OOS TECHNICAL DOCUMENT 2011 – 45 – *VR 1*

BEST OF PRACTICE METHODS FOR MET – OCEAN BUOYS

OCEAN OBSERVATION SYSTEMS

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

(Ministry of Earth Sciences, Government of India)

CHENNAI – 600 100

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ACRONYMS USED AND DEFINITION:

BPR	- Bottom Pressure Recorder
CC	- Central Cylinder
CT sensor	- Conductivity, Temperature Sensor
DR team	- Deployment and Retrieval team
FA	- Failure Analysis
FOS	- Factor of Safety
G.I	- Galvanized Iron
H_2	- Hydrogen
KF	- Keel Frame
LL	- Lessons Learnt
MBES	- Multi - Beam Echo Sounder
MBL	- Maximum Breaking Load
MRU	- Motion Reference Unit
MT	- Mechanical Team
N_2	- Nitrogen
NIOT	- National Institute of Ocean Technology
OBM	- Over Board Motor
OOS	- Ocean Observation Systems
PCD	- Pitch Circle Diameter
PL	- Proof Load
PMU	- Power Management Unit
PVC	- PolyVinyl Chloride
SL Nut	- Self Lock Nut
SWL	- Safe Working Load
TIG Welding	- Tungsten Inert Gas Welding
WCR	- Watch Circle Radius

UNITS:

A	- Amphere
hPa	- Hecta Pascal
m	- Metre
psi	- Pound per Square Inch
V	- Volts

1. INTRODUCTION

Data Buoys are moored offshore platforms, fitted with meteorological and oceanographic sensors, deployed at specific locations to observe in-situ Met-Ocean data at regular intervals. The observed raw data is then transmitted to shore station located at NIOT Chennai for further processing and dissemination.

Following are the standard suite of sensors on buoys to measure:

- Air and Water Temperature
- Atmospheric Pressure
- Conductivity
- Precipitation
- Relative humidity
- Salinity
- Water quality
- Wave data and
- Wind Direction, Speed and Gust

Since buoys play a primary role in providing in-situ ground-truth measurements, stands as a reference point for validating ocean related data from other observational means and provides inputs to various models to predict and forecast weather and long-term climatic changes, it is very important that the data obtained from these buoys are continuous and accurate.

To provide continuous and accurate data, the buoy system has to undergo a thorough testing and in-house calibration process.

1.1 PURPOSE

This manual describes the procurement, testing, integration, deployment, retrieval and data quality control used to ensure the accuracy of measurements. It may be used as a tutorial for new comers to OOS and as a reference for all of the activities of Ocean Observation Systems. This manual incorporates procurement of materials and sensors, testing, deployment, retrieval and data quality control.

2. PROCUREMENT OF BUOY COMPONENTS

The procurement of component is done from reputed and experienced organizations as per the norms of the Indian Government. Initially the required functionalities and qualities of the each and every components are arrived by NIOT officials and it is published as tender document. The placement of order for every component is done after screening based on the technical specification in the fabrication and every effort is made to reduce the cost without having any compromise in Quality.

TABLE 2.1 LIST OF SENSORS

Sl. No	Name of the Sensor	Make of the Sensor
1	Wind	LAMBRECHT R M YOUNG
2	Humidity / Air Temperature	ROTRONICS
3	Air Pressure	VAISALA
4	Wave Measurement	SEATEX MRU
5	Conductivity and Temperature	VALEPORT, ALLEC, SEABIRD
6	Satellite Transceiver	T&T / INMARSAT
7	Precipitation	R M YOUNG
8	Radiation Sensor	EPPLY LAB
9	Compass	KVH

3. TESTING OF BUOY COMPONENTS

The design of mooring system is finalized for each Buoy system based on Depth, Current and Wind Speed by using software packages like ORCAFLEX, CABLE and by using Mathematical Models. Based on the Analysis, component of the mooring system is designed.

Test certificates are asked from the suppliers to ensure the quality of the each Component. List of components and its test certificates are given below.

3.1 Surface treatment

Surface treatment on metallic components is given preference to avoid corrosion such as in Mast assembly, Central Cylinder and Mooring Components. Powder Coating is done for aluminium Components and Galvanizing for G.I Components.

3.1.1 Surface treatment for Aluminium Components:

Powder coating process for Central Cylinder, Mast Assembly and Antenna Flange:

The powder coating process involves three basic steps:

- Part preparation or the Pre treatment
- The powder application
- Curing

Removal of oil, soil, greases, metal oxides, welding scales etc. is done prior to the powder coating process through sand blasting or other method. The most common method for applying the powder coating to metal objects is to spray the powder using an electrostatic gun, or Corona gun.

TABLE 3.1 TESTS FOR MECHANICAL COMPONENTS

SL. NO.	PART NO	COMPONENTS DESCRIPTION	TEST	REMARKS
FRP COMPONENTS				
1	001	FRP Hull	Water ingression test for 48 hours	Laminate properties certificate is common for all FRP components
2	002	FRP Hood		
3	061	FRP Battery Box	Leak test upto pressure of 1 bar	
ALUMINIUM COMPONENTS				
4	005	Aluminium Central Cylinder	**Destructive Test:** • Tension test • Shear test • Hardness test • Impact test • Bend test • Chemical analysis	1. Hydro test is only for central cylinder at FRP battery box 2. TIG welding for aluminium components
Mast Assembly				
5	011	Upper Mast		
6	012	Lower Mast	**Non-Destructive Test:** • Visual Inspection • Dye penetration test • Ultrasonic scan test	
7	013	Sensor arm		
8	---	Hood rod and washer		
Aluminium Accessories				
9	039	Air inlet on sensor arm		
10	042	Antenna flange		
11	047	Compass clamp		
12	060	Cable gripper (Big & Small)		
13	087	Fender Plate Washer		
STAINLESS STEEL COMPONENTS				
14	017	Lifting Ring	**Destructive Test** • Tension test, • Shear test • Chemical analysis **Non-Destructive test:** • Visual Inspection • Dye penetration test • Ultrasonic scan test	1. TIG Welding is used 2. Grade of Stainless Steel is SS316 3. For all fasteners breaking torque, stress at 0.2% permanent strain and elongation after fracture is also found from testing
15	018	Lifting Lug		
16	019	Fin Lug		
17	020	Mooring Lug		
18	021	Tension Steel band – Long		
19	022	Tension Steel band – Medium		
20	023	Lid hinge plate with hinge		
21	024	Battery Press Rod		
22	038	Air inlet on lid		
23	041	Vent pipe		
24	048	Antenna Cable Adaptor		
25	053	Current Meter Frame		
26	099	Lid Lock Keys		
27	---	Nitrogen Plug Fasteners		
28	---	Mast Cable adaptor		
29	---	Long Bolt with SL nut and washers		

SL. NO.	PART NO	COMPONENTS DESCRIPTION	TEST	REMARKS
RUBBER COMPONENTS				
30	008	"O" Ring for • Antenna cable adaptor • Air inlet • Central Cylinder • Mast Cable adaptor • Nitrogen Plug • Vent Pipe	• Material test certificate • Hardness test for rubber fender	
31	037	Rubber fender		
STEEL COMPONENTS				
32	014	Keel Weight		
33	015	Keel Frame		
34	052	Conductivity and Temperature Sensor Frame	**Destructive test:** • Tension test • Shear test • Hardness test • Impact test • Bend test • Electrical Conductivity test • Chemical analysis	Galvanizing is doing after the sand blasting operation. Certificates to be produced for sand blasting as well as Galvanizing (Mass of zinc coding and quality of zinc)
35	142	GI Pipe	**Non-Destructive test:** • Visual Inspection • Dye penetration test • Ultrasonic scan test	
36	143	Surface Modem Clamp (two parts)		

OTHER COMPONENTS				
37	016	PVC Flange		
38	036	Bush for band		
39	040	Anti rotation fin		
40	046	Vent valve with spacer	Material test certificate for all components	Electro-Chemical properties certificates are to be produced for Zinc anodes
41	048	Gland for AC Adaptor		
42	050	MRU Holder		
43	051	Water trap		
44	058	Air inlet tube		
45	063	Zinc anode		
46	---	Battery Box hose		
47	---	Bush for CC & KF		
48	---	Elbow type pneumatic connector		
49	---	Double flange (separable)		
50	---	Bush for lifting ring hole		
51	---	Double flange (separable)		
52	---	Bush for keel weight and cylinder fixing hole		
MOORING COMPONENTS				
	Mooring Ropes			
53	151	Combination Rope	**Test Certificates for:** Proof Load Minimum Breaking Load, Safe working Load	
54	152	Nylon Rope		
55	153	Polypropylene Rope		
	G.I. CHAIN			
56	174	G.I Chain 13 Link	**Test Certificates for:** Material Composition, Breaking Load, Proof Load, Safe, Working Load	
57	175	G.I Chain (Short Link) 1m		
58	176	G.I Chain (Short Link) 3m		

	G.I. BOW SHACKLE			
59	171	G.I Bow Shackle 1”	**Test Certificates for:** Material Composition, Breaking Load, Proof Load, Safe, Working Load	
60	172	G.I Bow Shackle 3/4"		
61	173	G.I Bow Shackle 5/8"		
	G.I. THIMBLE			
62	180	G.I. Thimble 1”	**Test Certificates for:** Material Composition, Breaking Load, Proof Load, Safe Working Load	
63	181	G.I. Thimble 5/8”		
	SS SHACKLE			
64	184	SS D-Shackle 5/8”	**Test Certificates for:** Material Composition, Breaking Load, Proof Load, Safe Working Load	
65	185	SS D-Shackle 3/8”		
66	177	Bearing Swivel	**Test Certificates for:** Breaking Load, Proof Load, Safe Working Load	
67	---	Drop Link Eye – Acoustic Release		

3.1.2 Colour of Polypropylene Powder Coating

Central Cylinder components	-	White
Antenna Flange	-	White
Mast assembly	-	Black
Air inlet in sensor arm	-	White

3.2 Surface treatment for Stainless Steel Components

The surface treatment for Stainless steel components consists of

- Descaling
- Pickling
- Passivation
- Cleaning

i) Descaling:

Removal of thick visible oxide layer from the surface and consist of two stage process.

(a) Mechanically loosen the scale

(b) Lift the loosened scale from the surface

ii) Pickling:

Pickling is the removal of thin layer of material from the surface of stainless steel. Mixtures of Nitric and hydrofluoric acids are used for pickling operation. one of the following methods may be adopted for pickling,

- Tank immersion pickling
- Spray Pickling
- Circulation Pickling

iii) Passivation:

Passivation usually occurs naturally on the surface of the stainless steel, but it may necessary to assist the process with oxidizing acid treatments.

iv) Cleaning:

If the component is contaminated with Grease or oil then Acid treatment should be carried out.

3.3 Steps to prevent bi-metallic contact

Every step is taken to avoid the Bi-metallic Corrosion. Even small area of bi-metallic contact makes a big problem. So keen observation is taken to avoid bi-metallic contact by using Surface treatment like Powder coating for aluminium components and Galvanizing for

Mild steel components (Mooring components), Anti-fouling paint, device and separators like PVC and Plastic between the potential areas of Interest.

3.3.1 Zinc anode

Zinc anodes are placed at the Bottom of the Central Cylinder, Keel Weight and Tsunami Pipe (G.I Pipe) to protect their metal parts from galvanic corrosion. The weight and quantity of zinc anodes used in buoy is given in Annexure - F.

Galvanic corrosion occurs when dissimilar metals are placed in an electrolyte solution such as seawater. Dissimilar metals are those metals which have different corrosion potential (measured in volts) as determined by the Galvanic Series, and the most common scenario is the current passing from the more noble metal to the less noble metal. This transfer of current results in deterioration of the less noble metal. The addition of zinc actually increases current activity between the metals, but because zinc is the least noble of the metal, corrosion damage is primarily confined to the zinc itself when properly installed.

The Weight and Placement of Zinc Anode plays a vital role in this process. The weight of the Zinc Anode depends on the surface Area to be protected and the current density of the parent material. Based on the conditions above said, the required weight is calculated and fixed at the parts of the components. For example, four number of 500g of Zinc Anode is placed at the Circumference of the keel Weight.

3.4 TESTS FOR ELECTRONICS COMPONENTS

After the materials received from the supplier, it will be physically verified by the scientific community from the other department and by the indenter, after the physical verification the entire sensor and electronics component will undergo for the preliminary test by powering up the sensor, the data will be verified by its entire range of operation and also the calibration and warranty certificate will be verified.

After the new sensor test if any problem in this sensor it will be return to the OEM otherwise it will be handed over to store inward.

NEW SENSOR TEST CERTIFICATE		
SENSOR NAME	:	
TOTAL No. OF SENSOR PROCURED	:	
INVOICE No & DATE	:	
ENGINEER NAME	:	

SL. NO.	SENSOR SERIAL NO	TEST REMARK	
		YES	NO
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
TESTED ENGINEER SIGNATURE (NIOT)			

TABLE 3.2 SENSOR RANGE TEST

Sl. No.	Parameters	Range in units
1	Air pressure	990 to1020hpa
2	Air Temperature	10 to 38^{0}C
3	Wind Speed	0.00 to 35m/s
4	Wind Direction	0 to 359^0
5	Wave Height	0.00 to 20m
6	Wave Period	0.00 to 25s
7	Water Temperature	15 to 33^{0}C
8	Humidity	30 to 100%
9	Current Speed	0 to 600cm/s
10	Current Direction	0 to 359^0
11	Salinity	20 to 38 PSU

3.4.1 SPIKE TEST

This test is failed when the difference between two adjacent measurements is too step.

TABLE 3.3 RANGE OF PARAMETERS

Sl. No	Parameters	Range in units
1	Air pressure difference	> 5hpa
2	Air Temperature difference	> 5^{0}C
3	Wind Speed difference	> 7m/s
5	Wave Height difference	> 3m
6	Wave Period difference	> 8s
7	Water Temperature difference	> 3 ^{0}C
8	Salinity difference	> 1 PSU

3.5 INDIVIDUAL SENSOR TESTING DETAILS

3.5.1 AIR PRESSURE SENSOR

Make : VAISALA Model : PTB220 A

Fig. 3.1 AIR PRESSURE SENSOR

Input power	:	10 -30V dc
Output power	:	RS 232
Range	:	50 to 1100hpa.

3.5.1.1 Default Communication Settings

Baud rate	:	9600
Parity	:	even
Data bits	:	7
Stop bits	:	1
Duple	:	full duplex

3.5.1.2 Test cables Connection Details

D-pin(PC side)		*Sensor Side D pin Connector*	
2	**---------------------------------------**	**2**	
3	**---------------------------------------**	**3**	
5	**---------------------------------------**	**5**	**short -- ve supply** (5 and 7)
		7	
		9	**+ ve supply**

3.5.1.3 Sensor Configuration for GENI

* Before setting the sensor refer to manual

Baud rate	:	9600
Parity	:	none
Data bits	:	8
Stop bits	:	1
Duplex	:	full duplex

3.5.1.4 Before configuration using hyper terminal

Software version	PTB220 / 3.05
Serial number	C1050004
Configuration	1
Linear adjustments	OFF
Multipoint adjustments	ON
Calibration date	2009-03-13
Baud Parity Data Stop Dpx	9600 E 7 1 F
Echo	ON
Sending mode	STOP
Measurement mode	NORMAL
Pulse mode	OFF SLOW LOW 0.0
Address	0
Output interval	1 S
Output format	4.2 P " " UUUU #r #n
Error output format	
SCOM format	
Pressure unit	hPa
Temperature unit	^{0}C
Averaging time	1.0 s

3.5.1.5 Change to be done

SERI 9600 N 8 1

9600 N 8 1 F

AVRG 60 S

Averaging time: 60.0

INTRV 30 S

Output intrv. : 30 s

ECHO OFF

Echo : OFF

3.5.1.6 Final settings for geni

Software version	PTB220 / 3.05
Serial number	C1050004
Configuration	1
Linear adjustments	OFF
Multipoint adjustments	ON
Calibration date	2009-03-13
Baud Parity Data Stop Dpx	9600 N 8 1 F
Echo	OFF

Sending mode	STOP
Measurement mode	NORMAL
Pulse mode	OFF SLOW LOW 0.0
Address	0
Output interval	30 s
Output format	4.2 P " " UUUU #r #n
Error output format	
SCOM format	
Pressure unit	hPa
Temperature unit	^{0}C
Averaging time	60.0 s

Output

Send

1009.00 hpa. (Range: 990 to 1025 Hpa)

3.5.2 WIND SPEED / DIRECTION SENSOR

MAKE : LAMBRECHT MODEL: 1453 S2 F1000

Fig 3.2 WIND SPEED / DIRECTION SENSOR

Professional Line	Series (1453 S2) Combined Small Wind Sensor	
Varieties	Wind direction	Wind speed
00.14532.000 030	**(1453 S2F1000)** precision ring potentiometer F1000	DC-generator G2
Measuring element:	wedge-shaped wind vane	3-armed cup rotor
Measuring range:	0...360°	0...35 m/s
Accuracy:	± 1%	± 2% FS
Resolution:	0.1°	0.1 m/s
Starting value:	1 m/s	1 m/s

3.5.2.1 Testing procedure using data buoy

* Before setting the sensor refer to manual

- Connect the sensor to GENI CPU
- Connect to Glink software and follow the commands

Pman
Debug
cmd>
(a)nalog i/o menu
(d)igital i/o menu
(P)ower o menu
(s)erial i/o menu
(p)rocess control menu
(D)atabase menu
(e)rror log menu
(b)oot computer
(q)uit
cmd> a
(m)onitor
(l)ower channels
(q)uit and go to main menu
analog/cmd> m
Rate? (1000) [ms]
Channel? (-1 to exit) 11
Channel? (-1 to exit) -1

Acquiring A/D measurements at 1.00 Hz (press any key to abort)

0.000
0.019
0.020
0.013 **directly take the connection from the wind sensor**
0.005 **6th and 7th pin measure voltage**
0.089 **range (0 to 1)volt**
0.068
0.074
0.097
0.119
0.146
0.193
0.185

```
0.292
 0.235
 0.186
 0.218
 0.255
 0.194
 0.269
 0.313
 0.266
 0.163
 0.123
 0.104
analog/cmd> m
Rate? (1000) [ms]
Channel? (-1 to exit) 12
Channel? (-1 to exit) -1

Acquiring A/D measurements at 1.00 Hz (press any key to abort)
```

wind direction range 0 to 360deg
Directly check the wind sensor 1st and 2nd **0.004** pin

position of Wind vanes (deg)	output from wind sensor (ohm)
0	000
90	300
180	530
270	875
360	1000

```
 0.004
 0.046
 0.046
 0.068
 0.068
 0.081
 0.082
 0.083
 0.107
 0.148
 0.178
 0.202
 0.214
 0.226
 0.231
 0.250
 0.246
 0.283
 0.287
 0.292
 0.294
analog/cmd> q
cmd> q
Quitting...
#
```

3.5.3 HUMIDITY / AIR TEMPERATURE SENSOR

MAKE: ROTRONIC MODEL: MP100A

Fig. 3.3 HUMIDITY / AIR TEMPERATURE SENSOR

3.5.3.1 Technical data

Humidity sensor	ROTRONIC-HYGROMER® IN-1
Temperature sensor	RTD Pt 100 1/3 DIN
Operating ranges:	
Humidity	0...100%RH
Temperature	-40...+60℃
Input voltage	12v
Output signals:	
Humidity	0 to 1v dc (0 to 100%)
Temperature	0 to 1v dc (-40 to+60deg c)

Connector wiring

Find the plug connection diagram belonging to your probe

Example: Code for the standard version with 7-pin Tuchel connector: T7

Connection designations	
+	Supply Voltage + VDC
GND	Common ground (-), - VDC
RH	Humidity (+)
T	Temperature (+)
0	Cable compensation

View of the connection side of the opposite connector Standard version with 7-pin Tuchel connector

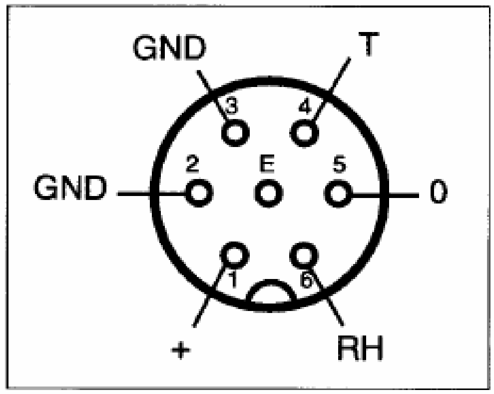

Fig 3.4 HUMIDITY SENSOR CONNECTOR DETAILS

3.5.3.2 Testing procedure using data buoy

* Before setting the sensor refer to manual

- Connect the sensor to GENI CPU
- Connect to Glink software and follow the commands

Pman

Debug
(a)nalog i/o menu
(d)igital i/o menu
(P)ower o menu
(s)erial i/o menu
(p)rocess control menu
(D)atabase menu
(e)rror log menu
(b)oot computer
(q)uit
cmd> a
analog/cmd>
(m)onitor
(l)ower channels
(q)uit and go to main menu
analog/cmd> m
Rate? (1000) [ms]
Channel? (-1 to exit) 3
Channel? (-1 to exit) 4
Channel? (-1 to exit) -1
Acquiring A/D measurements at 1.00 Hz (press any key to abort)

Humidity temperature

0.534	0.262	
0.534	0.261	
0.534	0.261	here channel 3 is humidity and 4 is Temperature
0.534	0.261	reading from humidity thro geni cpu for 27 to 38deg
0.534	0.262	
0.535	0.262	
0.534	0.263	
0.537	0.264	
0.537	0.265	
0.534	0.266	
0.092	0.590	
0.092	0.549	
0.083	0.680	
0.058	0.884	
0.045	0.771	
0.068	0.591	
0.086	0.525	
0.108	0.475	
0.136	0.432	
0.168	0.402	
0.200	0.380	
0.258	0.351	
0.281	0.340	
0.299	0.328	

analog/cmd> q
cmd> q
Quitting...
#

3.5.4 MOTION REFERENCE UNIT (WAVE SENSOR)

MAKE : SEATEX	**MODEL :** MRU-4/6
Power requirements	12 - 30V DC, 6 W
Analog channels	#4, ±10V, 14 bit resolution
Digital output variables	#16 (max), RS232 or RS422
Output data rate (max)	100 Hz (10 ms)
Internal update rate	400 Hz (angular)

Fig.3.5 WAVE SENSOR

For GENI system settings

Baud rate	9600
Parity	none
Data bits	8
Stop bits	1
Duplex	Full duplex

* Before setting the sensor refer to manual

- Connect to MRC Software.

3.5.4.1 MRU CONFIGURATION PROCEDURE FOR WAVE BUOY (MRC S/W)

VESSEL

- **Geometry**

Length (m)	width (m)	Height (m)
0	0	0

From CG to AP (AFT point) = 0.000

From CG to CL (Center Line) = 0.000

From CG to the keel = 0.000

- **Description**

Ressal description

User annotation Wavescan seawatch 0.01h

SENSOR

- **Geometry**

	X(m)	y(m)	z(m)
From MRU to CG	0.000	0.000	0.000
From MRU to MP	0.000	0.000	0.000
Mounting Angles	0.000	-90.00	0.000
	Roll	Pitch	Yaw

- **Heave config**

Filter	General purpose
Period	10.000
Damping	1.000

3.5.4.2 DATA INTERFACE

- **Digital**

Port setup	sys 9600n81
Protocol	MRU Normal
Token	34
Digital channels	6
Interval	1000

02	PosMonD	[m]	FFLOAT
100	PosMonN	[m]	FFLOAT
101	PosMonE	[m]	FFLOAT
68	Heading	ang	FFLOAT
66	RollHippy	[-1 1]	FFLOAT
67	PitchHinny	[-1 1]	FFLOAT

- **Auxiliary**

  Aux 1 port setup aux1 9600 n 8 1

  Aux 2 port setup aux2 9600 n 8 1

  Aux 3

  Mode not used

  External heading age 20 ms

- **Analog**

  Analog output enabled no

SPECIAL OPTIONS

- **Filter**

  Surge filter

  Period 2.5 s

  Damping 0.6

  Sway filter

  Period 2.5 s

  Damping 0.6

  Vibration

  Low pass 25HZ

- **Limitation**

  Velocity 10.000ms

  Position 10.000 m

- **Emulation**

  Emulate MRU type off

- **Magnetic condition**

  Latitude 0.000deg

  Magnetic deviation 0.000 deg

  Fluxgate usage Strong adhersion

3.5.4.3 PARAMETER MANAGEMENT

- **Download to MRU**
- **Save the file**
- Fix the MRU with Holder where R points downwards.
- Switch ON MRU and check for MRU readings in glink display.

