

**ORV- Sagar Kanya**

**SK-341 Cruise Report**

(August 3<sup>rd</sup> 2017 to September 11<sup>th</sup> 2017)

**Geo-scientific Studies of the  
Exclusive Economic Zone**



**NATIONAL CENTRE FOR ANTARCTIC AND  
OCEAN RESEARCH  
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## **ANNEXURE**

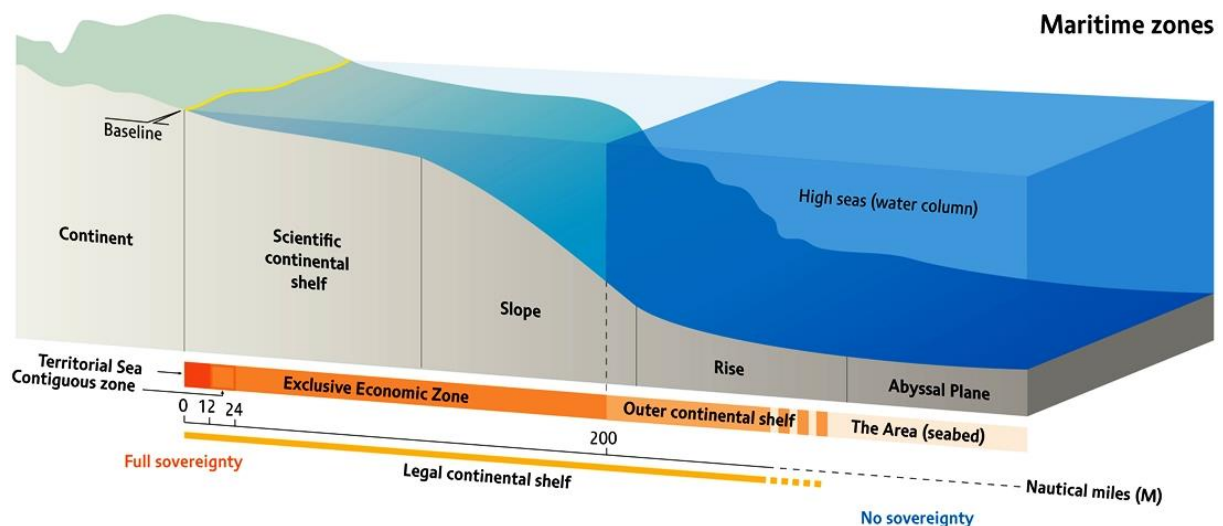
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# 1. INTRODUCTION

Judicious utilization of offshore resources is very vital for the economic prosperity of any country in the world. The control over the oceans is regulated by the *Law of the Sea convention* of 1982, which came into force on November 16, 1994 and it defines oceanic jurisdiction for all countries. This Law extends the legal right to the coastal countries to exploit, develop, manage and conserve all resources to be found in the water and in the sub-soil of an area extending 200 nautical miles from its shore i.e. Exclusive Economic Zone (EEZ).

## *Utilities:*

The Exclusive Economic Zone (EEZ), about 200 nautical miles from coast, the zone outside the territorial water of the country over which a country is permitted to do economic activities like fishing and is entitled to explore and exploit the natural resources of the area.

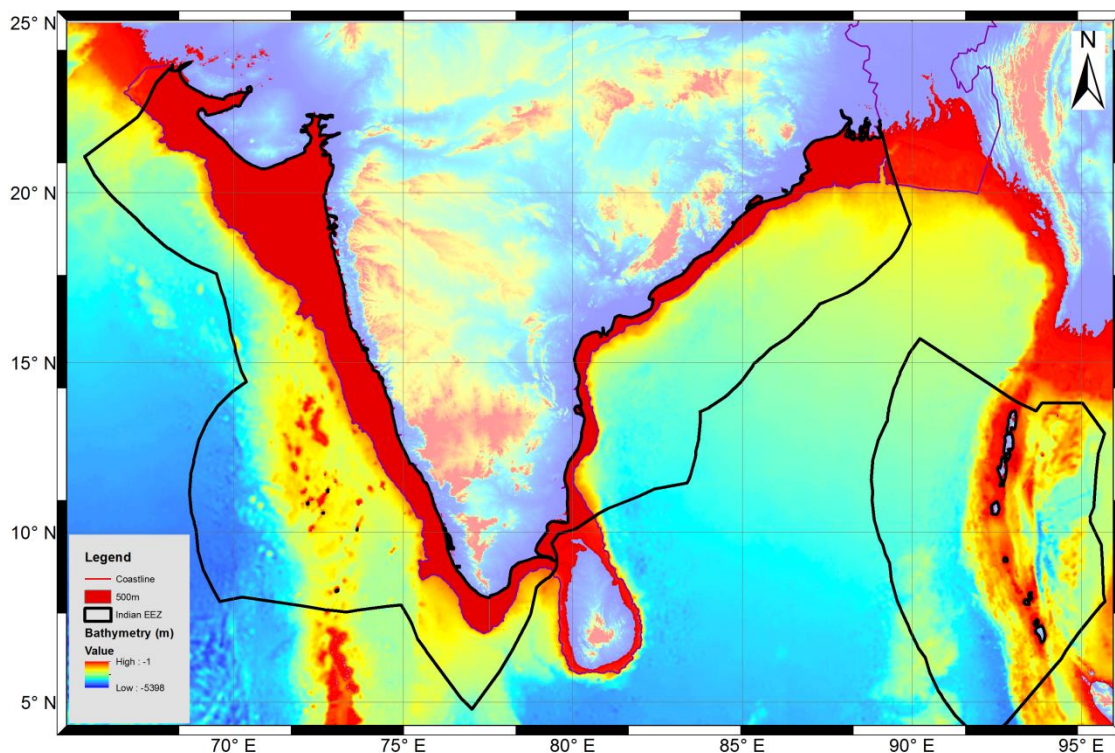


*The detailed map of the EEZ shall be useful in the following purposes:*

- (i) Fishermen for fishing operations using deep trawl or bottom fishing gear,
- (ii) Petroleum, natural gas and mineral exploration as well as exploitation,
- (iii) Development and assessment of mineral resources,
- (iv) Telecommunication industry for laying cables,
- (v) Sub-sea pipe lines for geological hazard assessment,
- (vi) Effective disposal of waste and reducing pollutants,
- (vii) Ocean engineers for constructing and maintaining structures of port and harbor.

