

* There ^{were} ~~was~~ no ~~data~~ azimuth data supplied

R/V ATLANTIS
ORTHOGONAL COORDINATE SURVEY & SENSOR ALIGNMENT
JANUARY – March 2011

FINAL REPORT

May 20, 2011 – Rev "2"



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Industrial Measurement Technology Engineering Consultants

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Electronic Data-Atlantis

- Final Data – mm.xls (Excel File of Tables)
- All Observations DXF.dxf
- All Observations Text .txt

3-25-2011 Rev 1- Shifted Origin Back to Aft Port Corner Hippy Plate- Table 1, 2 & 3, Hippy Plate Graphic, Old PHIN Graphic

5-20-2011 Rev 2 -Shifted origin to locate PBM10 24.456 Meters aft of Frame zero and at faired baseline at bottom of keel thus placing the origin at Frame Zero on the Faired Ship Base line.

PROJECT OVERVIEW

Purpose

The purpose of this commentary is to summarize the procedures and analytical methods employed to perform the 3-D coordinate total station inspection that produced the data in this report for those unfamiliar with the equipment and process.

Dimensional data resulting from the inspection is included with the report.

General Comments

This report summarizes coordinate measurement data taken on the vessel R/V Atlantis during the period of January 26, 2011 through March 7, 2011. The vessel was in a floating drydock at BAE Systems in Jacksonville, FL.

Tasks performed January 26-28:

Coordinate measurements were taken to characterize the vessel and create the required reference coordinate system for reporting azimuth, pitch, and roll and coordinate data.

Measurements were taken to obtain the center coordinates of antennae located on the main mast.

Verification of Pitch of the existing fairing structure that was being reworked to allow the installation of a Kongsberg EM122 Multibeam Sonar Array TX frame.

Transfer ship's reference system into the GSM Stores room via a hole cut in the hull side shell. Reference plate is being machined to accept 3 IXSEA PHINS units that will be aligned to the ships AZ line.

A reference plane was left on keel blocks and drydock walls to allow personnel from BAE Systems to tack wing normal to the ship's reference plane.

Tasks performed February 16 through February 19, 2011:

Verify Wing installation/ monitor welding.

Layout 2 degree reference lines to facilitate strut installation.

Set Reference Plate (old Hippy plate) to ship's azimuth.

Survey the final position and inclination of new IXSEA PHINS units.

Value all existing permanent benchmarks (4 fantail, 4 bow, 4 in GSM Stores room / Passageway)

Tasks performed March 4 through March 7, 2011

Support installation of Kongsberg EM122 TX and RX frames to achieve required flatness.

Survey the remaining transducers/ sensors on hull bottom.

3-D Coordinate Measurement Equipment

A Sokkia NET 1200 enhanced electronic total station operated through a notebook computer running New River Kinematics Spatial Analyzer™ measurement and analysis software was utilized. This system measures 3-D spherical coordinates by recording an azimuth and zenith angle simultaneously with the near infrared distance coaxial with the telescope line of sight for each observation. Spatial Analyzer measurement and analysis software converts the spherical coordinate data to a Cartesian coordinate system that can be defined by the user. Measurements are made to either adhesive or kinematic targets that have a retro-reflective target face. Where practical, certain features were measured with the instrument in the "Reflectorless" targeting mode.

Temporary "benchmarks" or reference points were placed throughout the vessel as required to allow for re-locating the instrument to a new position or "Station" and tie all of the data to the common coordinate system for comparison.

The measuring system used for this final inspection report is one of several owned by The IMTEC Group, Ltd. The NET 1200 total station, S/N 110350 was calibrated, traceable to N.I.S.T. and in accordance with A.N.S.I. Z-540-1, at the Sokkia USA Factory Service Center January 19, 2011.

Reference Coordinate System

The following parameters were used to define the reference coordinate system for reporting the survey data:

A total of 9 pairs of points were taken along the keel to represent the vessel's Azimuth and Pitch. 6 points were acquired on the Fantail to represent the vessel's Roll plane.