Table 3.4 THE RANGE AND PARAMETERS

SL NO	PARAMETER	RANGE	UNIT
1	Hm0	0 - 20	m
2	Tm02	0 -30	s
3	Mdir	0-360	Deg
4	Hm0a	0 - 20	m
5	Tm02a	0 - 30	s
6	mdira	0 - 360	Deg
7	hmax	0 - 30	m
8	thmax	0 - 30	s
9	thtp	0 - 360	Deg
10	Mdirb	0 - 360	Deg
11	Ui	0 - 1	
12	tp	0 - 30	s
13	Sprtp	0 - 90	Deg
14	thhf	0 - 360	Deg
15	Hm0b	0 - 20	m
16	Tm02b	0 - 30	s
17	Tmm10	0 - 30	s
18	tz	0 - 30	s
19	heave	-15 to 15	m
20	Compass	0 - 360	Deg
21	pitch	-1 to 1	
22	roll	-1 to 1	

3.5.5. CT SENSOR

MAKE: VALEPORT MODEL: 620 CT

Fig 3.6 CT SENSOR

Test cable Connection Details with hyper terminal

D-pin(Pc side)		Sensor side	
1		**1**	
2	**--------------------------------------**	**3**	**here pin 1 and 6 are sort**
3	**--------------------------------------**	**2**	
4	**--------------------------------------**	**4--- (+12v dc)**	}
5		**5**	}
6	**--------------------------------------**	**6 -- (-12v dc)**	

Testing procedure using data buoy

*Before setting the sensor refer to manual

Connect to Hyper terminal

Baud rate	9600
Parity	none
Data bits	8
Stop bits	1
Duplex	full duplex

- The Model 620 will begin sampling immediately on power up, in whichever mode was previously used.

- The unit will also automatically begin sampling if interrupted and left inactive for 5 minutes.
- The unit can be interrupted by sending the command " # " until it responds with a NAK (§) or ACK (♠).
- The user may then change the following parameters by sending the appropriate commands:

Here following commands are used for valeport setting to geni system

1. #034 (to set the baud rate)
2. #036 (read the baud rate)
3. #010 (to set the sampling frequency)
4. #011 (read the sampling frequency)

Table 3.5 CT SENSOR CABLE DETAILS

Subconn 6 pin male line	Function	9 Way D Type	4mm Banana Plugs	
Pin		Pin	Pin	Wire colour
1	RS232 GND	5 (Link to 1,6,8,9)		
2	RS232 Tx (Out of sensor)	2		
3	RS232 Rx (Into sensor)	3		
4	+V (8 – 15vDC)		Red Plug	Red, linked inside D type hood
5	N/C			
6	Power GND		Black Plug	Black, linked inside D type hood

3.5.5.1 CT Sensor Reading Range

Conductivity Range : 0 - 80 mS/cm.

Temperature Range : 15 to 45^{0}C.

3.5.5.2 CONDUCTIVITY AND TEMPERATURE SENSOR CONFIGURATION

```
#034 9600          //SET BAUDRATE
9600
#036               //VIEW BAUDRATE
9600
#010 1             // SET SAMPLING FREQUENCY
1
#011               //VIEW SAMPLING FREQUENCY
1
620CT
```

T=	+30.130	C=	+00.037
T=	+30.114	C=	+00.018
T=	+30.103	C=	+00.001
T=	+30.100	C=	+00.009
T=	+30.098	C=	+00.018
T=	+30.098	C=	+00.007
T=	+30.099	C=	+00.009
T=	+30.101	C=	-00.004
T=	+30.102	C=	-00.008
T=	+30.102	C=	+00.001
T=	+30.106	C=	-00.004
T=	+30.106	C=	+00.009

3.5.6 SAILOR Mini-C MODEM

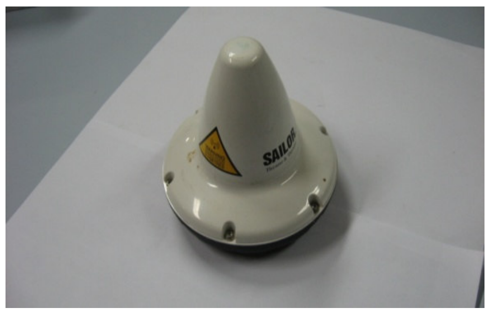

Fig. 3.7 SAILOR MINI – C MODEM

3.5.6.1 Introduction

The TT3026 D/M/S easy Track Transceiver is a complete Inmarsat mini – C Transceiver with built in LPA / HPA electronics and an omni directional antenna.

3.5.6.2 System Specification

1. Power Supply Details
   DC Voltage: 10.5 – 32V DC.

2. Baud rate:
   Baud rate: 4800 bits per second.

3.5.6.3 Test Procedure

1. Connect the Power Supply, Data & Control Signals to Mini – C MODEM & TT3616D Interconnection Box as per the Manual.
2. Connect the Interconnection Box to the Date Terminal Equipment (PC) through D9 Female Connector as per the Manual.
3. Install the EasyMail Software (if not installed in PC).Run the EasyMail Software.
4. Check the GPS Connection, Antenna Signal Strength and PC Connect Signals, which are indicated by Green & Red Colour Indications as per the Manual.
5. Configure the Basic Setups for EasyMail and Perform the LINK Test as per the Manual
6. Alternatively the Mini C MODEM can be tested using HyperTerminal Software through the list of commands given in the manual.

7. Check the Mini C MODEM in loop back by sending data to same modem and check transmission and reception using Ilink software provided.

Note: For further Details, refer the Manual

3.5.7 BEACON LAMP

Fig. 3.8 BEACON LAMP

3.5.7.1 System Specification

- Power Supply Details

  DC Voltage: 12V DC.

3.5.7.2 Test Procedure

- Connect the 12V DC Power Supply to the Beacon lamp via the Two Pin / Four Pin Connector (1 -> +12V, 2 -> GND).
- Cover the Beacon Lamp for darkness around it. Visually check the blinking of Beacon Lamp.

3.5.8 Compass

Power Inputs	+8 to +18 VDC	White
	+18 to +28 VDC	Red
	Gnd, Common Ground	Black

Function	Signal	Wire Color
Serial I/O Port	RXD, RS232 or 0 to +5V Data Input	Red/Black Tracer
	TXD, RS232 or 0 to +5V Data Output	Blue/Black Tracer
	Inverted TXD, 0 to +5V Data Output	Blue/White Tracer
	Gnd, Common Ground	Black/White Tracer

1.4.2 Aluminum Housed Unit (SE-25 sensor)

Table 2 defines the Power and Data interface connections for the housed C100 electronic compass.

Note The wire colors are different from Table 1.

Table 2. C100 Interface Wiring - SE-25 Sensor (Housed Unit Only)

Function	Signal	Wire Color
Serial I/O Port	RXD, RS232 or 0 to +5V Data Input	Red/Black Tracer
	TXD, RS232 or 0 to +5V Data Output	Blue/Black Tracer
	Inverted TXD, 0 to +5V Data Output	Blue/White Tracer
	Gnd, Common Ground	Black/White Tracer
Digital I/O Port	Clk, 10kHz 0 to +5V Clock Output	Blue
	Data, 0 to +5V Data Output	Orange/Black Tracer
	Strobe, 0 to +5V Strobe Input	Green/Black Tracer
Analog Outputs	Sin, Sine or Analog Output	Orange
	Cos, Cosine or Analog Output	Green
	Ref, Reference or Analog Output	White/Black Tracer
Power Inputs	+8 to +18 VDC	White
	+18 to +28 VDC	Red
	Gnd, Common Ground	Black
Not Used		Green/White Tracer
Not Used		Red/White Tracer

The cable shield is connected to the aluminum housing.

Testing procedure using data buoy

***Before setting the sensor refer to manual**

Connect to Hyper terminal

Default settings

Baud rate 4800
Parity none
Data bits 8
Stop bits 1
Duplex full duplex

1. Fix the compass north(Arrow mark) to the true north.Observe the value

   Will be **0** for true north.

2. Change the compass direction like 90,180,270,360 deg,

   See the value through hyper terminal

   $HCHDM,001.2,M*2A
   $HCHDM,003.7,M*2D
   $HCHDM,005.2,M*2E

3.5.9 INDIVIDUAL SENSOR TEST REPORT

SENSOR NAME	:	**Wind Speed**
MODEL	:	Lambrecht 1453 S2 F100
SERIAL NO	:	731547.0009
TEST PERIOD	:	3 Days (From 29/12/10 to 31/12/10)
TEST OUTPUT DATA	:	Annexure

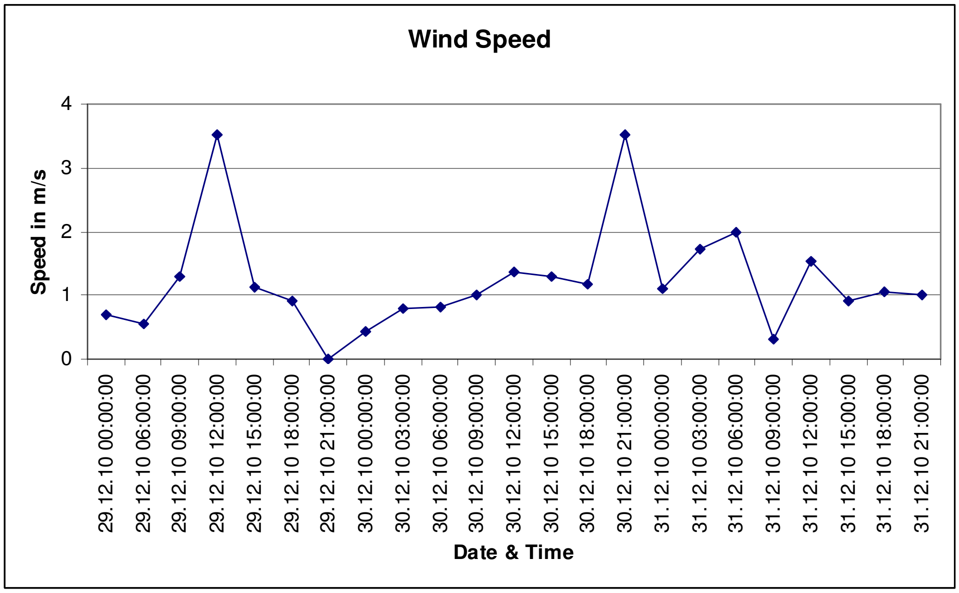

Fig. 3.9 DATA GRAPH WIND SPEED

SENSOR STATUS	:	WORKING / NOT WORKING
NATURE OF PROBLEM	:	
(If not working)		
Remarks if any	:	

………………………………………………………………………………

Tested by Verified by Approved by

SENSOR NAME : **Wind Direction**

MODEL : Lambrecht 1453 S2 F100

SERIAL NO : 731547.0009

TEST PERIOD : 3 Days (From 29/12/10 to 31/12/10)

TEST OUTPUT DATA : Annexure

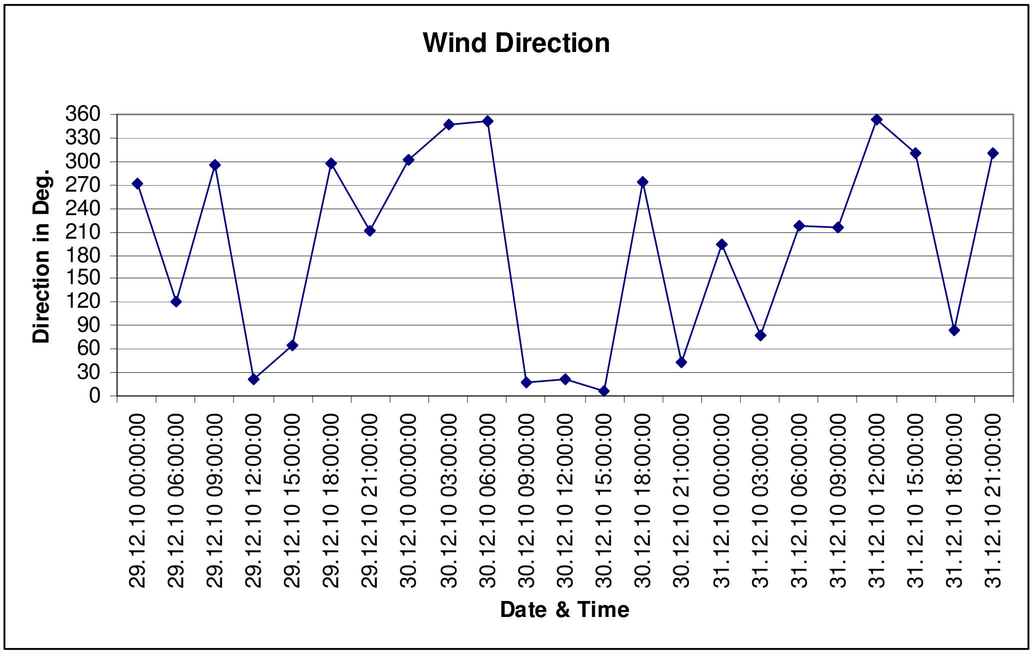

Fig. 3.10 DATA GRAPH FOR WIND DIRECTION

SENSOR STATUS : WORKING / NOT WORKING

NATURE OF PROBLEM :

(If not working)

Remarks if any :

....

Tested by Verified by Approved by

SENSOR NAME	:	**Air Temperature**
MODEL	:	Rotronic
SERIAL NO	:	46741020
TEST PERIOD	:	3 Days (From 29/12/10 to 31/12/10)
TEST OUTPUT DATA	:	Annexure

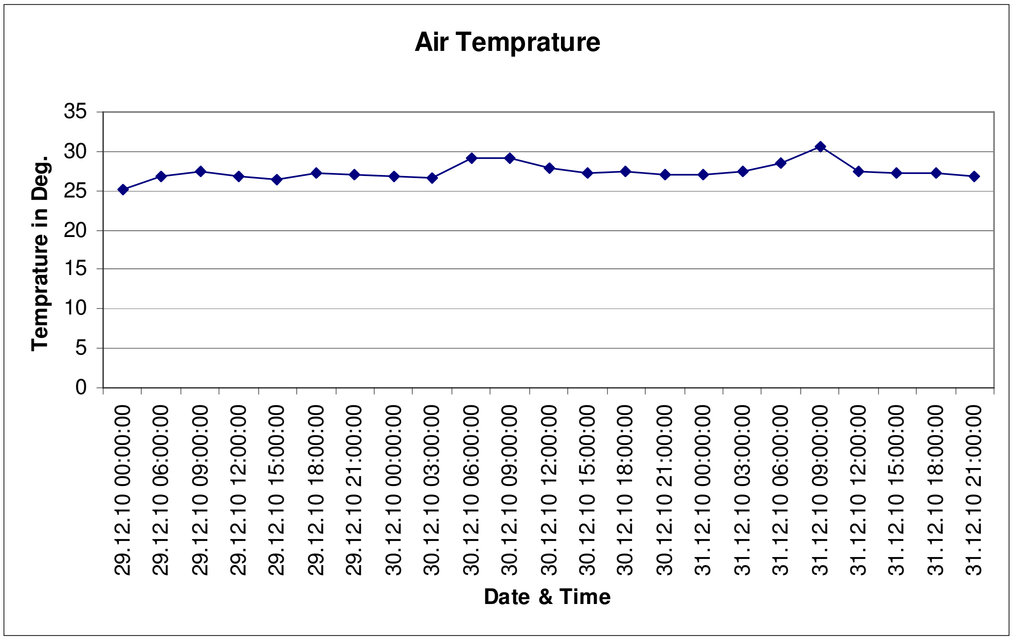

Fig. 3.11 DATA GRAPH FOR AIR TEMPERATURE

SENSOR STATUS	:	WORKING / NOT WORKING
NATURE OF PROBLEM	:	
(If not working)		
Remarks if any	:	

....

Tested by　　　Verified by　　　Approved by

SENSOR NAME	:	**Air Humidity**
MODEL	:	Rotronic
SERIAL NO	:	46741020
TEST PERIOD	:	3 Days (From 29/12/10 to 31/12/10)
TEST OUTPUT DATA	:	Annexure

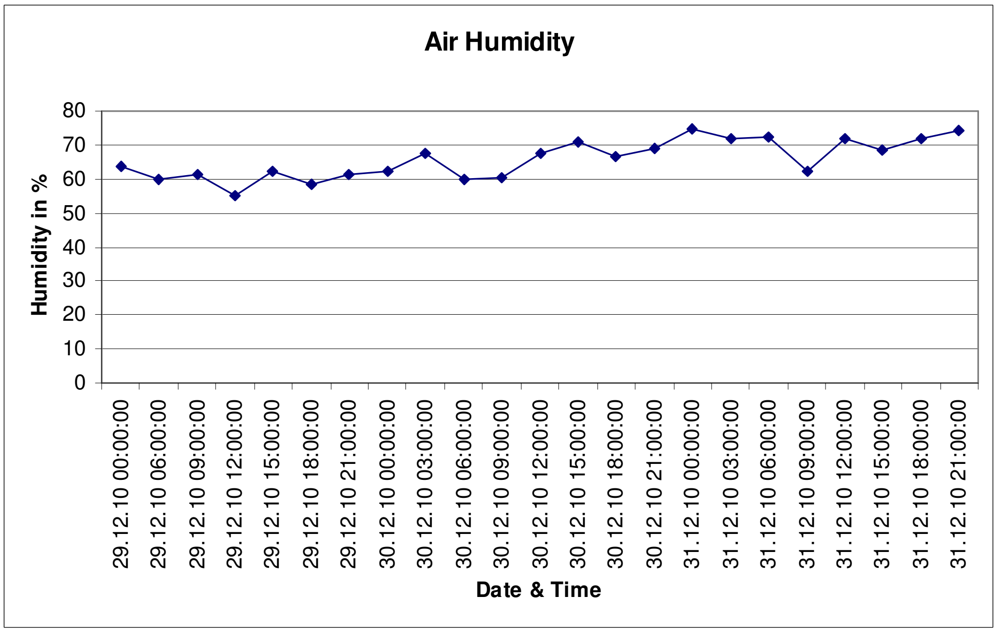

Fig. 3.12 GRAPH DATA FOR AIR HUMIDITY

SENSOR STATUS	:	WORKING / NOT WORKING
NATURE OF PROBLEM (If not working)	:	
Remarks if any	:	

……………………………………………………………………………

Tested by Verified by Approved by

SENSOR NAME : **Air Pressure**

MODEL : Vaisala PTB220

SERIAL NO : C1050038

TEST PERIOD : 3 Days (From 29/12/10 to 31/12/10)

TEST OUTPUT DATA : Annexure

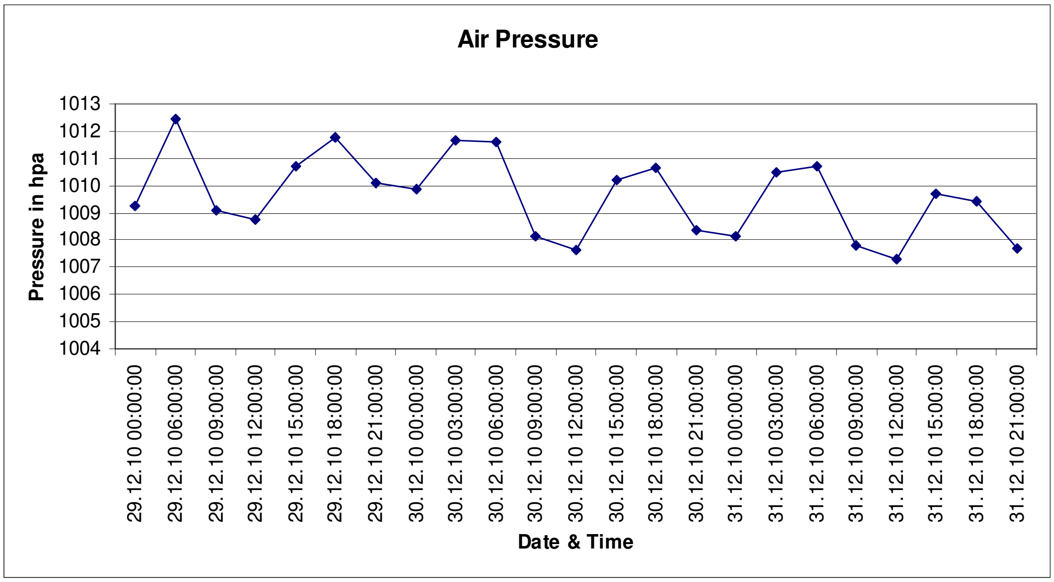

Fig. 3.13 DATA GRAPH FOR AIR PRESSURE

SENSOR STATUS : WORKING / NOT WORKING

NATURE OF PROBLEM:

(If not working)

Remarks if any :

……………………………………………………………………………………

Tested by Verified by Approved by

SENSOR NAME	:	**Compass Heading**
MODEL	:	KVH C100
SERIAL NO	:	100800814
TEST PERIOD	:	3 Days (From 29/12/2010 to 31/12/2010)
TEST OUTPUT DATA	:	Annexure

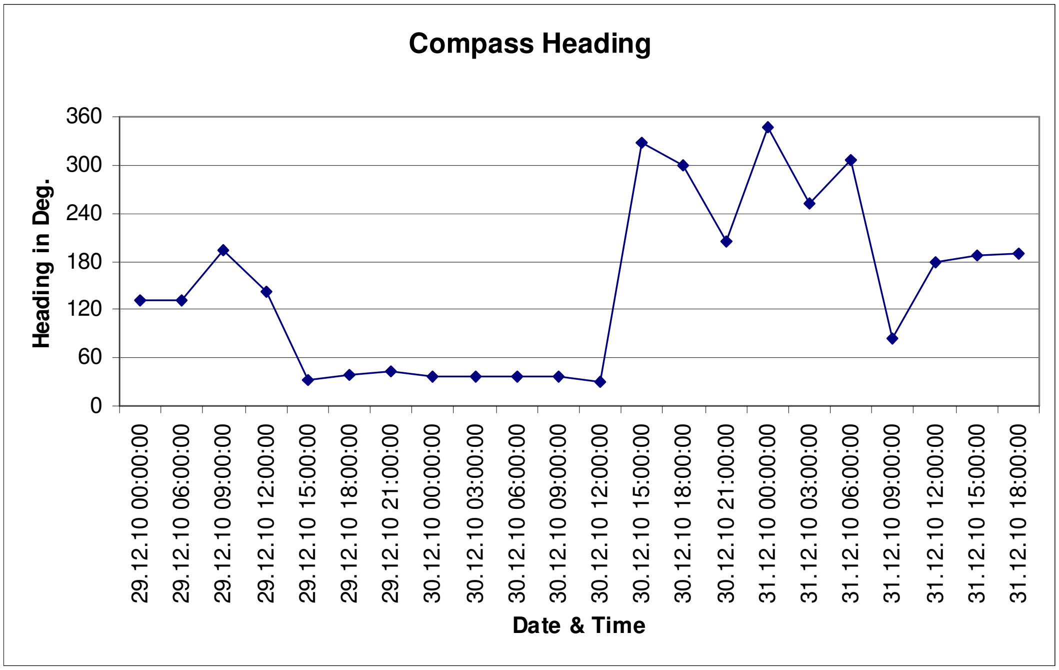

Fig. 3.14 GRAPH DATA FOR COMPASS HEADING

SENSOR STATUS	:	WORKING / NOT WORKING
NATURE OF PROBLEM	:	
(If not working)		
Remarks if any	:	

