of the final post-processed aircraft trajectory, along with the camera interior and exterior orientation information) without use of any Aerial Triangulation (AT) and ground control.

All individual rectified images for an area were used in Trimble's OrthoVista software to create the final 0.10m resolution 4-band tiled GeoTIFF image mosaics. The GeoTIFF images were converted to 3-band ECW images for editing purposes.

4.3 Lidar

4.3.1 Raw Data Processing

Lidar processing was conducted using the Leica Lidar Survey Studio (LSS) software. Calibration information, along with processed trajectory information were combined with the raw laser data to create an accurately georeferenced lidar point cloud for the entire survey in LAS v1.4 format. All points from the topographic and bathymetric laser include 16-bit intensity values.

During the LSS processing stage, an automatic land/water discrimination was made for the bathymetric waveforms. This allowed the bathymetric (green) pulses over water to be automatically refracted for the pulse hitting the water surface and travelling through the water column, producing the correct depth. Another advantage of the automatic land/water discrimination was that it permitted calculation of an accurate water surface over smaller areas, allowing simple bathymetric processing of smaller, narrower streams and drainage channels. Sloping water surfaces were also handled correctly.

Prior to processing, the hydrographer adjusted waveform sensitivity settings dependent on the environment encountered and entered a value for the refraction index to be used for bathymetry. The index of refraction was an indication of the water type. Values used for sensitivity settings and the index of refraction are included in the LSS processing settings files. A value of 1.341696 was used for the index of refraction, indicating salt water.

In order to determine the optimal waveform sensitivity settings for final processing, sample areas were selected and processed with multiple different settings, to iteratively converge on the best possible settings. This was done by reviewing the processed point cloud and waveforms within sample areas. A sample waveform is provided in **Figure 5**. Settings affected which waveform peaks were classified as valid seabed, and which peaks were classified as noise.

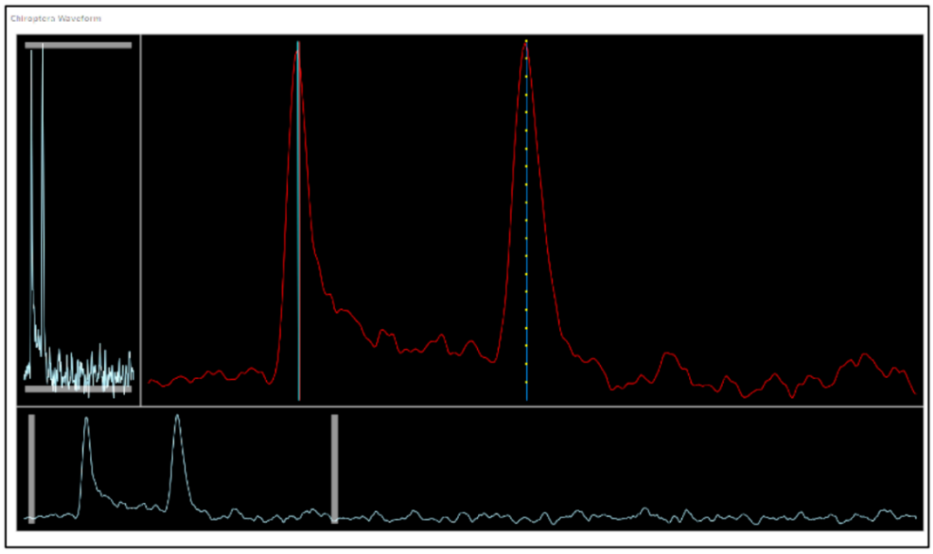

Figure 5. Sample Waveform in Shallow Water

Optimal settings struck a balance between the amount of valid data that was classified as seabed bottom, and the amount of noise that was incorrectly classified due to peaks in the waveforms. All valid data was selected, while only a small amount of noise remained to be edited out. Once optimal threshold settings were chosen, they were used for the entire project.

It is important to note that all digitized waveform peaks were available to be reviewed by the hydrographer; both valid seabed bottom and peaks classed as noise. This allowed the hydrographer to review data during TerraScan editing for valid data such as objects that may have been misclassified as noise.

Woolpert developed proprietary routines implemented in our in-house GTools software to run further checks on the lidar data prior to import to Terrascan project tiles. These checks automatically identified areas where Multiple Pulse in Air (MPIA) errors occurred, as well as invalid derived water surface data, and deleted the erroneous data from the dataset. In addition, GTools merged the multiple small files per flight line generated by LSS into a single LAS file per flight line. Data in each LAS file was also classed into a standard LAS class structure in preparation for data editing.

4.3.2 Lidar Data Classification/Editing

After data were processed through LSS and the data integrity reviewed, data were organized into tiles within a TerraScan project. Data classification and spatial algorithms were applied in Terrasolid's TerraScan software. Customized spatial algorithms, such as isolated points and low point filters, were run to remove gross fliers in the bathymetric and topographic data. The LAS files return a 'point count mismatch' upon being queried as synthetic points are present in the derived water surface.

All data were reviewed manually to reclassify any valid bathy points incorrectly identified by the automated routines in LSS as invalid, and vice versa. In addition, any topographic points remaining over the water were reclassified to a Topographic Water class to correct the ground representation. Manual editing was conducted in TerraScan. Product grids and TIN models were used at the required product resolution to assist in data editing and QC results. Steps conducted during the manual editing phase included:

- Removing noise from the unclassified topographic class to leave only valid data (e.g., vegetation, buildings, real temporary objects in the environment such as cars, people, etc.);
- Removing any topographic unclassified, topographic ground, and valid seabed class data from the water surface to a water surface class, including along the shoreline;
- Filling gaps in the topographic ground and seabed classes, including potential objects such as swampy islands along the coast; and
- Removing any remaining noise from the topographic ground and seabed classes.

4.3.3 Reflectance

Once all lidar data were edited, final seabed class data were used to compute project specific correction parameters and normalize the raw intensity data for depth. Corrected values were then written back into the LAS files.

Although the bathymetric data includes intensity values, these are raw values. For intensity (reflectance) to correctly represent the reflectance of the seabed, the intensities must be normalized for any losses in signal as the light travels through the water column, so that the intensity value better reflects the intensity of the seabed itself.

One of the fundamental issues that exists with reflectance imagery is the variance in return due to water clarity differences occurring spatially along line, and temporally from day to day. This is challenging for any bathymetric lidar sensor.

If water clarity is relatively consistent along a line, then it is possible to achieve an overall homogenous reflectance image for an area. To a certain extent, variation in reflectivity intensity can be minimized by limiting the size of flight blocks and trying to ensure similar environmental parameters exist within a single flight block. In other words, where changes in water clarity or environment may be expected, flight blocks should be split to allow different normalization parameters to be used per block for the reflectance processing. Where this is not possible and water clarity varies significantly along a line, variation in reflective intensity will be seen in the output imagery. While this imagery can still be analyzed and used for manual seabed classification, it prohibits the use of unsupervised, or semiautomated classification.

Woolpert used proprietary in-house scripts to compute project specific correction parameters and normalize the raw intensity data for depth. This provided intensities that more closely represent the reflectance of the actual seabed. Corrected values were used to create reflectance images per flight line using Applied Imagery's QT Modeler software. Individual flight line reflectance images were then used in Trimble's OrthoVista software to create a final reflectance image for the entire area.

OrthoVista was used to improve radiometric balancing between lines and the seamline editor was used to improve the joins between lines to remove as much line-to-line edge matching and cloud artifact issues as possible. As well as delivering the reflectance raster mosaics themselves, the processed reflectance data was used to correct the intensity values within the LAS files for delivery.

4.3.4 Lidar Datum Conversions

All editing was conducted with the lidar data elevations on the ellipsoid. Once editing was completed, data were transformed from ITRF14 (Current Epoch) to NAD83(2011) UTM Zone 15N epoch:2010 using values derived from NOAA's Vertical Datum Transformation tool. The dataset was further transformed to a set of LAS containing NAVD88 height using Geoid 18 for use in non-LAS product creation.

TerraScan was then used to compare the lidar data to known ground control points. For each known location, a small TIN was created from the surrounding lidar points, and the elevation difference from the TIN plane to the point computed.

5. Quality Control

Quality control was carried out through every phase of the project. Several checks were used to ensure data integrity and quality was maintained. Specific statistics were generated during cross line analysis and from direct comparison to topographic control.

5.1 Calibration

Calibration, which is fundamental to ensuring good data accuracy, is discussed in detail in **Section 2.1.2**.