The X-axis is positive forward, the Y-axis is positive starboard and the Z-axis is positive towards the keel.

ORIGIN is located at the aft Starboard corner of the Hippy Plate

Measurement Procedure

Adhesive targets with retro reflective target face were used throughout the survey as temporary benchmarks for relocating the instrument to new stations. Kinematic (a target with a known offset) retro reflective targets such as the RT-50M swivel targets used to measure some of the features defining the specified elements to be reported. The RT-50M was also frequently used as a temporary benchmark. Where possible, a retro reflective surface target was used to eliminate any offsets.

A Sokkia NET 1200 total station operated through a notebook computer running Spatial Analyzer™ industrial measurement software was used to measure the benchmarks, targets and record observations.

ORIGIN is located at the aft Starboard corner of the Hippy Plate
ORIGIN is located at the PBM 10-24-456 Meters aft of frame
zero and @ faired baseline @ bottom of keel thus
placing the origin * @ frame
zero on the faired
Ship Base
line.

3-D X, Y, Z coordinates, Post Processing

In some cases, the features or targets defining the elements required by the survey were made to a kinematic target with a known offset orthogonal to the vessel's final reference coordinate system. After the each survey was complete, these offsets were applied to report the final X, Y, Z value of the element.

The azimuth, pitch and roll values for the MRP were processed mathematically in the Spatial Analyzer software. Backup data is provided with this report.

Data files

One measurement file was used to perform the survey.

All measurement files were backed up at the completion of a set of observations from a particular station and on a daily basis.

This vessel coordinate system was created from the initial characterization file.

Station transformations are used to bring a new instrument location into the current vessel coordinate system (see measurement procedure). The result produces some residuals.

Measurement Precision and Uncertainty

Based on the best fit solution Uncertainties are reported to be:

(Note: Uncertainty values are based on fit to previous survey values and may be less than shown)

Region to Region, i.e., Reference Plate to antennae, EM122 TX/RX and other hull features:

$$X \leq 3 \text{ mm}$$

$$Y \leq 3 \text{ mm}$$

$$Z \leq 3 \text{ mm}$$

Angular precision is based on analysis of features measured and calculation of the mathematical relationship of these features.

The angular measurement precision of the NET1200 is < 1 arc second in azimuth and zenith. There can be some error introduced by targeting. Random and systematic errors can be introduced by the working environment.

The expected angular precision is analyzed to be:

Azimuth: ≤ 00°00' 30"
Pitch: ≤ 00°01' 00"
Roll: ≤ 00°01' 00"

PROJECT DATA

The required data is summarized in tabular form on the following page. The units of measure for reporting are indicated on the table.

Nearly all of the data included with this report, both by hard and electronic format has been reviewed by the **WHOI** engineer in the form of preliminary reports submitted electronically, e.g. e-mail, by the IMTEC engineer for review.

The measurement data is also included in electronic format, AutoCad*.dxf", ASCII *.txt and SA *.xit. The electronic data files include X, Y, and Z coordinates for all targets measured during the performance of this orthogonal survey. Included are temporary benchmarks or reference points used to re-locate the instrument or to tie the area surveys together. Some editing was done on various targets to correct for kinematic target offsets and some targets are calculated values such as circle centers, etc.

See the contents page of this report for the listing of electronic files included by attachment with this report.

Table 1 reports the X, Y and Z, values for specified components in units of millimeters and in the final vessel coordinate system.

* Add → **ORIGIN** - frame zero on faired ship baseline

Change description of this benchmark to "Aft Port Corner Hippy Plate"