………………………………………………………………………………

Tested by　　　　Verified by　　　　Approved by

SENSOR NAME	:	**Water Conductivity**
MODEL	:	Vale Port 620
SERIAL NO	:	25769
TEST PERIOD	:	3 Days (From 29/12/2010 to 31/12/2010)
TEST OUTPUT DATA	:	Annexure

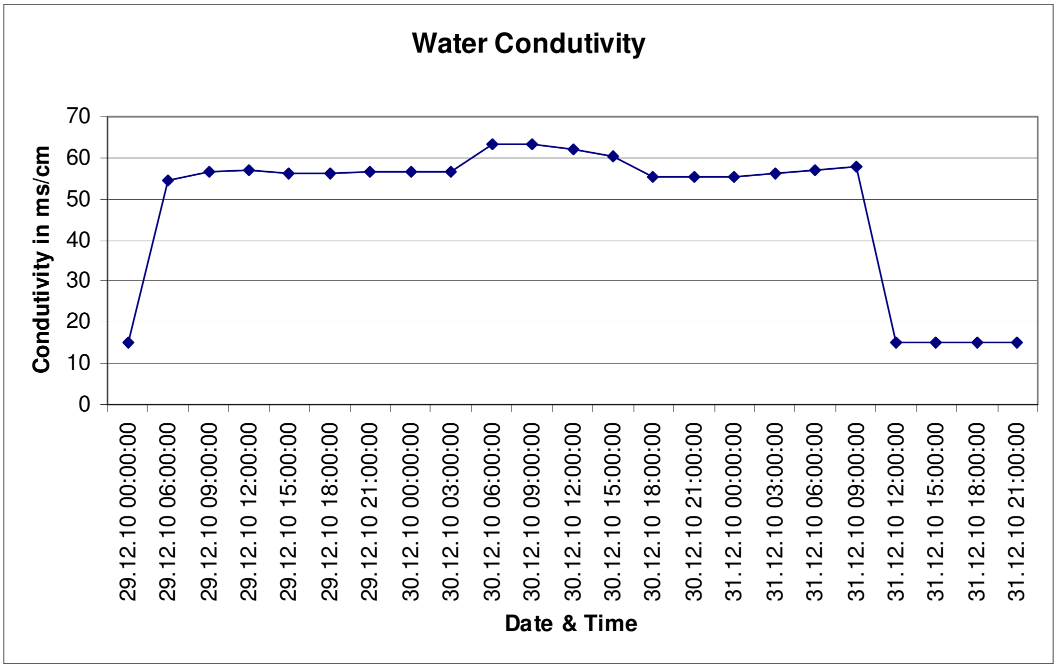

Fig. 3.15 DATA GRAPH FOR WATER CONDUCTIVITY

SENSOR STATUS	:	WORKING / NOT WORKING
NATURE OF PROBLEM	:	
(If not working)		
Remarks if any	:…	

Tested by | Verified by | Approved by

SENSOR NAME : **Sea Surface Temperature**

MODEL : Vale port 620

SERIAL NO : 25769

TEST PERIOD : 3 Days (From 29/12/2010 to 31/12/2010)

TEST OUTPUT DATA : Annexure

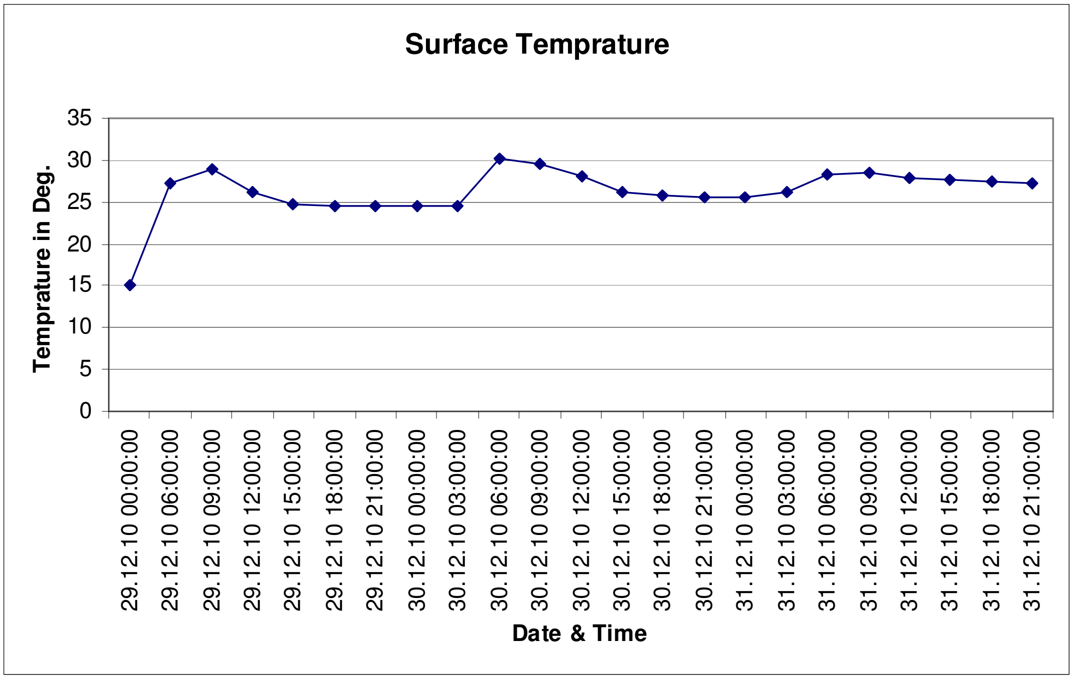

Fig 3.16 DATA GRAPH FOR SURFACE TEMPERATURE

SENSOR STATUS : WORKING / NOT WORKING

NATURE OF PROBLEM :

(If not working)

Remarks if any :

………………………………………………………………………………

Tested by | Verified by | Approved by

COMPONENT NAME	:	**Beacon Lamp**
TEST PERIOD	:	1 Day (From 30/12/10to 30/12/10)
SENSOR STATUS	:	WORKING / NOT WORKING

NATURE OF PROBLEM:

(If not working)

Remarks if any :

Tested by   Verified by   Approved by

COMPONENT NAME	:	**Transceiver**
MODEL	:	TT3026
SERIAL NO	:	456500138
TEST PERIOD	:	1 Day (From 29/12/10 to 29/12/10)
TEST OUTPUT DATA	:	Annexure
SENSOR STATUS	:	WORKING / NOT WORKING

NATURE OF PROBLEM:

(If not working)

Remarks if any :

Tested by   Verified by   Approved by

ANTENNA VERSION:

TT-3026M Non-SOLAS Maritime Inmarsat Mini-C Transceiver, Tr Version 3.00

(C) Copyright 2005 Thrane & Thrane A/S

Version 2.24 Apr 1 2008 11:57:34

ANTENNA POSITION:

SET -P

Position : 12 56 73 N 080 12 71 E———————— at 12:28:15 UTC Valid————————

Course : 165———————— deg/true north

Speed : 000———————— knots : 0000 kmph : 0000 mph

ANTENNA MOBILE NO:

: SET -U **456500138**

The number will now be stored permanently

SIGNAL STRENGTH:

: ST -S

Signal strength : _5_

ANTENNA SERIAL NO:

Serial number	: _07114769_
Terminal type	: _Inmarsat-C Transceiver_
Mobile number	: _456500138_
Mobile type	: _TT-3026M Non-SOLAS Maritime_
ISN number	: _4TT0888AAF43_

TRANSCEIVER STATUS:

: ST -C

SOFTWARE: Version 2.25 Feb 6 2009 11:10:10, Inmarsat-C Transceiver

Synchronization : yes———————————— Serial no : 07114769

Logged in : yes———————————— Mobile no : 456500138

TDM type : NCS Preferred ocean : Indian

TDM channel number : 10840

Current channel : NCS

Current protocol : Free

TDM origin : 344

TDM frame number : 5203

BB error rate : 2 of 100

Last login at Tue Dec 28 01:57:44 2010

3.5.10 Sensor Interface Test

3.5.10.1 Cable Continuity Test

TABLE 3.6 MAST CABLE DETAILS

Sl.No	Mast Cable Pin details	Sensor end	Description	Name Of Sensor
1	1	1	PWR	Flash Light
2	2	2	GND	
3	3	NC	NC	Humidity & Temperature (Rotronic)
4	4	1	PWR	
5	5	2,5	GND	
6	6	6	Humidity	
7	7	4	Temp	
8	8	-	shield	
9	9	3	Dir Exit	Wind Sensor(Lambrecht)
10	10	1	Dir Ref(Gnd)	
11	11	2	Dir sign	
12	12	6	Speed sign	
13	13	7	Speed ref(Gnd)	
14	14	NC	NC	
15	15	NC	NC	
16	16	Red	PWR	Inmarsat Modem/AntennaTT 3026
17	17	Red	PWR	
18	18	Black	GND	

19	19	Black	GND	
20	20	Yellow	Remote On/Off	
21	21	Green	Rx	
22	22	Black/Red	Tx	
23	23	Orange	Gnd	
24	24	NC	NC	
25	25	Blue	CTS	
26	26	Violet	RTS	
27	27	NC	NC	

TABLE 3.7 COMPASS CABLE DETAILS

Sl.No	Connector end	Description	Sensor End
1	A	Gnd	Black & Black/White
2	D	Power 5	White
3	E	COM 10TX from GENI	Red/Black
4	F	COM 10 RX to GENI	Blue/Black

TABLE 3.8 CONDUCTIVITY AND TEMPERATURE CABLE DETAILS

Sl.No	Sensor end (6 pin female)	Description	Lid end(7 pin male)
1	1,6	Gnd	1
2	4	Power 11	4
3	2	COM 6 TX from GENI	2
4	3	COM 6 RX to GENI	3

TABLE 3.9 PRESSURE SENSOR CABLE DETAILS

Sl.No	Connector end	Description	Sensor End
1	A	Gnd	5,7
2	D	Power 2	9
3	E	COM 7 TX from GENI	3
4	F	COM 7 RX to GENI	2

TABLE 3.10 BATTERY CABLE DETAILS

Sl.No	Sensor end	Description
1	A	Cable lug Acc+
2	B	Cable lug Acc+
3	C	Cable lug Acc-
4	D	Cable lug Acc-
5	E	Power
6	F	Thermistor
7	G	Gnd
8	H	Thermistor

3.5.11 SAFETY MEASURES

3.5.11.1 VENT VALVE

Vent valve is fixed at the Cylinder Lid to allow positive ventilation to the buoy battery chamber while prohibiting salt or fresh water entering in to the cylinder via vent line when the buoy is submerged and/or tilted more than 45 degrees.

Vent valve is specially designed to the intended purpose with buoyant upper ball and heavy lower ball.

When the buoy becomes submerged, the buoyant upper ball will float up against the seal ring and seal the vent.

When the buoy rolls over approximately 45 degrees, the heavy lower ball shifts along the molded angle of the insert and pushes the upper ball against the seal ring and seals the vent.

4 INSPECTION OF FABRICATION WORKS

Inspection for mechanical components is done at various stages of the fabrication in the workshops. During the inspection, inspection report is prepared. The report contains the persons involved, things taken for inspection, stages of work done, suggestions given and modifications done during the fabrication inspection.

The standard inspection process for the specific components and it's purposes are given in the following Table:

Table 4.1 INSPECTION PROCEDURE FOR MECHANICAL COMPONENTS

S.No	Part No.	Description of the Component	Inspection procedure	Purpose
1.	001	Hull	1.Checking the water ingression test. 2. Checking of dimensions as per the NIOT specification 3. Checking of Tolerance and provisions for handling.	1. To check the quality of product and the work flow. 2. To check the fabrication and material used for fabrication is followed as per NIOT specification and drawing 3. Checking all surface treatment processes done by the NIOT specification
2.	005	Central Cylinder	1.Checking of dimensions as per the NIOT specification 2. Checking of TIG welding as continuous weld and the waviness of the weld. 3.Checking of hole arrangement and Pitch Circle Diameter (PCD) in top flange of cylinder. 4. Checking of availability of rib under the ϕ18mm hole for lifting ring. 5. A PVC flange is taken for inspection to check the PCD of	

S.No	Part No.	Description of the Component	Inspection procedure	Purpose
			bottom flange holes. 6. Checking the availability of flange and rib for Battery box rod. 7. Oriention of holes for Lid hinge plate and lid lock groove on the lid. 8. Powder coating thickness is checked. 9.Checking of hole for cable routing.	
3	011-013	Mast Assembly	1. Checking of dimensions as per the NIOT specification. 2. Orientation of sensor arm wings. 3. Checking of guiding holes. 4. Checking of hole for cable routing in sensor arm (2 Nos), Lower mast (1No) and Upper mast (1No). 5. Powder coating thickness is checked. 6. Checking the height of antenna fixing flange at sensor arm. 7. Checking of TIG welding as continuous weld and the waviness of the weld.	
4	142	GI Pipe	1. Checking of dimensions as per the NIOT specification. 2. Diameters of the both flanges were checked as per the drawing since the diameter of two flanges is not same. 3.Pitch circle diameter of the both flange holes are checked by using PVC flange 4. Anode fixing hole diameter and distances between the holes were checked. 5. Checking of MIG welding as continuous weld and the waviness of the weld. 6.Checking of sand-blasting and hot dip galvanizing processes.	
5.	014 - 015	Keel Weight and Keel Frame	1.Checking of dimensions as per the NIOT specification 2. A PVC flange is taken for inspection to check the PCD of bottom flange holes of KW and KF. 3. Checking of MIG welding as continuous weld and the waviness of the weld. 4. Checking of sand-blasting and hot dip galvanizing processes.	

S.No	Part No.	Description of the Component	Inspection procedure	Purpose
6	017 - 024	SS Components	1.Checking of dimensions as per the NIOT specification 2. Checking of TIG welding as continuous weld and the waviness of the weld. 3.Checking of PCD of components and surface treatment(Pickling and Passivation).	
7	036 - 063	Ancillary items	1.Checking of dimensions as per the NIOT specification 2. Checking of TIG welding as continuous weld and the waviness of the weld. 3.Checking of PCD of components and surface treatments.	
8	156	Sinker Weight	1.Checking of dimensions as per the NIOT specification 2. Checking of welding as continuous weld and the waviness of the weld. 3. 1" shackle is taken for inspection to check the diameter of the sinker weight lifting hook hole. 4. Weight of each sinker weight is checked and noted in the inspection report.	
9	155	Anchor	1.Checking of dimensions as per the NIOT specification 2. Checking of welding as continuous weld and the waviness of the weld. 3.Checking the shackle size and weight of each anchor.	

5 DOCUMENTATION OF TEST REPORTS AND INSPECTION REPORTS

In Ocean Observation Systems, Preference is given for testing and documentation. For every testing and inspection, a report is prepared and documented for future reference. Then report number with month and date of the report prepared is included in the report.

6 ASSEMBLY OF BUOYS

Assembly of buoy consists of various operations which are given in the following tables with respective topics.

6.1 Pre–Assembly Inspection

Before assembling of buoy, each and every part of the buoy is inspected visually. If any damages found, the parts are replaced with the new one. No compromise is given for the usage of old components.

6.2 Buoy Assembly Procedure

The following table describes the assembly process of different types of Buoys. During assembly process, the individuals are supplied with all equipments and Safety precaution.

TABLE 6.1 BUOY ASSEMBLY PROCESS

SI.NO	DESCRIPTION	REMARKS		COMMENTS
		YES	NO	
1	Visual inspection for the evidence of cracks and damages in hull. Inspection on the Tungsten Inert Gas(TIG) welding and pitting of Central cylinder(CC)			
2	Cleaning of Hull, Central cylinder and making available all kind of fasteners and accessories required for assembly			
3	Assembling of lifting ring, lid hinge and lid lock keys with Silicone grease in CC			
4	Position one half of the hull with the groove in hull facing upward			
5	Fixing of Zinc anode at the bottom of the central cylinder , put it on the hull by using over-head crane and lower mast fixing at the respective groove of the hull			
6	Place the other half of the hull over the cylinder by using over-head crane			
7	Fixing of medium tension bands at top and bottom neck of the hull and keep the buoy in upright position.			
8	Assembly of lifting lug, mooring lug and Fin lug and keep the buoy in position using Overhead crane.			
9	Assembly of long tension bands and check all nuts for its correct tightness			
10	Assembly of fenders, making of holes in fender for fixing the fender plate washer.			
11	Assembly of Battery box with handling studs and eye bolts and it get down to the cylinder. The movement of the battery box is restricted with the help of battery press rod.			
12	Geni/Motion Reference Unit (MRU) and compass is fixed in the instrument plate and it is fitted to the collar which is inside the central cylinder			
13	Fixing of lid hinge plate, vent valve, Nitrogen plugs, Air inlet valve, Antenna cable adaptor/Mast cable adaptor, lid handle etc in lid at their respective places			
14	“O”- ring is fixed in Central cylinder top flange groove applying silicone grease			
15	Lid fixing using the lid lock keys in central cylinder			

16	Keep the buoy in inclined position, and fix the keel weight, keel frame and PVC flange at the bottom of the central cylinder in the prescribed sequence, in case of MET/Wave buoy.			
17	In case of Tsunami buoy, GI pipe and keel frame only need to be fixed. Make sure that, the legs of the keel frame are covered with plastic hose.			
18	In the keel frame the surface modem is fixed.			
19	Fill with Nitrogen (N_2) gas at a pressure of 7.35 psi to avoid condensation of air with Hydrogen (H_2) gas and purging.			
20	Fix the required sensors in sensor arm, central cylinder and mooring. For MET buoy, o Wind sensor o Humidity sensor o Air pressure o Compass o Current Meter o Conductivity For WAVE buoy, o Wind sensor o Humidity sensor o Air pressure o Current Meter o Conductivity o MRU For Tsunami buoy, o Surface modem In some specific cases Water Quality Sensor may also be used.			
21	Assemble the upper mast with the lower one, hood and sensor arm with their respective places.			

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6.3 Post Assembly Inspection

After assembling, checking of mechanical component fitted in the buoy assembly is done by using the checklist. Also all the sensor and its positioning is checked for its assembly.

6.3.1 Burn in Test

No of sample for each sensor can be configured through CPU.

parameter measured by NIOT buoy system	depth/height/ NIOT	Sample period /Rate	sample time
wind speed	3M	10min @ 1 Hz	23.49, 00.49 .....
wind gust		10min @ 1 Hz	23.49, 00.49 ......
wind direction	3M	10min @ 1 Hz	23.49, 00.49 ......
irradiation	3M	1 min @ 1 Hz	23.44, 00.44 ......
netradiation	3M	1 min @ 1 Hz	23.44 , 00.44 ......
rainfall	2.5M	1 min @ 1 Hz	23.44 , 00.44 ......
air humidity	3M	1 min @ 1 Hz	23.44 , 00.44 ......
air temperature	3M	1 min @ 1 Hz	23.44 , 00.44 ......
airpressure	3M	1 sample/integrated value of 1 min	23.57 , 00.57 ......
current dir,current speed	1.2 m	5 min 120 ping	23.55,00.55… ….
temp and conductivity	5m	10 sec @ 1 Hz	23.50 ,00.50……
temp and conductivity,cur speed,cur dir	10m	5 min 120 ping	23.55 ,00.55……
temp and conductivity	15M	1 per 60min	23.55,00.55… …
temp and conductivity,cur speed,cur dir	20m	1 per 30min	23.55,00.55… …
temp and conductivity,cur speed,cur dir	30M	1 per 60min/ 5min 120 ping	23.55,00.55… …
temp and conductivity,cur speed,cur dir	50M	1 per 60min/ 5min 120 ping	23.55,00.55… …
temp and conductivity	75M	1 per 60min	23.55,00.55… …
temp and conductivity,cur speed,cur dir	100M	1 per 60min/ 5min 120 ping	23.55,00.55… …
temp and conductivity	200M	1 per 60min	23.55,00.55… …
temp , conductivity pressure	500M	1 per 60min	23.55,00.55… …

Standard Sample Rate

After the individual sensor test and continuity test the integrated buoy will undergo for the burn in test in the open environment for 100 transmissions with the following.

