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# OUTPOST SUNRISE QUICK LOOK REPORT



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<p>→ The Office of Naval Research ASW Environmental Acoustic Support (AEAS) Program sponsored a deep-ocean ambient noise measurement exercise in the eastern Pacific Ocean from 3 to 17 October 1988. The operation was designed to measure low frequency, wind generated, ambient noise mechanisms and levels in the ocean. The acoustic and supporting environmental data acquired can be analyzed to support design and development of new ASW systems and to validate the Ambient Noise Directionality Estimation System (ANDES) computer model. This report describes the equipment used to acquire the acoustic and environmental data and gives a quick look summary of the data acquired.</p> <p><i>thin sediment bottom. (KR)</i> ← <i>Keywords: wind noise</i></p>					
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## **OUTPOST SUNRISE - QUICK LOOK REPORT EXECUTIVE SUMMARY**

The Office of Naval Research ASW Environmental Acoustic Support (AEAS) Program sponsored a deep-ocean ambient noise measurement exercise in the eastern Pacific Ocean from 3 to 17 October 1988. The operation was designed to measure low frequency, wind generated, ambient noise mechanisms and levels in the ocean. The acoustic and supporting environmental data acquired can be analyzed to support design and development of new ASW systems and to validate the Ambient Noise Directionality Estimation System (ANDES) computer model.

*M/V INDEPENDENCE* was used to deploy three Versatile Experimental Data Acquisition Buoy Systems (VEDABS), acoustic projectors, a horizontal line array, two oceanographic/meteorologic buoys, SUS charges, XBT's and CTD's. Maritime aircraft were deployed from VP-46 to conduct shipping surveillance, oceanic temperature and ambient noise measurements, and SUS deployments.

The VEDABS, one configured with both vertical and horizontal components resulting in an **L-shaped** array and two each configured as vertical (**I-shaped**) arrays, were deployed on the ocean bottom at two sites (S and Q) some 140 Km apart in a water depth of 4300 meters.

*USNS TRIUMPH* (TAGOS-4) was outfitted with the Fault Location and Performance (FLAP) system and recorded ambient noise data at an array depth of 520 meters.

A summary of data acquired at each site is shown below:

	<u>Ambient Noise</u>	<u>CW*</u>	<u>SUS**</u>
Site S (41N/136-28W)			
<b>L-shaped</b> Array	68 hours	12 hours	18 hours
<b>I-shaped</b> Array	63 hours	30 hours	24 hours
met/ocean buoy - 12 days			
Site Q (42-10N/135-30W)			
<b>I-shaped</b> Array	60 hours	12 hours	26 hours
met/ocean buoy - 6 days			
In vicinity of S and Q			
SURTASS	335 hours	30 hours	26 hours
Maritime Patrol Aircraft	71 hours		

In addition to the primary objectives of ambient noise measurements made under a variety of wind/wave conditions and shipping densities, projector operations were also used by COSP for processing and bearing tests and NOSC in support of the High Gain Initiative (HGI).

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\* CW projector tows were for analysis of propagation loss, and signal and array gain

\*\* SUS charges were used to determine arrival structure, bottom loss, and propagation loss

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## SECTION 1 - INTRODUCTION

This Quick Look Report summarizes the key events of and data acquired during OUTPOST SUNRISE. A detailed operations summary and data analysis plan are forthcoming in the Final Report.

### **1.1 Objectives**

OUTPOST SUNRISE was designed to be a detailed scientific measurement and analysis program to determine the low frequency, wind generated, ambient noise mechanisms and levels in an ocean area having a thin sediment bottom. Several very low frequency (VLF) experiments were also conducted to collect VLF ambient noise data from a variety of arrays. After analysis, the acoustic data acquired will support design and development of new ASW systems, the validation of the Ambient Noise Directionality Estimation System (ANDES) computer model, and other research efforts including the study of:

- low frequency horizontal and vertical ambient noise directionalities,
- low frequency ambient noise omnidirectional levels,
- low frequency ambient noise spatial and temporal statistics,
- thin sediment propagation and bottom loss,
- thin sediment vertical arrival structure,
- low frequency signal field structure and coherence,
- signal and array gain,
- environmental parameters, and
- VLF characteristics.

The measurement location and schedule were selected to maximize the probability of obtaining extreme variations in shipping noise and wind/wave intensity over the data acquisition period. The exercise was conducted from 3 to 17 October 1988 in the area shown in Figure 1.

### **1.2 Participating Organizations**

OUTPOST SUNRISE was sponsored by the Office of Naval Research ASW Environmental Acoustic Support (AEAS) Program. Primary responsibility for exercise planning and execution was assigned to the Naval Ocean Research and Development Activity (NORDA). NORDA provided the Chief Scientist and scientific crew aboard *M/V INDEPENDENCE*. It also provided the data acquisition equipment and instrumentation, the Towed Oceanographic Sound Source (TOSS) and extensive support in the planning, installation and execution of the exercise. The Exercise Director was provided by the Naval Ocean Systems Center (NOSC). The Naval Air Development Center (NADC) provided technical crew and the ELF acoustic projector.

