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Geothermal Service of Canada

Service géothermique du Canada

ACQUISITION OF GEOTHERMAL DATA IN OFFSHORE WELLS

PHASE 1

Arctic Geotechnical Group

EBA Engineering Consultants Ltd.
Edmonton, Alberta

Earth Physics Branch Open File Number 82-14
Ottawa, Canada, 1982

41p & 61 p Appendices

Price/Prix: $46.50

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Abstract

This report describes a suite of equipment which could be used to monitor temperatures to depths of 1000 m in offshore abandoned hydrocarbon exploration drillholes. It describes feasible methods of deployment and recovery through both open-water and waters with perennial ice-cover. Both passive and acoustic telemetry data acquisition systems are considered.

Résumé

L'auteur décrit un équipement qui pourrait être utilisé pour observer des températures à des profondeurs de 1000 m dans des sondages sous-marins abandonnés ayant servi à la recherche d'hydrocarbures. Il explique des méthodes pouvant être employées pour mettre en place et récupérer le matériel en eaux libres et dans les eaux couvertes de glace pérenne. Il envisage des systèmes de saisie des données par voie passive et par télémétrie acoustique.

ACQUISITION OF GEOTHERMAL DATA IN OFFSHORE WELLS

PHASE I

Report to

ENERGY MINES AND RESOURCES, CANADA
EARTH PHYSICS BRANCH
OTTAWA, ONTARIO

by

EBA ENGINEERING CONSULTANTS LTD.
EDMONTON, ALBERTA

JUNE 1982

EXECUTIVE SUMMARY

This report describes a suite of equipment which will monitor temperatures in abandoned oil wells at least once per day over a period exceeding one year. Also described are methods of deployment and recovery considered feasible for both open-water areas and areas of perennial ice cover. Further, the report explores the use of available acoustic data telemetry systems as an alternative to equipment recovery from beneath ice cover in areas of low ice-drift. Cost estimates are presented for both the equipment and field operations.

The report recommends two specific pieces of "off-the-shelf" equipment that will be suitable for this task with little or no modification required. Several weak links still exist in the operational phases, but these may be overcome in High Arctic areas with low ice drift by developing a task-specific acoustic telemetry system.

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1.0 INTRODUCTION

1.1 Terms of Reference

The terms of reference for this report are given in the DSS contract OSQ81-00230 awarded to EBA Engineering Consultants Ltd., (EBA) by the Department of Supply and Services for Energy, Mines and Resources Canada, Earth Physics Branch (EMR) on March 26th, 1982. The report presents details of a suitable suite of data acquisition and retrieval equipment that provides a method of deployment of a thermistor cable and instruments at the time of well completion, and of retrieval of the data package a year or more later. The specifications supplied with the contract for this equipment are presented in Appendix A, Table A.1.

It is proposed that up to 1000 metres of thermistor cable, linking up to 16 thermistors, be placed into a subsea well after completion. This cable would be attached to a data acquisition system (DAS) which would monitor, at least once a day, the ambient temperature at each thermistor elevation. After a period of one year or longer, the data acquisition system would be retrieved using an acoustic release system (ARS), after parting the thermistor cable with an electro-mechanical device. At a meeting held between representatives of EMR and EBA on April 13th, EMR expressed a desire for supplemental information on subsea acoustic data telemetry systems. Consequently, this item has been added to the original terms of reference for this report.

1.2 Preparation of the Report

The sequence of preparation of this report is shown in Figure 2.1. This sequence largely follows that outlined in our proposal (EBA File No. P-6030).

A full chronology of companies and individuals contacted during the preparation of this report is included in Appendix A, Table A.2. A brief summary of discussions held at these pertinent meetings is also provided in Table. A.2

1.3 The Canada Oil and Gas Drilling Regulations

These regulations and their amendments control the way in which the oil and gas industry conducts drilling, completion, abandonment and/or suspension operations, both onshore and offshore. The regulations pertinent to this report appear in Part VIII, entitled "Well Termination". In general, this Part defines acceptable methods for casing removal and setting of concrete plugs in suspended, abandoned or completed wells.

Assuming that the thermistor cable will be deployed to a depth not exceeding the depth of the lowest casing shoe, casing removal and setting of the lower abandonment plugs will precede the deployment operation and will thus not interfere with it. However, a problem will arise if "a cement plug shall be placed on a bridge plug set at a depth of not more than 150 m below the seafloor" (Part VIII, Para. 210 (1) (h)). If this plug is set before cable

deployment, it would provide a barrier to the method of cable deployment envisioned in the text of this report. Discussions held with both operators and EMR concluded that, provided the quality of the lower abandonment plug is consistent with the regulations, its function is largely superfluous.

The feasibility of setting the abandonment plug after cable deployment or placing the cable between casings were both assessed and considered impracticable.