5.2 Online Checks

The airborne operator monitored the system status of the scanners and receivers, waveforms, data coverage, flight lines, and navigation system during data acquisition. Flight logs were maintained during data acquisition. Logs not only tracked lines acquired, but also any relevant information on weather or water clarity, instances when sensor issues occurred, and so on. These logs were a valuable resource during processing. Flight logs are provided in **Section 8.1**.

5.3 Positioning

During acquisition, aircraft bank angles were restricted to 20 degrees to avoid any potential GNSS dropouts. No flights were planned if the PDOP was expected to go above 3.0. Position processing and results are discussed in **Section 2.2.2** .

5.4 Accuracy Checks

5.4.1 Comparison to Adjacent Lines (Relative Accuracy)

Throughout data editing, adjacent survey lines of data were compared to ensure there were no data busts or system artifacts. During processing, TerraSolid's TMatch software was run to examine the Delta Z differences between overlapping lines, then a simple Z correction was applied per flight line to remove any vertical differences between flight lines. Using TMatch to move all the lines into the same relative plane reduced any remaining small differences caused by the limitations of the trajectory accuracy.

Woolpert's in-house software, GTools, was used to generate dZ grids representing flight line to flight line differences in areas of overlap. Any results within areas of slope greater than 10 degrees were removed, and final dZ statistics generated for the project. This provided a measure of inter-swath accuracy.

Interswath or overlap consistency for the topographic laser was assessed in all areas of overlap with slopes of less than 10 degrees. The topographic RMSDz average for the project is 0.028 m. This meets the required accuracy of ± 8 cm.

Interswath or overlap consistency for the bathymetric laser was assessed in all areas of overlap with slopes of less than 10 degrees. The bathymetric RMSDz average for the project lines is 0.036 m. This meets the required accuracy of ± 29.6 cm.

Results for each survey area are presented in **Table 9**.

Table 9. Line to Line Relative Accuracy

Processing Area	Topographic Laser RMSDz (m)	Bathymetric Laser RMSDz (m)
West	0.030	0.036
Central	0.024	0.040
East	0.030	0.041
Average	**0.028**	**0.036**

5.4.2 Cross Line Analyses

Cross lines were run in a direction perpendicular to main scheme lines across the entire survey area, providing a good representation for analysis of consistency. All cross lines were used for cross line comparisons. Cross line analysis was performed using the Fledermaus CrossCheck tool. Cross line point data were compared to a 2 m gridded surface of the main scheme survey lines and statistics generated. For each line, a histogram of the point comparison was reviewed in CrossCheck to ensure there was a normal distribution of data. A summary of the CrossCheck results is provided in **Table 10**. The result of the analysis meets the required IHO Order 2b depth accuracy requirements.

Table 10. Cross Line Point to Surface Results

	All Areas
No. of Points Compared	12663615
Mean Difference (MD) in m	-0.002
Standard Deviation (St. Dev)	0.042
Mean + 2* Std. Dev	0.096

In addition, 2 m surfaces were created for the cross lines, and surface differences generated between the cross line and main scheme surfaces. Statistics for the difference surfaces were generated. Results matched those from the CrossCheck analysis, as shown in **Table 11**.

Table 11. Cross Line Surface Difference Results

	All Areas
Mean Difference (MD) in m	**0.001**
Standard Deviation (St. Dev)	**0.041**

5.4.3 Comparison to Topographic Control

Topographic control data were acquired through the project area to check against the point cloud.

5.4.3.1 Primary Ellipsoidal Height Control

Ground survey was collected by Woolpert. Once all manual reclassification was completed, data were compared to the ground control to compute an average shift value to be applied. Results are noted in **Table 12**. One check point (1033) was removed from analysis and identified as an outlier during this check. This check point was removed due to the observation being directly on a sandy beach (which may have seen temporal shifting) and was >25 centimeters out of alignment with the ground as surveyed by the CH4x.

Table 12. Comparison to Topo Ground Control

Number of Control Points	Average dZ (m)	Std. Deviation
35	0.059	0.036

Absolute vertical accuracy for the lidar points was calculated using the acquired checks points. A summary of results is provided in **Table 13**, **Table 14**, and **Table 15**. The check points were observed in three (3) different land cover types to assess absolute vertical accuracy: vegetated (VVA), non-vegetated (NVA), and bathymetric (BVA). One check point (2018) was removed from NVA analysis and identified as an outlier. This check point was removed due to the observation being directly on a sandy beach and was >25 centimeters out of alignment with the ground as surveyed by the CH4x. There was one BVA point utilized.

This data set tested 0.080 meters fundamental vertical accuracy at 95th percent confidence level in open terrain using RMSE (z) x 1.9600.

Table 13. Comparison to NVA Check Points Results

NVA Check Point Accuracy			
Average dZ (m)	Std. Deviation	RMSE (m)	Accuracy (95% Confidence)
-0.016	0.038	0.041	0.080

Table 14. Comparison to VVA Check Points Results

VVA Check Point Accuracy		
Average dZ (m)	Std. Deviation	RMSE (m)
0.233	0.165	0.28

Table 15. Comparison to BVA Check Points Results

BVA Check Point Accuracy		
Average dZ (m)	Std. Deviation	RMSE (m)
0.052	--	0.052

5.4.3.2 Imagery Accuracy

While this project did not have control over the calibration location suitable for horizontal accuracy, relative statistics were easily derived. Imagery collected simultaneously during the calibration survey (**Section 2.1.2**) was used to calibrate the camera head file (which contained information about the PPO and misalignment) for imagery processing, as well as to assess accuracy.

Five-centimeter ortho imagery, the finest the camera is able to produce at the chosen calibration elevation (500 m), was generated. Sixteen easily identifiable features (paint lines, edges of concrete pads, etc.) were found in the area where three or more flight lines intersected. For each feature, the frame that had the nearest principal point was used, and the coordinates of the feature in the imagery were then noted. The differences between frames were calculated using a near analysis. Results showed good relative agreement between different frames and lines flown in different directions at the calibration altitude (**Table 16**).

Table 16. Summary of Relative Accuracy of Imagery Results

RMSE (m)	0.045
Standard Deviation (m)	0.083

6. Flight Trajectories

The flight trajectories used for the survey collection are provided in ESRI Shapefile format. The Shapefile contains the attributes date of capture, local start time, local end time, and flight line number.

6.1 Flight Trajectories

The project was surveyed between October 4, 2022, and October 21, 2022. A total of 439 flight lines were collected.

Figure 6. Flight Trajectories

7. Products

Deliverables required for the project are listed in **Table 17**.

Table 17. Product Deliverable Structure

ID	Item	Deliverable	Resolution (m)	Tiled	Delivery Folder
1	Classified LAZ Point Cloud	LAZ	--	✓	LA2208-TB-C\01_LAZ
2	Topo bathy Bare Earth DEM	GeoTIFF	1.0	✓	LA2208-TB-C \02_DEM
3	TPU	GeoTIFF	1.0	✓	LA2208-TB-C \03_TPU
4	Normalized Seabed Intensity	GeoTIFF	1.0	✓	LA2208-TB-C \04_Reflectance
5	RGBN Imagery	GeoTIFF	0.10	✓	LA2208-TB-C \05_Imagery
6	Trajectories	Txt	--	--	LA2208-TB-C \06_Trajectory
7	Bathy Voids	ESRI Shp	--	--	LA2208-TB-C \07_SHP_GIS
8	Flightline Index	ESRI Shp	--	--	LA2208-TB-C \07_SHP_GIS
9	Tile Index DEM	ESRI Shp	--	--	LA2208-TB-C \07_SHP_GIS
10	Tile Index Imagery	ESRI Shp	--	--	LA2208-TB-C \07_SHP_GIS
11	Tile Index LAS	ESRI Shp	--	--	LA2208-TB-C \07_SHP_GIS
12	Metadata Per Product	XML	--	--	LA2208-TB-C \08_Metadata
13	Topographic dZOrtho	GeoTIFF	1.0	✓	LA2208-TB-C \09_dZOrtho\Topo
14	Bathymetric dZOrtho	GeoTIFF	1.0	✓	LA2208-TB-C \09_dZOrtho\Bathy
15	Direct Georeferenced EO Files	Txt	--	--	LA2208-TB-C \10_EO

The bulk of the products were delivered with orthometric height, except for the LAS point cloud, which was delivered with ellipsoidal height. The data coordinate reference system applied to orthometric products was:

- Horizontal: UTM Zone 15N, NAD83(2011) epoch:2010, meters
- Vertical: NAVD-88 (Geoid18), meters

The classified point cloud was delivered as tiled LAS files with the following coordinate reference system:

- Horizontal: UTM Zone 15N, NAD83(2011) epoch:2010, meters
- Vertical: NAD83(2011) epoch:2010 Ellipsoid, meters

Delivered LAS data are provided in Point Record Format 6 and include Adjusted GPS Time and 16-bit intensity values. LAS file classes delivered are shown in **Table 18**. Classes 2 and 40 provide the ground model for the project.