During the exercise, operational support was provided by COMPATWINGTEN, PATRON 46, TAGOS-4, NOCD NAS Moffett Field, COMOCEANSYSPAC, and COMSUBPAC. Additional contractor support was provided by: ARL:UT, B-K Dynamics, Planning Systems Inc., Science Applications International Corp., SYNTEK Engineering, and Systems Integrated.

### **1.3 Report Organization**

This report contains the following sections: Section 2 - Measurement and Data Acquisition Equipment, Section 3 - Data Acquisition, and Section 4 - Summary.

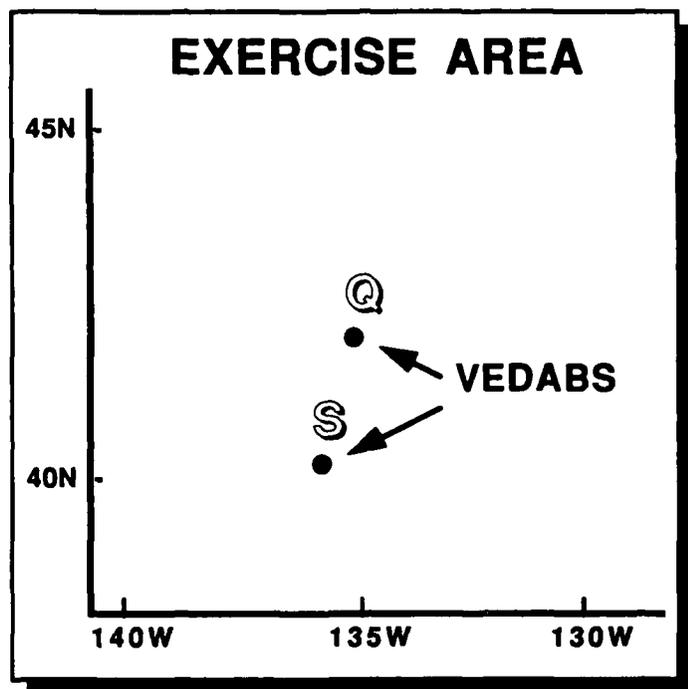


Figure 1. OUTPOST SUNRISE EXERCISE AREA

## SECTION 2 - MEASUREMENT AND DATA ACQUISITION EQUIPMENT

This section of the report describes the measurement and data acquisition equipment used to acquire acoustic and environmental data during OUTPOST SUNRISE.

### **2.1 Acoustic Data Acquisition**

The primary acoustic measurement system was the Versatile Experimental Data Acquisition Buoy System (VEDABS). VEDABS is a self-recording, sub-surface, bottom-moored ocean acoustic measurement system. Its acoustic bandwidth is 10 Hz to 1000 Hz with a dynamic range of 30 to 40 dB.

#### **VEDABS**

The VEDABS, one configured with both vertical and horizontal components resulting in an L-shaped array and two each configured as vertical arrays (I-shaped), were deployed at two sites (S and Q) 140 Km apart in a water depth of 4300 meters. Specific locations were:

Site S I-shaped VEDABS - 41-00.7N/136-28.2W  
Site S L-shaped VEDABS - 41-01.8N/136-27.7W  
Site Q I-shaped VEDABS - 42-10.7N/135-30.0W.

Schematics of the two mooring configurations for VEDABS are shown in Figure 2. VEDABS Configuration 1, the L-shaped array, consisted of two components: a vertical component with a nested array of 24 hydrophones cut for 75/150 Hz spacing and a horizontal component with a nested array of 26 hydrophones cut for 75/150 Hz spacing. The vertical component had one additional hydrophone placed in the deep sound channel (DSC). Both vertical and horizontal components were connected at the Instrumentation Pressure Vessel (IPV).

VEDABS Configuration 2, the I-shaped array, consisted of a nested array of 23 hydrophones cut for 75/150 Hz spacing with one additional hydrophone placed in the DSC and the 25th hydrophone of the vertical array placed on the ocean bottom.

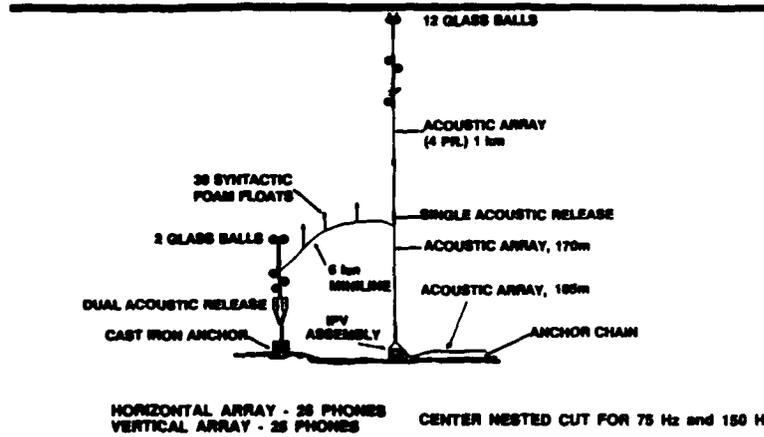
Each VEDABS was programmed for six days (144 hours) of continuous recording. The I-shaped array at Site S had a preprogrammed six-day delay in "turn on".