Transmission Started on	:	29/12/2010
Transmission Completed on	:	10/01/2011
No of Days	:	11 days
Transmission Duration	:	3 hours
Remarks	:	

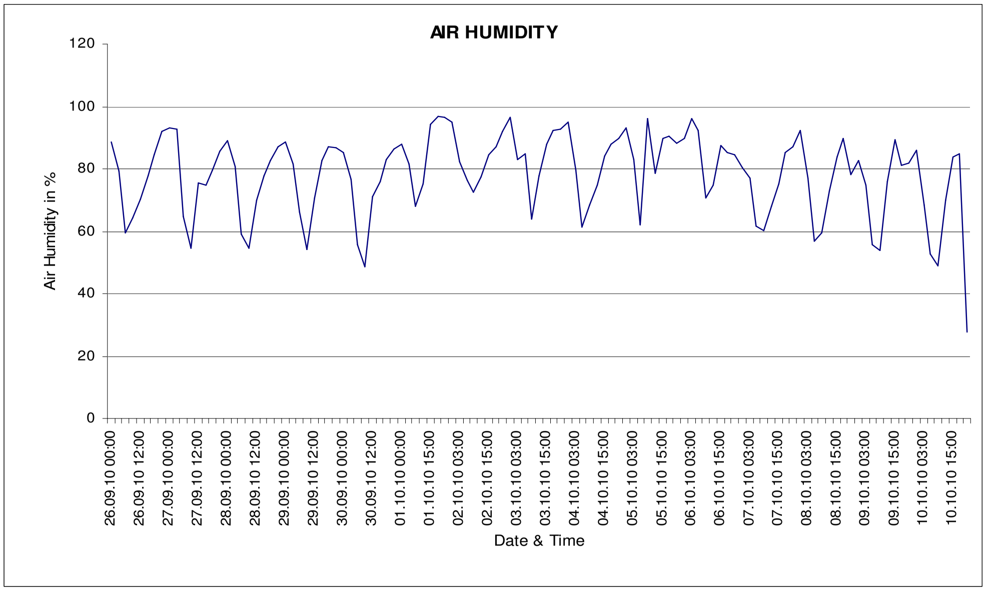
Tested by

Verified by

Verified by

Ocean Observation System
National Institute of Ocean Technology
Chennai

Fig. 6.1 ASSEMBLED BUOY FOR BURN IN TEST


AIR HUMIDITY
Air Humidity in %
0
20
40
60
80
100
120
Date & Time
26.09.10 00:00
26.09.10 12:00
27.09.10 00:00
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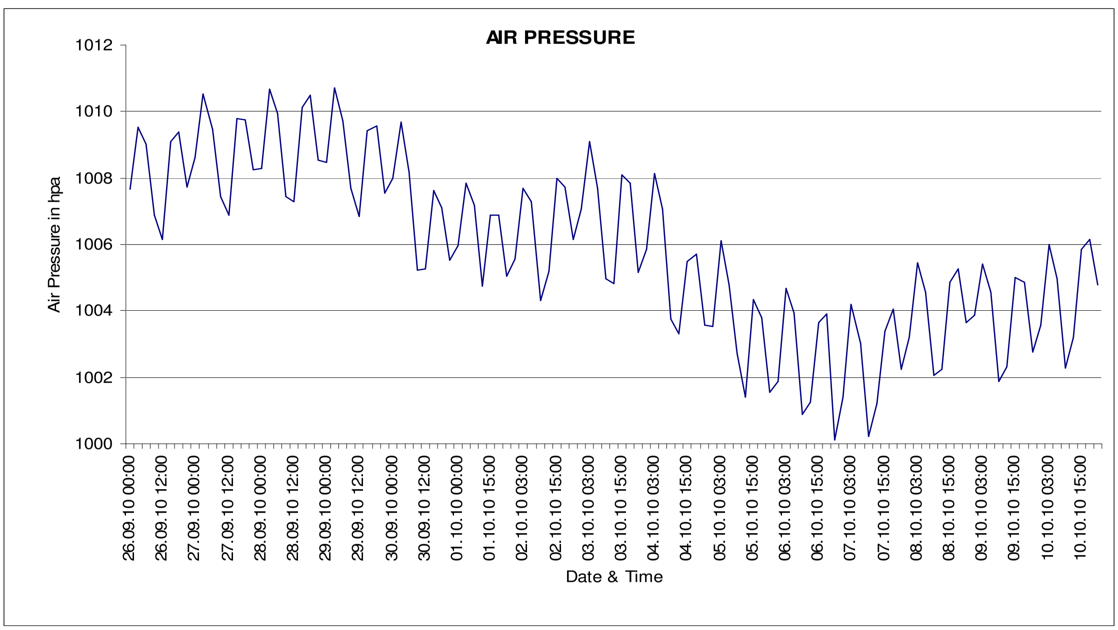
AIR PRESSURE
Air Pressure in hpa
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1002
1004
1006
1008
1010
1012
Date & Time
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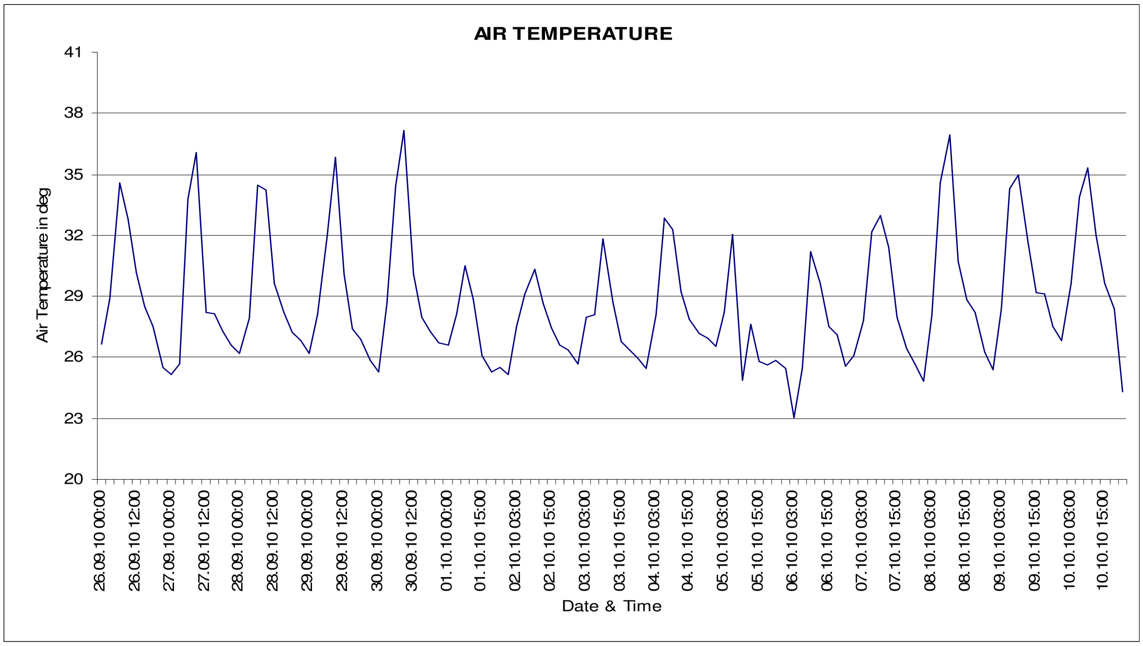
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Air Temperature in deg
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38
35
32
29
26
23
20
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27.09.10 12:00
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02.10.10 15:00
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03.10.10 15:00
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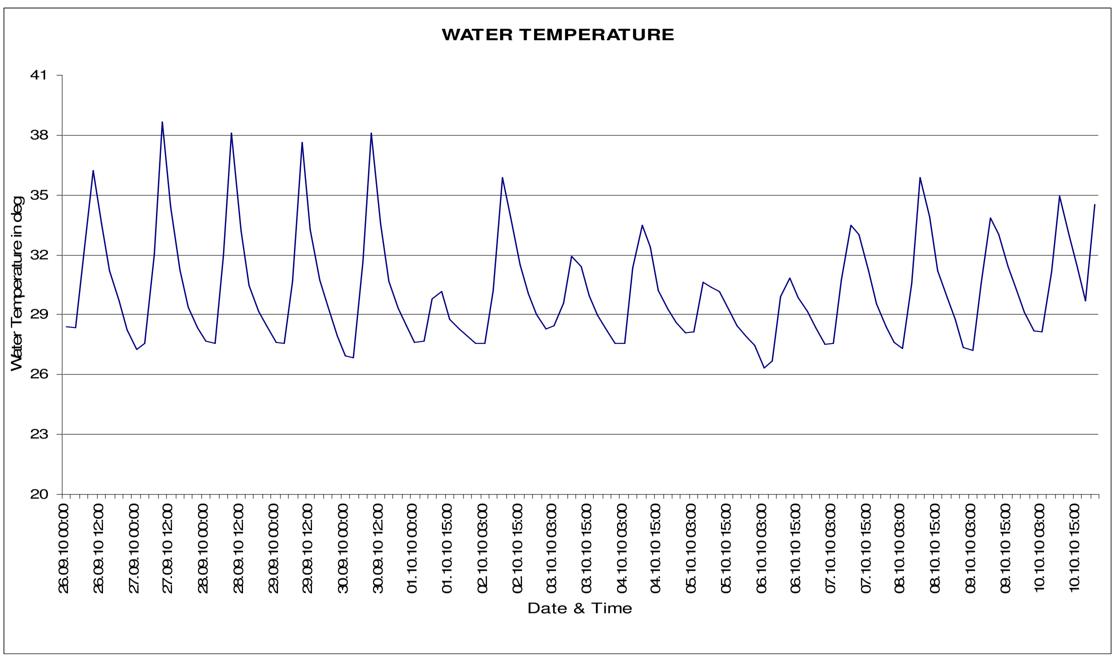
Date & Time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Water Temperature in deg
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38
35
32
29
26
23
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27.09.10 12:00
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28.09.10 12:00
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29.09.10 12:00
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04.10.10 15:00
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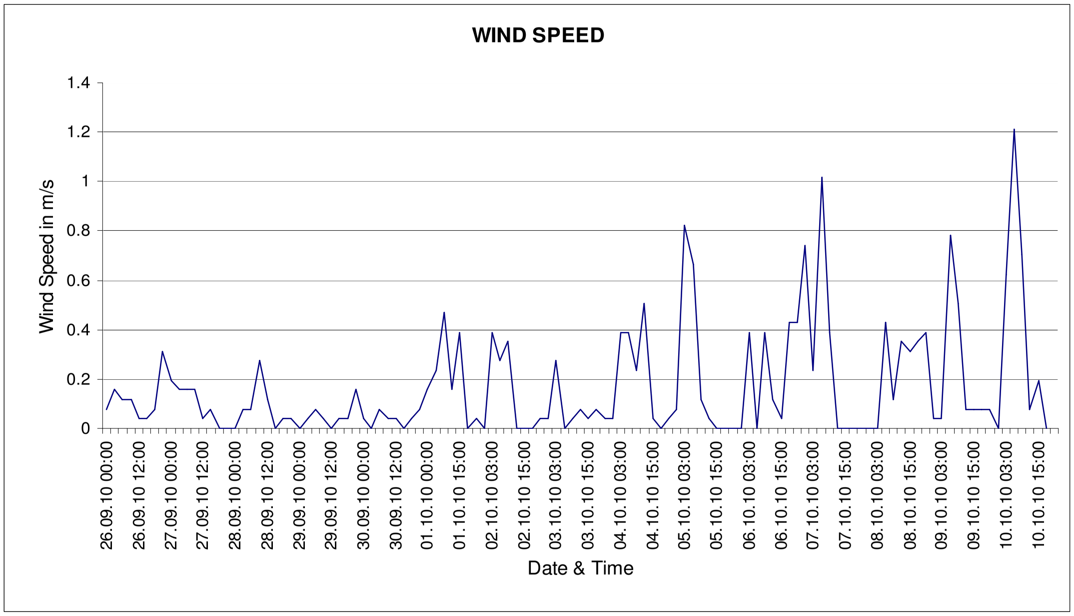
Date & Time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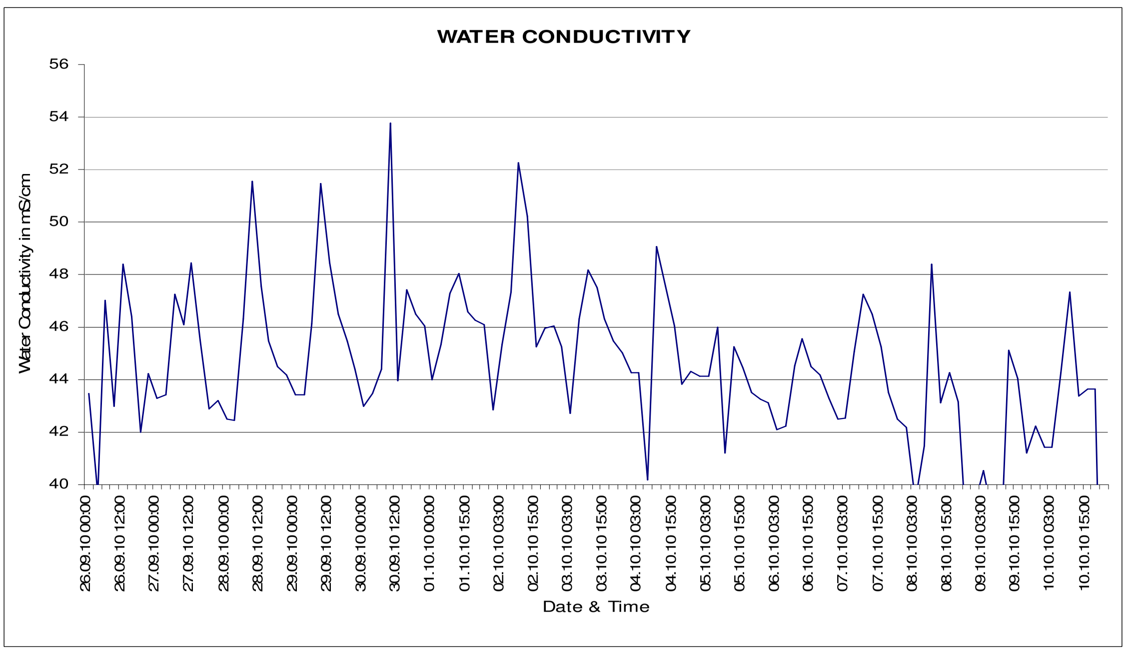
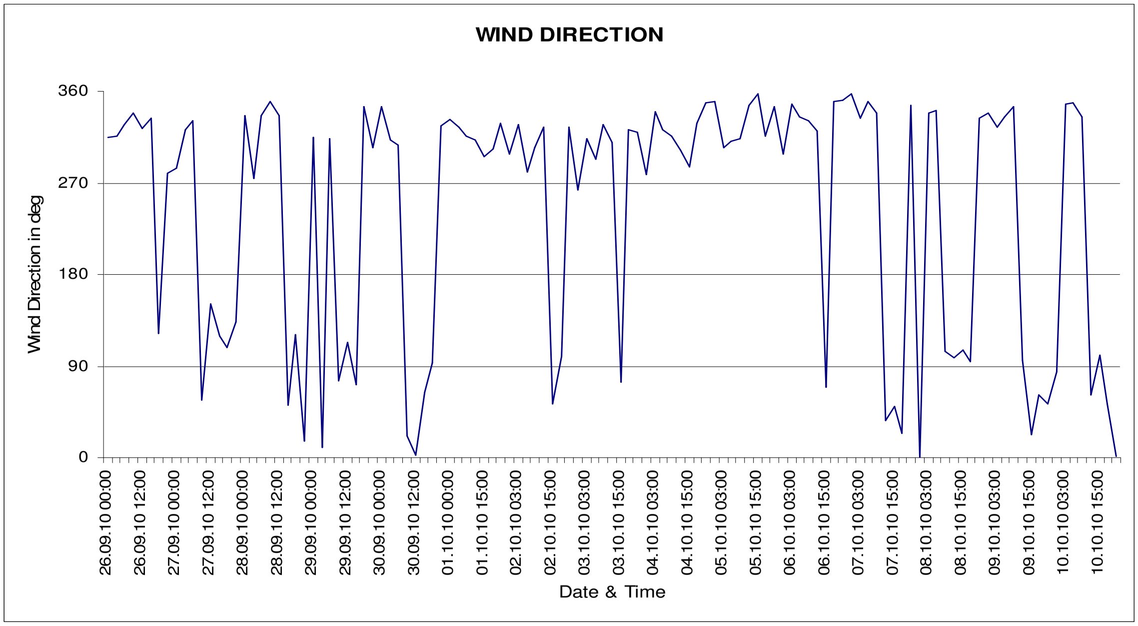
Wind Speed in m/s
Date & Time


WATER CONDUCTIVITY
Water Conductivity in mS/cm
Date & Time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Wind Direction in deg
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04.10.10 03:00
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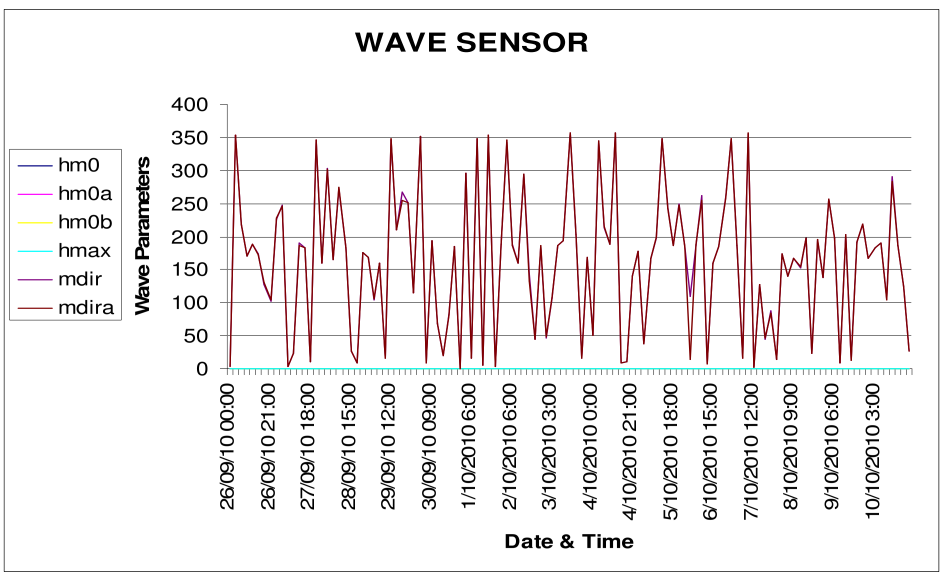
Date & Time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hm0
hm0a
hm0b
hmax
mdir
mdira
Wave Parameters
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100
150
200
250
300
350
400
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26/09/10 21:00
27/09/10 18:00
28/09/10 15:00
29/09/10 12:00
30/09/10 09:00
1/10/2010 6:00
2/10/2010 6:00
3/10/2010 3:00
4/10/2010 0:00
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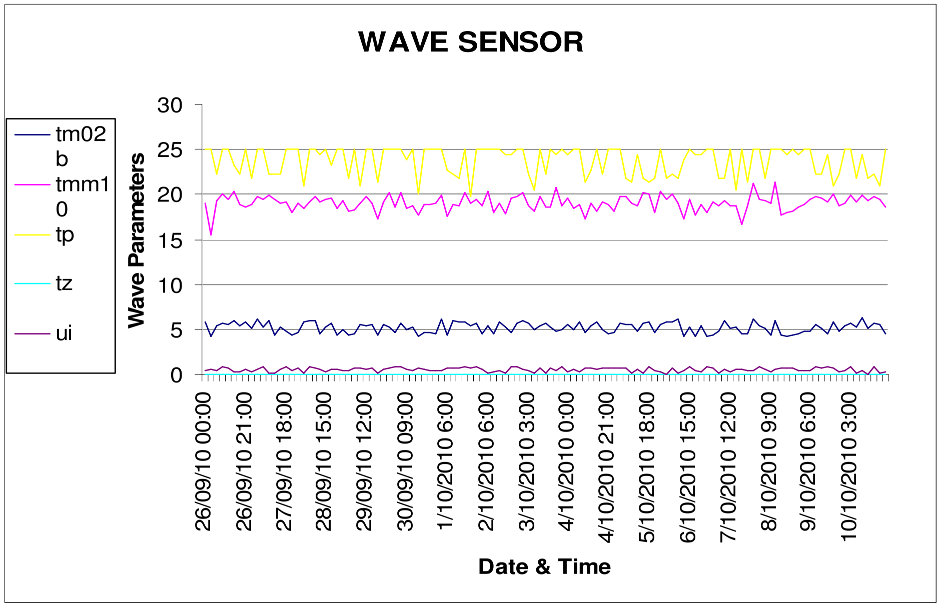
5/10/2010 18:00
6/10/2010 15:00
7/10/2010 12:00
8/10/2010 9:00
9/10/2010 6:00
10/10/2010 3:00
Date & Time


WAVE SENSOR
tm02b
tmm10
tp
tz
ui
Wave Parameters
30
25
20
15
10
5
0
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26/09/10 21:00
27/09/10 18:00
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2/10/2010 6:00
3/10/2010 3:00
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5/10/2010 18:00
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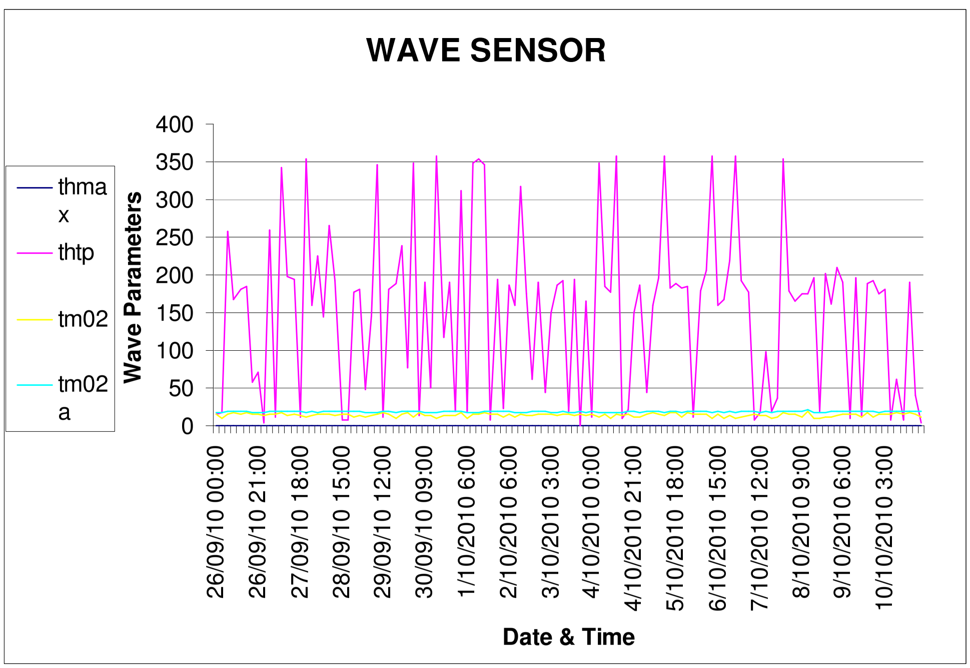
9/10/2010 6:00
10/10/2010 3:00
Date & Time


WAVE SENSOR
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thtp
tm02
tm02a
Wave Parameters
400
350
300
250
200
150
100
50
0
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7/10/2010 12:00
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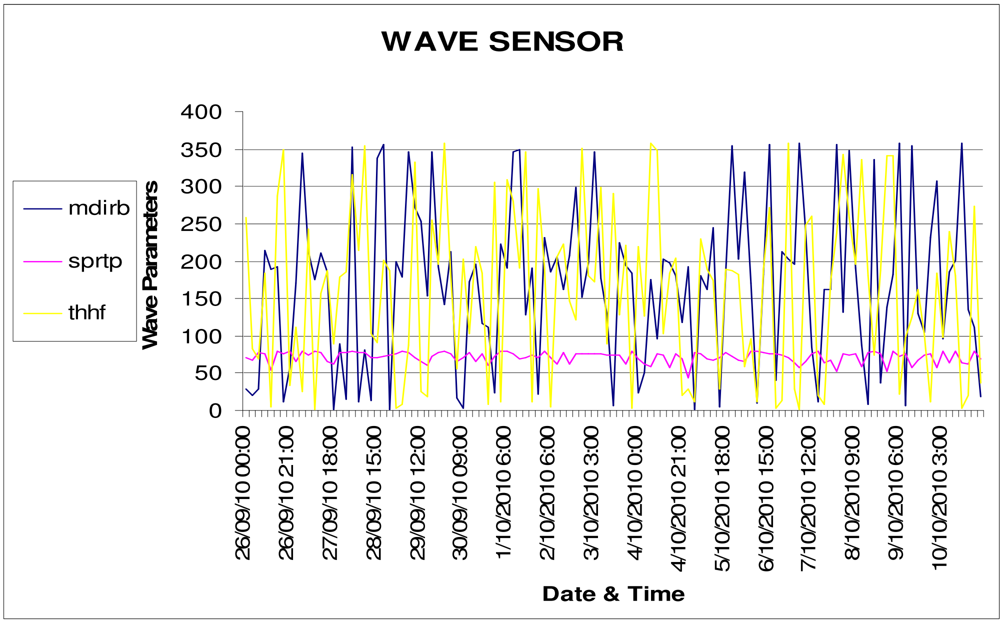
9/10/2010 6:00
10/10/2010 3:00
Date & Time


WAVE SENSOR
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sprtp
thhf
Wave Parameters
400
350
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5/10/2010 18:00
6/10/2010 15:00
7/10/2010 12:00
8/10/2010 9:00
9/10/2010 6:00
10/10/2010 3:00
Date & Time

7. MOORING SYSTEMS

Ocean Observation Systems, NIOT has three types of Buoys and specific moorings types, which are given in the forthcoming topics.

