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INCLINE EQUIPMENT REVIEW



MEMBER

The Society of Naval Architects and Marine Engineers, American Society of Naval Engineers, International Association of Marine Investigators
QUALIFIED by the MISSISSIPPI GAMING COMMISSION; AUTHORIZED by the LOUISIANA RIVER BOAT GAMING DIVISION

DATA GATHERING COMPUTER UNIT



Data Gathering & Recording

The above-pictured Computer station has been designed and built by EMCsq for the purpose of Incline Experiments. The computer is a KDS laptop converted to a base unit. The Monitor is a Sync Master 172w Flat Panel with a 17" rectangular screen. The panel at left of the computer is for the connections of the proceeding equipment listed. The upper half of the panel is for Disto connections with the lower half being for the Pendulums and Loadcell connections, the small push buttons next to the connectors are momentary push buttons to "Zero" the meters at the Pendulum and loadcell units. The 7 black bars at the left of the screen are on screen remote meters that allow the real time monitoring of the Pendulums and Loadcells meters at the station. All remote units are hard wired to the computer system.

The program used for the incline is a 23 page EXCEL spread sheet. EMCsq has developed the spreadsheet for a complete data gathering and calculations on site to avoid any mistakes in the test.

The system gathers the data from the Disto Freeboard & Distance measurement devices when the operator of that device triggers the measurement; it is then recorded on the spreadsheet. The Pendulum and Loadcell readings are triggered at the computer by the F12 key and recorded on the spreadsheet. This eliminates any Human Error in readings and recording. Also you will note on the following pages that the equipment used has a far superior accuracy of measurement then traditional methods as well as equipment not normally used in an Incline Test.

To better understand how this system works review the Stability Test Report. All the data gathered by this system is auto inputted to the correct locations on the spreadsheets that then do all the calculations of the Incline.

PENDULUMS



The Pendulum Arm is balanced on two adjustable pivots that are honed to a point about the same size & shape as a fine ballpoint pen. The pivots are vertical and parallel to the arm. The weight is 32 oz. The couple between the Arm & the Transducer Rod is magnetic for no friction resistance. The rod has 10 grams of resistance.

OMEGA CERTIFICATION OF LINEARITY OF LINER TRANSDUCERS in PENDULUMS

OMEGA ENGINEERING, INC. An OMEGA Technologies Company	OMEGA ENGINEERING, INC. An OMEGA Technologies Company	OMEGA ENGINEERING, INC. An OMEGA Technologies Company
Type <u>LD 600-15</u>	Type <u>LD 600-15</u>	Type <u>LD 600-15</u>
Linearity <u>0.20</u> %	Linearity <u>0.21</u> %	Linearity <u>0.15</u> %
at <u>10</u> Volts <u>20</u> KHz	at <u>10</u> Volts <u>20</u> KHz	at <u>10</u> Volts <u>20</u> KHz
Sensitivity <u>25.67</u> mV / mm	Sensitivity <u>25.64</u> mV / mm	Sensitivity <u>25.22</u> mV / mm
Ballast Resistor	Ballast Resistor	Ballast Resistor
K. Ohms. Connected	K. Ohms. Connected	K. Ohms. Connected
between Yellow /	between Yellow /	between Yellow /
Residual Signal	Residual Signal	Residual Signal
Connections	Connections	Connections
Red Blue	Red Blue	Red Blue
Green White	Green White	Green White
Yellow	Yellow	Yellow
SERIAL NO. <u>M922084B323-02</u>	SERIAL NO. <u>M922084C316-01</u>	SERIAL NO. <u>M922084B323-05</u>

ASTM Precision & Bias for Pendulums; based against 80" pendulum at ± 1/32" or nearest 1/16"

Liner Displacement	Pendulum			Travel	Linearity	Accuracy	ASTM Required/Pass	
Omega FWD	M922084B323-05	LD600-15		0.68	0.0015	0.001020	0.001935	TRUE
Omega Midship	I7922084C316-01	LD600-15		0.68	0.0021	0.001428	0.001703	TRUE
Omega AFT	M922084B323-02	LD600-15		0.68	0.0020	0.001360	0.001681	TRUE