#### **SURTASS**

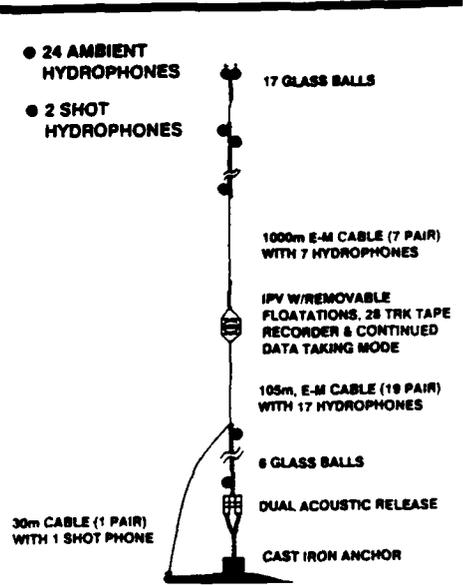
USNS TRIUMPH (TAGOS-4) was outfitted with the Fault Location and Performance (FLAP) system to record hydrophone levels and beam noise during operations in the vicinity of sites S and Q. Prior to the arrival of M/V INDEPENDENCE into the exercise area, USNS TRIUMPH performed four complete nine-sided polygons: two polygons in the northern sector and two polygons in the southern sector of the exercise area. USNS TRIUMPH remained in the area during the exercise acquiring ambient noise data and monitoring signals while acoustic projectors were being operated.

**OUTPOST SUNRISE  
Mooring Configuration Schematic**

**VEDABS CONFIGURATION 1**



**VEDABS CONFIGURATION 2**



VERTICAL ARRAY  
CONSISTS OF 24 PHONES - CENTER NESTED CUT FOR 75 Hz and 150 Hz

Figure 2. VEDABS MOORING CONFIGURATIONS FOR OUTPOST SUNRISE

## **SONOBUOYS**

Patrol Squadron VP-46 provided nine dedicated flights deploying calibrated sonobuoys for ambient noise data acquisition. The following sonobuoys were used:

<u>Number</u>	<u>Type</u>
39	AN/SSQ-53B (DIFAR)
116	AN/SSQ-57A (LOFAR)
13	AN/SSQ-77 (VLAD)

## **2.2 Environmental Data Acquisition**

### **BATHYMETRY**

The bathymetric system installed aboard *M/V INDEPENDENCE* by NORDA consisted of a bracket-mounted 12 kHz transducer (Edo Western Model 323HP) and a Raytheon LSR-1811 Line Scan Reader. Site surveys were performed at sites S and Q prior to VEDABS deployments.

### **METEOROLOGY**

Enviro Labs weather logging gear was mounted on *M/V INDEPENDENCE* to record wind speed, wind direction, air temperature and barometric pressure. The meteorologic data were measured every 60 seconds and logged as 15 minute block averages. The standard ship meteorologic data consisting of wind speed, wind direction, air temperature, barometric pressure, sea height and sea direction were manually recorded every four hours. The wind speed and sea height were converted to Sea State and Beaufort Scale values. Regional weather information from National Weather Service, San Francisco was received by *M/V INDEPENDENCE* daily.

Two meteorologic/oceanographic buoys fitted with drogue chutes were deployed, one at each Site S and Q. The buoys were capable of measuring air temperature, sea temperature, wind direction, wind speed and barometric pressure. Buoy data were transmitted ashore (to France) via the ARGOS satellite system and are being sent to NORDA.

National Data Buoy Center (NDBC) buoy #46006 is situated in the south central portion of the exercise area. Data on air temperature, sea surface temperature, wind direction, wind speed, barometric pressure, wave height and direction for that site were recorded.

### **OCEANOGRAPHY**

Shipboard water column measurements for conductivity-temperature-depth (CTD) were made aboard *M/V INDEPENDENCE* at each Site S and Q with the Ocean Data Equipment Model 302A profiling system downloaded to a Macintosh 512 computer.

A Sippican Mark-9 XBT system was used to measure bathythermograph data. A total of 33 expendable bathythermographs (XBT's) were dropped from *M/V INDEPENDENCE* during the course of the exercise.

A total of 148 airborne expendable bathythermographs (AXBT's) were deployed by maritime patrol aircraft during the exercise.