7.1. Mooring Diagram for Wave Buoy

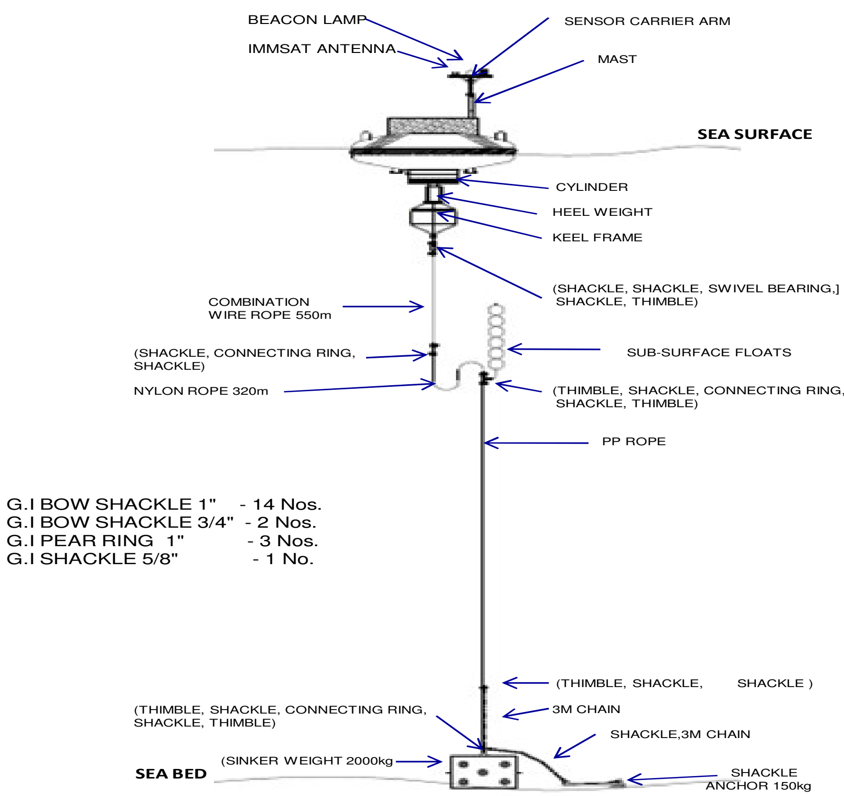


Fig.7.1 WAVE BUOY MOORING DIAGRAM

7.2. MOORING DIAGRAM FOR MET BUOY

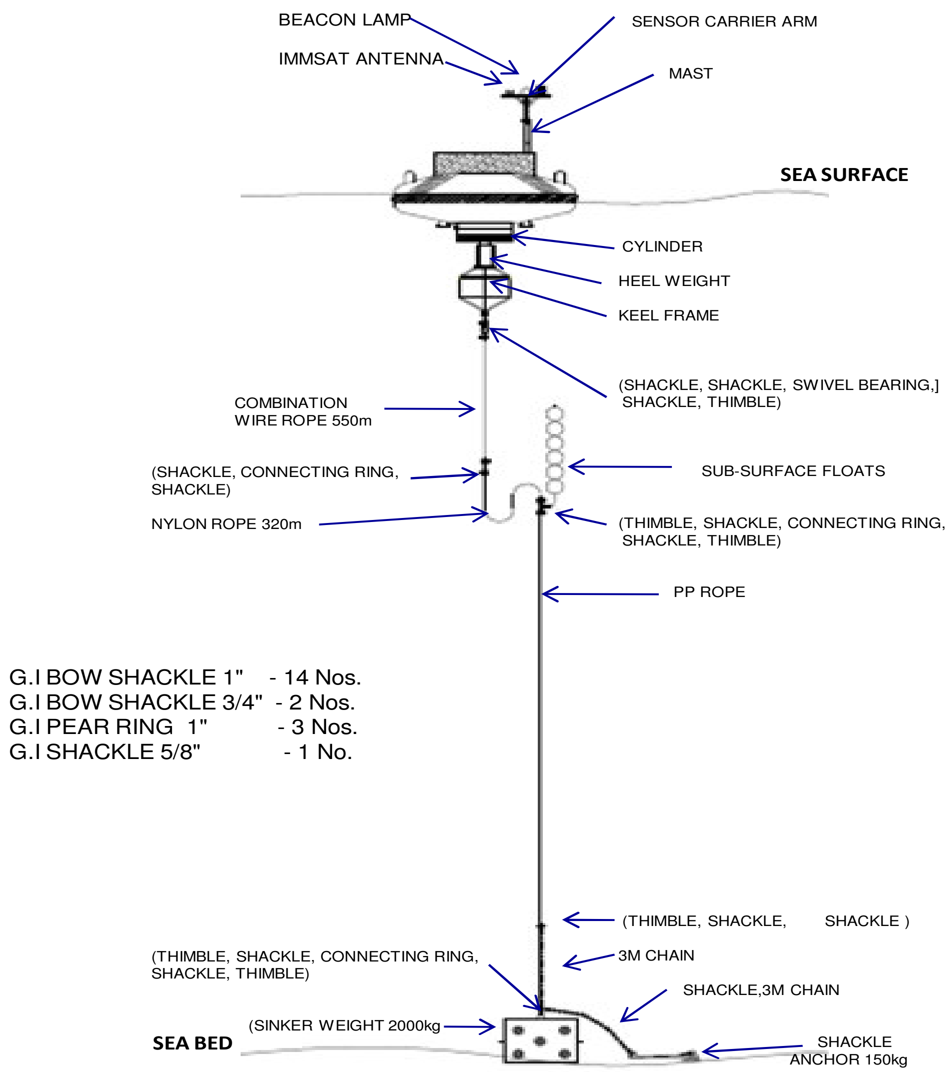


Fig.7.2 MET BUOY MOORING DIAGRAM

7.3. MOORING DIAGRAM FOR TSUNAMI BUOY

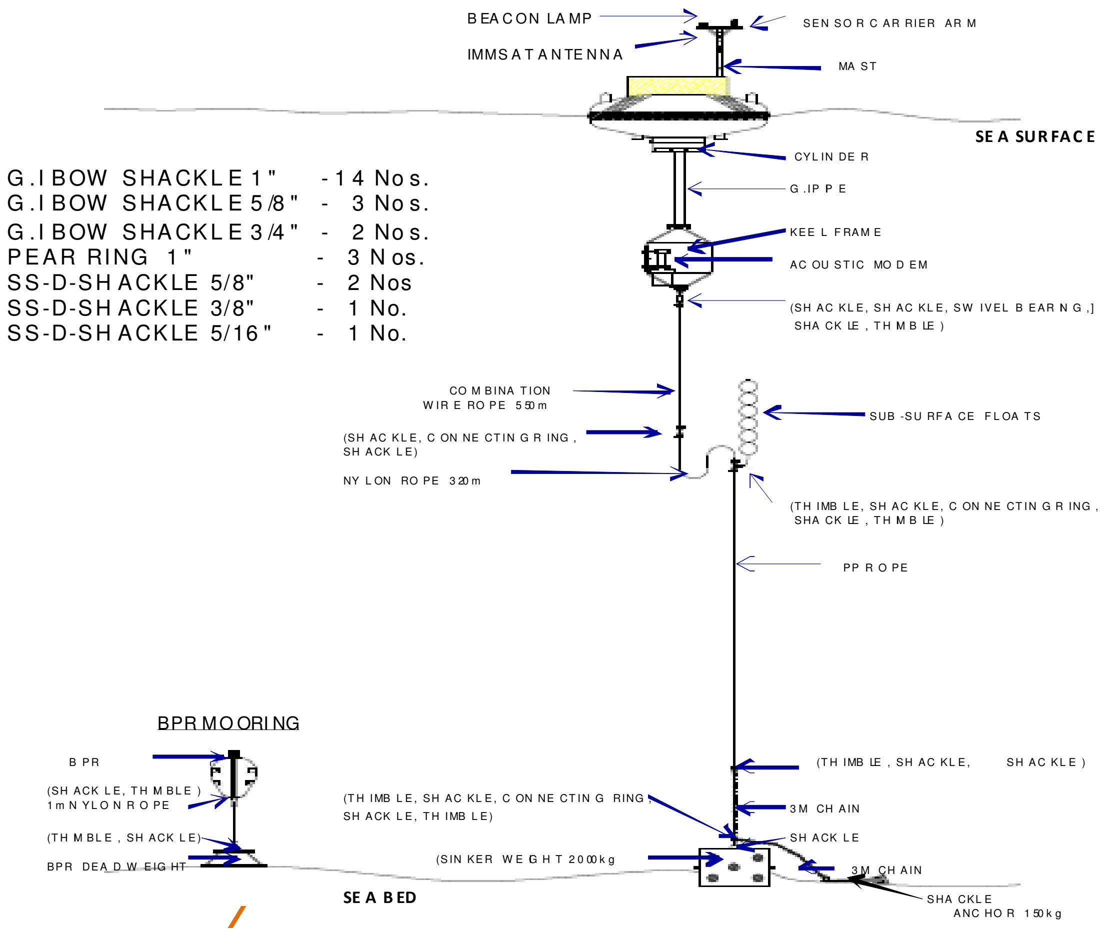


Fig.7.3 TSUNAMI BUOY MOORING DIAGRAM

7.4 MOORING DIAGRAM

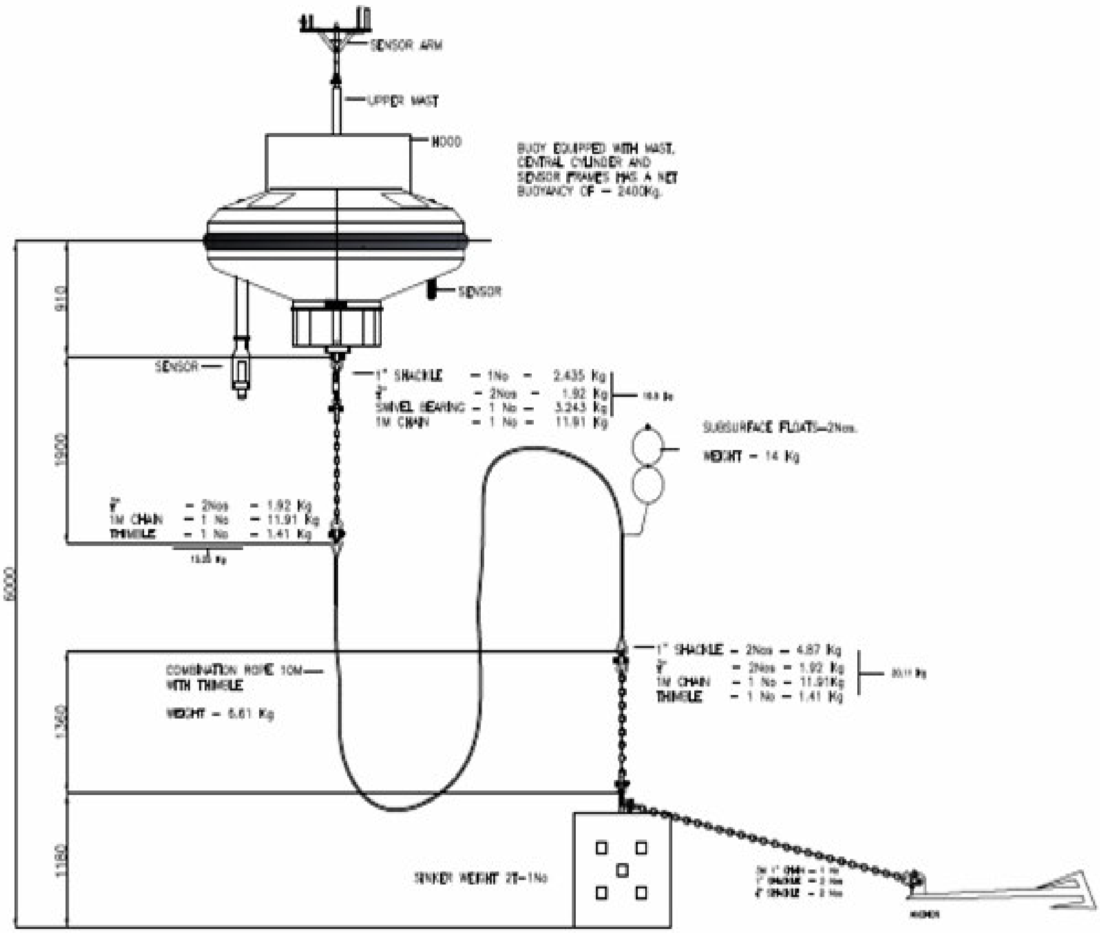


Fig.7.4 ANDAMAN (RP2) BUOY MOORING DIAGRAM

7.4.1 INPUTS

The following inputs are used to carry out the analysis. They are,

- Buoy details such as weight, material, Dimensions and the weight of the included components.
- Number of sub-surface floats used and its net-buoyancy values.
- Wire rope properties such as Length and weight.
- Details of sinker weight such as dimensions and weight.
- Current speed.

- Proposed Mooring Diagram.

ANDAMAN BUOY

Part.No	DESCRIPTION OF THE COMPONENT	MATERIAL	DIMENSION	QTY	WEIGHT IN AIR	C_d
001	**BUOY HULL**	Polyethylene filled with EPS foam	Diameter (Incl. Fender) = 2.85m	1	Weight = 708.1 kg (Incl. cylinder)	
011-013	**MAST (including Upper mast lower mast and sensor arm**	Al 6061	Total height above sea level = 4 m Diameter = 100mm Thickness = 8mm	1	15 kg	
002	**HOOD**	Aluminium		1	47 kg	
007	**INSTRUMENT PLATE**	Al 6061		1	8.10 kg	
053	**ALUMINIUM CURRENT METER FRAME**	Al 6061		1	7.2 kg	
151	**WIRE ROPE**	Steel wire covered by polypropylene	Length = 10m, Diameter = 18 mm		Weight = 0.74 kg/m Total Weight = 7.4 kg	1.3
174	**CHAIN**		Total Length = 5m Diameter = 25.4mm (0.0254m)		weight = 13.7 kg/m Total weight =68.5 kg	1.3
182	**SUB-SURFACE FLOAT**	Polyethylene shell filled with synthetic foam	Diameter = 0.28m(11.03in) Dia. Of centre hole = 0.025m Circumference = 0.88m	2 Nos	Net Buoyancy = 7 kg	
171	**SHACKLE 1”**	Galvanized iron		5 Nos	Weight = 2.8 Kg/ unit Total Weight = 14 kg	1.3
172	**SHACKLE ¾”**	Galvanized iron		8 Nos	Weight = 1.1 Kg/ unit Total weight = 8.8kg	1.3
142	**GI FLANGE**	Galvanized iron		1	22 kg	
156	**SINKER WEIGHT**	Reinforced Concrete Cement	**Dimension = 1m x 1mx 1 m (Length x WidthxHeight)**	1	2000 kg	
155	**ANCHOR**	IS 2062		1	150 kg	

C_d - Co-efficient of discharge

Table. 1 Material properties

NOTE (Approximate Weights)

1	Weight of Electronic items inside the cylinder including battery pack	120 kg
2	Weight of Current Meter and Environmental sensor	2 kg

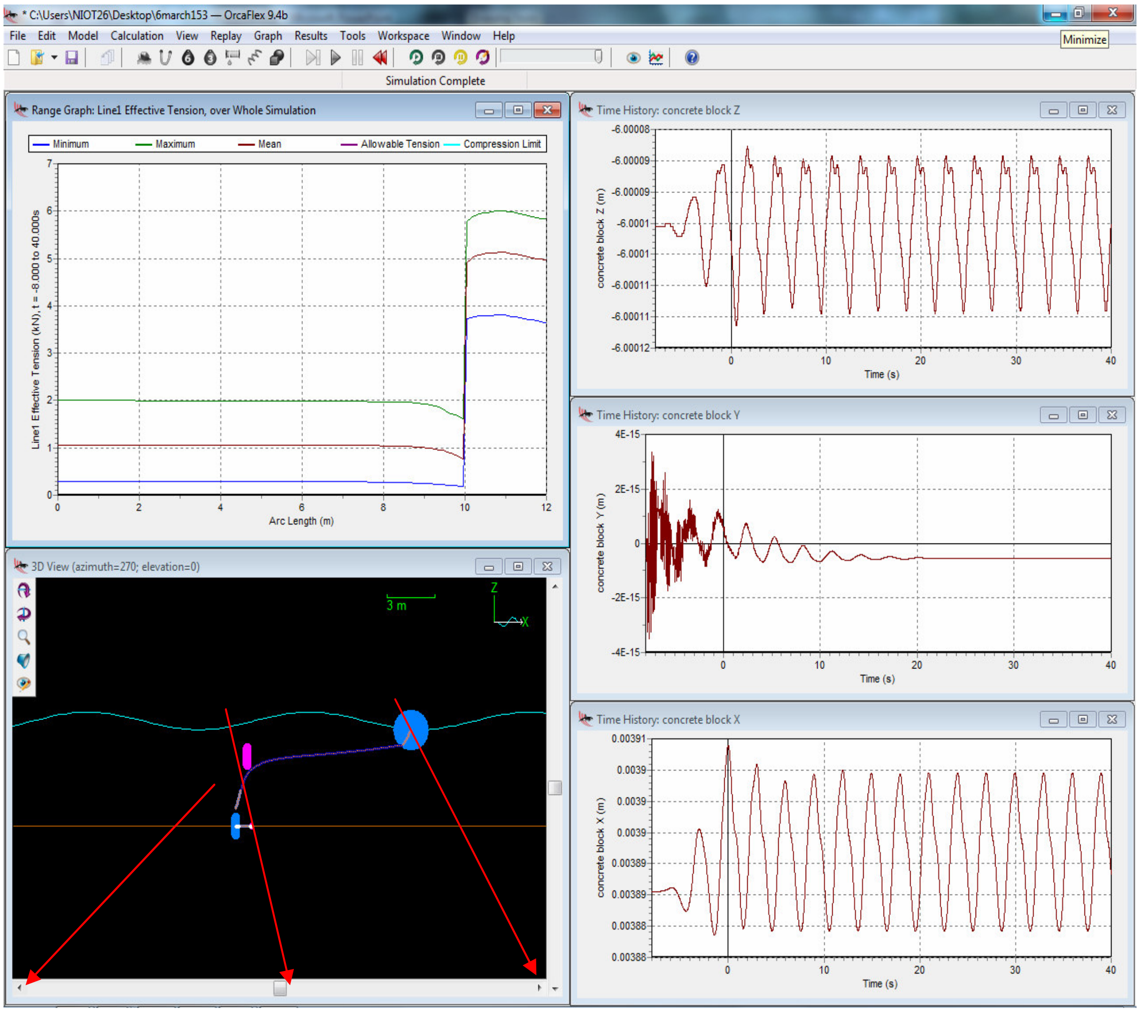
METEOROLOGICAL PARAMETER READINGS TAKEN FROM THE BUOY AT ANDAMAN

S.No	DESCRIPTION	MAXIMUM(m/s)	MINIMUM (m/s)	AVERAGE (m/s)
1	**WIND SPEED**	6.5625	2.759	0.23
2	**WIND GUST**	7.92	0.54	3.9
3	**CURRENT SPEED**	0.29	0.0078	0.1

Table.2 Meteorological Parameter Readings

7.5 ANALYSIS RESULTS

As a result of the analysis it is observed that the maximum load is acting on the wire rope is about 6 kN (0.61T, breaking load is 11.5 T) and only negligible amount of movement has taken place in sinker weight.



Sinker Weight Sub Surface Float Buoy

Fig.7.5 SAMPLE SHEET OF MOORING ANALYSIS

8 CRUISE PREPARATION

Cruise preparation operation comprises:

1. Material list preparation for the cruise based on type of buoy
2. Checking of materials and tools with checklist
3. Documents taken for cruise.

8.1 Documents to be taken for Cruise

1. Cruise track -2 Nos (One for Captain and One for Chief Scientist)
2. Mooring diagrams
3. Material list (Includes all mechanical items)
4. Tools list (including the tools which are used for Deployment and assembly)
5. Buoy details document
6. Telephone numbers
7. Cruise number to be noted
8. Old Cruise report (soft copy)- 1 No
9. Mail to be sent to Group Head – OOS, Shore Station In charge and Shore Station Team.

9 DEPLOYMENT

9.1 Buoy assembly for deployment at deck

At the deck of ship, keel weight and keel frame is attached to the bottom of the Central cylinder. The combination rope thimble is connected to the keel frame end. Antenna with sensors is fixed to the buoy.

9.2 On board Test report

After getting confirmation from the data quality all the material shipment to the vessel for deployment, the check list will be confirm that the entire material is loaded.

Fig. 9.1 ONBOARD TEST

During the sailing the entire buoy system will be on testing until the location of the deployment and data quality will be verified during this period and record will be maintained in the shore station.

TABLE: 9.1 ON BOARD TEST REPORT

	OCEAN OBSERVATION SYSYTEMS			**Date**	
	ON BOARD TEST REPORT			**Report No**	
Cruise Period	**July 2010**		**Location**	**Lat**	**Long**
Type of Buoy	**MET / WAVE / TSUNAMI**		**Buoy ID**		
Sl. No.	**ITEM DESCRIPTION**	**COMP. Sl.No / ID No. / Code No**	**Tested at NIOT (OK / NOT OK)**	**Onboard Test (OK / NOT OK)**	**Remarks**
I	**MECHANICAL COMPONENTS**				
1	FRP buoy assembly				
2	Central cylinder with hull				
3	Long band fixing				
4	Medium band fixing				
5	Lifting ring, lifting lug fixing				
6	Mooring lug,Anti-rotation fin fixing				
7	Fender fixing				
8	Battery box fixing				
9	Vent hose fixing				
10	Battery press rod fixing				
11	Lid and lid locking screws fixing				
12	Vent Valve assembly				
13	Nitrogen plugs, Air inlet and Antenna cable adaptor fixing				
14	Anode fixing at central cylinder, G.I.Pipe and keel weight				

Sl. No.	ITEM DESCRIPTION	COMP. Sl.No / ID No. / Code No	Tested at NIOT (OK / NOT OK)	Onboard Test (OK / NOT OK)	Remarks
15	Upper mast /Lower mast fixing				
16	Hood with Al.long bolt/Nut/Washer assembly				
17	CPU and compass fixing				
18	Keel weight/frame fixing				
19	Junction box fixing				
20	Antenna fixing				
21	Current meter fixing clamps/frames				
22	Conductivity and temperature sensor fixing				
23	MRU fixing				
24	Wind sensor, Humidity sensor and pressure sensor fixing				
25	Beacon lamp fixing				
26	Sinker weight assembly				
27	Sub-surface float assembly				
28	Radar reflector fixing				
29	Shackle tightening				
30	Cotter pin fixing				
31	Length of rope checking				
32	G.I.Thimble splicing				

Sl. No.	ITEM DESCRIPTION	COMP. Sl.No / ID No. / Code No	Tested at NIOT (OK / NOT OK)	Onboard Test (OK / NOT OK)	Remarks
33	Anchor, Sinker weight chain fixing				
34	Nitrogen gas filling in central cylinder				
35	Connecting ring connection checking				
36	Bearing swivel fixing in proper place				
37	Combination rope checking				
38	Nylon rope checking				
39	Polypropylene rope checking				
40	Acoustic release connection checking				
41	Surface modem fixture fixing				
42	BPR dead weight fixing with BPR and BPR float				
43	Cable gripper fixing in Central cylinder and keel frame				
44	PVC plate fixing between Central cylinder and keel frame				
45	Rubber sheet and hose pipe around the keel frame for tsunami buoy				

Sl. No.	ITEM DESCRIPTION	COMP. Sl.No / ID No. / Code No	Tested at NIOT (OK / NOT OK)	Onboard Test (OK / NOT OK)	Remarks
II	**ELECTRONICS / INSTRUMENTATION**				
46	CPU				
47	MRU				
48	Compass				
49	Wind Sensor				
50	Humidity / Air temperature sensor				
51	Air pressure Sensor				
52	Mini - C (Modem / Antenna)				
53	CT Sensor				
54	Beacon lamp				
55	Battery Pack				
56	Data transmission				
57	Data reception and decoding				
58	Cables and connectors				
59	BPR				
60	BPR Battery				
61	Surface Acoustic modem				
62	Surface modem cable				
63	Acoustic modem power pack				
III	**Overall Buoy Status**				

9.2.1 Avoiding the Bi-metallic contact and corrosion

Before deployment a thorough looking in buoy is taken to avoid the bi-metallic corrosion. If anything is found, it is rectified immediately before the deployment.