TABLE 1 ELEMENTS (Millimeters)			
DESCRIPTION	X	Y	Z
TR109_CENTER	-32288.12	627.17	625.75
TX_CENTER	-30181.29	-390.07	423.54
RX_CENTER	-25715.81	-11.10	504.88
ORIGIN	-27565.91	172.35	-2769.14
HIPPIE_CALC_CENTER POINT	-27232.99	457.48	-2767.91
OLD_PHIN_CENTER	-27324.59	508.29	-4417.69
UQC_A_Center	-32499.71	-2189.94	-159.49
UQC_B_Center	-31681.69	-2658.51	-227.40
UQC_C_Center	-32508.92	2172.43	-154.37
UQC_D_Center	-31675.12	2650.76	-227.06
RD500B_Center	-27710.96	715.28	624.25
RD500A_Center	-28317.90	710.81	611.10
TC12A_Center	-31363.22	517.21	619.11
TC12B_Center	-31363.79	973.30	621.61
DS530_Center	-29553.64	826.70	602.79
CURRENT PROFILER	-33187.52	556.90	627.50
TRACK_POINT_Center	-33188.69	-1851.36	-121.03
PHIN_PIN_LOC_1	-27475.69	527.79	-2766.81
PHIN_PIN_LOC_2	-27476.52	388.02	-2767.81
PHIN_PIN_LOC_3	-27354.89	657.57	-2766.17
PHIN_PIN_LOC_4	-27228.73	657.75	-2766.48
PHIN_PIN_LOC_5	-27344.73	458.04	-2767.63
PHIN_PIN_LOC_6	-27219.61	457.88	-2767.94
PHIN_PIN_LOC_7	-27355.84	257.99	-2769.04
PHIN_PIN_LOC_8	-27230.57	257.86	-2769.36
HP_AFT_AZ_FINAL	-27565.27	742.58	-2789.65
HP_FWD_AZ_FINAL	-26899.91	742.63	-2791.84
TX_AZ_FINAL_Mid	-30172.20	-390.07	423.53
TX_AZ_FINAL_A	-26374.26	-389.70	419.68
TX_AZ_FINAL_B	-33970.13	-390.45	427.39
RX_AZ_FINAL_Mid	-25715.82	-14.20	504.88
RX_AZ_FINAL_A	-25707.58	3405.43	499.64
RX_AZ_FINAL_B	-25724.05	-3433.82	510.13
GP90D-GPS	-37838.24	2932.77	-30623.95
INMARSAT-C	-37388.82	2990.85	-30580.27
STBD WINDBIRD	-36882.98	3042.80	-30143.11
NORTHSTAR 941 GPS	-37921.40	1502.50	-29924.59
FURUNO GPS 1	-37974.06	-2365.46	-29851.97
AIS	-38137.65	-2968.60	-29954.99
FURUNO GPS 2	-36934.51	-1577.15	-30537.24
C-NAV	-37462.23	-3157.60	-30234.94
PORT WINDBIRD	-36905.02	-3144.77	-30120.13
RX_CL_POINT	-25708.53	-9.67	602.47
OLD_PHIN_LOCATION_1	-27246.40	586.47	-4417.69
OLD_PHIN_LOCATION_2	-27402.77	586.47	-4417.69
OLD_PHIN_LOCATION_3	-27402.77	430.10	-4417.69
OLD_PHIN_LOCATION_4	-27246.40	430.10	-4417.69

TABLE 2 BENCHMARKS (Millimeters)			
Description	X	Y	Z
PBM1	5133.02	1379.86	-12575.65
PBM2	-30720.46	445.40	-21165.08
PBM3	-34145.25	-7900.79	-21187.30
PBM4	-34148.50	7907.72	-21177.25
PBM5	-43527.28	1672.50	-21137.92
PBM6	-62809.84	-3346.06	-10273.54
PBM7	-66924.68	5816.34	-9665.64
PBM8	-76297.30	2597.13	-8462.08
PBM9	-76298.85	-3487.42	-8468.79
PBM10	-24456.00	-849.90	-2624.89
PBM11	-25084.01	-5505.03	-2598.21
PBM12	-26198.84	5789.39	-2602.91
PBM13	-33390.34	-991.17	-4761.32