*USNS TRIUMPH* deployed a total of 42 XBT's at 12 hour intervals.

## **GEOLOGY**

A survey of the exercise area will be conducted by NAVOCEANO during December 1988. Core samples to six meters will be taken and analyzed at each Site S and Q and a seismic track will be recorded along a track between the two sites.

### **2.3 Sound Sources**

#### **ACOUSTIC PROJECTORS**

Two acoustic projectors were used during the exercise: the Towed Oceanographic Sound Source (TOSS) and the Extremely Low Frequency (ELF) projector. TOSS, consisting of two projectors (HX-29 and HX-231), and ELF generated continuous wave (CW) tones. Details on the frequencies and levels transmitted will be provided in the Final Report.

#### **DETONATIONS**

Mark 82 oceanographic R&D signal underwater sound (SUS) charges were dropped with a detonation depth of 1000 meters. *M/V INDEPENDENCE* dropped a total of 218 SUS, while maritime patrol aircraft dropped 72 SUS .

#### **SHIPPING**

Shipping surveillance was performed by maritime patrol aircraft during the nine dedicated flights using radar, IRDS and visual means. Photographs were taken of every contact within 100 Km of Sites S and Q during each flight. Logs of surface traffic were also maintained aboard *M/V INDEPENDENCE* and *USNS TRIUMPH* .

### **2.4 Summary of Operations**

A summary of activity and the general location of events are given in Figure 3. The tracks shown are those of *M/V INDEPENDENCE* .



## SECTION 3 - DATA ACQUIRED

This section of the report discusses the data acquired during OUTPOST SUNRISE.

### 3.1 VEDABS Data

The following table provides a summary of data recorded on the VEDABS:

<u>LOCATION</u>	<u>Ambient Noise</u>	<u>CW</u>	<u>SUS</u>
Site S			
L-shaped VEDABS	68 Hours	12 Hours	18 Hours
I-shaped VEDABS	63 Hours	30 Hours	24 Hours
Site Q			
I-shaped VEDABS	60 Hours	12 Hours	26 Hours

For the two I-shaped VEDABS, a recording bandwidth from 10 Hz to 1000 Hz was employed for each of 26 channels. Since the L-shaped VEDABS had two components, that tape recording employed a band shift where 25 channels for the vertical component were recorded at 10 Hz to 300 Hz and 26 channels for the horizontal component were recorded for 10 Hz to 300 Hz but recorded on the tape at 610 Hz to 900 Hz. This was the first time that a vertical and horizontal (L-shaped) array have been deployed from and recorded in the same IPV. A total of 576 hours of data is recorded on the three tapes.

### 3.2 Aircraft Data

The following table provides a summary of data recorded by maritime patrol aircraft:

<u>Number</u>	<u>Type</u>
148	AN/SSQ-36 (AXBT)
39	AN/SSQ-53B (DIFAR)
116	AN/SSQ-57A (LOFAR)
13	AN/SSQ-77 (VLAD)

Ambient noise data were recorded on EVCR (a total of 36 hours, 18 channel, low frequency data) and on M-14 tape (a total of 35 hours, 28 track, full frequency data).

Shipping surveillance was performed on each of the nine dedicated flights using radar, IRDS and visual means. During each flight photographs were taken of every contact within 100 Km of Sites S and Q.

### 3.3 SURTASS

A total of 335 hours of ambient noise data were recorded on the FLAP system aboard *USNS TRIUMPH*. These data were recorded during four complete nine-sided polygons and a standoff period while *M/V INDEPENDENCE* was in the exercise area.

Standard SURTASS USH-26 ( CMTU ) cassette tapes were also recorded during the cruise.

### 3.4 Projector Operations

The following table summarizes acoustic projector operations performed aboard *M/V INDEPENDENCE*:

<u>Source</u>	<u>Transmission</u>	<u>Period</u>
TOSS	CW	8 Hour
TOSS	CW (Dither)	19 Hours
ELF	CW	12 Hours
ELF	CW	15 Hours

These transmissions were monitored by VEDABS, SURTASS, sonobuoys, and bottomed arrays. Details on the frequencies and levels of transmission will be provided in the Final Report.

### 3.5 Environmental Data

#### **BATHYMETRY**

Bathymetric site surveys were performed at each VEDABS deployment site. At Site S, approximately 48 Km of 12 kHz data were recorded. A rough contour chart of the sound-speed corrected bathymetric data indicated bottom roughness to the south and southwest of Site S, while the remainder of the surveyed region appeared to be relatively flat. At Site Q, approximately 39 Km of 12 kHz data were recorded indicating a relatively flat bottom at and to the south of Site Q.