9.3 Mooring length calculation based on depth at deployment location

Based on the depth measured in the anchor drop location, the calculation of mooring length is done. Mooring comprises of three ropes. They are:

1. 18mm Combination rope (Wire rope)- Up to 550m
2. 16mm Nylon rope - 320m for wave buoy and Tsunami buoy
3. 18mm Polypropylene rope- Remaining depth for wave buoys (150m rope extra).

For Tsunami buoy 160m Polypropylene rope is deducted from the remaining rope. It is deducted because of getting good communication between Bottom Pressure Recorder and Surface Modem.

9.4 Watch Circle Radius Calculation

Using the mooring length of each rope, the Watch Circle Radius of the buoy is calculated. The Mechanical team of Ocean Observation System has a “C” program to find the watch circle radius of the buoy.

9.5 Preparation of Mooring ropes and hardwares

Based on the watch circle radius calculation, the required length of PP rope is prepared and nylon rope is laid down on the deck for easy operation. Then based on the mooring diagram, the required mooring hardwares are prepared.

9.6 Finding the depth of deployment location

Depth and bathymetry survey is taken from the Multi-Beam Echo Sounder (MBES).The details of the MBES are given below.

Make of Multi-Beam Echo Sounder	: SEABIRD – 7150
Frequency	: 12 KHz
Maximum Depth	: 12800 m

9.7 Seabed Observation

The observation of seabed is taken from wedge display of Multi-Beam Echo Sounder**.** The sea bottom observation is done using the Echo sounder before and after 1 nm radial of the deployment location. The anchor deployment position selected based on the topography. The results of the Echo sounder are taken for documentation. A soft copy is also taken as backup.

9.8 Final assembly check-up for the deployment

Before deployment, the assembly is checked again for all the mechanical components with the help of Checklist prepared by the Mechanical Team.

9.9 Arrangement of mooring hardwares

Shackle-Swivel Connection:

1. The recommended connection between the shackle and swivel is the bow to eye connection. But if the bow will not fit through the top eye of the swivel the bolt-pin to eye connection may be used.
2. When constructing the mooring, orient each swivel with the head of the eye to eye connecting bolt upward, otherwise the swivel may bind.

Chain-Shackle connection:

The bolt-pin through the link connection is recommended.

A swivel is placed between the chain or wire rope and the sinking nylon responds to the motion of the buoy and prevents twisting of the chain or wire and mooring rope.

A swivel is placed between the Polypropylene rope and the chain, prevents twist in the chain and the mooring rope.

TABLE 9.2 MECHANICAL WORK CHECK LIST FOR DATABUOY ASSEMBLY

S.No	DESCRIPTION		REMARKS
1	Hull assembly	FRP hull / Plastic Hull	
2	Fender		
3	Battery box fixing		
4	Vent hose fixing		
5	Battery press rod fixing		
6	Lid fixing and checking		
7	Vent pipe and Valve assembly		
8	Nitrogen plugs fixing		
9	Hull painting		
10	Anode fixing at cylinder		
11	Upper mast /Lower mast fixing		
12	Hood checking		
13	Al.long bolt/Nut/Washer		
14	Keel weight/frame fixing		
15	Keel weight painting/anode fixing		
16	Antenna fixing		
17	Current meter fixing clamps/frames		
19	Pallets for transporting/rubber pads		
20	Solar panel fixing		
21	Gemini craft readiness		
22	OBM		
23	Splicing of various lengths of ropes		
24	Nylon rope		
25	Polypropylene rope		
26	Combination rope		
27	Chain cutting and fixing		
28	Sinker weight assembly		
29	Subsurface float assembly		
30	Nitrogen gas filling		
31	Radar reflector fixing		

1. The Central Cylinder should always be filled with N_2 gas to the specified maximum pressure (7.35psi) before deploying the buoy. The gas is flushed to prevent air moisture from condensing in the respective compartments. Safety valve is used in gas supply tube. This protects the electronics and enables emission of generated H_2 and O_2 gas.

2. The lid lock keys should be tightened for the required tightening torque.

3. Fixing of Radar reflector.

4. Fixing of sensor arm, hood and quick release on buoy is done at last. The guiding ropes are used to guide the buoy for smooth deployment.

9.10 Deployment of buoy

The buoy is heaved from the deck slowly. When it reaches the sea water surface, the quick release is activated to release the buoy to the sea water surface and the buoy reached the water surface. When the buoy reached the water surface, the propeller is turned 'ON' to keep the buoy away from the ship.

Fig 9.2 DEPLOYMENT OF BUOY

9.11 Mooring rope payout

Wire rope and PP rope is paid out from the coil fitted in spool stand. Nylon rope is laid on deck for the deployment and at the same time all the required mooring component like shackles were prepared. Then mooring ropes is paid out.

9.11.1 Keeping eye on mooring rope angle with the deck (upto Nylon rope)

During the pay out of mooring ropes, care should be taken about the mooring rope angle with the deck. If the rope is gone inside the aft, the rope may get cut with the propeller. This care should be taken up to Nylon rope. There is no need to care on PP rope because it will float.

9.11.2 Deployment of Sinker weight, BPR and Anchor

At last anchor and sinker weight are deployed. For Tsunami buoy, the distance between the Buoy and BPR is about 300 m. The BPR is assembled with the BPR float, BPR deadweight and Acoustic release. Then the BPR is heaved to the water by using the deep sea winch. The error between the winch reading and BPR reading is found out.BPR is heaved up to the 100m from the sea bottom. Finally BPR is released from the acoustic release for free falling. Reach of BPR to the seabed is confirmed and then waiting for the confirmation of data from the shore station. For each deployment operations, the ship will move to the next location after getting confirmation from the shore station. All BPR floats are tested in Hyperbaric chamber in Hyperbaric test facility by using ASME BPVC VIII-3 standard.

9.12 Preparation of Lesson learnt (LL) report

During deployment, some problems may be faced and it is rectified by some mean. But it should not be repeated. Mechanical Team decided to make Lessons Learnt report to record the problem faced and steps will be taken to avoid it in the near future.

After the deployment the position of the anchor drop will be noted and two sets of data quality will be verified from the shore station before proceeding to the next deployment action.

TABLE 9.3 DEPLOYMENT SHEET - DATA BUOY

DATA BUOY					
Location ID					
Position	*Latitude*		*Longitude*		
Deployment	*Date*		*Time (IST)*		
Station Depth (m)					
Flash Light Characteristics					
CPU Type					
Satellite used (Please tick the appropriate column)	INMARSAT	↗	INSAT		
Transmitting file No					
Storage file No					
Vessel Name and Cruise Reference ID					
Cruising period					
INSTRUMENT FIT					
Sensor	***Serial No/make***	***Sensor***	***Serial No./make***	***Sensor***	***Serial No./make***
Air Pressure		*Compass*		*Current Meter*	
Humidity/air temperature		*SST*			
		GPS			
Wind		*Battery*			
MRU		*Modem*			
Solar Panel		*Antenna*			
Field Team Remarks					
Shore Station Remarks					

Signature

Signature

Signature
NIOT

Signature
Ship –Master

10 RETRIEVAL OPERATION

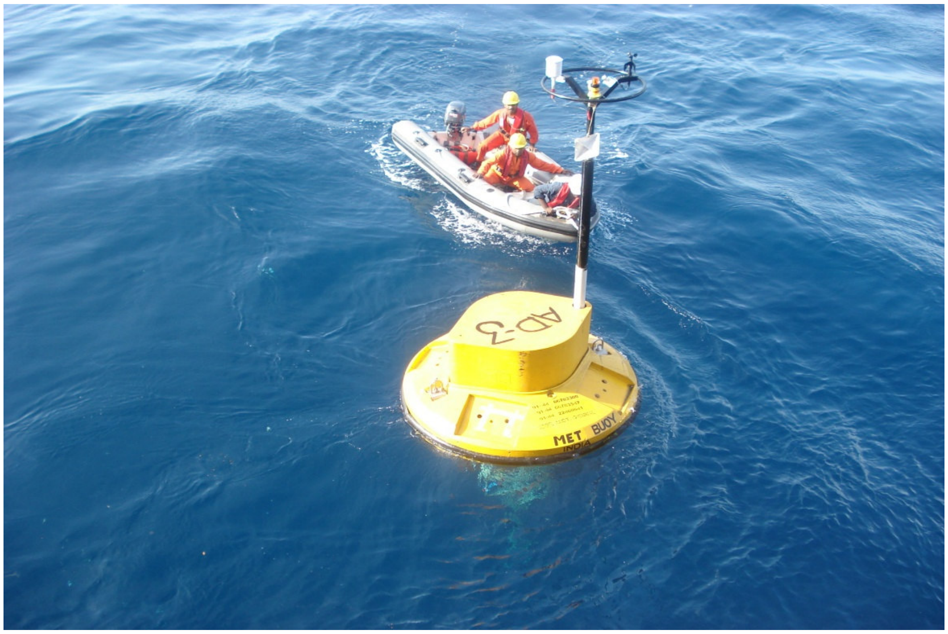


Fig. 10.1 Retrieval Operation

Retrieval of the Buoy is done by using the Work boat. The hook is fitted in the lifting ring and it is lifted up after the seamen gone away from the buoy. The buoy is taken using ship crane and then the rope is cut using cutting tools. In all activities, preference is given for safety. All persons involving in the deployment and retrieval operations should wear safety helmets, safety boots, coverall, life jacket and hand gloves etc.

After the retrieval of Buoy, a photography is taken for the whole buoy system for further studies and for vandalized components.

The retrieved components are listed and physical damages are noted down in the following table.

TABLE 10.1 RETRIEVAL REPORT- DATA BUOY

Station		**Buoy ID**	
Buoy Type		**Last transmission from buoy**	
Retrieved @ Latitude		**Retrieved @ Longitude**	
Date of retrieval		**Buoy deployed Date**	

Electronics

Sl.No	Item Description	Serial No. of Item	Type	Status
1.	CPU			
2.	Power box			
3.	Modem			
4.	Antenna			
5.	MRU			
6.	Pressure Sensor			
7.	Air Temperature/Humidity			
8.	SST			
9.	Wind sensor			
10.	Current Meter			
11.	Radar reflector			
12.	Flash light			
13.	Solar panel			
14.	Battery			
15.	Internal cables			
16.	Mast cable			
17.	Solar panel cable			
18.	CM cable			

Mechanical

19.	Buoy Hull (WS)			
20.	Cylinder			
21.	Upper mast			
22.	Sensor carrier arm			
23.	Keel weight and frame			
24.	Hood			

Cruise No	
Vessel used	
Chief Scientist	
Team members	

Retrieval team comments/Failure reasons:

Signature

Signature

Signature
NIOT

Signature
Ship –Master

10.1 Buoy Search Operation – Report

Vessel Name :

Date of search :

Cruise reference No :

10.1.1 Search Operation Details

Reached buoy deployed location at 14:00 hrs. Buoy not found in location. The weather was good with a surface visibility of 6 nm. A Search was done in Buoy Location till 18: 30 hrs with 5 nm as radius. Buoy was not found during the search operation.

(Chief Scientist) **(Ship- Master)**

10.2 Inspection of retrieved buoy

Once the buoy is retrieved, thorough study on the buoy will be done.

10.3 Dismantling of Buoy

After the retrieval of buoy, keel weight and keel frame is to be removed first then followed by mast assembly and hood.

All the electronic components is to be removed and further are taken in the testing room at NIOT.

Before dismantling the buoy assembly, full photograph of the buoy is taken to identify the presence of any evidence of vandalism.

10.3.1 Collecting the vandalized (damaged) components

The damaged parts are separated for Failure Analysis. Photographs are taken immediately for the evidence of failure analysis.

10.3.2 Sending the collected components for Failure Analysis (FA)

The damaged parts are sent to the reputed Failure analysis institution (like CSIR) or organization after returned to NIOT. After analysis a FA report is obtained from the institute.

10.4 Preparing observation report with photos

The condition of the buoy is observed from the photographs. Using the observations, an observation report is prepared and sent immediately to Technical group.

10.4.1 Documenting the Observation and Failure analysis reports

The observation and Failure analysis reports are documented for future reference.

10.4.2 Lesson Learnt (LL) report preparation from the FA report

From the Lessons Learnt report will be prepared for future. It will used to avoid repeated mistakes and modification of design will be done based on the reports.

10.4.3 Retrieved buoy come back to NIOT

The retrieved buoys will be sent to NIOT using trucks.

10.4.4 Making modification in design of buoy using LL report:

Based on the lessons from the observation as well as LL reports, Mechanical team will change the design modification to get more efficient operation.

11 CRUISE REPORT PREPARATION

The cruise report comprises:

1. Number of buoy deployment and retrieval operation
2. Diary of events
3. Location of Deployment and retrieval operation, Depth, time with date
4. Lesson learnt from the Deployment and retrieval operation

12 DATA RECEPTION, INTERPRETATION AND QUALITY CONTROL

Data buoys are moored platforms at sea to measure Meteorological and Oceanographic parameters. OOS an operational programme of NIOT has deployed and maintains 12 such data buoys in Indian waters. These buoys measure met ocean parameters at fixed intervals and transmits the same using INMARSAT-C to shore station at synoptic hours. Few are programmed to transmit at one hour interval for specific needs. INMARSAT-C is a satellite based communication system providing worldwide, 2-way, store and forward text communications via TELEX or other data services. The INMARSAT-C space segment consists of four operational communication satellites. Each satellite has a coverage area (also known as the footprint), that corresponds to one of the four ocean regions: Atlantic Ocean East, Atlantic Ocean West, Pacific Ocean and the Indian Ocean.

These four-ocean regions span the majority of the earth's surface, providing worldwide coverage. The success rate of data transmission depends on the Satellite's signal strength and establishment of link lock. The buoy hardware at the time of data transmission establishes a link called as *lock,* with the satellite and starts transmitting the data. The data is then sent to the LES (Land Earth Station), which is a gateway between the INMARSAT-C Satellite system and the national and international fixed communication networks. The LES after necessary accounting, uplinks and delivers the message back to OOS shore station. Indian Data Buoys uses IOR (Indian Ocean Region) satellite for data transmission and SINGTEL-Singapore as the LES.

As challenges arise in the form of natural disasters, OOS has been identified to deploy buoys capable of identifying Tsunami's as part of Tsunami Early Warning System in India. Data from Tsunami buoys are sent to OOS and INCOIS.

Real-time data ingest happens at shore station via Inmarsat satellite system for data and OMNI buoys and thru mail communication for Tsunami Buoys. All decoded data are stored in a master database and on individual log files.

12.1 Procedure

Manual Data Quality Control should be carried out in two steps. Initial manual quality check to be done by SSAMC (Watch Standers) team and their findings to be notified to SSMT (Data Analyst) team before or by 12:30 hrs IST every day. The findings should be vetted by SSMT (Data Analyst) team before or by 16:30 hrs IST every day. The manual data quality control exercise should be completed by 17:30 hrs IST every day with necessary flags and archival done. However, SSAMC team, since they support 24x7 they will continue to do the initial data quality check during weekends and their findings will be vetted by SSMT(Data Analyst) the following Monday before or by 12:30 hrs IST.

12.2 Manual QC

1.1 All buoy / platform position to be checked. If any drift sensed on one or more buoys / platforms, drift path to be plotted and should be notified to SSMT team & Group head by means of E-mail along with the plotted graph, information on total drift and drift from the previous transmission. From the first day of the drift, graphs to be plotted and reviewed daily.

1.2 If the buoy / platform have drifted **6nm** out of its deployed location then release of data for that location should be flagged with comment (Buoy Off location) and a note to INCOIS and CG on buoy drift to be sent.

1.3 Master file has to be updated with necessary flags and the data to be excluded from the quality controlled database.

1.4 Request for retrieval of drifting buoy to be initiated to the Field Support Team to plan for retrieval operation and cruise.

1.5 If the buoy happens to be an OMNI Buoy visually inspect the under water pressure sensor data for abrupt decreases corresponding to buoy movement.

12.3 Transmission Fails

In situations where transmissions fails or a dead buoy begins transmitting again, the following steps should be taken.

1.1 When buoy fails enter the failure should be entered in daily LOG. e

1.2 Change the Transmission Flag in the DB to Transmission Outage.

1.3 The date is the date of the failure, and makes a comment explaining the failure. Copy this information down to all the sensors.

1.4 If vandalism suspected mention it in the log book

12.4 Manual Quality Control

Key to perform QC on Met Ocean parameters.

Measurement	Preliminary gross automated error checking	Sensor measurements that will generate automated error alerts	Additional daily checks
Wind direction		Hourly and daily compass or vane zero; daily compass or vane constant; daily direction varies more than 40° per 3 hour interval.	Visual inspection of last ten days against available model data
Wind velocity		Daily speed changes more than 7 m/s from previous 6 observations	Visual inspection of last ten days against available model data
Relative humidity (RH)	RH set to missing if > 99.9%	Daily RH outside 65-99%; hourly RH outside 50-100% within past two weeks; changes >20% from previous observation 30% in 3hr	Compare hourly and daily RH against hourly and daily air temperature to ensure an invalid air temperature measurement did not cause the anomaly
Air temperature (AT)	AT set to missing if > 40° or < 15°	Daily AT changes > 5℃ from previous day; daily AT - SST > 1.4℃;daily AT outside 6 - 32℃; hourly AT outside 15 - 33℃ within past two weeks 4° per 3hr	Visually inspect hourly air temperature for > 2° changes from previous hour
Sea surface temperature (SST)	SST set to missing if > 6° or < 20°	Daily SST changes > 5℃ from previous day; daily SST - T at 20m or 25m > 0.2°; hourly SST outside 20 - 30℃ within past two weeks	1.5℃ per hr 3℃ per hr Visual inspection of the last two weeks time series plot of SST vs. wind vectors
Subsurface temperature (T)	Daily T set to missing if > 40.0° or < -2.0°.	Daily T changes > 5℃ from previous day; vertical gradient between adjacent sensors checked. Daily T conforms to the reference values for the current average (± 3 standard deviations of 90-day mean)	2° C per 3hr 1° C per hr above 100m depth , 0.5° C per hr 100m and below Visual inspection of T profiles
Rainfall	Rate > 500 mm/hr	Sensor output full scale; daily rainfall rate outside -0.1-10 mm/hr; daily rain rate > 1.0 mm/hr for < 5% time raining; daily rain rate < 0.1 mm/hr for > 25% time raining	250mm/hr ,Visually inspect last ten days percent time raining for invalid measurement trends

Measurement	Preliminary gross automated error checking	Sensor measurements that will generate automated error alerts	Additional daily checks
Barometric pressure (BP)	900-1080 mb	BP changes > 5 millibars from previous 3hr ; daily BP outside 990-1018 millibars; hourly barometric pressure outside 990-1018 millibars in past two weeks	5mb/3hr, Visual inspection and comparison with neighboring sites.
Salinity	Computed only for conductivity in range 30.0-70.0 milli Siemans per centimeter (mS/cm) and T > 0.0° 20-45 psu	Salinity changes by > 0.5 psu; salinity outside 31.0 - 36.5 psu; density inversions computed from daily averaged salinities and temperatures > 0.05 kg/m3; salinity does not conform to the reference values for the current average (> ± 3 standard deviations of 90-day mean)	25-35 psu for BoB and 30-40 psu for AS, Visually inspect last ten days of salinity for erratic trends

12. 5 Escalation and Notification

SSAMC watch standers (people who are in shift) shall notify the appropriate POC as per E&N in the event of Tsunami - primarily in IOR, Earth Quake - primarily in IOR, whenever a station fails, station drifts, erratic sensor reading, drift in sensor reading, communication issues, transmission failures and any unusual events as per following guideline.

Sl. No.	Event	Time & Criteria	Notification by
1	Tsunami in IOR	As soon as alert noted / Notification received.	Phone / SMS / E-mail / Fax
2	Earth Quake in IOR	As soon as alert noted / Notification received.	Phone / SMS / E-mail
3	Station(s) Failure	If not resumed after two consecutive transmissions	E-mail / SMS
4	Drift in Sensor(s) Reading	After confirmation from Data Analyst	E-mail
5	Erratic Sensor Reading	After two consecutive transmissions and confirmation from Data Analyst	E-mail
6	Station Drift	As soon as drift confirmed after two consecutive transmissions	E-mail / Fax
7	Communication Issues	As soon as noted and after resumption.	E-mail / SMS
8	Station(s) Drift	As soon as drift confirmed after two consecutive transmissions	E-mail / Fax
9	Transmission Failure	As soon as noted and after resumption.	Email / SMS
10	Unusual Event(s)	As soon as an unusual event noticed and depending upon the criticality.	Phone / E-Mail / SMS

12.5.1 E-MAIL Sample

FROM: "ssamc" <ssamc@niot.res.in>
TO: SENTOSA SHIFT<g-sses@singtel.com>or<BT.ROKADE@tatacommunications.com>
CC: venkat@niot.res.in, sundar@niot.res.in, arul@niot.res.in, rsundar@niot.res.in, …….

Subject: No Data transmission from Modem No: <XXXXXXXXX>

This is to inform that we have not received data from Modem No. <XXXXXXXXX **>** for the last **hh** hours or XX GMT, XX GMT (specific GMT). Please check your communication link, servers, software, etc. and report us the results back to ssamc@niot.res.in with reply all option.

Thanks,

With Kind Regards,

<Watch Stander Name>

Date:
Time:

12.5.2 Follow-Up E-MAIL sample

If **no reply** received from LES **within 30 minutes** in case of **Tsunami** Buoy(s) and **3 hours** in case of **Met** or **Omni** Buoy then the follow-up email to be sent to respective LES along with their **escalation contacts** in CC. **Note**: Old mail should be forwarded along with the follow-up mail.

FROM: "ssamc" <ssamc@niot.res.in>
TO: SENTOSA SHIFT<g-sses@singtel.com>or<BT.ROKADE@tatacommunications.com>
CC: escalated-contact@singtel.com, escalated-contact@tatacommunication.com, venkat@niot.res.in, sundar@niot.res.in, arul@niot.res.in, ………….

Subject: Reminder-1 -No Data transmission from Modem No: <XXXXXXXXX>

Please refer to our earlier communication (forwarded herewith) on the non receipt of data from Modem(s) No. <XXXXXXXXX **>** for the last **hh** hours or XX GMT, XX GMT (specific GMT). Please act immediately by verifying your communication link, servers, software, etc. and report us the results back to ssamc@niot.res.in with reply all option.

Thanks,

With Kind Regards, Date:
<Watch Stander Name> Time:

<Forwarded Mail>--------------

FROM: "ssamc" <ssamc@niot.res.in>
TO: SENTOSA SHIFT<g-ses@singtel.com>or<BT.ROKADE@tatacommunications.com>
CC: venkat@niot.res.in, sundar@niot.res.in, arul@niot.res.in, rsundar@niot.res.in, …….
Subject: No Data transmission from Modem No: <XXXXXXXXX>

This is to inform that we have not received data from Modem No. <XXXXXXXXX **>** for the last **hh** hours or XX GMT, XX GMT (specific GMT). Please check your communication link, servers, software, etc. and report us the results back to ssamc@niot.res.in with reply all option.

12.5.3 Escalated E-MAIL sample

Even after sending a follow-up reminder, if **no reply** received from LES **within 30 minutes** in case of **Tsunami** Buoy(s) and **1 hour** in case of **Met** or **Omni** Buoy then an **escalation phone call** and an email to be sent to respective LES's escalated contacts along with LES next level **escalation contacts** in CC.