### **Indian EEZ:**

India has an Exclusive Economic Zone (EEZ) with an area of about 23,05,143 km<sup>2</sup> along its 7516km coastline (including the coastline of Andaman and Nicobar Islands and Lakshadweep Islands) as shown in figure-1. This constitutes about two-third of the land area of the country. Realizing the need to be cognizant about the enormous potentials of our country's EEZ, the *Government of India* has decided to prepare a comprehensive map of entire EEZ of India and *National Centre for Antarctic and Ocean Research (NCAOR)*, Goa has been appointed as the nodal agency for the implementation of this programme.



*Figure 1: Indian EEZ map with the satellite bathymetry data, costal line of India and EEZ boundary of India*

## **2. CRUISE ITERNERY**

SK-341 consisted of three sorties. Initially, after dry-dock at Colombo a scientific member from NCAOR (Mr. Abhishek Tyagi) arrived onboard ORV Sagar Kanya to inspect the functioning of the vessel. Following the initial inspection, calibration of Multibeam Echosounder was carried out in second sortie. The cruise iternery of three sorties is mentioned below.

<b>SK-341</b>	<b>From</b>	<b>To</b>
Sortie 1	03/08/2017	07/08/2017
Sortie 2	08/08/2017	12/08/2017
Sortie 3	17/08/2017	11/09/2017

The scientific team for multibeam survey in Gulf of Mannar, embarked onboard the vessel at Tuticorin Port on 07<sup>th</sup> August 2017. After completion of the survey, vessel returned to Tuticorin Port on 11<sup>th</sup> September 2017.

Departure : Tuticorin, 08.08.2017

Arrival : Tuticorin, 11.09.2017

### **3. LIST OF PARTICIPANTS**

- |                       |         |                  |
|-----------------------|---------|------------------|
| 1. Susanth S          | NCAOR   | Scientist        |
| 2. Twinkle Damodharan | -do-    | Scientist        |
| 3. Pawan P            | -do-    | Shipboard Asst.  |
| 4. A.C. Luis          | Norinco | Service Engineer |
| 5. R. Mohamed Ismail  | -do-    | -do-             |
| 6. G. Mahadevan       | -do-    | -do-             |
| 7. M. Manivannan      | -do-    | -do-             |

### **4. OBJECTIVE and AREA OF OPERATION**

The primary objective of the SK-341 cruise was to undertake multibeam bathymetric survey in Gulf of Mannar region (Block\_A7) within the EEZ of India as shown in figure-2. Also to collect gravity cores / grab and to conduct CTD/SVP cast at different locations within survey area. And in figure 3 shows the CTD/Sound Velocity Profile (SVP) locations and Grab (GB) locations along with vessel tracks prepared for the bathymetry data acquisition. Initially functioning of vessel and equipments were checked during the transit from Colombo port to Tuticorin port (03/08/2017 to 07/08/2017). Later a trial cruise was held between 8<sup>th</sup> August 2017 to 12<sup>th</sup> August 2017 to calibrate multibeam and check the winches used for scientific operation. The calibration report is attached with this document (Annexure-5). Vessel returned to tuticorin port after completion of trials on 12<sup>th</sup> August 2017. On arrival at shore, issues in DGPS system and Propulsion Motors were rectified. Vessel sailed back to survey location (A7 Block) on 17<sup>th</sup> August 2017.

The total area covered in Block\_A7 is **4815 sq. km**, with trackline distance of **2850 km**.

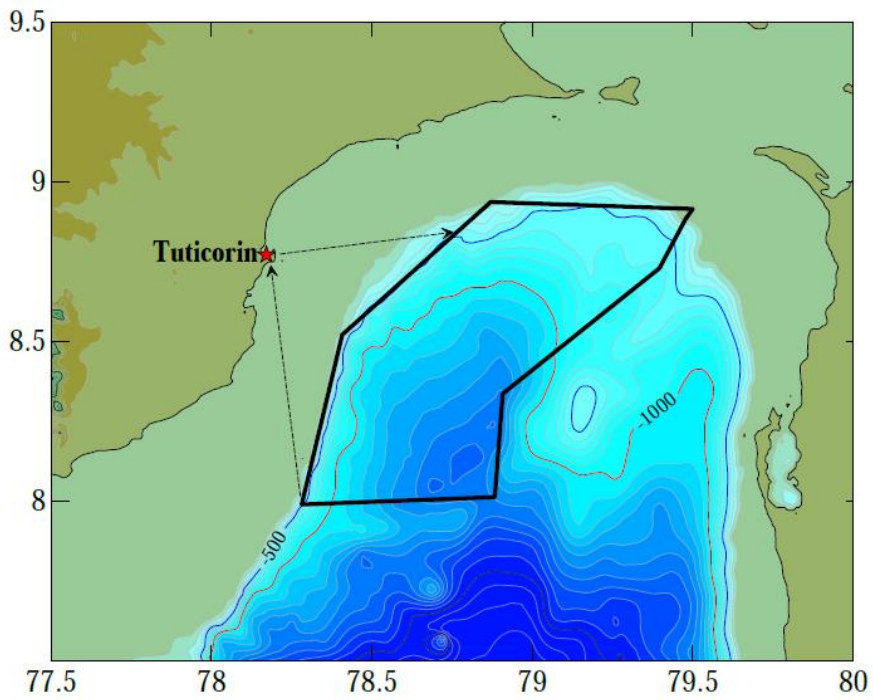


Figure 2: Image shows the transit from Tuticorin Port and proposed survey block, Block\_A7 (Above 8° N).