#### **METEOROLOGY**

A summary of wind and seas experienced aboard *M/V INDEPENDENCE* over the exercise period is shown in Figure 4. Shaded areas on Figure 4 indicate periods where a wide range of conditions were experienced for that period. Data recorded from remote oceanographic/meteorologic buoys deployed at each VEDABS site are in the process of being reduced and analyzed. The buoy deployed at Site S drifted 65.5 Km to the south-south-east during its 12 day excursion while the buoy deployed at Site Q drifted 11.3 Km to the north during its 6 days in the water. Data from NDBC buoy #46006, located 100 Km west-south-west of Site S and 214 Km southwest of Site Q, have been requested and should be available in February 1989.

#### **OCEANOGRAPHY**

Water column measurements taken at Sites S and Q are plotted in Figure 5. Both salinity and temperature plots versus depth were consistent with expected profiles for this oceanographically benign region. The lower salinity found at the surface is due to water carried into the region from arctic regions as part of the Subarctic Current. The mixed layer at the surface, extending down to 50 meters, was consistent with subsequent XBT casts and the calculated Ekman depths ranging from 38-111 meters for wind speeds of 12-35 knots, respectively. XBT casts taken at two-hour intervals during the initial phases of the exercise show very little variation from the profiles given in Figure 5 with the exception of slightly cooler surface mixed-layer temperatures in the northern part of the exercise area ( less than 18 degrees Celsius versus slightly greater than 18 degrees Celsius in the southern part ).

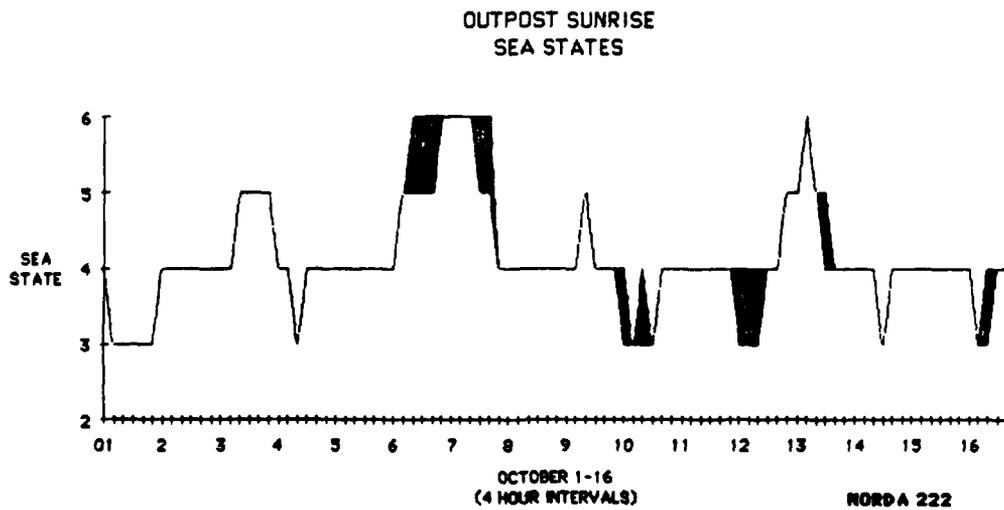
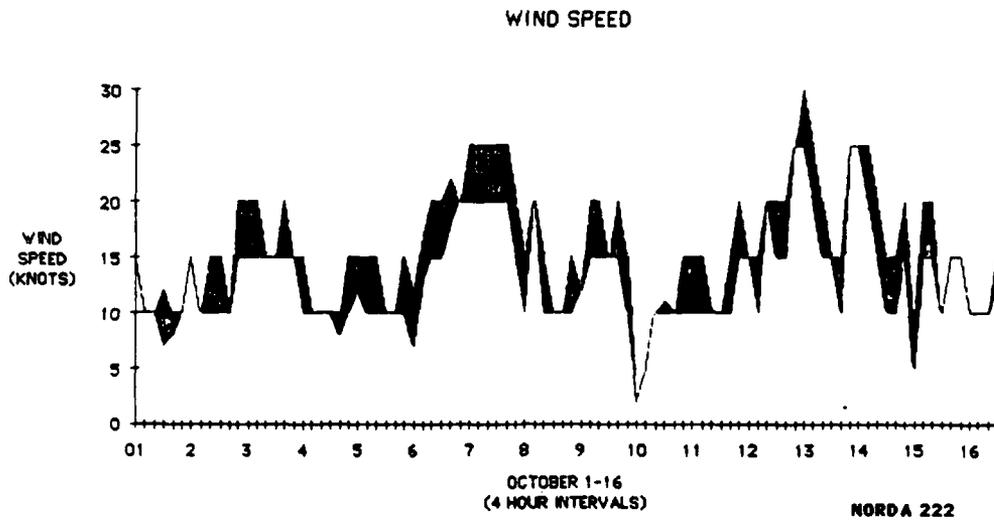