FROM: "ssamc" <ssamc@niot.res.in>
TO: escalated-contact@singtel.com, escalated-contact@tatacommunication.com
CC: SENTOSA SHIFT<g-sses@singtel.com>or<BT.ROKADE@tatacommunications.com>, venkat@niot.res.in, sundar@niot.res.in, arul@niot.res.in, Next level escalated-contact@singtel.com, Next level escalated-contact@tatacommunication.com

Subject: **No response** to our request from Singtel or Tata Communications –reg.

Please refer to our earlier communications on the non receipt of data from modem(s). We have not received any response from your end till now. Please be aware that the data communicated through the modem(s) have high visibility, sensitivity and of national importance. Any delay in obtaining the data leads to severe impact and hence request you to direct your team to act on this quickly.

Thanks,

With Kind Regards,
<Watch Stander Name>

Date:
Time:

12.5.4 FAX sample

The content of the mail shall be used as per standard FAX template

OCEAN OBSERVATION SYSTEMS

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

Ministry of Earth Sciences, Government of India
Tambaram – Velachery Main Road , Pallikaranai
Chennai – 600 100, INDIA

Pages including cover sheet [ ] Urgent [ ] Please Reply [ ] -44-22460661

F/NIOT/OOS/<recipient-reference>-CORRES
Month, dd,yyyy

------------- FAX MESSAGE -------------

Request re-fax by calling : 91-44-22462944 / 66783536 / 666783537 / 22460678

12.5.5 Frequency & Logging of Events

Daily an entry on a Watch Log, day wise and event wise to be recorded. In addition to verifying the quality of meteorological and oceanographic data received from stations, this procedure mandates that power checks also to be performed on all buoys / platforms daily and transmission wise.

12.6 Meta Data Sheet

ODAS abbrev	Description (number/alphanumeric)	Core/ option	In ODAS format	Notes
Station details				
ID	ODAS ID (n)	O	Yes	-
WMOn	WMO number (n)	C	Yes	-
stn	Station name (a)	O	Yes	**RP02**
ts	Type of station (a)	C	Yes	**Moored buoy**
stat	Status (a)	C	No	**Operational**
ind	Start date (a)	O	Yes	**20/03/2011**
oed	End date (a)	O	Yes	-
pdepl	Period of deployment (a)	O	No	**All year**
cnty	Country of ownership (a)	C	Yes	**INDIA**
ragy	Operating agency/institute (a)	C	Yes	**NIOT**
DA	Degree of automation (n)	O	Yes	**=1 for moored buoy**
Lat	Latitude (of deployment) (n)	C	Yes	**10.8819**
Lon	Longitude (of deployment) (n)	C	Yes	**72.2187**
WC	Watch circle (n (n)	O	Yes	**30m**
Hult	Hull type (a)	C	Yes	**Discus**
HulMS	Hull manufacturer/model (a)	O	No	**Furgo OCEANOR**
HulMat	Hull material (a)	O	yes	**Plastic**
lngth	Length (m) (n)	O	Yes	-
Brth	Breadth/width (m) (n)	O	Yes	-
Diam	Diameter (m) (n)	O	Yes	**2.85 m**
Mtyp	Mooring type (a)	O	Yes	**S-Shape Mooring**
openv	Operating environment (a) O	No	**Open ocean**	
wdpth	Water depth (m) (n)	O	Yes	**20m**
elev	Elevation above sea level (m) (n)	O	No	**-**
Cmsy	Primary data collection system (a)	O	Yes	**Include Geni with Inmarsat**
Stt	Primary (satellite) transmission time (a)	O	Yes	**One Hour**
Stno	Primary sat transmission ID (n) O	No	**2018**	
Cmsy2	Secondary data collection system (a)	O	No	As appropriate
Stt2	Secondary (satellite) transmission	O	No	
	time (a)			
Stno2	Secondary sat transmission ID (n)	O	No	
Foo	Observation frequency (hrs) (n) C	Yes	**One Hour**	

ODAS abbrev	Description (number/alphanumeric)	Core/ option	In ODAS format	Notes
AIn	Any other ID (a)	O	Yes	-
davail	Data availability (a) C	No	**Internal storage and GTS data available in internet**	
dfmt	Data format (a) C	Yes	**Netcdf**	
belec	Type & version of internal buoy O	No	**FOAS Geni3**	
	processor (a)			
WebA	Web address (a) O	Yes	**www.niot.res.in**	

ODAS abbrev	Description (number/alphanumeric)	Core/ option	In ODAS format	Notes
Anemometry (if installed)				
nanemo	Number of systems (n)	O	No	**2**
anml	Primary anemometer type (a)	C	Yes	**Cup anemometer**
aMS	Primary anemometer model (a)	C	Yes	**Lambrecht 1453 S2 F1000**
sdim	No of axes (n)	O	No	**If a sonic anemometer (2 or 3)**
cmpT	Primary wind direction sensor model (a)	C	Yes	**Lambrecht 1453 S2 F1000**
hwl	Measurement height (m asl) (n)	C	Yes	**+3m**
sfWS	Wind speed sampling freq (Hz) (n)	O	Yes	**1 Hz**
sfWD	Wind direction sampling freq (Hz) (n)	O	Yes	**1 Hz**
apWS	Wind speed averaging period (mins) (n)	C	Yes	**10 mins**
apWD	Wind direction averaging period (min)(n)	C	Yes	**10 mins**
ctilt	Corrected for buoy tilt (a)	O	No	**no**
amWS	Averaging method for wind speed (a)	O	Yes	**Scalar (s)**
gust	Gust length (s) (n)	O	No	**3s**
anml2	Secondary anemometer type (a)	C	No	**Cup anemometer**
aMS2	Secondary anemometer model (a)	O	No	**Lambrecht 1453 S2 F1000**
sdim2	No of axes (if a sonic) (n)	O	No	**If a sonic anemometer (2 or 3)**
cmpT2	Secondary wind direction sensor model(a)	O	No	**Lambrecht 1453 S2 F1000**
hwl2	Measurement height (m asl) (n)	O	No	**+3m**
sfWS2	Wind speed sampling freq (Hz) (n)	O	No	**1 Hz**
sfWD2	Wind direction sampling freq (Hz) (n)	O	No	**1 Hz**
apWS2	Wind speed averaging period (mins) (n)	O	No	**10 mins**
apWD2	Wind direction averaging period (min)(n)	O	No	**10 mins**
ctilt2	Corrected for buoy tilt (a)	O	No	**no**
amWS2	Averaging method for wind speed (a)	O	No	**Scalar (s)**

gust2	Gust length (s) (n)	O	No	**3s**

ODAS abbrev	Description (number/alphanumeric)	Core/ option	In ODAS format	Notes
Air temperature (if installed)				
nats	Number of systems	O	No	**2**
ats	Primary instrument type	C	Yes	**Pt-100 RTD**
atsMS	Primary sensor model	C	Yes	**Rotornic MP101A**
atswl	Measurement height	C	Yes	**+3m**
apaT	Averaging period (mins)	C	Yes	**1 mins**
ats2	Secondary instrument type	O	No	**Pt-100 RTD**
atsMS2	Secondary sensor model	O	No	**Rotornic MP101A**
atswl2	Measurement height	O	No	**+3m**
apaT2	Averaging period (mins)	O	No	**1 mins**
Sea surface temperature (if installed)				
nwts	Number of systems	O	No	**2**
wts	Primary instrument type	C	Yes	**sontek**
wtsMS	Primary sensor model	C	Yes	**Argonet-MD**
dws	Measurement depth	C	Yes	**2m**
apWT	Averaging period (mins)	C	Yes	**2mins**
wts2	Secondary instrument type	O	No	**MicroCAT-CT**
wtsMS2	Secondary sensor model	O	No	**YSI Sonde 6600**
dws2	Measurement depth	O	No	**1m**
apWT2	Averaging period (mins)	O	No	**10 sec**
Sea surface salinity (if installed)				
nSs	Number of systems	O	No	**1**
Sstp	Primary instrument type	C	Yes	**MicroCAT-CT**
Ssm	Primary sensor model	C	Yes	**YSI Sonde 6600**
dss	Measurement depth	C	Yes	**1m**
apSs	Averaging period (mins)	C	Yes	**10 sec**
Sstp2	Secondary instrument type	O	No	
Ssm2	Secondary sensor model	O	No	
dss2	Measurement depth	O	No	
apSs2	Averaging period (mins)	O	No	

ANNEXURE – A

MECHANICAL COMPONENTS FOR BUOY: BILL OF MATERIALS

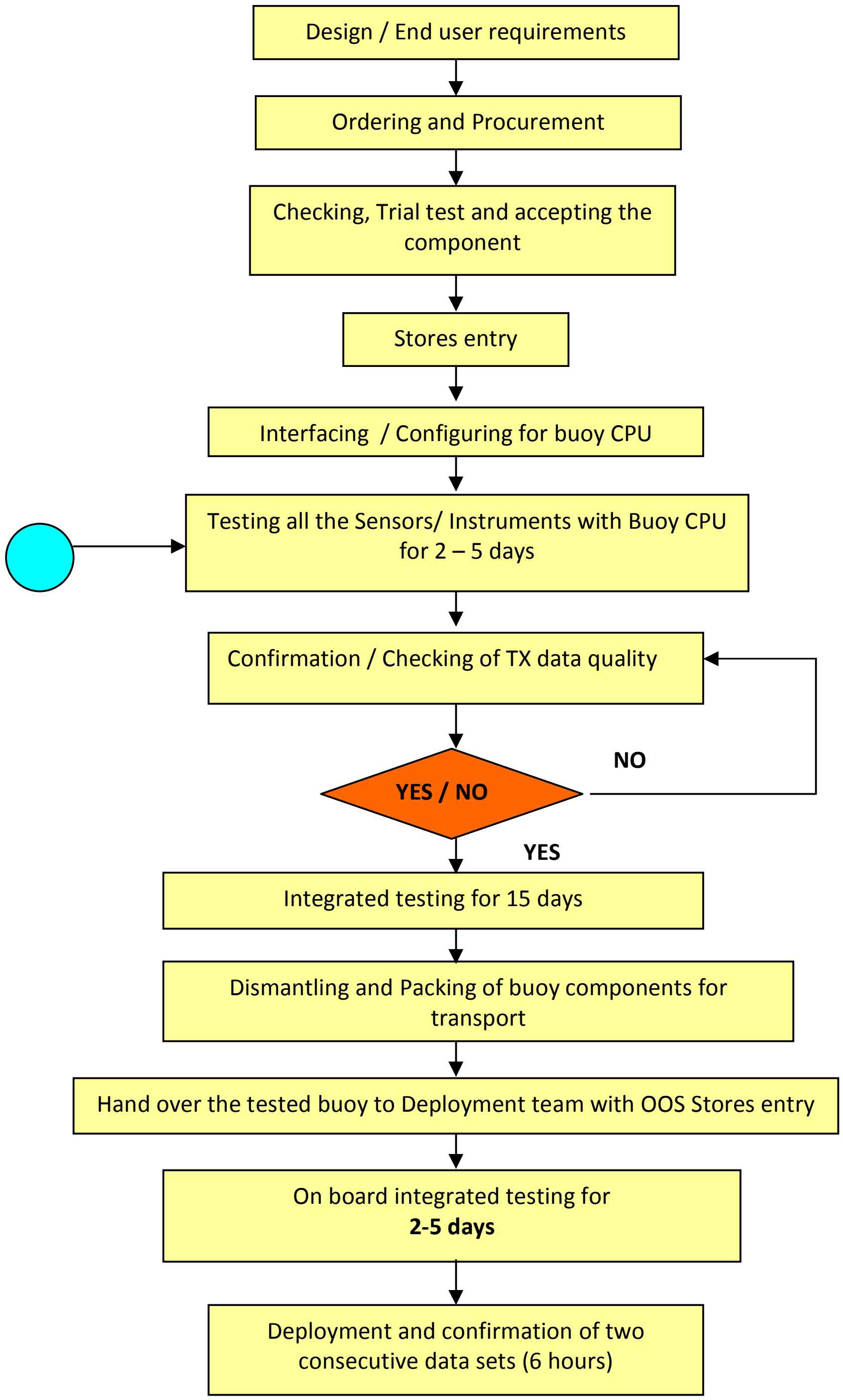
Part.No	NAME OF THE COMPONENTS	Quantity per buoy
1.0	**FRP COMPONENTS**	
001	Hull	2 half (1 set)
061	FRP Battery Box	1 No.
002	FRP protective hood	1 No.
2.0	**ALUMINIUM COMPONENTS**	
	Central Cylinder	
005	Aluminium Central Cylinder	1 No
006	Cylinder lid	1 No
007	Instrument plate	1 No
	Mast Assembly	
012	Lower mast	1 No
011	Upper mast	1 No
013	Sensor arm	1 No
004	Hood rod, nut & washer	
	Aluminium Accessories	
042	Antenna Flange(2 parts)	1 No each
038	Air inlet on Sensor Arm	1 No
047	Compass Clamp	1 No
059-060	Cable Gripper(2 sizes)	1 No each
087	Fender plate washer	1 No
043	Radar reflector	1 set
	STAINLESS STEEL COMPONENTS	
	Stainless Steel Accessories	
017	Lifting ring	1 No
018	Lifting lug	2 Nos
019	Fin lug	1 No
020	Mooring lug	1 No
021	Tension steel band- long,	2 half (1 set)
022	Tension steel band-medium	4 half (2 sets)
004	Long bolt	2 Nos
023	Lid hinge plate with hinge	1 No on each
024	Battery press rod	2 Nos
048	Antenna cable adaptor	1 No
068	Mast cable adaptor	1 No
038	Air inlet on lid	1 No
099	Lid lock keys	16 Nos
041	Vent pipe	2 Nos
053	Current meter frame	1 No
044	Nitrogen plug	2 Nos
	Fasteners	
071	*Sensor arm:* M8x40 **Allen** head bolt with one self lock nut and two washers	4 Nos.
074	*Mast:* M12x50 **Allen** head bolt with one self lock nut and two washers	4 Nos.
077	*Clamping rings:* M16 x 160 Hexagonal head bolt with one self lock nut and two washers	4 Nos.
	Small clamping rings: M10 x 80 Hexagonal head bolt with one self lock nut and two washers	4 Nos.
081	*Lifting rings:* M16 x 50 Hexagonal head bolt with one self lock nut and two washers	8 Nos.
083	*Keel weight:* M16 x 76 Hexagonal head bolt with one self lock nut and two washers	16 Nos.
091	*General Purpose:* M6 x 20 Hexagonal socket head cap bolt	20 Nos.

Part.No	NAME OF THE COMPONENTS	Quantity per buoy
	with one self lock nut and two washers	
085	*Anode:* M6 x 8 Allen head bolt with one self lock nut and two washers	16 Nos.
086	*Fender:* M10 self lock nut and two washers	6 set
090	*Sensors:* M5 x 20 Allen bolt with one self lock nut and two washers	4 Nos.
	Anode: M6 flower washer	16 Nos.
098	*Lid bolt:* M10 x 35 Hexagonal socket head cap special bolt with a center pin	16 Nos.
101	*Lifting lug:* M20 check nut and lock nut	2 Nos on each
091	M6*20 for humidity sensor (Allen or hexagonal screw, SL nut and washer)	2 Nos.
090	M5*20 for Beacon lamp(Allen or hexagonal screw ,SL nut and washer)	3 Nos.
093	M4*12 for antenna and flange fixing(Allen or hexagonal screw ,SL nut and washer)	3 Nos.
092	M6*25 for antenna flange with sensor arm fixing (Allen or hexagonal screw ,SL nut and washer)	3 Nos.
090	M5*20 for wind sensor fixing (Allen screw, SL nut and washer)	5 Nos.
091	M6*20 for air inlet fixing in sensor arm (Allen screw, SL nut and washer)	4 Nos.
095	M6*10 for pressure sensor (Allen screw only with washer)	4 Nos.
	M4*15for MRU&MRU holder fixing (Allen screw and washer)	4 Nos.
	M6*50 for CT sensor frame (Allen screw, SL nut and washer)	4 Nos.
092	M6*25 for MRU holder and Instrument plate fixing (Allen screw only with washer)	4 Nos.
	M8*70,M6*50 for surface modem clamp(Allen screw ,SL nut and washer) M6*40 for surface modem clamp(Allen screw ,SL nut and washer)	4 Nos each 6 Nos
	RUBBER COMPONENTS	
037	Fender	2 half (1 set)
	'O' ring	
038	Air Inlet	1 No
036	Rubber Bush	6 Nos.
039	Mast cable adaptor	2 Nos.
	Nitrogen plug	2 Nos.
	Vent pipe	2 Nos.
	Antenna cable adaptor	1 No
	Central Cylinder	
	MILD STEEL COMPONENTS	
014	Keel Weight	1 No
015	Keel Frame	1 No
052	Conductivity & Temperature Sensor Frame	1 No
142	GI Pipe	1 No
--	Surface modem clamp (two parts)	1 No on each
	OTHER COMPONENTS	
045	Vent valve with spacer	2 Nos on each
051	Water trap	1 No
058	Air inlet tube (2 sizes)	3m on each
063	Zinc anode	16 Nos
	Other accessories	
016	PVC Flange	1 No

Part.No	NAME OF THE COMPONENTS	Quantity per buoy
036	Bush for band	12 Nos
036	Bush for Central Cylinder & Keel Frame	8 Nos
040	Anti rotation fin	1 No
048	Gland for Antenna Cable Adaptor	1 No
050	MRU Holder	1 No
056	Battery box hose(2.5 m length)	2 Nos
--	Elbow type pneumatic connector	3 Nos
--	Double flange(separable) bush for lifting ring hole	16 Nos

ANNEXURE - B

WORK FLOW CHART FOR NEW DATA BUOY TESTING



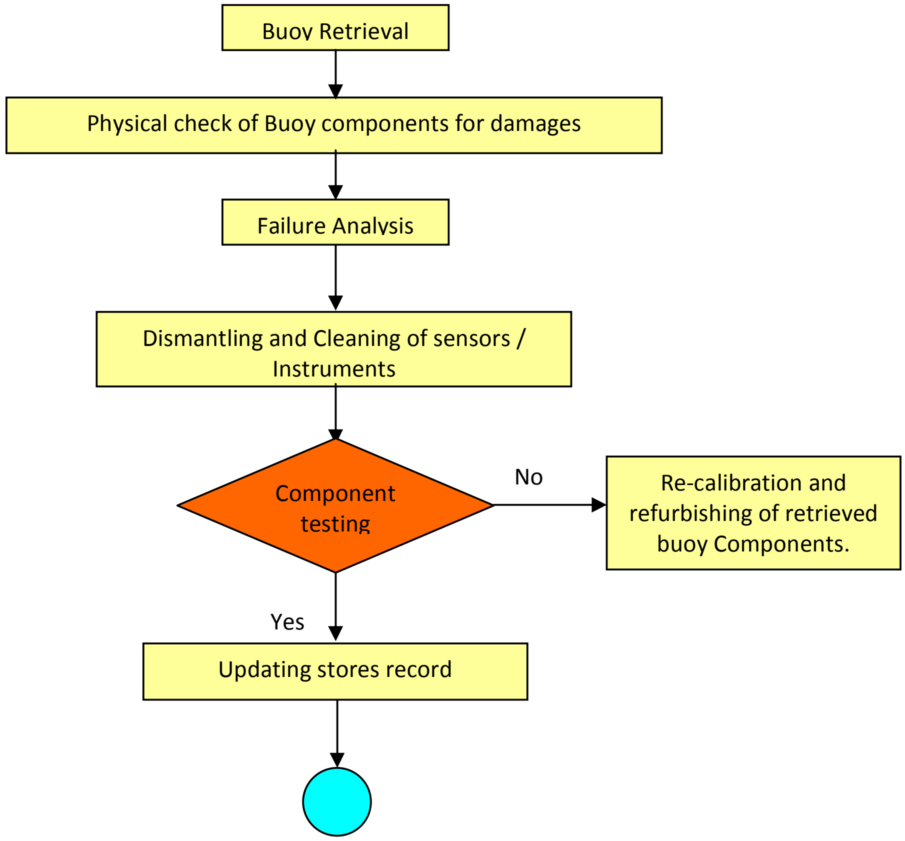
ANNEXURE – C

DEPLOYMENT PROCEDURE

S.NO	DESCRIPTION	REMARKS		COMMENTS
		YES	NO	
DEPLOYMENT OPERATION				
1	Conduct the bathymetry survey around 1 nm radially from the proposed anchor deployment location with the help of Multi-Beam Echo Sounder (MBES).			
2	Prepare the required length of mooring ropes based on the depth of the location			
3	Watch Circle Radius (WCR) of the buoy is calculated after determining the mooring rope length.			
4	Connect 1m Galvanized iron (GI) chain at the connecting point of keel frame (KF).			
5	Place the combination rope coil on the spool stand.			
6	Lay down Nylon rope on the deck, for easy operation and cut down the required length of the polypropylene rope from the coil.			
7	Connect the chain and combination rope by ¾" GI shackle.			
8	By using the ship crane lower the Buoy slowly, up to the sea water surface with the help of sling and quick release.			
9	Start paying out of combination rope. At the end of combination rope connect the nylon rope with the help of ¾" shackle and start paying out of nylon rope.			
10	Connect the mooring hardwares in order with suitable Minimum breaking load(MBL),Proof Load(PL) and Safe Working Load(SWL) as per the instructions given below and mooring diagram given in annexure			
11	Six numbers of subsurface floats are attached at the end of the nylon rope. Connect the Polypropylene (PP) rope with nylon rope end.			
12	Then start paying out of PP rope. During the payout of PP rope, dead weight and anchor is connected with 3m GI chain. One more 3m chain is connected to the dead weight.			
13	PP rope end is connected to the 3m chain which is connected to the deadweight with the aid of ¾" shackles.			
14	At last, the dead weight and sinker weight are dropped at the anchor dropping location.			
15	In case of Tsunami Buoy, the ship is moved to 300m away from the anchor drop location. BPR is assembled with BPR float. A shackle is tied with the BPR deadweight and it is connected to the BPR by 1m Nylon rope.			
16	BPR battery voltage is to be checked. It should be replaced if it has less voltage.			

ANNEXURE – D

WORK FLOW CHART FOR RETRIEVED BUOY



ANNEXURE - E

BUOY RETRIEVAL OPERATION

S.NO	DESCRIPTION	REMARKS		COMMENTS
		YES	NO	
BUOY RETRIEVAL OPERATION				
1	Retrieval of the Buoy is done by using the Work boat with On-Board Motor (OBM). A rope with hook is fitted in the lifting ring /lifting lug and the other end of the rope is given to the ship. The rope is attached to the capstan. By using the capstan, the buoy is dragged near to the ship.			
2	The ship crane hook is attached to the lifting ring and it is lifted up after the seamen gone away from the buoy.			
3	In all activities, preference is given for safety. All persons involving in the deployment and retrieval operations should wear safety helmets, safety boots, coverall, life jacket and hand gloves etc.			
4	The guiding ropes are attached at combination rope and the other end of the guiding ropes is attached to the guiding provisions given in the ship.			
5	The tension in the rope is reduced by lowering the crane. Then the shackle at the end of the chain in the mooring is disconnected and then the remaining rope will be allowed to go down to the sea.			
6	After retrieval of the buoy, thorough study on the buoy will be done. The damaged parts are separated for Failure Analysis. Photographs are taken immediately for the evidence of failure and Vandalized parts.			

ANNEXURE - F

BPR RETRIEVAL OPERATION

S.NO	DESCRIPTION	REMARKS		COMMENTS
		YES	NO	
BPR RETRIEVAL OPERATION				
1	At first, the ship is moved to the BPR deployed location. By using dunker modem, the slope value is taken between the BPR and dunker modem. If the communication between the BPR and dunker modem is done, then position of dunker modem deployment location is changed. When the slope is very less among various slope values taken, then at the moment the BPR is released by the release command.			
2	BPR search operation is done with the help of triangulation method by making BPR deployed location as center and 500m as side of the triangle.			