As the setting of abandonment plugs appears to be at the discretion of the conservation engineer (Part VIII, 210 (2)(a)), it is possible that the regulations could be relaxed in wells being considered by EMR for ground temperature instrumentation.

2.0 EQUIPMENT REVIEW

A block diagram of the components is presented in Figure 3.1 for reference.

2.1 Thermistor Cable

The exceptional length of thermistor cable specified (up to 1000 metres) requires that a specialist company be contracted for fabrication of this equipment. Although only one company has shown interest in building this equipment, it is thought that with a firm order for large lengths of the cable, several other companies might also compete for its supply.

The principal criterion for the design of the thermistor cable was cable diameter. It was felt necessary that, for deployment from a drum winch,

the minimum bend diameter be no greater than 0.76 m (30"); thus, the diameter of the cable could not exceed 25 mm (1"). Other important criteria were:

a) The ability to support the self-weight of 1000 metres of cable in air, through an external stress member;
b) The ability to withstand perforation of the outer sheath without inundation of the conductor core;
c) Light weight strengthening and armour (total weight in air no more than 50 kg/100 m length of cable);
d) Minimal heat conduction along the cable axis; and,
e) The ability to withstand freezing-in.

To a large extent, the ability to withstand freezing-in is allowed for by the safety factor inherent in criterion (a); that is, the reduction in the longitudinal strength required to support the self-weight air in drill mud from that required in air.

The basic cable specifications are shown in Figure 3.2

The major features of this cable are as follows (from the centre outwards);

a) An internal "kevlar" stress member of 5000 kN breaking strength, used for stiffening the cable, but not to be put under strain when the cable is deployed;
b) A twenty-conductor, No. 20 gauge, teflon-coated wire segment;
c) A "mylar" insulating sheath;
d) A braided foil shield; and