Figure 4. SUMMARY OF WIND AND SEA CONDITIONS ( AT SHIP LOCATION )\*

\* Shaded areas indicate periods when a wide range of conditions were observed

WATER COLUMN MEASUREMENTS AT SITE Q WATER COLUMN MEASUREMENTS AT SITE S

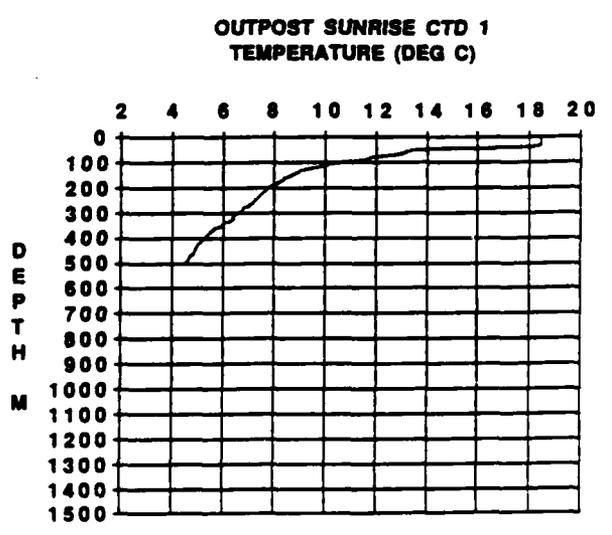
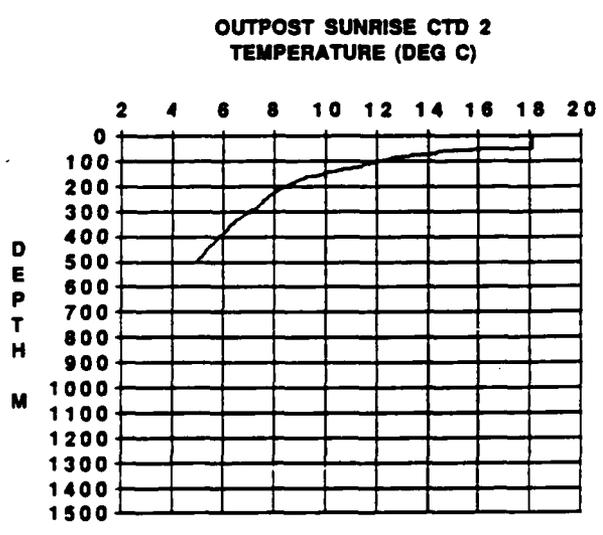
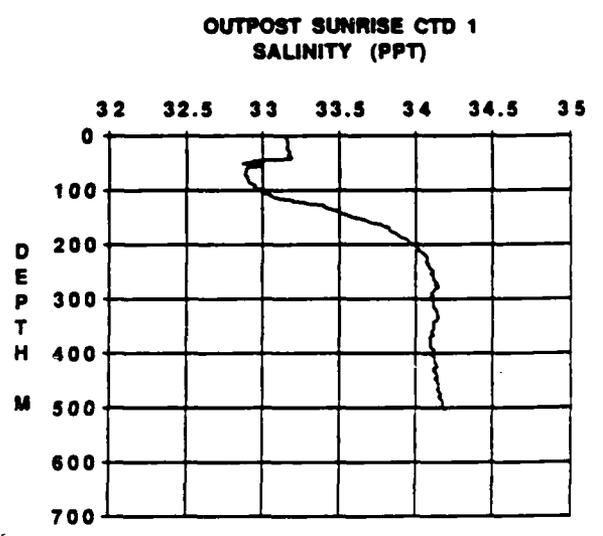
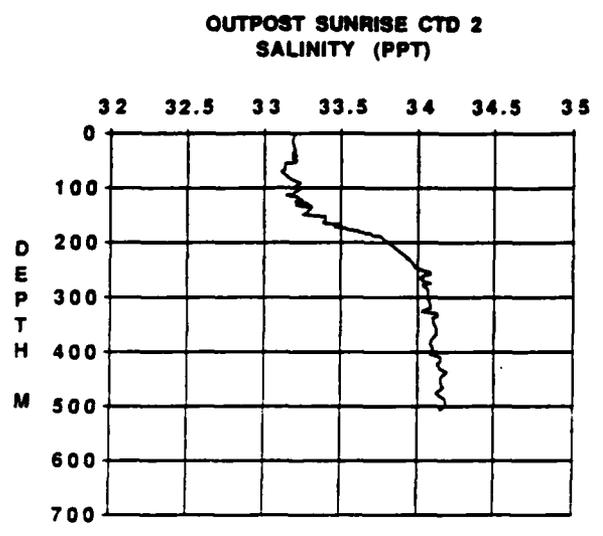


Figure 5. WATER COLUMN MEASUREMENTS

A period of low wind speeds, less cloud cover and subsequent surface warming was experienced on 10 October. XBT casts from 11 October indicate a resultant weakening of the surface mixed layer with some casts showing a decreased layer depth and a strengthened thermocline.