Table 18. LAS Classes

NUMBER	POINT CLASS	DESCRIPTION
1	Default	Valid unclassified data from the topographic laser
2	Ground	Bare Earth Ground
W7	Low Noise	Spurious high/low point returns (unusable)
9	Water	Water Surface (topographic sensor)
W18	High Noise	Spurious high/low noise points from the bathymetric laser over land.
40	Bathymetric Point	Submerged Topography
41	Water Surface	Water Surface, distinct from Point Class 9, which is used in topographic-only lidar and only designates “water,” not “water surface”.
S42	Derived Water Surface	Synthetic water surface location used in computing refraction at water surface
43	Submerged object	Submerged Object, not otherwise specified (e.g., wreck, rock, submerged piling).
44	IHO S-57 Object	IHO S-57 Object, not otherwise specified
64	Submerged Aquatic Vegetation	Submerged Aquatic Vegetation
65	Temporal Change	Denotes bathymetric bottom temporal changes from varying lifts, not utilized in bathymetric point class

8. Related Information

8.1 Flight Logs

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	Stennis (KHSA)
LOCATION / AREA:	Ida / BL32, QC61	**DATE:**	4 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	Ida, IdaEast	**CLOUDS:**	Clouds @ 3000ft
BASE STATION:	JX10	**WIND:**	10 kts @ 80
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-01

ENGINE START:	20:28	**ENGINE OFF:**	0:06	**ENGINE TIME:**	03:38
TAKEOFF:	20:48	**LANDING:**	23:56	**AIR TIME**	03:08

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		20:48:00					Takeoff
		21:29:08					DS: QC61_20221004_212908
000_FL1	6101	21:29:08	21:32:18	400	300	4	RCD error/No functioning
001_FL1	6101	21:35:49	21:39:12	400	300	4	RCD error/No functioning
002_FL1	6101	21:42:05	21:45:31	400	300	4	RCD error/No functioning
		22:03:22					DS: BL32_20221004_220322
000_FL1	3201	22:03:22	22:05:10	400	300	4	RCD error/No functioning
001_FL2	3202	22:08:12	22:09:55	400	300	4	RCD error/No functioning
002_FL3	3203	22:13:21	22:15:06	400	300	4	RCD error/No functioning
003_FL4	3204	22:18:05	22:19:49	400	300	4	RCD error/No functioning
004_FL5	3205	22:23:31	22:24:53	400	300	4	RCD error/No functioning
005_FL6	3206	22:27:56	22:28:58	400	300	4	RCD error/No functioning
006_FL7	3207	22:32:23	22:33:10	400	300	4	RCD error/No functioning
007_FL17	3296	22:36:09	22:37:32	400	300	4	RCD error/No functioning
008_FL8	3208	22:41:07	22:41:56	400	300	4	RCD error/No functioning
009_FL9	3209	22:44:56	22:46:18	400	300	4	RCD error/No functioning
010_FL10	3210	22:50:01	22:52:11	400	300	4	RCD error/No functioning
011_FL11	3211	22:55:33	22:57:39	400	300	4	RCD error/No functioning
012_FL12	3212	23:01:15	23:03:20	400	300	4	RCD error/No functioning
013_FL13	3213	23:06:36	23:08:45	400	300	4	RCD error/No functioning
014_FL14	3214	23:12:11	23:14:14	400	300	4	RCD error/No functioning
015_FL15	3215	23:17:34	23:19:36	400	300	4	RCD error/No functioning
016_FL16	3295	23:23:01	23:24:20	400	300	4	
		23:26:00					End survey
		23:56:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	Stennis (KHSA)
LOCATION / AREA:	Ida / BL28, BL29, BL30, BL31, QC61	**DATE:**	6 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaEast, IdaLA	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:		**RCD DRIVE:**	RCD-02

ENGINE START:	15:11	**ENGINE OFF:**	21:11	**ENGINE TIME:**	06:00
TAKEOFF:	15:28	**LANDING:**	21:00	**AIR TIME**	05:32

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		15:28:00					Takeoff
		16:02:53					DS: QC61_20221006_160253
000_FL1	6101	16:02:53	16:06:07	400	300	4	
001_FL1	6101	16:09:13	16:12:34	400	300	4	
		16:18:15					DS: BL28_20221006_161815
000_FL51	2895	16:18:15	16:20:46	400	300	4	
		16:34:49					DS: BL31_20221006_163449
000_FL1	3101	16:34:49	16:36:49	400	300	4	
001_FL2	3102	16:39:33	16:41:32	400	300	4	
002_FL3	3103	16:44:46	16:46:51	400	300	4	
003_FL4	3104	16:49:39	16:52:45	400	300	4	
004_FL5	3105	16:55:39	16:58:53	400	300	4	
005_FL6	3106	17:01:35	17:04:51	400	300	4	
006_FL7	3107	17:07:26	17:10:39	400	300	4	
007_FL8	3108	17:13:24	17:16:24	400	300	4	
008_FL9	3109	17:18:51	17:21:46	400	300	4	
009_FL10	3110	17:24:39	17:27:12	400	300	4	
010_FL11	3111	17:30:33	17:32:46	400	300	4	
011_FL12	3112	17:35:38	17:37:37	400	300	4	
012_FL13	3113	17:40:29	17:42:14	400	300	4	
013_FL14	3114	17:45:07	17:46:38	400	300	4	
014_FL15	3115	17:49:18	17:50:34	400	300	4	
015_FL16	3116	17:53:11	17:54:15	400	300	4	
016_FL17	3117	17:57:19	17:59:02	400	300	4	
		18:01:04					DS: BL30_20221006_180104
000_FL8	3095	18:01:04	18:02:19	400	300	4	
001_FL7	3007	18:06:07	18:08:00	400	300	4	
002_FL6	3006	18:10:20	18:12:13	400	300	4	
003_FL5	3005	18:14:57	18:17:01	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	Stennis (KHSA)
LOCATION / AREA:	Ida / BL28, BL29, BL30, BL31, QC61	**DATE:**	6 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaEast, IdaLA	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:		**RCD DRIVE:**	RCD-02

ENGINE START:	15:11	**ENGINE OFF:**	21:11	**ENGINE TIME:**	06:00
TAKEOFF:	15:28	**LANDING:**	21:00	**AIR TIME**	05:32

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
004_FL4	3004	18:19:25	18:21:23	400	300	4	
005_FL3	3003	18:24:06	18:25:57	400	300	4	
006_FL2	3002	18:28:22	18:30:00	400	300	4	
007_FL1	3001	18:32:38	18:34:00	400	300	4	
		18:37:13					DS: BL29_20221006_183713
000_FL1	2901	18:37:13	18:41:16	400	300	4	
001_FL2	2902	18:44:11	18:48:26	400	300	4	
002_FL3	2903	18:51:08	18:55:33	400	300	4	
003_FL4	2904	18:57:56	19:02:26	400	300	4	
004_FL5	2905	19:05:04	19:09:34	400	300	4	
005_FL6	2906	19:12:00	19:16:24	400	300	4	
006_FL7	2907	19:18:55	19:23:11	400	300	4	
007_FL8	2995	19:27:05	19:28:15	400	300	4	
		19:31:40					DS: BL28_20221006_193140
000_FL1	2801	19:31:40	19:32:52	400	300	4	
001_FL2	2802	19:35:13	19:36:33	400	300	4	
002_FL3	2803	19:39:28	19:41:10	400	300	4	
003_FL4	2804	19:43:46	19:45:30	400	300	4	
004_FL5	2805	19:48:14	19:50:01	400	300	4	
005_FL6	2806	19:52:32	19:54:18	400	300	4	
006_FL7	2807	19:57:08	19:58:52	400	300	4	
007_FL8	2808	20:01:28	20:03:08	400	300	4	
008_FL9	2809	20:05:50	20:07:26	400	300	4	
009_FL10	2810	20:10:51	20:11:50	400	300	4	
010_FL50	2897	20:14:33	20:15:57	400	300	4	
		20:16:00					End survey for fuel
		21:00:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL01, BL02, QC62	**DATE:**	7 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10 kts @ 330
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:05	**ENGINE OFF:**	19:07	**ENGINE TIME:**	06:02
TAKEOFF:	13:28	**LANDING:**	18:55	**AIR TIME**	05:27