TABLE 3 DRAFT MARKS						
LOCATION	X (mm)	Y(mm)	Z(mm)	X (Ft)	Y(Ft)	Z (Ft)
GONDOLA DMS10	-24020.6	5806.3	341.9	11.6	16.6	9.96
GONDOLA DMS12	-24014.6	6154.9	-268.6	11.6	17.8	11.97
GONDOLA DMS14	-23990.9	6387.4	-878.7	11.7	18.5	13.97
GONDOLA DMS16	-24010.2	6605.8	-1484.5	11.7	19.2	15.96
GONDOLA DMS18	-24012.6	6817.9	-2091.4	11.7	19.9	17.95
GONDOLA DMS20	-24012.0	7024.7	-2700.8	11.7	20.6	19.95
GONDOLA DMS24	-23987.5	7340.5	-3922.5	11.7	21.6	23.95
GONDOLA DMP10	-24139.7	-5834.4	350.8	11.2	-21.6	9.93
GONDOLA DMP12	-24117.2	-6173.1	-258.3	11.3	-22.7	11.93
GONDOLA DMP14	-24130.5	-6419.5	-870.0	11.3	-23.5	13.94
GONDOLA DMP16	-24103.6	-6637.3	-1480.9	11.4	-24.2	15.94
GONDOLA DMP18	-24102.9	-6849.8	-2086.3	11.4	-24.9	17.93
GONDOLA DMP20	-24105.6	-7048.9	-2693.9	11.4	-25.6	19.92
GONDOLA DMP24	-24134.6	-7375.6	-3914.1	11.3	-26.6	23.93
AFT DMS16	-69924.8	6805.7	-2087.1	-139.0	19.9	15.93
AFT DMS18	-69937.2	7322.3	-2697.7	-139.0	21.6	17.94
AFT DMS20	-69935.5	7653.0	-3308.5	-139.0	22.7	19.94
AFT DMP 16	-70096.0	-6727.4	-2098.5	-139.5	-24.5	15.97
AFT DMP 18	-70079.4	-7275.6	-2719.6	-139.5	-26.3	18.01
AFT DMP 20	-70092.8	-7607.3	-3340.7	-139.5	-27.4	20.05
FWD DMS9	-4842.2	831.8	32.2	74.6	0.3	8.98
FWD DMS10	-4836.4	928.6	-270.5	74.6	0.6	9.97
FWD DMS12	-4849.0	1147.6	-884.2	74.5	1.3	11.99
FWD DMS14	-4830.0	1382.9	-1493.0	74.6	2.1	13.98
FWD DMS16	-4841.3	1661.0	-2102.1	74.6	3.0	15.98
FWD DMS18	-4833.4	1945.7	-2710.8	74.6	3.9	17.98
FWD DMS20	-4834.2	2264.4	-3320.9	74.6	5.0	19.98
FWD DMS22	-4844.9	2592.7	-3924.0	74.5	6.1	21.96
FWD DMP10	-4950.6	-1013.6	-279.2	74.2	-5.8	10.00
FWD DMP12	-4950.7	-1233.1	-887.1	74.2	-6.5	12.00
FWD DMP14	-4978.5	-1490.4	-1499.3	74.1	-7.3	14.00
FWD DMP16	-4959.6	-1762.8	-2110.1	74.2	-8.2	16.01
FWD DMP18	-4962.7	-2067.7	-2724.0	74.2	-9.2	18.02
FWD DMP20	-4968.9	-2388.8	-3333.9	74.1	-10.3	20.02
FWD DMP22	-4961.7	-2715.9	-3935.7	74.2	-11.3	22.00

looks like final change in origin was not applied

missing an origin shift ???
not certain which one

Certificate of Calibration

Item No. & Model: NET1200

Manufacturer: SOKKIA CO., LTD.

Serial No.: 110350

Certificate Number: 69840

This certifies that the above instrument has been inspected and calibrated by the Sokkia Corporation Service Department. This inspection was performed using the procedures set forth in the NET SERIES INSTRUMENT CALIBRATION AND CERTIFICATION MANUAL (August 18, 2005 Rev. 8). At the time of completion of this service, Sokkia Corporation certifies that the above stated instrument meets or exceeds all factory specifications and tolerances for instrument parameters and performance of this instrument model. The certification is effective for a 12 month period from the calibration date shown below.