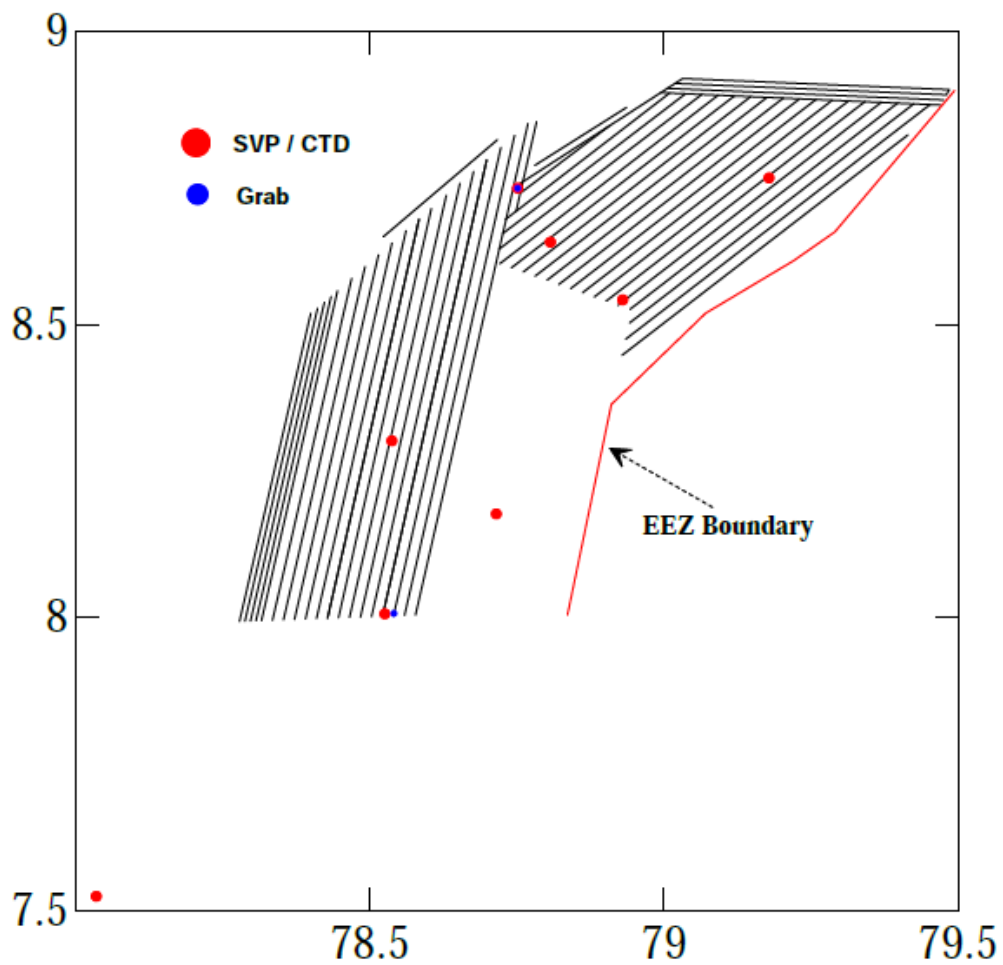


Figure 3: Cruise tracks of the bathymetry survey and locations of Grab and CTD/SVP stations.

## 5. METHODOLOGY AND SURVEY EQUIPMENTS

### a. Methodology :

The Multibeam survey was carried out using standard Survey practices. The tracklines were planned in order to obtain about 50% overlap at average speed of 5-7.5knots. Navigational and attitude information is provided by C-NAV DGPS system. Ship track was maintained within  $\pm 20$  m.

### b. Equipment details:

#### 7.2.1 SeaBeam-3012 MultibeamEchosounder System:

SeaBeam-3012 MultibeamEchosounder on board ORV-SagarKanya was utilised to carry out the surveys in Gulf of Mannar region. The SB-3012 is a 12 kHz, 201 beam sonar system, has a beam width of  $2^\circ$  at nadir and is capable of measuring depths ranging from 200 m to 11000 m. Brief technical specification of the SB-3012 MBES system are as follows:

*Manufacturer* : L3-Communications Elac-Nautik GmbH, Germany

*Number of Beams* : 201

*Swath Coverage* :  $140^\circ$ ,  $2^\circ \times 2^\circ$  ( $5.5 \times \text{Depth}$ ),  $\sim 20$  dB backscatter

*Depth* : 200 to 11, 000 m

*Frequency of Operation* : 12 kHz

*Max. Source Level* :  $2^\circ = 241$  dB/mPa

*Pulse Length* : 2, 3, 5, 7, 10, 14, 20 ms

*Side Lobe Suppression* :  $> -30$  dB

*Technology* : Full motion compensation (Sweptbeam technology)

*Acquisition Software* : Hydrostar

*Data Processing Software* : EIVA

The complete Multibeam system complex comprises of many sub systems:

a. *Surface Sound velocity (SSV)*: The surface sound velocity profiler is an underway ocean surface profiling system that collects the water sound speed continuously.

b. *Gyro & Motion Sensor*: Multibeam system uses IXSEA-Octans sensor for Gyro and motion input. Octans is an IMO compliant survey grade gyrocompass with an integral motion sensor.

*c. Positioning System:* The C-NAV DGPS subsystem is used for positioning accuracy. C-NavGcGPS corrections are similar to other wide area DGPS system such as the Federal Aviation Administration's (FDA) wide area augmentation system (WAAS). The C-Nav GPS receiver can accept two (2) different GcGPS correction service message formats. The C-Nav, dual frequency, GPS equipment receives either of these corrections broadcast from the communications satellite, applies them its own observed refraction corrected C/A code, dual frequency observations, and performs a navigation solution. The resulting corrected GPS position; velocity and time (PVT) are output from the C-Nav equipment to other subsystems on the platform/vehicle/vessel to support the navigation positioning control requirements.

*d. Network Time Server with GPS Synchronized Time Base:* LANTIME (local area network timeserver) provides a high precision time base to a TCP/IP network (stratum-1-server). The NTP (network time protocol) is used to synchronize all NTP clients with the reference. LANTIME/GPS is a set of equipment composed of a satellite controlled clock GPS167, a single board computer with integrated network board and a power supply, all installed in a metal 19" on the single-board computer flash disk. Four push buttons and a 2 x 40 character LC display can be used configure and monitor the time server. After the network connection has been established, the timeserver can also be configured and monitored remotely from a work station via TEL/NET or FTP.

*e. Network Time Protocol (NTP):* NTP is a common method for synchronization of hardware clocks in local and global networks. Timeservers synchronize themselves by a reference time source, such as a radio controlled clock, GPS-receiver or modem time distribution. Stratum-1-server distribute their time to several clients in the network which are called stratum-2. A high precision synchronization is feasible because of the several time references. Every computer synchronizes itself by up to three valued time sources. NTP enable the comparison of the hardware times and the adjustment of the own clock, a time precision of 128 ms, often better than 50 ms is possible.

#### *7.2.2. Conductivity Temperature & Depth (CTD)*

As the Sound Velocity Profiler (SVP) depth display was working, for this Sound Velocity Profiler attached with the CTD cast. The vertical structure of sound velocity was derived using SVP and CTD Cast. CTD is used to study various parameters like temperature, conductivity, pressure etc. at various depths. The *SBE-911plus* was utilized to measure conductivity, temperature, and pressure in depths up to 6,000 meters. The sketch diagram of deployment of CTD as shown in figure 6.