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		13:28:00					Takeoff
		13:46:11					DS: QC62_20221007_134611
000_FL1	6201	13:46:11	13:48:57	400	300	4	
		14:37:04					DS: BL01_20221007_143704
000_FL1	0101	14:37:04	14:48:11	400	300	4	
001_FL2	0102	14:50:46	15:02:23	400	300	4	
002_FL3	0103	15:04:58	15:16:37	400	300	4	
003_FL4	0104	15:19:26	15:30:50	400	300	4	
004_FL5	0105	15:33:34	15:45:08	400	300	4	
005_FL6	0106	15:47:42	15:58:58	400	300	4	
006_FL7	0107	16:01:25	16:12:43	400	300	4	
007_FL10	0196	16:18:56	16:20:16	400	300	4	
008_FL9	0195	16:25:35	16:26:53	400	300	4	
		16:34:36					DS: BL02_20221007_163436
000_FL13	0213	16:34:36	16:40:16	400	300	4	
001_FL12	0212	16:43:08	16:48:55	400	300	4	Drifted 25m on line
002_FL11	0211	16:51:35	16:57:26	400	300	4	Roll exceeded 9 degrees
003_FL1	0201	16:59:38	17:00:25	400	300	4	
004_FL2	0202	17:02:49	17:03:41	400	300	4	
005_FL3	0203	17:06:23	17:07:20	400	300	4	
006_FL4	0204	17:11:47	17:16:44	400	300	4	Turbulent
007_FL5	0205	17:19:14	17:24:16	400	300	4	Turbulent
008_FL6	0206	17:27:13	17:32:31	400	300	4	
009_FL7	0207	17:35:05	17:40:35	400	300	4	Turbulent
010_FL8	0208	17:43:08	17:48:56	400	300	4	Turbulent
011_FL9	0209	17:51:15	17:57:00	400	300	4	Turbulent
012_FL10	0210	17:59:37	18:05:27	400	300	4	Turbulent
013_FL14	0295	18:10:19	18:11:44	400	300	4	
		18:12:00					End survey for fuel

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL01, BL02, QC62	**DATE:**	7 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10 kts @ 330
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:05	**ENGINE OFF:**	19:07	**ENGINE TIME:**	06:02
TAKEOFF:	13:28	**LANDING:**	18:55	**AIR TIME**	05:27

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		18:55:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL03, BL04, BL05, BL06, QC62	**DATE:**	8 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	15-20 kts @ 330
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:30	**ENGINE OFF:**	19:13	**ENGINE TIME:**	05:43
TAKEOFF:	13:43	**LANDING:**	19:01	**AIR TIME**	05:18

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		13:43:00					Takeoff
		14:01:00					DS: QC62_20221008_140100
000_FL1	6201	14:01:00	14:03:39	400	300	4	25m Off Line
		14:36:36					DS: BL03_20221008_143636
000_FL1	0301	14:36:36	14:39:17	400	300	4	
001_FL2	0302	14:41:42	14:44:23	400	300	4	
002_FL3	0303	14:47:03	14:49:44	400	300	4	
003_FL4	0304	14:52:11	14:54:54	400	300	4	
004_FL5	0305	14:57:18	15:00:02	400	300	4	Smoke in area
005_FL6	0306	15:02:31	15:05:16	400	300	4	Smoke in area
006_FL7	0307	15:08:03	15:10:49	400	300	4	Smoke in area
007_FL8	0395	15:14:42	15:16:46	400	300	4	
		15:19:27					DS: BL04_20221008_151927
000_FL1	0401	15:19:27	15:20:53	400	300	4	
001_FL2	0402	15:23:34	15:25:42	400	300	4	
002_FL3	0403	15:28:41	15:31:27	400	300	4	
003_FL4	0404	15:33:54	15:36:58	400	300	4	
004_FL5	0405	15:39:52	15:43:24	400	300	4	
005_FL6	0406	15:45:46	15:49:20	400	300	4	Turbulent
006_FL7	0407	15:52:19	15:56:17	400	300	4	30m Off Line
007_FL8	0408	15:58:46	16:02:40	400	300	4	
008_FL9	0409	16:05:18	16:09:28	400	300	4	
009_FL10	0410	16:12:00	16:15:50	400	300	4	
010_FL11	0411	16:18:38	16:22:49	400	300	4	
011_FL12	0412	16:25:20	16:29:13	400	300	4	Turbulent
012_FL13	0413	16:32:02	16:36:08	400	300	4	
013_FL14	0495	16:39:45	16:41:33	400	300	4	Turbulent
		16:45:22					DS: BL05_20221008_164522
000_FL1	0501	16:45:22	16:51:01	400	300	4	30m Off Line

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL03, BL04, BL05, BL06, QC62	**DATE:**	8 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	15-20 kts @ 330
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:30	**ENGINE OFF:**	19:13	**ENGINE TIME:**	05:43
TAKEOFF:	13:43	**LANDING:**	19:01	**AIR TIME**	05:18

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
001_FL2	0502	16:53:27	16:59:47	400	300	4	30m Off Line
002_FL3	0503	17:02:38	17:09:21	400	300	4	30m Off Line
003_FL4	0504	17:11:46	17:18:07	400	300	4	30m Off Line
004_FL5	0505	17:20:40	17:27:24	400	300	4	30m Off Line
005_FL6	0506	17:29:52	17:36:19	400	300	4	
006_FL7	0595	17:41:31	17:42:55	400	300	4	45m Off Line
		17:46:07					DS: BL06_20221008_174607
000_FL1	0601	17:46:07	17:48:34	400	300	4	30m Off Line
001_FL2	0602	17:52:03	17:55:48	400	300	4	30m Off Line
002_FL3	0603	17:58:25	18:02:08	400	300	4	30m Off Line
003_FL4	0604	18:04:40	18:08:20	400	300	4	30m Off Line
004_FL5	0605	18:10:44	18:14:28	400	300	4	30m Off Line
005_FL6	0606	18:16:44	18:20:26	400	300	4	30m Off Line
006_FL7	0695	18:23:48	18:25:00	400	300	4	Pilot unable to hold line
		18:25:00					End survey for fuel
		19:01:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL07, BL08, BL09, QC62	**DATE:**	9 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10-15 kts @ 80
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:27	**ENGINE OFF:**	19:24	**ENGINE TIME:**	05:57
TAKEOFF:	13:41	**LANDING:**	19:11	**AIR TIME**	05:30

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		13:41:00					Takeoff
		13:57:36					DS: QC62_20221009_135736
000_FL1	6201	13:57:36	14:00:08	400	300	4	
		14:27:19					DS: BL07_20221009_142719
000_FL1	0701	14:27:19	14:28:37	400	300	4	
001_FL2	0702	14:31:30	14:32:47	400	300	4	
002_FL3	0703	14:35:42	14:36:58	400	300	4	
003_FL4	0704	14:39:43	14:41:01	400	300	4	
004_FL5	0705	14:43:45	14:45:02	400	300	4	
005_FL6	0706	14:48:01	14:49:18	400	300	4	
006_FL7	0795	14:52:10	14:53:20	400	300	4	
		14:56:23					DS: BL08_20221009_145623
000_FL1	0801	14:56:23	14:58:09	400	300	4	
001_FL2	0802	15:00:55	15:03:30	400	300	4	
002_FL3	0803	15:06:36	15:10:23	400	300	4	
003_FL4	0804	15:13:07	15:16:56	400	300	4	40m Off Line
004_FL5	0805	15:19:31	15:23:31	400	300	4	
005_FL6	0806	15:26:07	15:29:57	400	300	4	
006_FL7	0807	15:32:47	15:36:46	400	300	4	
007_FL8	0808	15:39:31	15:43:18	400	300	4	
008_FL9	0895	15:47:45	15:49:05	400	300	4	
		15:55:28					DS: BL09_20221009_155528
000_FL1	0901	15:55:28	15:56:34	400	300	4	
001_FL2	0902	15:59:17	16:01:15	400	300	4	
002_FL3	0903	16:03:43	16:05:44	400	300	4	
003_FL4	0904	16:11:29	16:13:30	400	300	4	
004_FL5	0905	16:16:14	16:18:19	400	300	4	
005_FL6	0906	16:20:55	16:23:04	400	300	4	
006_FL7	0907	16:25:44	16:27:53	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL07, BL08, BL09, QC62	**DATE:**	9 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10-15 kts @ 80
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:27	**ENGINE OFF:**	19:24	**ENGINE TIME:**	05:57
TAKEOFF:	13:41	**LANDING:**	19:11	**AIR TIME**	05:30