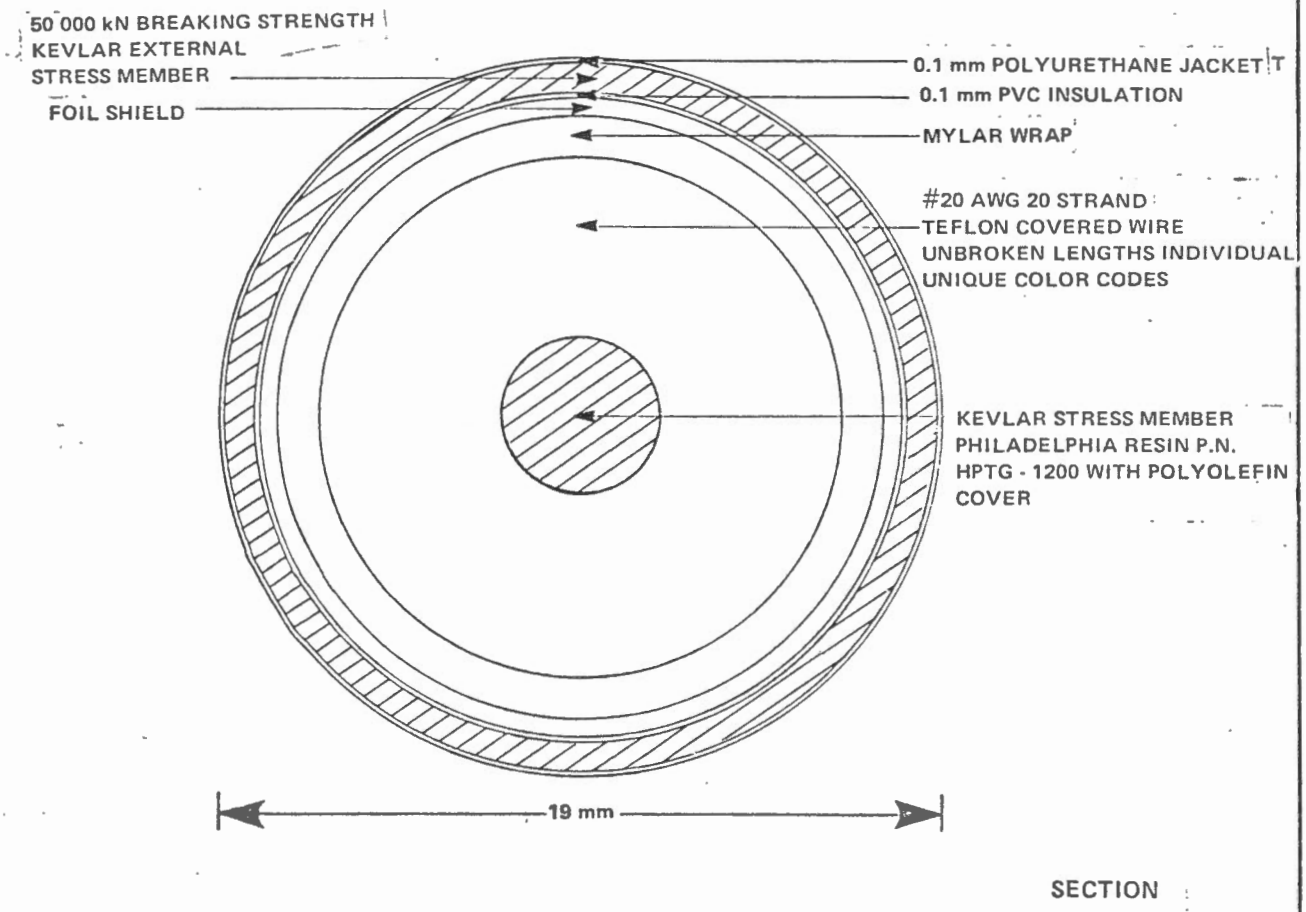


FIGURE 3.2 CONCEPTUAL DIAGRAM OF THERMISTOR CABLE

e) A 0.1 mm thick PVC sheath

These segments comprise the standard, fully waterproof, conductor core of the thermistor cable. Surrounding the conductor core are;

a) An external "kevlar" stress armouring member of 50 000 kN breaking strength. This sheath is the stress member that fully supports the weight of the cable when deployed and will terminate in a clevic at both the top and the bottom of the string.

b) An outer 0.1 mm thick polyurethane jacket to allow easy handling of the cable and provide abrasion protection for the "kevlar" member.

The thermistors (type YSI 44030 of 3K ohm nominal resistance) would be fully strain-relieved. The attachment process involves connecting the thermistors to the conductor core prior to enclosing the core in the armour and outer jacket. Each thermistor would be connected and set in an epoxy assembly. The cable would then be looped on either side of the thermistor so that cable strain cannot be transmitted to the electrical connections. Once connected, the epoxy assembly would be rejacketed. The armour and sheath layers would be pulled over the conductor core after all the thermistors have been installed.

Twenty-conductor cable is thought necessary for sixteen thermistors to provide redundancy on the neutral line to the thermistors, and to allow the coupling of reference resistors in the cable to monitor thermistor drift. "Kevlar" and "mylar", are both prestressed polyester fibres that provide strong, lightweight strengthening and insulating members. By avoiding metal-based armouring, the potential heat conduction along the cable,

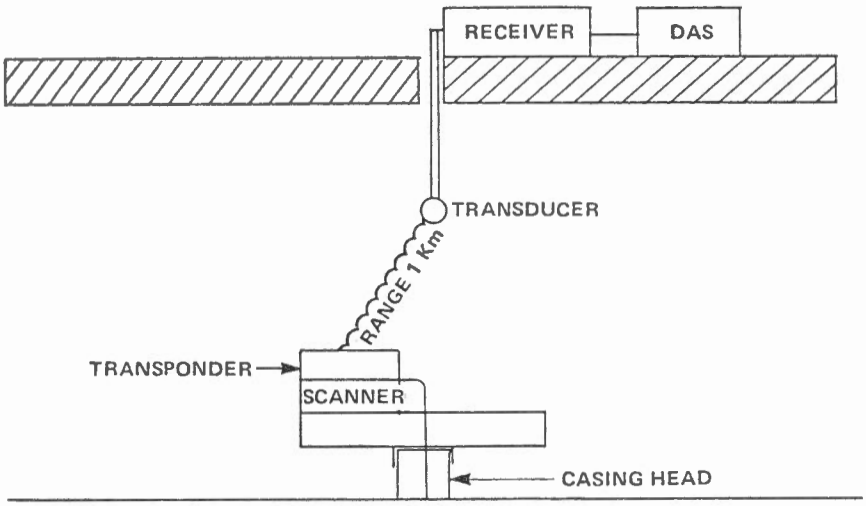
Once deployed, the operation of the DAS is threefold: it acts firstly as a scanner that interrogates each thermistor in turn and measures its resistance at some predetermined frequency; secondly, as an analog to digital interface that converts thermistor resistances to a digital format; and thirdly, as a data storage system recording thermistor resistances, along with a time code and reference number, in ten bit digital words. With 16 channels in operation logging the thermistor values, the 24 channels provide an additional eight channel capacity to record resistance values for reference resistors that record water temperatures at or near the sea bottom.

2.4 Acoustic Telemetry System (ATS)

For High Arctic drilling locations, recovery of an instrument package from beneath thick multi-year ice could prove to be a difficult task. An alternative procedure would be relaying data to the surface by acoustic telemetry. Figure 3.3 presents a schematic representation of a typical telemetry system. With this system, the data logger would be located on the surface and would communicate with a seabed unit by means of an acoustic transducer suspended well beneath the ice.