ANNEXURE – G

CALCULATION OF WATCH CIRCLE RADIUS

Sample Watch Circle Radius Calculation (WCR):

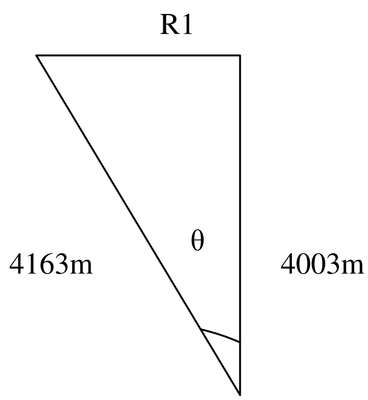
For instance, if a buoy is deployed to a depth of 4000 m, the following length of mooring ropes are essential to calculate the WCR of Data buoy and BPR

1. Combination rope	= 550m
2. Nylon rope	= 160m
3. Polypropylene rope	= (4000-550)
	= 3450m

3m chain is being used for fixing sinker weight at the Polypropylene rope end and hence it has to be taken for calculation.

Calculation of Buoy Watch Circle Radius

Buoy's Depth	=	4000m
Mooring length when calm weather + 3m chain	=	4003m
Maximum mooring length	=	(550+160+3450+3)
	=	4163



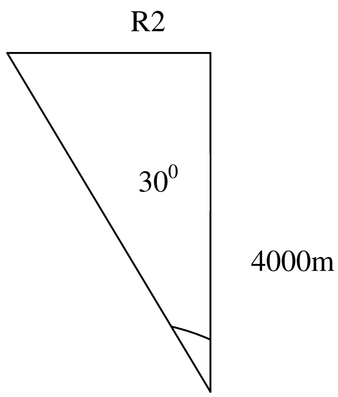
Cosθ	=	4003/416
θ	**=**	**15.94^0**
Sinθ	=	(R1)/4163
Sin15.94	=	(R1)/4163
R_1	=	0.27*4163
	=	1124.01m

Therefore**, Buoy watch circle Radius =1124.01m.**

Also, BPR is deployed 500m far from the buoy anchor position.

Calculation of BPR Watch Circle Radius

Depth at the place	= 4000m
Hal-beam angle for the BPR	= 30^0



TanΦ	=	(R2)/4000
$Tan30^0$	=	(R2)/4000
R2	=	.58*4000
	=	2320m
BPR watch circle Radius	**=**	**2320m.**

CONCLUSION:

From the above calculation, it is observed that

Buoy watch circle radius	=	1124.01m
Distance between the BPR and Buoy anchor position	=	500m
BPR watch circle radius	=	2320m

The above details have plotted in AutoCAD and it is concluded that the Buoy watch circle lies within the BPR watch circle. Hence, there will be good communication between the surface modem and the BPR. After getting confirmation, BPR is lowered at the desired location.

ANNEXURE - H

PLACEMENTS OF ZINC ANODE IN THE BUOY

Sl.No	Description	Quantity	Weight (g)	Remarks
1	Bottom of Central cylinder	4	500	
2	Circumference of keel weight	8	500	
3	Side of Fin lug	1	200	
4	Side of mooring lug	1	200	

ANNEXURE – I

CHECK LIST FOR RETRIEVED BUOY SERVICE

S.NO	DESCRIPTION	REMARKS
1	Flotation body outer skin cleaned and marine growth removed by high-pressure washer and coat with antifouling SEAALU – Jotun.	
2	Mast flange inspected for damage, cracks: loose or missing bolts, nuts and washer on mast sections, Missing Bolts etc. replaced.	
3	Mast surface inspected for corrosion: Corroded/ scratch areas must be cleaned and repainted.	
4	Central cylinder lid connectors inspected for damage, bends or evidence of corrosion.	
5	O – ring inspected and the O – ring groove inspected for evidence of corrosion and O- ring replaced if necessary.	
6	Apply silicone to O-ring.	
7	Lid clamp bolts and lid clamps inspected	
8	Apply grease (NOVA LUBE) to lid clamp bolts if necessary.	
9	Bottom part of cylinder area (outside) cleaned and repainted with antifouling SEAALU – Jotun.	
10	Keel flanges and keel weight inspected for damage, cracks, loose or missing bolts, nuts and washers. Missing bolts etc. replaced.	
11	Zinc Anodes inspected for heavy corrosion and replaced if necessary	
12	Mooring cleaned for marine growth:	
13	Chain, shackle, rope, wire and thimbles were inspected for sign of corrosion and replaced if necessary.	
14	Taken care when handling a buoy after months of operation. Flush the buoy with N2 gas (or air) immediately after lifting it up from the seawater.	

ANNEXURE : J

MOORING ROPES DETAILS

Combination rope

Nominal diameter	:	18 mm
Minimum Breaking Load	:	9 tons
Tensile grade of wire	:	1770 N/ mm^2.
Galvanization	:	Wires shall be type "A" galvanized, as per IS 1835/Equivalent
Lubrication	:	Medium duty marine application
Strand Construction	:	6 x 19 + IWRC
Sheathing	:	Each strand of the rope except IWRC shall be sheathed with polypropylene.
Type of lay	:	Right hand Ordinary Lay

Nylon rope:

Nominal diameter of the rope	:	16 mm
Minimum breaking load	:	5.5 tons
Specific gravity	:	Around 1.14
Melting Point	:	260° C.
Length of the rope	:	320m per spool
Water absorption	:	max 4%
Breaking Elongation	:	21%
Strand Construction	:	12 strands (2x6)

Polypropylene rope:

Nominal diameter of the rope	:	18 mm
Minimum breaking load	:	5.5 tons
Specific gravity	:	0.99
Melting Point	:	260° C
Water absorption	:	1%
Breaking Elongation	:	12-14%
Strand Construction	:	6 x 12

Mooring Hardwares details:

Part.No	**Description**	**Material**	**Size**	**SWL** (Tons)
171 - 173	Shackle	Alloy steel-Bow type	¾"	4.75
		Alloy steel-Bow type	5/8"	4.5
		Stainless steel-D type	5/8"	3.25
		Stainless steel –D type	3/8"	1
		Stainless steel- D type	5/16"	0.75
175	Chain	Alloysteel	1"	8.5
177	Bearing swivel	Alloysteel	-	5
178	Mechanical swivel	Alloysteel	1"	8.5
180	Thimble	steel	Based on rope size	8.5
--	Master link	Alloysteel	1"	8.5

ANNEXURE – K

ZINC ANODE WEIGHT CALCULATION

FORMULA USED

1. PROTECTIVE CURRENT:

$$I_G = A_G \times i_S$$

Where,

I_G – Total Protective Current in Amperes (A)
A_G – Total Area to be protected in meters.
i_S – Protective Current Density in A/m^2

2. ANODE WEIGHT:

$$m_G = \frac{I_G \times t_S}{Q_g}$$

Where,

m_G - Required Anode Weight in grams (g)
I_G - Total protective current in Amperes (A)
t_S - Protective period in Hours.
Qg - Electrochemical efficiency of the anode alloy in A h/g

CONSTANTS USED:

Protective current density (I_s) =20 mA/ m^2
Electrochemical efficiency of the anode alloy (Q_g) = 780A h / Kg = 780 ×1000 A h / g.

CALCULATION

1. SURFACE AREA CALCULATION FOR CYLINDER LID:

Surface area of the lid $= \frac{\pi}{4} \times 745^2$ = 435915.62 mm^2

Area of the M8 Holes for lid hinge and handle fixing (6 Nos) $= 6 \times \frac{\pi}{4} \times 8^2$ = 301.59 mm^2

Area of the Φ 26 Holes for vent pipe fixing (2 Nos) $= 2 \times \frac{\pi}{4} \times 26^2$ = 1061.86 mm^2

Area of the Slots for lid key fixing (16 Nos) $= 16 \times \frac{\pi}{8} \times 25^2$ = 3926.99 mm^2

(semi circle)

Area of the Handle and spacer = 310 ×20 = 6200 mm^2

Area of the Spacer $= \frac{\pi}{4} \times (18^2 - 12^2)$ = 141.37 mm^2

Total Area (A_G) = (Surface area of the lid - Area of the M8 Holes - Area of the Φ 26 Holes - Area of the Slots + Area of the Handle and spacer)

= 435915.62 - 301.59 - 1061.86 - 3926.99 + 6200 + 141.37

= 436825.18 mm^2 = 436966.55 × 10^{-6} m^2

2. PROTECTIVE CURRENT (I_G):

$$I_G = A_G \times i_S$$
$$= 436966.55 \times 10^{-6} \times 20 \times 10^{-3}$$
$$= 8.74 \times 10^{-3}\ A$$

3. ANODE WEIGHT (m_G**)**

$$m_G = \frac{I_G \times t_S}{Q_g}$$
$$= \frac{8.74 \times 10^{-3} \times 8760}{780 \times 1000}$$
$$= 0.0982\ Kg \sim 100\ g.$$

REFERENCE:

1. Oceanor Wave Scan Buoy User Manual
2. http://www.ndbc.noaa.gov/
3. Surface Buoy Moored system Document, NIOT-OOS.
4. www.gl-group.com/infoservices/rules/pdfs/english/ergvors/teil-10/kap-2/englisch/abschn07.pdf
5. http://www.pmel.noaa.gov/tao/

Note:

The supporting Documents and References regarding Assembly, testing, deployment and retrieval of Data/ Tsunami Buoys and technical documents are available in the system (192.168.77.154) OOS/P.MURUGESH/ New Volume (F)/PROCESSES/D&M.

GLOSSARY:

Accuracy

Degree of conformity of a measure to a standard or true value; in other words, how close a predicted or measured value is to the true value.

ADCP

Acoustic Doppler Current Profiler

Altimeter

An instrument that indicates the altitude of an object above a fixed level. Pressure altimeters use an aneroid barometer with a scale graduated in altitude instead of pressure.

Analog

1. Class of measuring devices in which the output varies continuously as a function of the input (non-digital).

2. A historical instance of a given meteorological scenario or feature that is used for comparison with another scenario or feature. For example, a long-range forecaster predicting conditions for the upcoming winter may make comparisons to analog seasons in which meteorological factors were similar to those of the upcoming season.

Analog Signal

A signal, such as voice, that varies in a continuous manner

Anemometer

An instrument used for measuring the speed of the wind.

Apparent Temperature

A measure of human discomfort due to combined heat and humidity (e.g., heat index).

Apparent Wind

The speed and true direction from which the wind appears to blow with reference to a moving point. Sometimes called RELATIVE WIND.

Azimuth

A direction in terms of a 360° compass. North is at 0°, east is at 90°, south is at 180°, and west is at 270°

Azimuth Angle

The direction or bearing toward which a sloping surface faces (e.g., a north-facing slope has an azimuth angle of 360°; a northeast-facing slope, an azimuth angle of 45°).

Bandwidth

The frequency range between the lowest and highest frequencies that are passed through a component, circuit, or system with acceptable attenuation.

Barometer

An instrument that measures atmospheric pressure.

Barometric Pressure

The pressure of the atmosphere as indicated by a barometer.

Bathymetry

The science of measuring depths of the oceans, lakes, seas, etc.

Buoyancy

The tendency of a body to float or to rise when submerged in a fluid; the power of a fluid to exert an upward force on a body placed in it.

Dew Point

(Abbrev. DWPT) - A measure of atmospheric moisture. It is the temperature to which air must be cooled in order to reach saturation (assuming air pressure and moisture content are constant). A higher dew point indicates more moisture present in the air. It is sometimes referred to as Dew Point Temperature, and sometimes written as one word (Dewpoint).

Calibration

In hydrologic terms, the process of using historical data to estimate parameters in a hydrologic forecast technique such as SACSMA, routings, and unit hydrographs.

Calm

A weather condition when no air motion (wind) is detected.

Capillary Waves

Waves caused by the initial wind stress on the water surface causes what are known as capillary waves. These have a wavelength of less than 1.73 cm, and the force that tries to restore them to equilibrium is the cohesion of the individual molecules. Capillary waves are important in starting the process of energy transfer from the air to the water.

Carbon Dioxide

CO_2; a colorless and odorless gas which is the fourth most abundant constituent of dry air

Circulation

The flow, or movement, of a fluid (e.g., water or air) in or through a given area or volume.

Climate Model

Mathematical model for quantitatively describing, simulating, and analyzing the interactions between the atmosphere and underlying surface (e.g., ocean, land, and ice).

Conduction

Flow of heat in response to a temperature gradient within an object or between objects that are in physical contact.

Current Meter

In hydrologic terms, device used to measure the water velocity or current in a river.

Degradation

In hydrologic terms, the geologic process by means of which various parts of the surface of the earth are worn down and carried away and their general level lowered, by the action of wind and water.

Detritus

In hydrologic terms,

(1) The heavier mineral debris moved by natural watercourses, usually in bed-load form.

(2) The sand, grit, and other coarse material removed by differential sedimentation in a relatively short period of detention.

Dew Point Depression

The difference in degrees between the air temperature and the dew point.

Fall Wind

A strong, cold, down slope wind

High Wind

Sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration.

High Wind Advisory

This product is issued by the National Weather Service when high wind speeds may pose a hazard. The criteria for this advisory varies from state to state. In Michigan, the criteria is sustained non-convective (not related to thunderstorms) winds greater than or equal to 30 mph lasting for one hour or longer, or winds greater than or equal to 45 mph for any duration.

Humidity

Generally, a measure of the water vapor content of the air. Popularly, it is used synonymously with relative humidity.

Humidity Recovery

The change in relative humidity over a given period of time; generally between late evening and sunrise. The moisture change in the fine fuels during this period is directly related to the amount of humidity recovery.

Hydrometeor

A particle of condensed water (liquid, snow, ice, graupel, hail) in the atmosphere.

Hygrometer

An instrument which measures the humidity of the air.

HZ

1) Haze- An aggregation in the atmosphere of very fine, widely dispersed, solid or liquid particles, or both, giving the air an opalescent appearance that subdues colors.

(or)

2) Hertz- An international unit of frequency equal to one cycle per second, and named after a German physicist.

Infiltration

In hydrologic terms, movement of water through the soil surface into the soil.

Infiltration Capacity

In hydrologic terms, the maximum rate at which water can enter the soil at a particular point under a given set of conditions.

Infiltration Index

In hydrologic terms, an average rate of infiltration, in inches per hour, equal to the average rate of rainfall such as that the volume of rainfall at greater rates equals the total direct runoff.

Infiltration Rate

In hydrologic terms,

1. The rate at which infiltration takes place expressed in depth of water per unit time, usually in inches per hour.
2. The rate, usually expressed in cubic feet per second, or million gallons per day per mile of waterway, at which ground water enters an infiltration ditch or gallery, drain, sewer, or other underground conduit.

Isotach

A line connecting points of equal wind speed.

Isotherm

A line connecting points of equal temperature

Jet

A fast-moving wind current surrounded by slower moving air.

Kinetic Energy

Energy that a body has as a result of its motion. Mathematically, it is defined as one-half the product of a body's mass and the square of its speed (KE = 1/2 * mass * velocity squared).

Laminar Flow

Streamline flow in which successive flow particles follow similar path lines and head loss varies with velocity to the first power.

Latent Heat

Heat absorbed or released during a change of phase at constant temperature and pressure

Latitude

(abbrev. LAT) The location north or south in reference to the equator, which is designated at zero (0) degrees. Lines of latitude are parallel to the equator and circle the globe. The North and South poles are at 90 degrees North and South latitude.

Local Convective Wind

In fire weather terminology, local thermally driven winds arising over a comparatively small area and influenced by local terrain. Examples include sea and land breezes, lake breezes, diurnal mountain wind systems and columnar convective currents.

Longitude

The location east or west in reference to the Prime Meridian, which is designated as zero (0) degrees longitude. The distance between lines of longitude are greater at the equator and smaller at the higher latitudes, intersecting at the earth's North and South Poles. Time zones are correlated to longitude.

Madden-Julian Oscillation

(abbrev. MJO)- Tropical rainfall exhibits strong variability on time scales shorter than the seasonal El Niño-Southern Oscillation (ENSO). These fluctuations in tropical rainfall often go through an entire cycle in 30-60 days, and are referred to as the Madden-Julian Oscillation or intraseasonal oscillations. The intraseasonal oscillations are a naturally occurring component of our coupled ocean-atmosphere system. They significantly affect the atmospheric circulation throughout the global Tropics and subtropics, and also strongly affect the wintertime jet stream and atmospheric circulation features over the North Pacific and western North America. As a result, they have an important impact on storminess and temperatures over the United States. During the summer these oscillations have a modulating effect on hurricane activity in both the Pacific and Atlantic basins.

Marine Weather Statement

A National Weather Service product to provide mariners with details on significant or potentially hazardous conditions not otherwise covered in existing marine warnings and forecasts. Marine weather statements are also used to supplement special marine warnings.

Maximum Temperature

This is the highest temperature recorded during a specified period of time. Common time periods include 6, 12 and 24 hours. The most common reference is to the daily maximum temperature, or "high."

Mean Annual Temperature

The average temperature for the entire year at any given location.

Mean Sea Level

(MSL) - The arithmetic mean of hourly water elevations observed over a specific 19-year tidal epoch.

Mercury Barometer

An instrument for measuring atmospheric pressure. The instrument contains an evacuated and graduated glass tube in which mercury rises or falls as the pressure of the atmosphere increases or decreases.

Mesoclimate

The climate of a small area of the earth's surface which may differ from the general climate of the district.

Meteorologist

A person who studies meteorology. There are many different paths within the field of meteorology. For example, one could be a research meteorologist, radar meteorologist, climatologist, or operational meteorologist.

Meteorology

The science dealing with the atmosphere and its phenomena. A distinction can be drawn between meteorology and climatology, the latter being primarily concerned with average, not actual, weather conditions.

Orographic Precipitation

Precipitation which is caused by hills or mountain ranges deflecting the moisture-laden air masses upward, causing them to cool and precipitate their moisture.

Precision

The accuracy with which a number can be represented, i.e., the number of digits used to represent a number.

RADAR

Acronym for **RA**dio **D**etection **A**nd **R**anging; a radio device or system for locating an object by means of ultrahigh-frequency radio waves reflected from the object and received, observed, and analyzed by the receiving part of the device in such a way that characteristics (as distance and direction) of the object may be determined.

Radar Beam

The straight line that a radar pulse travels along. As the radar beam gets further away from the radar, it gets wider and wider. In order for a precipitation target to be detected by the radar, it must fill the entire radar beam; therefore, the radar will have a difficult time detecting small showers and thunderstorms at a great distance from the radar.

Radar Cross Section

The area of a fictitious, perfect reflector of electromagnetic waves (e.g., metal sphere) that would reflect the same amount of energy back to the radar as the actual target (e.g., lumpy snowflake).

Radar Meteorology

Branch of meteorology that uses radars for weather observations and forecasts.

Radar Range

Distance from the radar antenna. The WSR-88D radar has a range for velocity products out to 124 nautical miles and reflectivity products out to 248 nautical miles.

Rain Gauge

An instrument for measuring the quantity of rain that has fallen.

Eccentricity

A dimensionless quantity describing the elliptical shape of a planet's orbit.

Sea Level Pressure

The sea level pressure is the atmospheric pressure at sea level at a given location. When observed at a reporting station that is not at sea level (nearly all stations), it is a correction of the **station pressure** to sea level. This correction takes into account the standard variation of pressure with height and the influence of temperature variations with height on the pressure. The temperature used in the sea level correction is a twelve hour mean, eliminating diurnal effects. Once calculated, horizontal variations of sea level pressure may be compared for location of high and low pressure areas and fronts.

Sea Surface Temperatures

The term refers to the mean temperature of the ocean in the upper few meters.

Signal-to-Noise Ratio

A ratio that measures the comprehensibility of data, usually expressed as the signal power divided by the noise power, usually expressed in decibels (dB).

Significant Wave Height

The mean or average height of the highest one third of all waves in a swell train or in a wave generating region. It approximates the value an experienced observer would report if visually estimating sea height. When expressed as a range (e.g. Seas 2-4 ft) , indicates a degree of uncertainty in the forecast and/or expected changing conditions (not that all waves are between 2-4 ft). Generally, it is assumed that individual wave heights can be described using a Rayleigh distribution.

Spectral Density

A radar term for the distribution of power by frequency.

Spectral Wave Density

On a buoy report, energy in (meter*meter)/Hz, for each frequency bin (typically from 0.03 Hz to 0.40 Hz).

Spectral Wave Direction

On a buoy report, mean wave direction, in degrees from true North, for each frequency bin.

Spectrum Width

This WSR-88D radar product depicts a full 360 degree sweep of spectrum width data indicating a measure of velocity dispersion within the radar sample volume. It is available for every elevation angle sampled, it provides a measure of the variability of the mean radial velocity estimates due to wind shear, turbulence, and/or the quality of the velocity samples. It is used to estimate turbulence associated with boundaries, thunderstorms, and mesocyclones; check the reliability of the velocity estimates; and locate boundaries (cold front, outflow, lake breeze, etc.).

VAD Wind Profile

A radar plot of horizontal winds, derived from VAD data, as a function of height above a Doppler Radar. The display is plotted with height as the vertical axis and time as the horizontal axis (a so-called time-height display), which then depicts the change in wind with time at various heights. This display is useful for observing local changes in vertical wind shear, such as backing of low-level winds, increases in speed shear, and development or evolution of nearby jet streams (including low-level jets). This product often is referred to erroneously as a VAD

Valid Time

The period of time during which a forecast or warning, until it is updated or superseded by a new forecast issuance, is in effect.

Vapor Pressure

The partial pressure of water vapor in an air-water system.

Variance

A measure of variability.

Very Windy

30 to 40 mph winds.

Wave Steepness

The ratio of wave height to wavelength and is an indicator of wave stability. When wave steepness exceeds a 1/7 ratio; the wave typically becomes unstable and begins to break.

Wave Trough

The lowest part of the wave.

Warm Front

A transition zone between a mass of warm air and the colder air it is replacing

Warm Sector

A region of warm surface air between a cold front and a warm front

Warning

A warning is issued when a hazardous weather or hydrologic event is occurring, is imminent, or has a very high probability of occurring. A warning is used for conditions posing a threat to life or property.

Wave Crest

The highest part of a wave

Wave Height

Distance from wave trough to wave crest.

Wave Period

Time, in seconds, between the passage of consecutive wave crests past a fixed point.

Wave Spectrum

The distribution of wave energy with respect to wave frequency or period. Wave spectra assist in differentiating between wind waves and swell.

Wave Trough

The lowest part of the wave.

Wavelength

Distance between crests or troughs of a wave.

Weighing-Type Precipitation Gage

A rain gage that weighs the rain or snow which falls into a bucket set on a platform of a spring or lever balance. The increasing weights of its contents plus the bucket are recorded on a chart. The record thus shows the accumulation of precipitation.

Whirlwind

A small, rotating column of air; may be visible as a dust devil

Wind Direction

The true direction **from which** the wind is blowing at a given location (i.e., wind blowing from the north to the south is a north wind). It is normally measured in tens of degrees from 10 degrees clockwise through 360 degrees. North is 360 degrees. A wind direction of 0^0 is only used when wind is calm.

Wind Field

The three-dimensional spatial pattern of winds.

Wind Rose

A diagram, for a given locality or area, showing the frequency and strength of the wind from various directions.

Zero Datum

In hydrologic terms, a reference "zero" elevation for a stream or river gage. This "zero" can be referenced (usually within ten feet of the bottom of the channel) to mean sea level, or to any other recognized datum.