The Sound Speed Profiles shown in Figure 6 were obtained from the CTD casts at Sites Q and S. A general schematic of measurement locations is also given in Figure 6. The sound speed profiles indicate that the mixed layer at the surface results in a surface duct that may be significant for propagation of ship and wave noise. It is expected that the duct weakens or disappears after the relatively warm period on 10 October (approximately half-way through the exercise). The deep sound channel axis appears to be around 600 meters, although the profile does not extend to that depth. Salinity from these casts are being merged with deep XBT profiles to obtain a deeper sound speed profile.

At Site S, sound speeds below the mixed layer are 2-5 meters/second lower than those found at Site Q. When comparing the temperature and salinity plots for each site, it is seen that the temperatures in the surface mixed layer are slightly warmer for Site S as expected; however temperatures below this mixed layer are lower on the order of one degree Celsius. In addition, Site S displays a layer of very low salinity (32.8 ppt). This combined with the lower temperature indicates the presence of Subarctic water in the region of Site S. This could be caused by some mesoscale feature, such as, a cold core eddy or meander in the Aleutian (Subarctic) Current. The lower sound speeds and increased sound speed gradient present below the mixed layer at Site S may result in reduced surface reverberation for Site S compared to Site Q.

#### **SHIPPING**

Shipping surveillance conducted by VP-46 aircraft is reflected on the plotting sheets, logs and data tapes from each flight provided by COMPATWINGTEN. Ship sightings logged by *M/V INDEPENDENCE* and *USNS TRIUMPH* have also been recorded. A summary of merchant traffic submitting weather observations for the exercise area during the period has been requested from FNOC, Monterey. The combination of these data will be used to reconstruct surface ship tracks within the exercise area.

CTD 1 (SITE S)  
CTD 2 (SITE Q)  
SOUND SPEED (M/S)

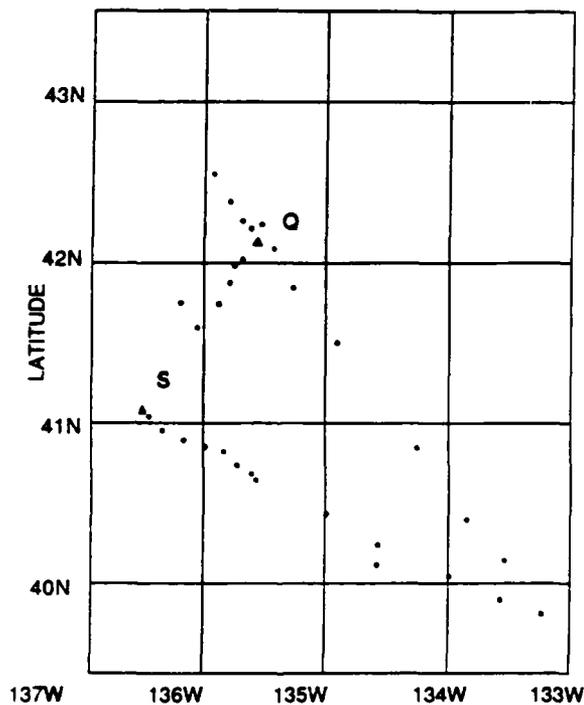
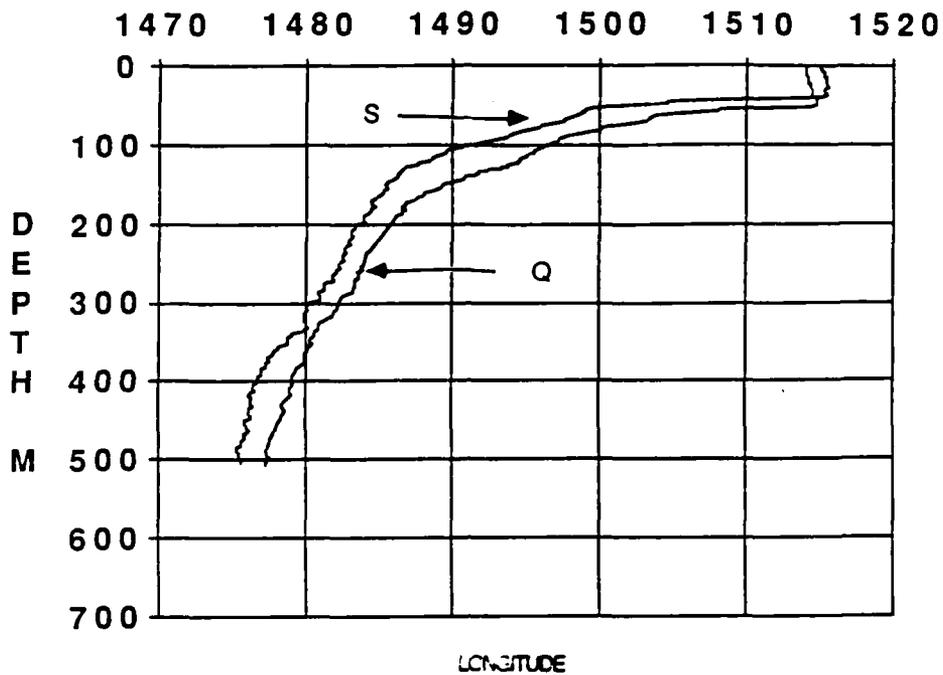