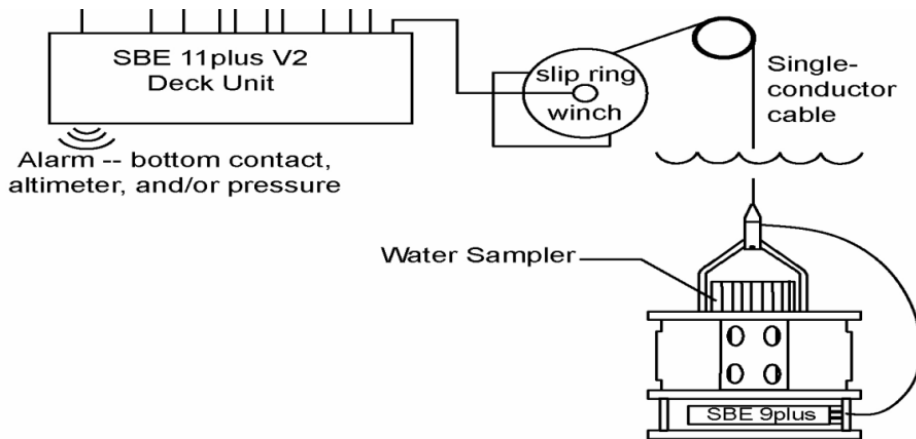


Figure 4: the sketch shows the CTD cast with deployment unit.

### 7.2.3: Gravity Coring:

Gravity corer could not be operated due to issues in deep sea winch (Unsafe operation : slow winch speed, hydraulic leak, sudden abnormal jerk, wrong counter reading etc). Hence it was decided to deploy lesser load and so Grabs were collected in two locations. Grab lowering as shown in figure 5.



Figure 5: Grab operation

## 6. SCIENTIFIC OBSERVATION AND OTHER WORK DURING THE CRUISE

a. During the cruise, the MB data was processed with CARIS and Mapped.

b. Grab was collected at 2 locations.

## 7. ACKNOWLEDGEMENT

The whole team of SK-341 place on record their deep sense of gratitude to *Director, National Centre for Antarctic and Ocean Research*, for assigning responsibilities for EEZ survey cruise. Team is also thankful to *Dr. John Kurian P, Mr. Abhishek Tyagi* and *Mr. M. M. Subramaniam* for their support for the success of SK-341 cruise. The Scientific team also wishes to thank the Master and crew of the vessel for their co-operation during the cruise. The support and co-operation rendered by NORINCO personnel is appreciated.

## ANNEXURE

### 1. Diary of Events

DIARY OF EVENTS SK-341		
Date	Time (GMT)	Events (Lat/Long - dd mmss ; SOG- Speed Over Ground; COG- Course Over Ground; D-Depth; WS- Wind Speed (knots); W- Weather)
03/08/2017		Vessel heading to Tuticorin from Colombo port.
Transit to Tuticorin. Vessel functioning and multibeam settings checked.		
07/08/2017		Vessel arrived at Tuticorin port.
08/08/2017		Proceeding for Seatrails (Gulf of Mannar)
MBES Roll calibration carried out; CTD winch and Deep Sea winch tested		
12/08/2017		Vessel arrived at Tuticorin port.
<b>BLOCK-A7</b>		
17/08/2017	1330	Vessel heading to survey location.
18/08/2017	@0230	08 34 18N, 78 35 42E, SOG 4.4; COG 181; D m; WS 34 knots; W Rough
	0350	Proposed line plan changed due to rough weather.
	0917	Cast CTD/SVP_01, 08 44.376N, 78 45.480E
	1000	CTD/SVP_01 onboard
	1015	Deep sea winch test
	1035	Deployed Grab GB_01, 08 44.376N, 78 45.480E
	1215	Grab onboard (Unsafe operation ; Deep sea winch issues like slow winch speed, hydraulic leak, sudden abnormal jerk, wrong counter reading etc.. )
	1321	SOL Cross1, 08 44 40 N, 78 46 03E
	1653	EOL Cross1, 08 55 39N, 79 02 11E
	1654	SOL-1, 08 55 38 N, 79 02 17E
	2050	EOL-1, 08 55 00N, 79 23 12E
	2100	SOL-2, 08 54 34N, 79 23 24E
19/08/2017	@0230	08 54.5'N, 79 05.5'E, SOG 6.0; COG 093; D 591m; WS 22 knots; W Cloudy
	0142	EOL-2, 08 55 07N, 79 01 31E
	0145	SOL-3, 08 54 46N, 79 01 30E

	0553	EOL-3, 08 53 39N, 79 25 20E
	0615	SOL-4, 08 53 21N, 79 24 50E
	0810	Line 4 diverted (stopped) due to difficulty in line keeping. Survey line plan changed to favour line keeping conditions. Vessel heading to 07 59 17N, 78 17 51E
	0902	SOL Cross2, 08 47 32 N, 79 15 43E
20/08/2017	@0230	07 59 10 N, 78 17 30E, SOG 4.4; COG 296; D 664m; WS 22 knots; W Cloudy
	0225	EOL Cross2, 07 59 08 N, 78 17 36E
	0226	SOL-4, 07 59 10 N, 78 17 30E
	0823	EOL-4, 08 31 55 N, 78 25 06E
	0843	SOL-5, 08 33 05 N, 78 25 47E
	1623	EOL-5, 07 56 42 N, 78 15 00E
	1624	Fishing Net, Line 6 dropped and proceeded to line7
	1744	SOL-7, 08 00 04 N, 76 19 41E
21/08/2017	@0230	08 33 35 N, 78 28 26E, SOG 3.7; COG 194; D 485 m; WS 21 knots; W Cloudy
	0130	EOL-7, 08 33 39 N, 78 27 11E
	0210	SOL-8, 08 34 52N, 78 28 14E
	1006	EOL-8, 07 58 59N, 78 20 33E
	1051	SOL-6, 07 59 06N, 78 19 07E
	1850	EOL-6, 08 32 59N, 78 26 29E
	1851	Transit to Line 9
	2103	SOL-9, 08 33 10N, 78 29 04E
22/08/2017	@0230	08 07 00 N, 78 23 26E, SOG 4.9; COG 192; D 1541 m; WS 27 knots; W Rough
	0419	EOL-9, 07 59 27N, 78 21 36E
	0420	Transit to line 10
	0520	SOL-10, 07 59 30N, 78 23 10E
	0630	DGPS was not showing, System restarted
	0730	Continue_ Line10, 08 07 06N, 78 24 14E
	0840	Hydrostar Application automatically closed. System restarted
	1300	Diverted_ Line10, 08 29 54N, 78 29 34E
		(Transit to Tuticorin for emergency disembarkation of NCAOR personnel)
23/08/2017	@0230	08 43 88 N, 78 26 89E, SOGVessel Anchored; COG -; D 30 m; WS 5 knots; W Calm
	1300	Transit to Line10 from Tuticorin Inner Anchorage.
	1730	Continue_ Line10, 08 07 06N, 78 24 14E
	1942	EOL-10, 08 37 15N, 78 26 16
	2025	SOL-11, 07 59 06N, 78 19 07E
24/08/2017	@0230	08 05 08N, 78 25 55E, SOG 5.7; COG 192; D 1076 m; WS 18 knots; W Cloudy
	0331	EOL-11, 07 59 30N, 78 24 02E
	0401	SOL-12, 08 39 55 N, 78 34 03E
	1125	EOL-12, 07 59 30N, 78 24 02E
	1151	SOL-13, 08 39 55 N, 78 24 02 E
	1904	EOL-13, 07 59 32 N, 78 26 16 E
	2002	SOL-14, 07 59 41 N, 78 27 23 E
25/08/2017	@0230	08 35 52N, 78 35 13E, SOG 5.4; COG 009; D 876 m; WS 14 knots; W Calm
	0341	EOL-14, 08 42 14N, 78 36 38E
	0417	SOL-15, 08 44 37N, 78 37 21E
	1133	EOL-15, 07 59 42N, 78 28 34E