Travel = Distance of travel of pendulum ± to achieve 4° heel is less than 0.34" from "0" in one direction, Full Calibrated stroke is 0.68"

Last Calibration Test of Pendulum Units;

Setup = Calibration Jig set on table and "Zeroed" as best as possible; (as shown Jig less than 0.08° out)

Target	FWD	4.953	MID	4.3593	AFT	4.3035	STDV	STDV
Step Deg.	Reading	Degrees	Reading	Degrees	Reading	Degrees	Reading	Degrees
0.5	-0.03738	-0.4324	-0.03327	-0.437279	-0.03229	-0.4299	0.0027006	0.003751
1	-0.07995	-0.9249	-0.07266	-0.954995	-0.07099	-0.9451	0.0047647	0.015369
2.5	-0.20705	-2.3951	-0.18341	-2.410621	-0.18150	-2.4164	0.014232	0.011017
4	-0.33904	-3.922	-0.29872	-3.92618	-0.29443	-3.92	0.0246108	0.003168
TREND	-0.01104	-0.1277	-0.01095	-0.14392	-0.01026	-0.1366	0.000426	0.008101

Per single Reading ASTM allowed STDV =

0.022381

Per 12 Readings above Total Test Average =

0.008326

12 against 1 reading PASSED by

0.014055

12 Reading TREND =

0.009242

Date	1/15/2004
By;	Ed Carlsen

ASTM F1321 Standard for above Pendulums

Pendulums	reading	degree	per 4 movements		STDV
FWD	per 1	0.00193	0.02238116	0.007739	0.08952466
MID	per 1	0.00170	0.02238116	0.006811	0.08952466
AFT	per 1	0.00168	0.02238116	0.006724	0.08952466
					Total Test
					0.021275
					Inch
					0.268574
					Degree

The above shows the ASTM allowable "Cumulative" deviations per test.

Avg allow = 0.02238116 ASTM allowable deviation in Degrees

FREEBOARD MEASUREMENT DISTANCE MEASUREMENT



Freeboard measurements are accomplished by the use of Disto Pro 4a laser measuring devices on stands as pictured above left. The stand base is set on deck at sheer, the line plumbbob with float is lowered into the water and the unit is turned on. The operator then aligns the laser dot on the float as pictured and takes a reading with a press of a button. This reading is automatically sent to the Laptop for recording. This reading is from sheer to water with all offsets done by the Disto unit.

Distance Measurements are taken by the unit pictured at right. This unit is used to measure the distance Test weights are moved with a beginning and end placement measurement. The reading is automatically sent to the Laptop for recording.

Disto / Leica Certification of unit performance; ASTM Required = nearest 1/8" = ± 1/16"

Measuring accuracy Pro 4a = Typical: ± 1.5 mm or 0.05905" (1/16" = 0.0625")

Measuring accuracy when Calibrated = Typical ± 0, Readings on unit 1/32", data transfer = 0.000