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
007_FL8	0908	16:30:49	16:33:01	400	300	4	
008_FL9	0909	16:36:16	16:38:29	400	300	4	
009_FL10	0910	16:41:55	16:44:13	400	300	4	
010_FL11	0911	16:47:04	16:49:21	400	300	4	
011_FL12	0912	16:52:18	16:54:42	400	300	4	
012_FL13	0913	16:57:51	17:00:09	400	300	4	
013_FL14	0914	17:03:12	17:05:34	400	300	4	
014_FL15	0915	17:08:54	17:11:14	400	300	4	
015_FL16	0916	17:14:07	17:16:31	400	300	4	
016_FL17	0917	17:19:15	17:21:39	400	300	4	
017_FL18	0918	17:24:44	17:29:31	400	300	4	
018_FL19	0919	17:32:35	17:38:01	400	300	4	
019_FL20	0920	17:40:47	17:46:40	400	300	4	
020_FL21	0921	17:49:16	17:55:29	400	300	4	
021_FL22	0922	17:58:42	18:04:45	400	300	4	25m Off Line
022_FL23	0923	18:07:42	18:13:51	400	300	4	Turbulence
023_FL24	0924	18:16:54	18:22:50	400	300	4	Turbulence
024_FL25	0925	18:25:32	18:31:31	400	300	4	Turbulence
025_FL26	0995	18:34:18	18:36:36	400	300	4	
026_FL27	0996	18:40:13	18:41:26	400	300	4	
		18:42:00					End survey for fuel
		19:11:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL10, QC62	**DATE:**	10 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	15-20 kts @ 70
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	12:41	**ENGINE OFF:**	16:10	**ENGINE TIME:**	03:29
TAKEOFF:	13:01	**LANDING:**	16:00	**AIR TIME**	02:59

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		13:01:00					Takeoff
		13:18:35					DS: QC62_20221010_131835
000_FL1	6201	13:18:35	13:21:11	400	300	4	
		13:38:59					DS: BL10_20221010_133859
000_FL1	1001	13:38:59	13:48:11	400	300	4	
001_FL2	1002	13:51:07	14:00:14	400	300	4	
002_FL3	1003	14:03:06	14:12:50	400	300	4	
003_FL4	1004	14:15:39	14:24:58	400	300	4	
004_FL5	1005	14:27:52	14:37:41	400	300	4	
005_FL6	1006	14:40:22	14:49:19	400	300	4	
006_FL7	1007	14:52:27	15:01:05	400	300	4	
007_FL8	1095	15:08:13	15:09:34	400	300	4	
008_FL9	1096	15:15:16	15:16:35	400	300	4	
		15:46:00					End survey due to drive read error
		16:00:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL11, BL12, BL13, QC62	**DATE:**	11 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	20-25 kts @ 100
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	12:39	**ENGINE OFF:**	17:55	**ENGINE TIME:**	05:16
TAKEOFF:	12:54	**LANDING:**	17:46	**AIR TIME**	04:52

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		12:54:00					Takeoff
		13:12:23					DS: QC62_20221011_131223
000_FL1	6201	13:12:23	13:14:56	400	300	4	
		13:21:03					DS: BL11_20221011_132103
000_FL1	1101	13:21:03	13:21:54	400	300	4	
001_FL2	1102	13:25:44	13:26:49	400	300	4	
002_FL3	1103	13:32:44	13:42:11	400	300	4	
003_FL4	1104	13:45:21	13:54:18	400	300	4	
004_FL5	1105	13:57:59	14:08:12	400	300	4	
005_FL6	1106	14:11:13	14:20:36	400	300	4	
006_FL7	1107	14:23:53	14:34:07	400	300	4	
007_FL8	1108	14:37:19	14:46:46	400	300	4	
008_FL9	1109	14:50:09	15:00:23	400	300	4	
009_FL10	1110	15:03:39	15:13:05	400	300	4	
010_FL11	1111	15:16:20	15:24:52	400	300	4	
011_FL12	1195	15:32:17	15:33:43	400	300	4	
012_FL13	1196	15:38:52	15:40:17	400	300	4	
		15:42:48					DS: BL12_20221011_154248
000_FL1	1201	15:42:48	15:47:00	400	300	4	
001_FL2	1202	15:50:07	15:54:39	400	300	4	
002_FL3	1203	15:58:02	16:02:39	400	300	4	
003_FL4	1204	16:05:25	16:09:54	400	300	4	
004_FL5	1205	16:13:18	16:17:48	400	300	4	
005_FL6	1206	16:20:41	16:25:01	400	300	4	
006_FL7	1207	16:27:48	16:31:46	400	300	4	
007_FL8	1208	16:34:07	16:36:53	400	300	4	
008_FL9	1209	16:40:00	16:41:54	400	300	4	
009_FL10	1295	16:44:37	16:46:01	400	300	4	
		16:48:56					DS: BL13_20221011_164856

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL11, BL12, BL13, QC62	**DATE:**	11 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	20-25 kts @ 100
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	12:39	**ENGINE OFF:**	17:55	**ENGINE TIME:**	05:16
TAKEOFF:	12:54	**LANDING:**	17:46	**AIR TIME**	04:52

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
000_FL1	1301	16:48:56	16:52:03	400	300	4	
001_FL2	1302	16:55:15	16:58:23	400	300	4	
002_FL3	1303	17:01:24	17:04:36	400	300	4	
003_FL4	1304	17:07:58	17:11:18	400	300	4	
004_FL5	1305	17:14:39	17:17:50	400	300	4	
005_FL6	1306	17:21:21	17:24:25	400	300	4	
006_FL7	1307	17:27:35	17:28:27	400	300	4	
007_FL8	1395	17:31:24	17:32:31	400	300	4	
		17:33:00					End survey for fuel
		17:46:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL14, BL15, QC62	**DATE:**	13 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10 kts @ 30
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-03

ENGINE START:	16:02	**ENGINE OFF:**	21:19	**ENGINE TIME:**	05:17
TAKEOFF:	16:17	**LANDING:**	21:07	**AIR TIME**	04:50

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		16:17:00					Takeoff
		16:34:39					DS: QC62_20221013_163439
000_FL1	6201	16:34:39	16:37:10	400	300	4	
		16:46:50					DS: BL14_20221013_164650
000_FL1	1401	16:46:50	16:53:16	400	300	4	
001_FL2	1402	16:55:52	17:02:36	400	300	4	
002_FL3	1403	17:05:36	17:12:20	400	300	4	
003_FL4	1404	17:14:56	17:21:43	400	300	4	
004_FL5	1405	17:24:23	17:31:27	400	300	4	
005_FL6	1406	17:34:00	17:40:56	400	300	4	
006_FL7	1407	17:43:35	17:50:27	400	300	4	
007_FL8	1408	17:53:10	18:00:01	400	300	4	
008_FL9	1409	18:03:00	18:09:52	400	300	4	
009_FL10	1410	18:12:41	18:19:10	400	300	4	
010_FL11	1411	18:22:43	18:28:40	400	300	4	
011_FL12	1412	18:31:13	18:36:10	400	300	4	
012_FL19	1496	18:38:41	18:40:13	400	300	4	
013_FL13	1413	18:42:35	18:45:08	400	300	4	
014_FL14	1414	18:47:53	18:49:29	400	300	4	
015_FL15	1415	18:51:59	18:53:22	400	300	4	
016_FL16	1416	18:56:17	18:57:27	400	300	4	
017_FL17	1417	19:00:20	19:01:16	400	300	4	
018_FL18	1495	19:04:08	19:06:08	400	300	4	
		19:09:19					DS: BL15_20221013_190919
000_FL1	1501	19:09:19	19:12:01	400	300	4	
001_FL2	1502	19:14:42	19:17:34	400	300	4	
002_FL3	1503	19:20:15	19:23:27	400	300	4	
003_FL4	1504	19:26:05	19:29:32	400	300	4	
004_FL5	1505	19:32:24	19:36:21	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL14, BL15, QC62	**DATE:**	13 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaLA, IdaWest	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	10 kts @ 30
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-03