All distance measurement parameters were tested and adjusted using factory calibration jigs and with the 10 Meter Calibration Rail whose accuracy is traceable to the National Institute of Standards and Technology (N.I.S.T) via Mutual Recognition Agreement. All angle measurement parameters were tested with a NIST traceable optical collimation system, using accepted collimation and adjustment procedures.

The quality system addresses and conforms to ANSI/NCSL Z540-1-1994 and ISO/IEC 17025-1999
(and, as a result ISO 9001-1994 or ISO 9002-1994)

This certificate shall not be reproduced except in full, without the written approval of Sokkia Corporation

Customer Name: IMTEC GROUP LTD THE

Customer Address: 19004 E. Ringo Circle

Customer City/State/Zip: Independence, MO, 64057

See individual sets of data for temperature and pressure

Date Calibrated: 01/19/2011 Date Recalibration Due: 01/19/2012

Signed: *Harry Tipton* Date: 01/19/2011

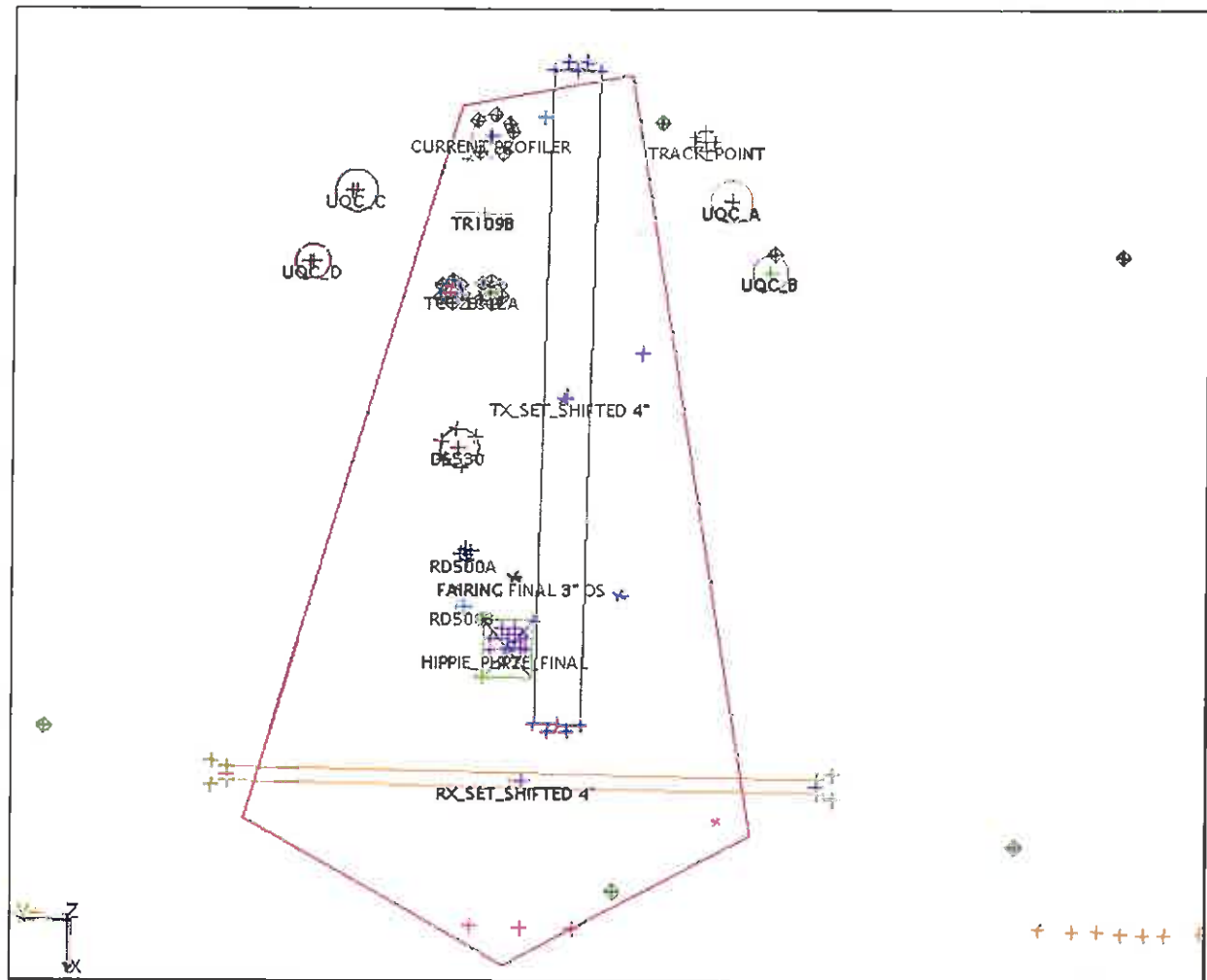
Yes No

X Is this a new instrument?

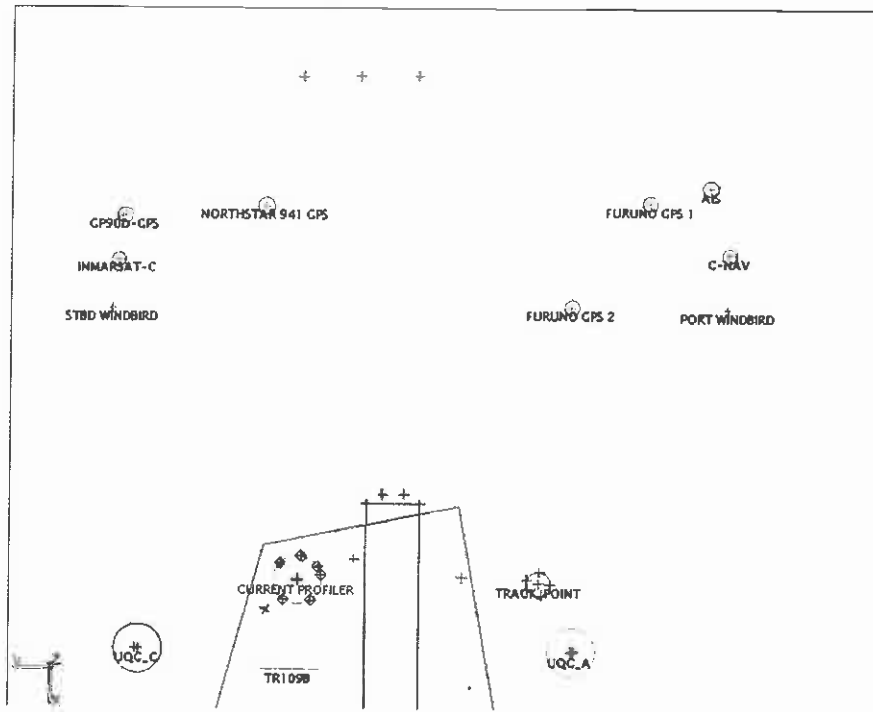
Answer the following questions only if the above answer is "No".

- X X Is this the first NIST calibration we have performed on this instrument?
- X X Were the calibration seals intact when the instrument was received?
- X X Were the initial collimation inspection results within tolerance?
- X X Were the initial EDM inspection results within tolerance?
- X X Was the instrument damaged/defective and unable to have an initial inspection?
- X X Corrective action recommended?