	1158	SOL-16, 07 59 42N, 78 29 34E
	2130	EOL-16, 08 45 55 N, 78 39 39 E
	2152	SOL-17, 08 46 09N, 78 40 52 E
26/08/2017	@0230	08 17 02N, 78 34 35E, SOG 6.5; COG 192; D 1311 m; WS 21 knots; W Cloudy
	0528	EOL-17, 07 59 43N, 78 30 40 E
	0747	Cast CTD/SVP_02, 8 00.136N, 78 32.146E
	0837	CTD/SVP_02 onboard
	1000	Deployed Grab GB_02, 08 00 19N, 78 33 06E
	1300	Grab GB_02 Onboard
	1531	SOL-18, 08 00 16N, 78 31 56E (GPS Data only; DGPS not functioning)
	1543	EOL-18, 08 00 12N, 78 31 39E (Line diverted due to strong winds upto 44 knots)
	1909	SOL-10B, 08 00 43N, 78 23 32E
27/08/2017	@0230	08 38 14N, 78 32 01E, SOG 7.1; COG 050; D 600 m; WS 19 knots; W Cloudy
	0100	EOL-10B, 08 29 26N, 78 29 39E
	0115	SOL-19A, 08 31 10N, 78 29 47E
	0200	EOL-19A, 08 35 28N, 78 29 47E
	0211	SOLpatch, 08 36 44N, 78 30 24E
	0437	EOLpatch, 08 48 20N, 78 41 30E
	0449	SOL-18, 08 48 33N, 78 42 36E
	1553	EOL- 18, 07 59 03N, 78 31 38 E
	1626	SOL -19, 07 58 08N, 78 32 16 E
	2100	DGPS functioning.
28/08/2017	@0230	08 50 50N, 78 44 10E, SOG 5.4; COG 070; D 462 m; WS 30 knots; W Rough
	0215	EOL-19, 08 48 59N, 78 43 49E
	0240	SOL-20, 08 50 12N, 78 44 44E
	1345	EOL-20, 07 59 50N, 78 34 05E
	1417	SOL-21, 07 59 53N, 78 35 29E
	2100	DGPS error. Data Gap. Rectified @2211
29/08/2017	@0230	08 54 21N, 79 00 08E, SOG 6.0; COG 081; D 629 m; WS 26 knots; W Rough
	0000	EOL-21, 08 50 25N, 78 46 20E
	0002	SOL-Transit, 08 50 59N, 78 46 32E
	0215	EOL-Transit, 08 54 12N, 78 59 32E
	0218	SOL-22, 08 54 18N, 79 00 08E
	0652	EOL-22, 08 53 17N, 79 24 57E
	0700	SOL-23, 08 53 01N, 79 24 47E
	0800	Line diverted due to strong winds. Proceeding to Line24
	1118	SOL-24, 08 50 39N, 79 25 17E
	1930	EOL-24, 08 27 42N, 78 57 02E
	2017	SOL -25, 08 28 43N, 78 56 33E
30/08/2017	@0230	08 51 30N, 79 25 30E, SOG 5.6; COG 050; D 588 m; WS 12 knots; W Calm
	0300	EOL-25, 08 53 19N, 79 27 43E
	0324	SOL-26, 08 53 22N, 79 25 55E
	0946	EOL-26, 08 30 20N, 78 56 53E
	1000	SOL-27, 08 30 53N, 78 56 32E
	1542	EOL-27, 08 51 54N, 79 22 24E
	1557	SOL-28, 08 52 34N, 79 21 28E