ENGINE START:	16:02	**ENGINE OFF:**	21:19	**ENGINE TIME:**	05:17
TAKEOFF:	16:17	**LANDING:**	21:07	**AIR TIME**	04:50

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
005_FL6	1506	19:39:28	19:43:28	400	300	4	
006_FL7	1507	19:46:25	19:50:37	400	300	4	
007_FL8	1508	19:53:21	19:57:29	400	300	4	
008_FL9	1509	20:00:34	20:04:42	400	300	4	
009_FL10	1510	20:07:31	20:11:26	400	300	4	
010_FL11	1511	20:14:44	20:18:46	400	300	4	
011_FL12	1512	20:21:35	20:25:22	400	300	4	
012_FL13	1513	20:28:26	20:32:02	400	300	4	
013_FL14	1514	20:34:51	20:36:15	400	300	4	
014_FL15	1515	20:39:32	20:40:47	400	300	4	
015_FL16	1516	20:43:28	20:44:40	400	300	4	
016_FL17	1517	20:47:44	20:48:43	400	300	4	
017_FL18	1595	20:51:41	20:53:37	400	300	4	
		20:53:00					End survey for fuel
		21:07:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL16, BL17, BL18, BL19, BL20, BL21, BL22, QC6	**DATE:**	14 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-03

ENGINE START:	12:42	**ENGINE OFF:**	18:39	**ENGINE TIME:**	05:57
TAKEOFF:	13:07	**LANDING:**	18:28	**AIR TIME**	05:21

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		13:07:00					Takeoff
		13:23:39					DS: QC62_20221014_132339
000_FL1	6201	13:23:39	13:26:07	400	300	4	
		13:50:33					DS: BL16_20221014_135033
000_FL1	1601	13:50:33	13:51:22	400	300	4	
001_FL2	1602	13:55:22	13:56:12	400	300	4	
002_FL3	1603	13:58:58	13:59:54	400	300	4	
003_FL4	1604	14:04:48	14:06:08	400	300	4	
004_FL5	1605	14:09:43	14:12:33	400	300	4	
005_FL6	1606	14:15:34	14:18:20	400	300	4	
006_FL9	1695	14:21:37	14:22:47	400	300	4	
007_FL7	1607	14:25:32	14:28:30	400	300	4	
008_FL8	1608	14:31:19	14:34:03	400	300	4	
009_FL10	1696	14:38:07	14:39:26	400	300	4	
		14:42:07					DS: BL17_20221014_144207
000_FL1	1701	14:42:07	14:44:50	400	300	4	
001_FL2	1702	14:47:55	14:50:30	400	300	4	
002_FL3	1703	14:54:00	14:56:54	400	300	4	
003_FL4	1704	14:59:27	15:01:56	400	300	4	
004_FL5	1795	15:05:04	15:06:09	400	300	4	
		15:08:46					DS: BL18_20221014_150846
000_FL1	1801	15:08:46	15:11:23	400	300	4	RCD30 frame lost
001_FL2	1802	15:14:15	15:16:46	400	300	4	
002_FL3	1803	15:19:46	15:22:30	400	300	4	
003_FL4	1804	15:25:10	15:27:50	400	300	4	
004_FL5	1895	15:31:19	15:32:34	400	300	4	
		15:36:32					DS: BL19_20221014_153632
000_FL1	1901	15:36:32	15:38:46	400	300	4	
001_FL2	1902	15:41:29	15:43:42	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL16, BL17, BL18, BL19, BL20, BL21, BL22, QC6	**DATE:**	14 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-03

ENGINE START:	12:42	**ENGINE OFF:**	18:39	**ENGINE TIME:**	05:57
TAKEOFF:	13:07	**LANDING:**	18:28	**AIR TIME**	05:21

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
002_FL3	1903	15:47:25	15:49:33	400	300	4	
003_FL4	1904	15:52:14	15:53:05	400	300	4	
004_FL5	1995	15:56:02	15:57:09	400	300	4	
		15:59:36					DS: BL20_20221014_155936
000_FL1	2001	15:59:36	16:01:09	400	300	4	
001_FL2	2002	16:04:04	16:05:32	400	300	4	
002_FL3	2003	16:08:41	16:10:15	400	300	4	
003_FL4	2004	16:13:06	16:14:28	400	300	4	RCD30 lost frames
004_FL5	2095	16:17:09	16:18:20	400	300	4	
		16:22:14					DS: BL21_20221014_162214
000_FL1	2101	16:22:14	16:23:24	400	300	4	
001_FL2	2102	16:26:30	16:27:36	400	300	4	
002_FL3	2103	16:30:55	16:31:39	400	300	4	
003_FL4	2104	16:33:51	16:34:44	400	300	4	
004_FL5	2105	16:37:20	16:38:07	400	300	4	
005_FL6	2106	16:40:56	16:41:40	400	300	4	
006_FL7	2195	16:44:37	16:45:40	400	300	4	
007_FL8	2196	16:48:08	16:49:22	400	300	4	
		16:51:48					DS: BL22_20221014_165148
000_FL1	2201	16:51:48	16:52:37	400	300	4	
001_FL2	2202	16:55:05	16:55:57	400	300	4	
002_FL3	2203	16:58:36	16:59:21	400	300	4	
003_FL15	2297	17:02:13	17:03:13	400	300	4	
004_FL4	2204	17:06:01	17:06:55	400	300	4	
005_FL5	2205	17:10:21	17:11:08	400	300	4	
006_FL6	2206	17:13:26	17:15:30	400	300	4	
007_FL7	2207	17:17:56	17:19:53	400	300	4	
008_FL8	2208	17:23:10	17:25:06	400	300	4	
009_FL9	2209	17:27:50	17:29:39	400	300	4	
010_FL10	2210	17:32:39	17:34:31	400	300	4	RCD30 lost frames

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL16, BL17, BL18, BL19, BL20, BL21, BL22, QC6	**DATE:**	14 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-03

ENGINE START:	12:42	**ENGINE OFF:**	18:39	**ENGINE TIME:**	05:57
TAKEOFF:	13:07	**LANDING:**	18:28	**AIR TIME**	05:21

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
011_FL11	2211	17:37:12	17:38:47	400	300	4	
012_FL12	2212	17:41:49	17:42:49	400	300	4	
013_FL10	2210	17:45:28	17:47:11	400	300	4	Reflew due to lost frames
014_FL13	2295	17:50:21	17:51:41	400	300	4	
015_FL14	2296	17:53:57	17:54:46	400	300	4	
016_FL4	2204	17:57:40	17:58:28	400	300	4	Reflew due to lost frames
		18:01:33					DS: BL18_20221014_180133
000_FL1	1801	18:01:33	18:03:59	400	300	4	Reflew
		18:04:00					End survey for fuel
		18:28:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL23, BL24, BL25, BL26, QC62	**DATE:**	15 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.
MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:18	**ENGINE OFF:**	19:27	**ENGINE TIME:**	06:09
TAKEOFF:	13:44	**LANDING:**	19:18	**AIR TIME**	05:34

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		13:44:00					Takeoff
		14:02:13					DS: QC62_20221015_140213
000_FL1	6201	14:02:13	14:04:51	400	300	4	
		14:36:01					DS: BL23_20221015_143601
000_FL1	2301	14:36:01	14:36:43	400	300	4	
001_FL2	2302	14:39:28	14:40:20	400	300	4	
002_FL3	2303	14:43:09	14:44:24	400	300	4	
003_FL4	2304	14:47:04	14:48:29	400	300	4	
004_FL5	2305	14:51:40	14:53:09	400	300	4	
005_FL6	2306	14:56:03	14:57:32	400	300	4	
006_FL7	2395	15:00:12	15:01:25	400	300	4	
		15:03:59					DS: BL24_20221015_150359
000_FL1	2401	15:03:59	15:05:08	400	300	4	
001_FL2	2402	15:08:01	15:09:23	400	300	4	
002_FL3	2403	15:12:45	15:14:34	400	300	4	
003_FL4	2404	15:18:24	15:21:30	400	300	4	
004_FL5	2405	15:24:29	15:27:41	400	300	4	
005_FL6	2406	15:30:33	15:33:46	400	300	4	
006_FL7	2407	15:37:00	15:40:18	400	300	4	
007_FL8	2408	15:42:57	15:46:10	400	300	4	
008_FL9	2495	15:49:06	15:50:23	400	300	4	
		15:54:03					DS: BL25_20221015_155403
000_FL1	2501	15:54:03	15:58:36	400	300	4	
001_FL2	2502	16:01:31	16:05:51	400	300	4	
002_FL3	2503	16:09:17	16:13:54	400	300	4	40m off line
003_FL4	2504	16:16:35	16:20:57	400	300	4	
004_FL5	2505	16:24:16	16:28:50	400	300	4	
005_FL6	2506	16:31:56	16:36:14	400	300	4	30m off line
006_FL7	2507	16:40:21	16:44:37	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL23, BL24, BL25, BL26, QC62	**DATE:**	15 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Ray L.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Andrew S.

MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clouds @5000ft+
BASE STATION:	PPP	**WIND:**	10-15 kts @ 150
LIDAR DRIVE:	HE4X-03	**RCD DRIVE:**	RCD-02

ENGINE START:	13:18	**ENGINE OFF:**	19:27	**ENGINE TIME:**	06:09
TAKEOFF:	13:44	**LANDING:**	19:18	**AIR TIME**	05:34

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
007_FL8	2508	16:47:42	16:51:40	400	300	4	
008_FL9	2509	16:55:15	16:59:24	400	300	4	
009_FL10	2510	17:02:36	17:06:24	400	300	4	
010_FL11	2511	17:09:43	17:13:31	400	300	4	
011_FL12	2512	17:16:12	17:19:44	400	300	4	
012_FL13	2513	17:23:18	17:26:07	400	300	4	
013_FL14	2514	17:28:58	17:30:18	400	300	4	
014_FL15	2595	17:33:10	17:34:53	400	300	4	
		17:38:20					DS: BL26_20221015_173820
000_FL1	2601	17:38:20	17:42:18	400	300	4	
001_FL2	2602	17:44:55	17:48:49	400	300	4	
002_FL3	2603	17:52:05	17:56:04	400	300	4	
003_FL4	2604	17:58:54	18:02:46	400	300	4	45m off line
004_FL5	2605	18:06:14	18:10:09	400	300	4	
005_FL6	2606	18:12:54	18:16:34	400	300	4	
006_FL7	2607	18:19:53	18:23:37	400	300	4	
007_FL8	2608	18:26:12	18:29:48	400	300	4	
008_FL9	2609	18:33:16	18:36:01	400	300	4	
009_FL10	2610	18:38:42	18:40:54	400	300	4	
010_FL18	2695	18:44:08	18:45:40	400	300	4	
		18:46:00					End survey for fuel
		19:18:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL27, QC61	**DATE:**	18 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	20-25 kts @ 20
LIDAR DRIVE:	HE4X-01	**RCD DRIVE:**	RCD-01

ENGINE START:	13:05	**ENGINE OFF:**	19:33	**ENGINE TIME:**	06:28
TAKEOFF:	13:36	**LANDING:**	19:21	**AIR TIME**	05:45

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		13:36:00					Takeoff
		14:18:26					DS: QC61_20221018_141826
000_FL1	6101	14:18:27	14:21:16	400	300	4	
		14:27:58					DS: BL27_20221018_142758
000_FL16	2716	14:27:58	14:33:56	400	300	4	
001_FL15	2715	14:36:54	14:42:58	400	300	4	deviation at end of line
002_FL14	2714	15:04:58	15:11:06	400	300	4	
003_FL13	2713	15:14:07	15:20:03	400	300	4	
004_FL12	2712	15:22:55	15:28:43	400	300	4	
005_FL11	2711	15:31:26	15:32:52	400	300	4	
006_FL10	2710	15:35:47	15:37:07	400	300	4	
007_FL9	2709	15:39:37	15:41:01	400	300	4	
008_FL8	2708	15:44:14	15:45:25	400	300	4	
009_FL7	2707	15:48:19	15:49:26	400	300	4	
010_FL6	2706	15:52:19	15:53:17	400	300	4	
011_FL5	2705	15:55:55	15:56:55	400	300	4	
012_FL4	2704	15:59:42	16:00:35	400	300	4	
013_FL3	2703	16:03:14	16:04:12	400	300	4	
014_FL2	2702	16:06:59	16:07:51	400	300	4	
015_FL1	2701	16:10:24	16:11:13	400	300	4	
016_FL35	2795	16:14:45	16:17:49	400	300	4	
017_FL34	2734	16:24:33	16:28:01	400	300	4	
018_FL33	2733	16:31:31	16:35:54	400	300	4	
019_FL32	2732	16:38:48	16:43:27	400	300	4	
020_FL31	2731	16:46:19	16:50:57	400	300	4	
021_FL30	2730	16:53:46	16:58:35	400	300	4	
022_FL29	2729	17:01:25	17:06:22	400	300	4	
023_FL28	2728	17:09:14	17:14:35	400	300	4	
024_FL27	2727	17:17:08	17:22:31	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL27, QC61	**DATE:**	18 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaCentral, IdaLA	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	20-25 kts @ 20
LIDAR DRIVE:	HE4X-01	**RCD DRIVE:**	RCD-01

ENGINE START:	13:05	**ENGINE OFF:**	19:33	**ENGINE TIME:**	06:28
TAKEOFF:	13:36	**LANDING:**	19:21	**AIR TIME**	05:45

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
025_FL26	2726	17:25:17	17:31:09	400	300	4	
026_FL25	2725	17:34:02	17:40:00	400	300	4	
027_FL24	2724	17:42:37	17:48:32	400	300	4	
028_FL23	2723	17:51:04	17:55:54	400	300	4	
029_FL22	2722	17:58:54	18:04:08	400	300	4	
030_FL21	2721	18:07:02	18:12:01	400	300	4	
031_FL20	2720	18:14:52	18:20:04	400	300	4	
032_FL19	2719	18:23:06	18:27:47	400	300	4	
033_FL18	2718	18:32:14	18:33:34	400	300	4	
034_FL17	2717	18:36:18	18:37:43	400	300	4	
		18:39:00					End survey for fuel
		19:21:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL28, QC61	**DATE:**	19 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaEast, IdaLA	**CLOUDS:**	Clouds @ 2000ft
BASE STATION:	PPP	**WIND:**	10-15 kts @ 20
LIDAR DRIVE:	HE4X-02	**RCD DRIVE:**	RCD-03

ENGINE START:	13:45	**ENGINE OFF:**	19:21	**ENGINE TIME:**	05:36
TAKEOFF:	14:12	**LANDING:**	19:08	**AIR TIME**	04:56

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		14:12:00					Takeoff
		14:57:27					DS: QC61_20221019_145727
000_FL1	6101	14:57:27	15:00:16	400	300	4	
		15:05:41					DS: BL28_20221019_150541
000_FL48	2848	15:05:41	15:07:33	400	300	4	
001_FL47	2847	15:12:27	15:18:38	400	300	4	
002_FL46	2846	15:21:17	15:27:22	400	300	4	
003_FL45	2845	15:30:20	15:36:42	400	300	4	
004_FL44	2844	15:41:28	15:50:06	400	300	4	
005_FL43	2843	15:52:51	16:01:58	400	300	4	
006_FL42	2842	16:04:59	16:13:35	400	300	4	
007_FL41	2841	16:16:51	16:25:57	400	300	4	
008_FL40	2840	16:28:54	16:38:02	400	300	4	
009_FL39	2839	16:41:09	16:50:26	400	300	4	
010_FL38	2838	16:54:57	17:05:14	400	300	4	
011_FL37	2837	17:08:46	17:19:24	400	300	4	
012_FL36	2836	17:22:30	17:33:12	400	300	4	
013_FL35	2835	17:36:19	17:47:25	400	300	4	
014_FL34	2834	17:50:02	18:00:44	400	300	4	
015_FL33	2833	18:03:48	18:14:33	400	300	4	
016_FL32	2832	18:17:02	18:27:40	400	300	4	
		18:38:00					End survey for fuel
		19:08:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL26, BL28, QC61	**DATE:**	20 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaCentral, IdaEast, IdaLA	**CLOUDS:**	Clear
BASE STATION:	PPP	**WIND:**	5-10 kts @ 340
LIDAR DRIVE:	HE4X-02	**RCD DRIVE:**	RCD-03

ENGINE START:	13:55	**ENGINE OFF:**	18:47	**ENGINE TIME:**	04:52
TAKEOFF:	14:17	**LANDING:**	18:37	**AIR TIME**	04:20

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF	TOPO PWR	REMARKS
		14:17:00					Takeoff
		14:59:16					DS: QC61_20221020_145916
000_FL1	6101	14:59:16	15:02:11	400	300	4	
		15:06:33					DS: BL28_20221020_150633
000_FL51	2895	15:06:33	15:09:09	400	300	4	
001_FL20	2820	15:14:00	15:17:06	400	300	4	
002_FL21	2821	15:19:40	15:22:56	400	300	4	
003_FL22	2822	15:25:56	15:29:37	400	300	4	
004_FL23	2823	15:32:17	15:36:06	400	300	4	
005_FL24	2824	15:38:50	15:42:52	400	300	4	
006_FL25	2825	15:45:25	15:49:36	400	300	4	
007_FL26	2826	15:52:12	15:56:42	400	300	4	
008_FL27	2827	16:07:08	16:15:29	400	300	4	
009_FL28	2828	16:18:12	16:27:21	400	300	4	
010_FL29	2829	16:30:14	16:39:15	400	300	4	
011_FL30	2830	16:42:08	16:51:28	400	300	4	
012_FL31	2831	16:56:06	17:07:08	400	300	4	
		17:20:22					DS: BL26_20221020_172022
000_FL19	2696	17:20:22	17:21:50	400	300	4	
001_FL17	2617	17:24:24	17:25:37	400	300	4	
002_FL16	2616	17:28:34	17:30:04	400	300	4	
003_FL15	2615	17:33:08	17:34:50	400	300	4	
004_FL14	2614	17:37:32	17:39:09	400	300	4	
005_FL13	2613	17:41:56	17:43:35	400	300	4	
006_FL12	2612	17:46:20	17:47:55	400	300	4	
007_FL11	2611	17:51:10	17:52:38	400	300	4	
		17:52:00					End survey for fuel
		18:37:00					Landing