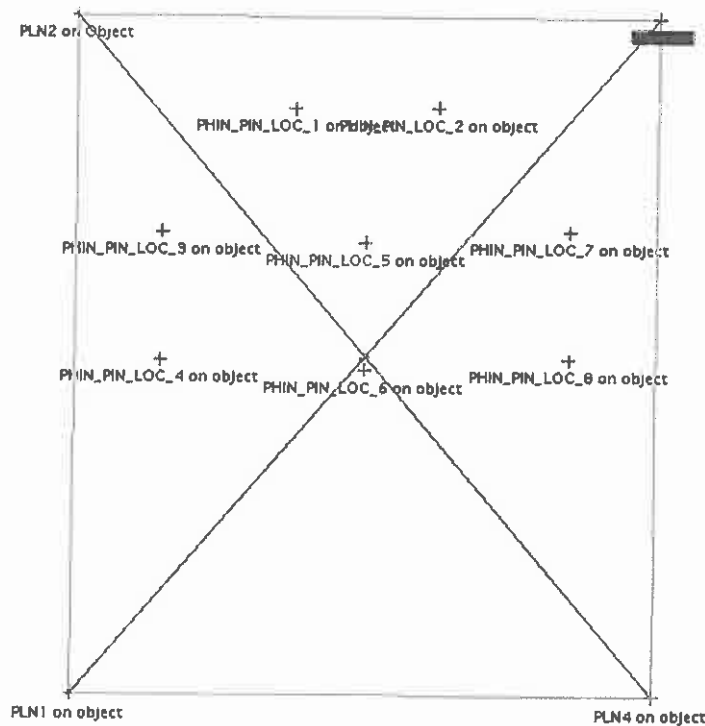
* See page 2 for a list of primary standards