Technical Data

	DISTO pro ⁴	DISTO pro ⁴ a
Measuring accuracy	typical.: ± 3 mm / max.: ± 5 mm *	typical.: ± 1.5 mm / max.: ± 2 mm *
Smallest displayed unit	1 mm	1 mm
Range	0.3 m to over 100 m **	0.3 m to over 100 m **
Time for a measurement ,distance	0.5 ... approx.4 s	0.5 ... approx.4 s
Time for a measurement, tracking	0.16 ... approx.1 s	0.16 ... approx.1 s
Battery capacity (4 x1.5V, AAA type)	over 3000 measurements	over 3000 measurements
Laser	visibility: 635 nm	visibility: 635 nm
Ø Laser dot (at distance)	6 / 30 / 60 mm (10 / 50 / 100 m)	6 / 30 / 60 mm (10 / 50 / 100 m)
Measuring in the field (adaptor for telescopic viewfinder)	✓	✓
Distance measurement	✓	✓
Timer	✓	✓
Tracking (continuous measurement)	✓	✓
Minimum/maximum distance-tracking	✓	✓
Calculation function (Pythagoras, areas, angles, ...)	14	14
Pocket calculator	✓	✓
Data memory	800 measured values	800 measured values
Memory key for constant values	9 constants	9 constants
Stack (buffer)	15 last values	15 last values
Graphic display, four lines, with LED	✓	✓
Alpha numeric keypad	✓	✓
Data interface	✓	✓
End cover with swivel foot	✓	✓
End cover with positioning bracket and alignment aid	✓	✓
Adapter end cover	✓	✓
Dust and splash proof	IP54 acc. IEC60529: rain proof,dust protected	IP54 acc. IEC60529:rain proof,dust protected
Dimensions, weight	188 x 70 x 47 mm, 440 g	188 x 70 x 47 mm, 440 g
Temperature range	-40°C to +70°C (-40°F to +158°F) -10°C to +50°C (-14°F to +122°F)	-40°C to +70°C (-40°F to +158°F) -10°C to +50°C (-14°F to +122°F)
storage operations		

DEPTH SOUNDINGS WATER MEASUREMENT



Depth Soundings are taken at the same locations as the Freeboard Readings and recorded on the Incline sheet. The green unit pictured above is a float with the Sonar unit mounted at center. The unit with readout is hand held and is a HAWK EYE Sonar unit Model: DF1000D with readouts at 1/10 of a foot.

Water Measurements of Temperature & SG are taken by the Hydrometer set pictured above. The manufacture of the set is Chase Instrument and they certify that the set meets NIST standards. The canister is for water samples.

TRIM MEASUREMENT



The Trim of the vessel during the Incline is monitored by the use of any one of the above-pictured electronic levels. The two levels pictured in the foreground read to 0.0° and have no certifications but have been found to be accurate. The Accu-Star Protractor pictured in the background reads to 0.00° and has NIST traceable certifications. There is no ASTM standard set for this equipments application in Incline Tests.

WIND MEASUREMENT



Wind Measurement is done by both units pictured above.

The Omega (yellow) unit is used at the beginning setup of the Incline to ascertain wind speeds low enough for the test, if they are the data is recorded. The unit has NIST traceable certifications.

The Weather Master unit by Davis Instruments is setup to monitor wind speeds and directions during the Incline test. Measurements are recorded at every movement with the pendulum readings. This unit also has NIST traceable certification. There is no ASTM standard set for this equipments application in Incline Tests.

LOADCELL for INCLINING & WEIGHTING



The loadcell pictured above has a capacity of 50,000 lb.

The loadcell along with the specially built pivot adapter is used to heel the vessels for an Incline Experiment. The procedure for the use of a loadcell in lieu of weights is quite simple in principle. A loadcell is attached to the vessel at the sheer and a small crane or other device is used to produce a heeling moment without added weight. The reading produced by the loadcell is recorded just as the movement of the weights in the conventional incline experiment. Since the distance of the loadcell from centerline remains constant, the heeling moment is easy to calculate to an accuracy that could never be achieved with the movement of weights on the deck. This procedure allows for target moments to be accurately created or recreated. The loadcell can be read while the load is being applied, this reading is the vessel creating resistance to movement. When the exact desired load is reached the movement is stopped and the pendulum readings are taken. The benefit of a loadcell is that it gives you the exact resistance in weight the vessel exhibits to heeling at that degree in any condition of loading without the introduction of additional weight which changes the hydrostatics of the vessel. Whether you apply a positive weight by traditional methods or apply a heeling moment without added weight as with the loadcell, you are still searching for the same answer, "What is the resistance of the vessel to heeling". With the loadcell you measure the resistance directly. The loadcell is also used to weigh items onboard the vessel to obtain the items' true weight and also to weigh test weights used in an incline test. EMCsq. has two models available - the 50k shown above and a 200k. They both have certifications for calibration.