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL28, BL32, QC61	**DATE:**	21 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaEast, IdaLA	**CLOUDS:**	Clouds @ 3500ft
BASE STATION:	PPP	**WIND:**	5-10 kts @ 150
LIDAR DRIVE:	HE4X-04	**RCD DRIVE:**	RCD-01

ENGINE START:	18:06	**ENGINE OFF:**	22:08	**ENGINE TIME:**	04:02
TAKEOFF:	18:33	**LANDING:**	21:58	**AIR TIME**	03:25

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
		18:33:00					Takeoff
		19:15:40					DS: QC61_20221021_191540
000_FL1	6101	19:15:40	19:18:45	400	300	4	
		19:27:01					DS: BL28_20221021_192701
000_FL49	2896	19:27:01	19:28:27	400	300	4	
001_FL11	2811	19:31:27	19:32:53	400	300	4	
002_FL12	2812	19:35:27	19:37:03	400	300	4	
003_FL13	2813	19:39:44	19:41:28	400	300	4	
004_FL14	2814	19:43:44	19:45:28	400	300	4	
005_FL15	2815	19:48:08	19:49:52	400	300	4	
006_FL16	2816	19:52:07	19:53:46	400	300	4	
007_FL17	2817	19:56:16	19:57:49	400	300	4	
008_FL18	2818	20:00:13	20:01:39	400	300	4	
009_FL19	2819	20:04:04	20:05:20	400	300	4	
		20:13:42					DS: BL32_20221021_201342
000_FL16	3295	20:13:42	20:15:05	400	300	4	
001_FL15	3215	20:18:04	20:19:57	400	300	4	
002_FL14	3214	20:23:07	20:25:20	400	300	4	
003_FL13	3213	20:27:40	20:29:43	400	300	4	
004_FL12	3212	20:32:10	20:34:18	400	300	4	
005_FL11	3211	20:36:46	20:38:51	400	300	4	
006_FL10	3210	20:41:32	20:43:41	400	300	4	
007_FL9	3209	20:46:09	20:47:33	400	300	4	
008_FL8	3208	20:50:09	20:50:56	400	300	4	
009_FL7	3207	20:51:52	20:52:42	400	300	4	
010_FL6	3206	20:55:05	20:56:10	400	300	4	
011_FL5	3205	20:58:58	21:00:19	400	300	4	
012_FL4	3204	21:02:54	21:04:31	400	300	4	
013_FL3	3203	21:07:14	21:09:01	400	300	4	

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FLIGHT LOG

PROJECT NAME:	2022-10010368 Ida	**BASE AIRPORT:**	New Iberia (KARA)
LOCATION / AREA:	Ida / BL28, BL32, QC61	**DATE:**	21 October 2022
AIRCRAFT:	Cessna 404 (N70790F)	**PILOT:**	Nevo D.
SYSTEM:	HawkEye 4X	**OPERATOR:**	Richard C.

MISSION ID:	IdaEast, IdaLA	**CLOUDS:**	Clouds @ 3500ft
BASE STATION:	PPP	**WIND:**	5-10 kts @ 150
LIDAR DRIVE:	HE4X-04	**RCD DRIVE:**	RCD-01

ENGINE START:	18:06	**ENGINE OFF:**	22:08	**ENGINE TIME:**	04:02
TAKEOFF:	18:33	**LANDING:**	21:58	**AIR TIME**	03:25

FL #	LINE #	START TIME	END TIME	ALTITUDE	TOPO PRF | PWR		REMARKS
014_FL2	3202	21:11:34	21:13:15	400	300	4	
015_FL1	3201	21:16:11	21:17:56	400	300	4	
016_FL17	3296	21:20:45	21:22:01	400	300	4	
		21:22:00					End survey for fuel
		21:58:00					Landing

8.2 Trajectory Processing Log

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TRAJECTORY PROCESSING

PROJECT NAME: LA2208-TB-C
LOCATION: New Iberia, Louisiana
AIRCRAFT: Cessna 404 N7079F
SYSTEM: Chiroptera 4x

Project Name	Download Airborne Data	Create IE Project Directory	Copy Data to IE Project /Raw	Run Project Wizard	Base Station			Check Base Coordinate & Datum	Check Lever Arms	Process Time Window		Process TC	Review QC Plots	Separation			Solution Status	Comments
					Station ID	Receiver Type	Antenna (ARP) Height (m)			Start Time (GPS Week Time)	End Time (GPS Week Time)			East RMS (m)	North RMS (m)	Up RMS (m)		
2022-10-06A_CH4X	GT	GT	GT	GT	PPP	NA	NA	GT	GT			GT	GT	0.009	0.005	0.027	FINAL	
2022-10-06A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.008	0.008	0.026	FINAL	
2022-10-07A_CH4X	GT	GT	GT	GT	PPP	NA	NA	GT	GT			GT	GT	0.038	0.016	0.061	FINAL	
2022-10-07A_HE4X	GT	GT	GT	GT	PPP	NA	NA	GT	GT			GT	GT	0.012	0.013	0.052	FINAL	
2022-10-08A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.028	0.015	0.076	FINAL	
2022-10-08A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.012	0.012	0.049	FINAL	
2022-10-09A_CH4X	GT	GT	GT	GT	PPP	NA	NA	GT	GT			GT	GT	0.014	0.011	0.045	FINAL	
2022-10-09A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.022	0.015	0.043	FINAL	
2022-10-10A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.010	0.010	0.030	FINAL	
2022-10-10A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.010	0.010	0.030	FINAL	
2022-10-11A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.017	0.011	0.043	FINAL	
2022-10-11A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.017	0.010	0.044	FINAL	
2022-10-13A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.018	0.016	0.084	FINAL	
2022-10-13A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.344	0.078	0.225	FINAL	
2022-10-14A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.015	0.012	0.048	FINAL	
2022-10-14A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.011	0.014	0.045	FINAL	
2022-10-15A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.018	0.015	0.085	FINAL	
2022-10-15A_HE4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.011	0.013	0.051	FINAL	
2022-10-18A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.028	0.015	0.045	FINAL	
2022-10-18A_HE4X	AS	AS	AS	AS	PPP	NA	NA	RC	RC			RC	RC	0.020	0.013	0.043	FINAL	

WOOLPERT

TRAJECTORY PROCESSING

PROJECT NAME: LA2208-TB-C
LOCATION: New Iberia, Louisiana
AIRCRAFT: Cessna 404 N7079F
SYSTEM: Chiroptera 4x

Project Name	Download Airborne Data	Create IE Project Directory	Copy Data to IE Project /Raw	Run Project Wizard	Base Station			Check Base Coordinate & Datum	Check Lever Arms	Process Time Window		Process TC	Review QC Plots	Separation			Solution Status	Comments
					Station ID	Receiver Type	Antenna (ARP) Height (m)			Start Time (GPS Week Time)	End Time (GPS Week Time)			East RMS (m)	North RMS (m)	Up RMS (m)		
2022-10-19A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.031	0.021	0.070	FINAL	
2022-10-19A_HE4X	AS	AS	AS	AS	PPP	NA	NA	RC	RC			RC	RC	0.042	0.022	0.072	FINAL	
2022-10-20A_CH4X	AS	AS	AS	AS	PPP	NA	NA	AS	AS			AS	AS	0.016	0.021	0.064	FINAL	
2022-10-20A_HE4X	AS	AS	AS	AS	PPP	NA	NA	RC	RC			RC	RC	0.017	0.022	0.060	FINAL	
2022-10-21A_CH4X	RC	RC	RC	RC	PPP	NA	NA	RC	RC			RC	RC	0.012	0.011	0.048	FINAL	
2022-10-21A_HE4X	RC	RC	RC	RC	PPP	NA	NA	RC	RC			RC	RC	0.012	0.012	0.046	FINAL	