Figure 6. SOUND SPEED PROFILES AND LOCATIONS OF MEASUREMENTS

## SECTION 4 - CHRONOLOGICAL SUMMARY

A timeline depicting the data acquired over the exercise period is shown in Figure 7. The figure is used to correlate acoustic data with those periods when desired environmental conditions existed. The timeline will be used as a guide and refined during the reconstruction effort.





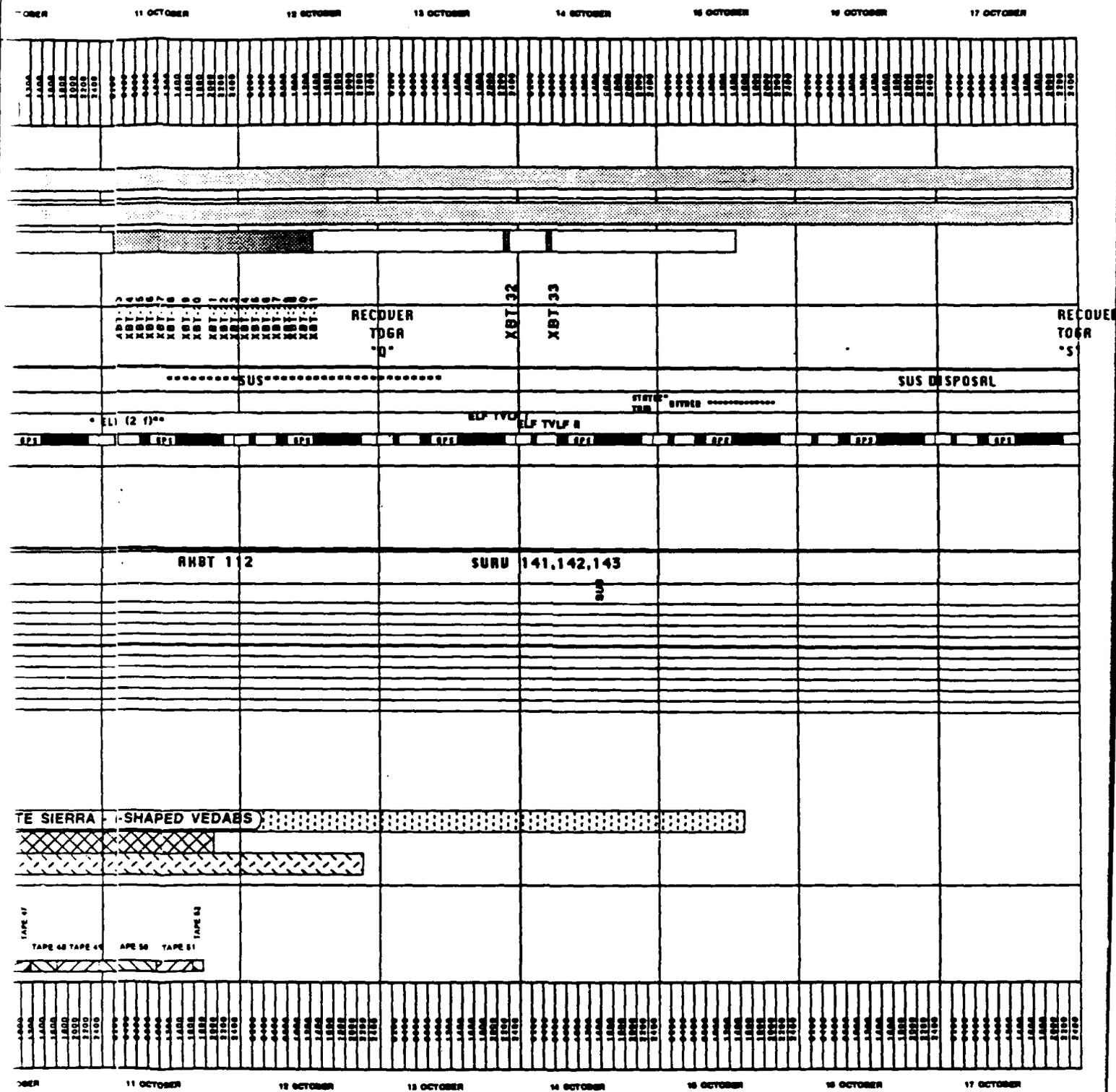


Figure 7. OUTPOST SUNRISE EVENT TIMELINE

3.2