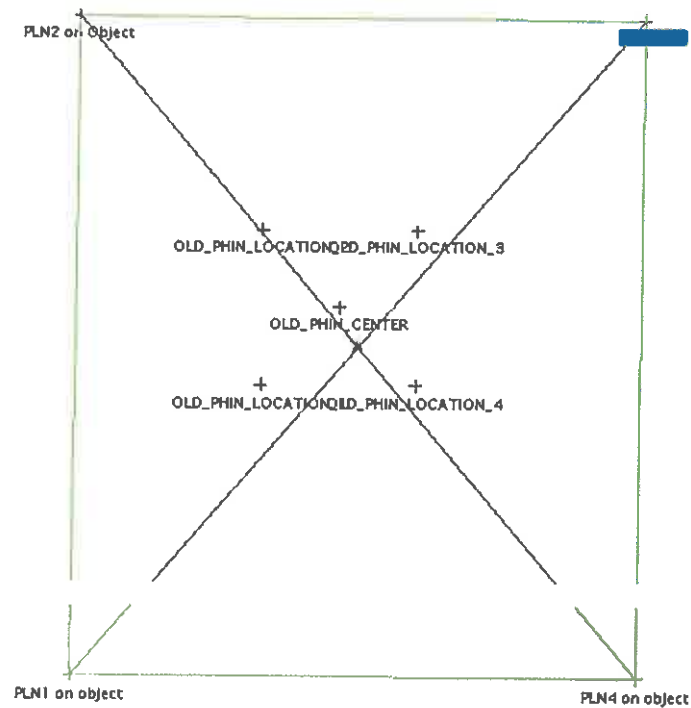
Fairing Features



Mast Features

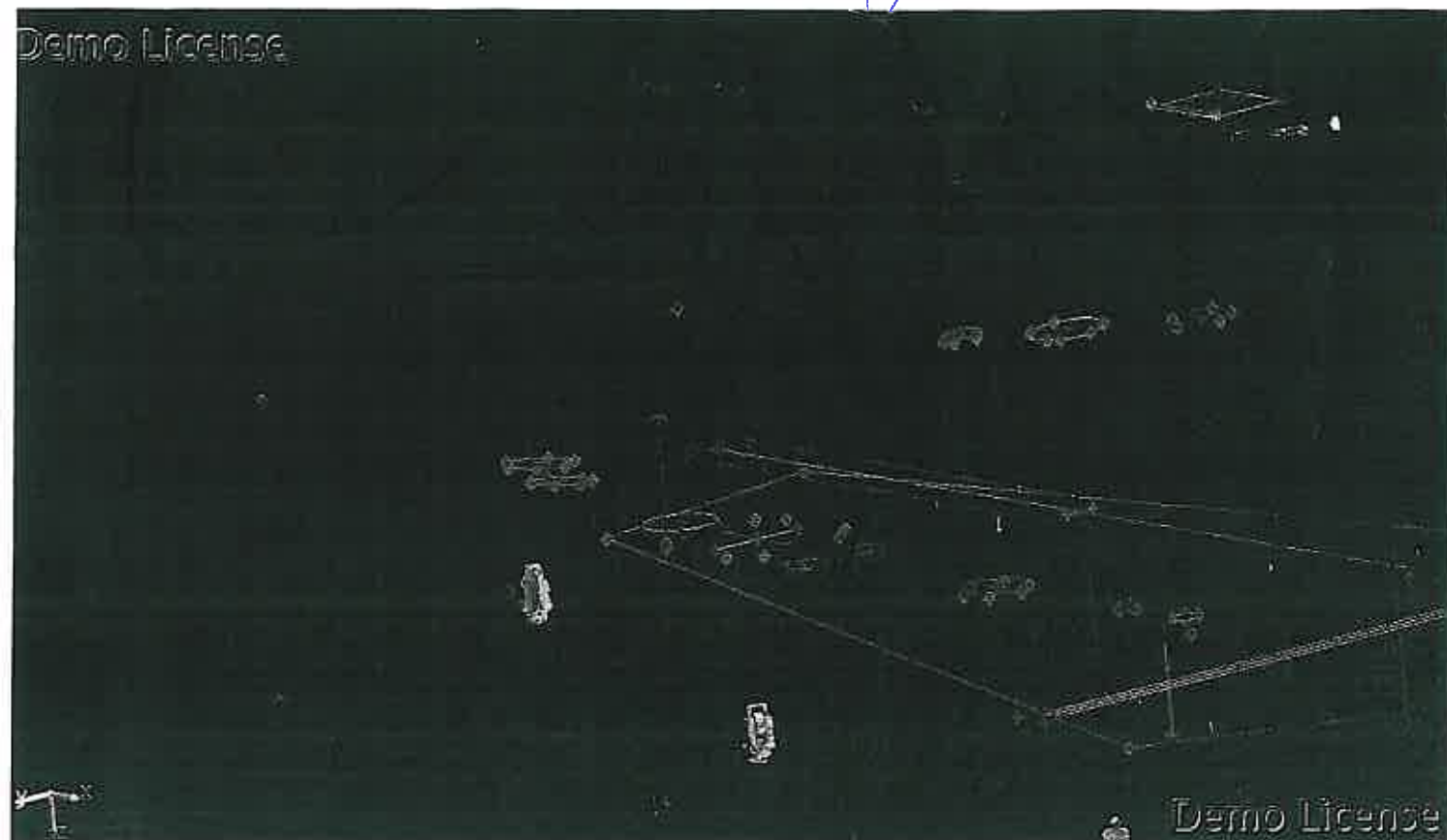


Hippy Plate



Old PHIN Locations

Example of page missing



I remember
Chuck X from
Kongsberg showing
me some other pages
as well - what other
info. is available
that we didn't get

Plane			
FINAL DATA 3-16-2011: HIPPIE PLATE FINAL			
A	B	C	D
0.0025	-0.0072	1.0000	0.0000
Proj. Ang.	Rx from Y	Ry from Z	Rz from X
(deg.)	90.4122	0.1424	-70.9433

HIPPIE PLATE PLANE:
BOW DOWN
PORT UP

Plane			
FINAL DATA 3-16-2011: TX SET SHIFTED 4"			
A	B	C	D
0.0010	0.0026	1.0000	-125.5342
Proj. Ang.	Rx from Y	Ry from Z	Rz from X
(deg.)	89.8531	0.0581	68.4003

TX PLANE -
BOW UP
PORT DOWN

Plane			
FINAL DATA 3-16-2011: RX SET SHIFTED 4"			
A	B	C	D
-0.0005	0.0015	1.0000	-128.8518
Proj. Ang.	Rx from Y	Ry from Z	Rz from X
(deg.)	89.9120	-0.0277	107.4839

RX PLANE -
BOW LEVEL
PORT DOWN

TX-AZ .00568 Degrees to Stbd
RX-AZ .13801 Degrees to Port