	2138	EOL-28, 08 32 15N, 78 55 46E
	2211	SOL- 29, 08 32 35N, 78 54 27E
31/08/2017	@0230	08 48 57N, 79 15 12E, SOG 6.1; COG 50; D 974 m; WS 9 knots; W Calm
	0330	EOL-29, 08 52 47N, 79 19 56E
	0348	SOL-30, 08 53 11N, 79 18 47E
	0430	Navigation PC hanged. Line re-caught @0600 hrs.
	1032	EOL-30, 08 33 07N, 78 53 22E
	1100	SOL-31, 08 33 00N, 78 51 44E
	1635	EOL-31, 08 53 41N, 79 17 40E
	1656	SOL-32, 08 54 06N, 79 16 33E
	1730	Hydrostar hanged. System restarted @1812 hrs
	1924	Vessel deviation from track due to gust winds.
	2330	EOL-32, 08 33 39N, 79 17 40E
01/09/2017	@0230	08 42 52N, 79 00 29E, SOG 5.8; COG 52 50; D 924 m; WS 12 knots; W Calm
	0000	SOL-33, 08 34 20N, 78 49 44E
	0030	Hydrostar hanged. Started recording @0100
	0535	EOL-33, 08 53 48N, 79 14 19E
	0600	SOL-34, 08 53 44N, 79 12 32E
	1045	EOL-34, 08 34 49N, 78 48 30E
	1112	SOL-35, 08 35 03N, 78 47 06E
	1506	Navigation PC hanged. System restarted @1522 hrs
	1700	EOL-35, 08 54 04N, 79 10 52E
	1702	SOL-36, 08 54 09N, 79 09 35E
	2200	EOL-36, 08 35 50N, 78 46 28E
	2237	SOL- 37, 08 35 50N, 78 44 11E
02/09/2017	@0230	08 48 16N, 79 00 19E, SOG 5.3; COG 52 50; D 770 m; WS 22 knots; W Cloudy
	0414	EOL- 37, 08 54 05N, 79 07 40E
	0436	SOL-38, 08 54 09N, 79 06 02E
	0914	EOL-38, 08 36 27N, 78 43 37E
	0945	SOL-39, 08 35 15N, 78 41 38E
	1452	EOL-39, 08 54 12N, 79 04 20E
	1511	SOL-40, 08 54 37N, 79 03 06E
	1953	EOL-40, 08 39 80N, 78 43 18E
	2012	SOL-41, 08 39 29N, 78 42 36E
03/09/2017	@0230	08 50 26N, 78 52 56E, SOG 5.6; COG 236; D 414 m; WS 12 knots; W Calm
	0034	EOL-41, 08 54 20N, 79 01 00E
	0046	SOL-42, 08 54 54N, 79 01 21E
	0356	EOL-42, 08 46 11N, 78 46 20E
	0412	SOL-Patch 2, 08 47 04N, 78 45 35E
	0736	EOL-Patch 2, 08 39 13N, 78 31 40E
	1400	SOL-Patch 3, 08 38 16N, 78 36 27E
	1412	EOL-Patch 3, 08 38 01N, 78 37 25E
	1430	Problem imMultibeamcentre beam/swath
	1500	System restarted multiple times
	1525	Noticed KTK-10 Capicitor fuse blown off.
	1600	System restarted after replacing fuse. Issue with MBES persists.

	2100	System shutdown.
04/09/2017	@0230	08 42 30N, 79 03 20 E, SOG 4.5; COG 088; D 414 m; WS 15 knots; W Calm
	0100	System restarted, issue not solved.
	0115	Transit to CTD/SVP_03
	0720	Cast CTD/SVP_03, 08 32.848N, 78 56.302E
	0837	CTD/SVP_03 onboard
	0930	Multibeam Survey Standby
Issue not solved. Awaiting for reply from Norinco, Chennai and OEM Engineer. Test lines run in different directions to check the influence of heading in data quality. Trying to cover patches in N-S / S-N direction.		
05/09/2017	@0230	08 42 28N, 78 44 11 E, SOG 3.7; COG 230; D 1670 m; WS 12 knots; W Calm
06/09/2017	@0230	08 47 24N, 79 11 12 E, SOG 2.3; COG 148; D -; WS 14 knots; W Cloudy
	0415	Cast CTD/SVP_04, 08°45.57 N , 79°11.23 E
	0513	CTD/SVP_04 onboard
07/09/2017	@0230	08 18 05N, 78 32 42 E, SOG In DP mode; COG 220; D 1252; WS 18 knots; W Cloudy
OEM Engineer Mr. Brockhoff responded to the MB issues. Followed the instructions as per the mail. Still the issues couldn't be resolved. Reverted back a detailed technical report.		
	0145	Cast CTD/SVP_05, 08°18.09 N, 78°32.75 E
	0250	CTD/SVP_05 onboard
	1045	Cast CTD/SVP_06, 08°38.790N, 78°48.869E
	1130	CTD/SVP_06 onboard
08/09/2017	@0230	08 12 54N, 78 43 24 E, SOG 1.7; COG 226; D -; WS 20 knots; W Cloudy
	0515	Cast CTD/SVP_07, 08°10.572N, 78°43.486E
	0605	CTD/SVP_07 onboard
Vessel called for port for better shore support. After discussion with Master and NCAOR, scheduled arrival at Tuticorin port was postponed to 11 <sup>th</sup> September, 2017.		
09/09/2017	@0230	07 37 30N, 78 17 48 E, SOG 4.3; COG 244; D -; WS 21 knots; W Cloudy
	0944	Cast CTD/SVP_08, 07°30.662N, 78°02.854E
	1050	CTD/SVP_08 onboard
Survey Completed. Vessel heading to Tuticorin Port.		

## 2. CTD/SVP Data Collection

SVP/CTD						
SI No	Date	Time UTC	Depth(m)	Latitude	Longitude	Filename/Folder name
1	18.08.2017	09:17	902m	08°44.376N	78°45.480E	SVP1_18082017
2	26.08.2017	07:47	1382m	08°00.136N	78°32.146E	SVP2_26082017
3	04.09.2017	01:15	1256m	08°32.848N	78°56.302E	SVP3_04092017
4	06.09.2017	04:15	1089m	08°45.574N	79°11.230E	SVP4_06092017
5	07.09.2017	01:45	1252m	08°18.090N	78°32.756E	SVP5_07092017
6	07.09.2017	10:45	1089m	08°38.790N	78°48.869E	SVP6_07092017
7	08.09.2017	05:15	1532m	08°10.572N	78°43.486E	SVP7_08092017
8	09.09.2017	09:44	1436m	07°30.662N	78°02.854E	SVP8_09092017

### 3. Logsheet

Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Dept h(m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
Roll1	09.08.20 17	21:35	2189	07 07 37	78 14 53	SK341_ROLL_20170 80921339	10.08.20 17	0:38	2249	07 21 25	78 30 01	SK341_ROLL_2017080921 339
Roll2	10.08.20 17	1:24	2252	07 21 24	78 30 04	SK341_ROLL_20170 810012341	10.08.20 17	6:03	2162	07 60 18	78 13 65	SK341_ROLL_2017081001 2341
Roll3	10.08.20 17	6:30	2188	07 16 38	78 14 46	SK341_ROLL_20170 810061332	10.08.20 17	9:13	2250	07 21 36	78 13 37	SK341_ROLL_2017081006 1332
Cross 1	18.08.20 17	13:21	833	08 44 40	78 46 03	Cross1- 201718Aug132113	18.08.20 17	16:53	618	08 55 39	79 02 11	Cross1- 201718Aug163840
Line 1	18.08.20 17	16:54	628	08 55 38	79 02 17	Line1- 201718Aug165427	18.08.20 17	20:50	467	08 55 00	79 23 12	Line1-201718Aug203459
Line 2	18.08.20 17	21:00	500	08 54 34	79 23 24	Line2- 201718Aug2120023	19.08.20 17	1:42	593	08 55 07	79 01 31	Line2-201719Aug012425
Line 3	19.08.20 17	1:45	612	08 54 46	79 01 30	Line3- 201719Aug014800	19.08.20 17	5:53	400	08 53 39	79 25 20	Line3-201719Aug054719

Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Dept h(m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
Cross 2	19.08.20 17	9:02	1001	08 47 32	79 15 43	Cross2- 201719Aug090253	20.08.20 17	2:25	698	07 59 08	78 17 36	Cross2- 201720Aug022115
Line 4	20.08.20 17	2:26	664	07 59 10	78 17 30	Line4- 201720Aug022626	20.08.20 17	8:23	177	08 31 55	78 25 06	Line4-201720Aug082000
Line 5	20.08.20 17	8:43	185	08 33 05	78 25 47	Line5- 201720Aug084329	20.08.20 17	8:43	185	08 33 05	78 25 47	Line5-201720Aug084329
Line 7	20.08.20 17	17:44	789	08 00 04	76 19 41	Line7- 201720Aug174427	21.08.20 17	1:30	343	08 33 39	78 27 11	Line7-201721Aug012330
Line 8	21.08.20 17	2:10	358	08 34 52	78 28 26	Line8- 201721Aug020348	21.08.20 17	10:06	887	07 58 59	78 20 33	Line8-201721Aug094137
Line 6	21.08.20 17	10:51	795	07 59 06	78 19 07	SK341-Line6- 201721Aug105113	21.08.20 17	18:50	993	08 32 59	78 26 29	SK341-Line6- 201721Aug105113
Line 9	21.08.20 17	21:03	627	08 33 10	78 29 04	SK341-Line9- 201721Aug210334	22.08.20 17	4:10	931	07 59 27	78 21 36	SK341-Line9- 201722Aug041929
Line 10	22.08.20 17	5:20	1026	07 59 30	78 23 10	SK341-Line10- 201721Aug052117	23.08.20 17	19:42	641	08 37 15	78 31 06	SK341-Line10- 201723Aug193947
Line 11	23.08.20 17	20:25	437	08 39 50	78 32 23	SK341-Line11- 201723Aug202109	24.08.20 17	3:31	1069	07 59 30	78 24 02	SK341-Line11- 201724Aug030654
Line 12	24.08.20	4:01	1103	07 52 30	78 24 02	SK341-Line12-	24.08.20	11:25	601	08 39 55	78 34 03	SK341-Line12-



Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
	17					201724Aug040141	17					201724Aug111303
Line 13	24.08.20 17	11:51	526	08 41 14	78 24 02	SK341-Line13- 201724Aug115129	24.08.20 17	19:04	1149	07 59 32	78 26 16	SK341-Line13- 201724Aug184802
Line 14	24.08.20 17	20:02	1197	07 59 41	78 27 23	SK341-Line14- 201724Aug200223	25.08.20 17	3:41	457	08 42 14	78 36 38	SK341-Line14- 201725Aug033038
Line 15	25.08.20 17	4:17	309	08 44 37	78 37 21	SK341-Line15- 201725Aug041657	25.08.20 17	11:33	1243	07 59 42	78 28 34	SK341-Line15- 201725Aug112555
Line 16	25.08.20 17	11:58	1290	07 59 42	78 29 34	SK341-Line16- 201725Aug115654	25.08.20 17	21:30	396	08 45 55	78 39 39	SK341-Line16- 201725Aug211742
Line 17	25.08.20 17	21:52	452	08 46 09	78 40 52	SK341-Line17- 201725Aug215155	26.08.20 17	5:28	1336	07 59 43	78 30 40	SK341-Line17- 201726Aug051430
Line 10B	26.08.20 17	19:09	1020	08 00 43	78 23 32	SK341-Line10B- 201726Aug190933	27.08.20 17	1:00	915	08 29 26	78 29 39	SK341-Line10B- 201727Aug005505
Line 9A	27.08.20 17	1:15	740	08 31 10	78 29 47	SK341-Line9A- 201727Aug005505	27.08.20 17	2:00	561	08 35 28	78 29 47	SK341-Line9A- 201727Aug014025
Patch	27.08.20 17	2:11	499	08 36 44	78 30 24	SK341-Patch- 201727Aug021142	27.08.20 17	4:37	365	08 48 20	78 41 30	SK341-Patch- 201727Aug042706
Line 18	27.08.20 17	4:49	403	08 48 33	78 42 36	SK341-Line18- 201727Aug044935	27.08.20 17	15:53	1378	07 59 03	78 31 38	SK341-Line18- 201727Aug153725

Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Dept h(m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
Line 19	27.08.20 17	16:26	1404	07 58 08	78 32 16	SK341-Line19- 201727Aug165712	28.08.20 17	2:15	481	08 48 59	78 43 49	SK341-Line19- 201728Aug020419
Line 20	28.08.20 17	2:40	363	08 50 12	78 44 44	SK341-Line20- 201728Aug023714	28.08.20 17	13:45	1456	07 59 50	78 34 05	SK341-Line20- 201728Aug132533
Line 21	28.08.20 17	14:17	1490	07 59 53	78 35 29	SK341-Line21- 201728Aug141753	29.08.20 17	0:00	357	08 50 25	78 46 20	SK341-Line21- 201728Aug235033
Line 22	29.08.20 17	2:18	532	08 54 18	79 00 08	SK341-Line22- 201729Aug021742	29.08.20 17	6:52	471	08 53 17	79 24 57	SK341-Line22- 201729Aug064737
Line 23	29.08.20 17	7:18	542	08 53 01	79 23 18	SK341-Line23- 201729Aug065951						
Line 24	29.08.20 17	11:18	646	08 50 39	79 25 17	SK341-Line24- 201729Aug111938	29.08.20 17	19:30	1377	08 27 42	78 57 02	SK341-Line24- 201729Aug192958
Line 25	29.08.20 17	20:17	1347	08 28 43	78 56 33	SK341-Line18- 201729Aug201655	30.08.20 17	3:00	62	08 53 19	79 27 43	SK341-Line25- 201730Aug032429
Line 26	30.08.20 17	3:24	76	08 53 22	79 25 55	SK341-Line26- 201730Aug032429	30.08.20 17	9:46	1304	08 30 20	78 56 53	SK341-Line26- 201730Aug093252
Line 27	30.08.20 17	10:24	1294	08 30 53	78 56 32	SK341-Line27- 201730Aug095802	30.08.20 17	15:46	698	08 51 54	79 22 24	SK341-Line27- 201730Aug153924
Line 28	30.08.20	15:57	678	08 52 34	79 21 28	SK341-Line28-	30.08.20	21:38	1262	08 32 15	78 55 46	SK341-Line28-

Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Dept h(m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
	17					201730Aug155710	17					201730Aug213356
Line 29	30.08.20 17	22:11	1252	08 32 35	78 54 27	SK341-Line29- 201730Aug221138	31.08.20 17	3:30	1048	08 41 37	79 05 41	SK341-Line29- 201731Aug032256
Line 30	31.08.20 17	3:48	710	08 53 11	79 18 47	SK341-Line30- 201731Aug034851	31.08.20 17	10:32	1242	08 33 07	78 53 22	SK341-Line30- 201731Aug101324
Line 31	31.08.20 17	11:00	1260	08 33 00	78 51 44	SK341-Line31- 201731Aug105907	31.08.20 17	16:35	705	08 53 06	79 17 40	SK341-Line31- 201731Aug161028
Line 32	31.08.20 17	16:56	691	08 54 06	79 16 33	SK341-Line32- 201731Aug165549	31.08.20 17	23:30	1245	08 33 29	78 50 31	SK341-Line32- 201731Aug232252
Line 33	01.09.20 17	00:00	1229	08 34 20	78 49 44	SK341-Line33- 201731Aug165549	01.09.20 17	5:35	780	08 53 48	79 14 19	SK341-Line33- 201701Sep051350
Line 34	01.09.20 17	6:00	756	08 53 44	79 12 32	SK341-Line34- 201701Sep055200	01.09.20 17	10:45	1192	08 34 49	78 48 30	SK341-Line34- 201701Sep102544
Line 35	01.09.20 17	11:12	1168	08 35 03	78 47 06	SK341-Line35- 201701Sep111239	01.09.20 17	17:00	800	08 54 04	79 10 52	SK341-Line35- 201701Sep163857
Line 36	01.09.20 17	17:02	790	08 54 09	79 09 35	SK341-Line36- 201701Sep170244	01.09.20 17	22:00	1085	08 35 50	78 46 28	SK341-Line36- 201701Sep215506
Line 37	01.09.20 17	22:37	1060	08 35 50	78 44 11	SK341-Line37- 201701Sep223729	02.09.20 17	4:14	649	08 54 05	79 07 40	SK341-Line37- 201702Sep035629

Line No	Beginning of Line						End of Line					
	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename	Date	Time (UTC)	Depth (m)	Latitude	Longitude	Filename
Line 38	02.09.20 17	4:36	639	08 54 09	79 06 02	SK341-Line38- 201702Sep043507	02.09.20 17	9:14	1043	08 36 27	78 43 37	SK341-Line38- 201702Sep090513
Line 39	02.09.20 17	9:45	1013	08 35 15	78 41 38	SK341-Line39- 201702Sep094544	02.09.20 17	14:52	641	08 54 12	79 04 20	SK341-Line39- 201702Sep143011
Line 40	02.09.20 17	15:11	680	08 54 37	79 03 06	SK341-Line40- 201702Sep151109	02.09.20 17	19:53	960	08 39 80	78 43 18	SK341-Line40- 201702Sep194707
Line 41	02.09.20 17	20:12	930	08 39 29	78 42 36	SK341-Line41- 201702Sep201213	03.09.20 17	0:34	618	08 54 20	79 01 00	SK341-Line41- 201703Sep002831
Line 42	03.09.20 17	0:46	599	08 54 54	79 01 21	SK341-Line42- 201703Sep004139	03.09.20 17	3:56	744	08 46 11	78 46 20	SK341-Line42- 201703Sep034943

#### 4. Sediment Sampling

Sediment Sampling Details							
Sl No.	Sample No.	Date	Time UTC	Depth(m)	Latitude	Longitude	Remarks
1	GRAB_01	18.08.2017	22:54	1100m	08°30.210N	78°36.480E	Greenish Grey soft silty CLAY with shell fragments
2	GRAB_02	26.08.2017	18:10	1475m	08°00.19N	78°33.06E	Greenish Grey silty CLAY with fine SAND

#### 5. Multibeam Calibration (Roll)

Sea trail as part of cruise SK341 was selected to perform the roll calibration. A 30 km long line was selected over a nearly flat patch of seafloor around 2200 m water depth. Prior to actual data acquisition a current sound velocity profile was measured. The profile reached down to approximately 2100 m. The sound velocity profile (SVP) was loaded in HydroStar Online, and then the previous Roll Offset in the HydroStaronline's ship parameter file was set to 0.0°.

- Location of SVP : 7° 13.062' N, 78° 12.281' E
- Name of SVP File : SVP.tsv
- SSV at location of SVP : 1539.7 m/s
- Run Line Start Point : 7° 16' 37.17 N, 78° 14' 53.43 E
- Run Line End Point : 7° 21' 25.03 N, 78° 30' 01.28 E
- Name of 1<sup>st</sup> File : sk341\_ROLL\_20170809213339
- Name of 2<sup>nd</sup> File : sk341\_ROLL\_20170810012341

The line was surveyed on course and counter course, each direction was logged to one file. Both files were loaded into CARIS Hips & Sips processing software. The files were loaded, cleaned, the SVP was associated with the files and then the data was loaded into the module.

The module requires that a rectangular area is marked covering the area covered by both files. In the following the software varies the roll offset in user defined interval and an increment. For each increment the software outputs the average error that results for the specific roll offset along a line parallel to the center line. The general idea is that the average error is minimal for the correction roll offset.

The minimum was calculated for 4 different distances from the planned track: -3000 m, -1500m, 1500m, 3000 m.

The results are as follows:

Offset from Center [m]	Roll [°]	Average Roll Offset [°]	Std. Dev Roll Offset [°]
-3000 m	+0.13	+0.12	0.008
-1500m	+0.12		
+1500 m	+0.11		
+3000 m	+0.12		

\*Table 1: Summary of Roll Calibration.

Since the standard deviation of all 4 values is considerably below the standard deviation of the motion sensor onboard (0.03°) the calibration results are good.