Installation of the seabed unit would follow a procedure that is described in Section 4. At the end of its useful life, no attempt would be made to recover the seabed telemetry unit. This unit must be capable of responding to an acoustic prompt by scanning all thermistors on the cable and relaying the readings to the surface acoustically. The surface unit would receive the readings and store them in the data logger in the same manner as for the submerged unit described in Section 3.2, although a surface data logger such as the Seadata 1250 logger described in Appendix B could be used instead of the underwater unit. Communication between the seabed and ice surface would be by means of an acoustic transducer/transponder suspended on a cable

NOT TO SCALE



MODE OF OPERATION

1. Sentry Mode
   Seabed unit on standby

2. Receiver Interrogate
   Surface receiver "wakes up" seabed unit, at least once per day

3. Data Scan and Transmission
   Seabed unit scans 16 channels and transmits data to receiver

4. Data storage
   Data acquisition system stores data

5. After suitable period of time, DAS removed or replaced with helicopter support

FIGURE 3.3 TELEMETRY BENEATH THE ICE

beneath the ice surface. To reduce the potential effects of interference by signals reflected from the sea bottom, the seabed transducer should be tethered at least 5 m above the native seabed.

Problems with data telemetry through layered media, be this layering due to salinity or temperature stratification, are well documented. It is hoped, however, that the slow rate of data transmission (close to once per day) will allow multiple transmission of data on a scale that will ensure error-free data retrieval.

Two existing telemetry systems were studied for this report. The features of each system are compared in Table 3.3. Also included are details of a proposed system that has not yet been developed (Caulfield Electronics System).

Limitations common to both of the available systems are listed in the following:

a) To date, no equipment has been designed specifically for the application considered herein. Therefore, some degree of interfacing will be required in order to obtain a working system. Costs related to this interfacing and to field testing of the systems are difficult to estimate and have not been indicated in this summary.

b) Low ambient temperatures in the Arctic environment will have a detrimental effect on surface equipment operation and battery life. It may be necessary for the surface unit to be housed in a heated shelter and powered by a thermoelectric wind-powered generator capable of maintaining a temperature

TABLE 3.3 ACOUSTIC TELEMETRY SYSTEM (ATS)

SYSTEM	MESOTECH	OCEANO	CAULFIELD
Model	440/515	RT121/PT122	N/A
Country of Manufacture	Canada	USA	Canada
Specifications:			
Frequencies	1.5-10 kHz	21-24 kHz	to spec
Power Supply	24 VDC	48 VDC	to spec
Depth	1500 m	1500 m	> 400 m
Operating Temperature	-20 to +50°C	-20 to +50°C	-55 to +50°C
Cost (Candian $)	50 000*	77 000*	52 100

* Field testing costs not included

within the dependable operating range of the equipment. Such generators are available from various suppliers (e.g. Global Thermoelectric Systems Ltd., P.O. Box 459, Bassano, Alberta).

2.5 Acoustic Release System (ARS)

Of all the systems investigated, the acoustic release is the most commonly employed offshore, and is readily available from numerous suppliers. Although several systems have been suggested by both EMR and the oil industry, only four have been considered in detail: these are manufactured by Mesotech, Interocean, EG & G and Oceano. For ease of comparison, the system has been broken down into its basic components as follows:

Acoustic Release Relay (ARR)
Acoustic Release Buoy (ARB)
Acoustic Release Tagline (ART)
Hydrophone or Transponder
Receive Command Unit (RCU)
Digital Range Indicator (DRI)

As can be seen from Table 3.4, the units chosen vary widely in in their characteristics, but all exceed the specifications established by EMR. Also, all units are capable of the basic functions required, those functions being:

TABLE 3.4 ACOUSTIC RELEASE SYSTEMS (APS)

ITEM	MESOTECH	INTEROCEAN	EG & G.	OCEANO
ACOUSTIC RELEASE RELAY (ARR) Model	525 ART	1090	722A	RT 121
Depth Rating (m)	1500	2500	900	200
Battery Life[1]	10 000 releases	dry cell/1 year	lithium/2 years	18,000 releases
Release Load (KN)	450	2300	1100	20,000
Weight in Air (KN)	45	163	480	290
Weight in Water	23	100	130	210
Operating Temp. (°C)	—— (2)	—— (2)	-10 to +60	-5 to +50
RELEASE COMMAND UNIT (RCU) Model	411	1100A-3	701	201
DIGITAL RANGE INDICATOR (DRI) Model	412	1300	301	201
Operating frequency(kHz)	15 and 20	12.5 and 14.5	9 and 11	8 to 16
Required power (v)	120 AC	40 DC	120 AC	20 to 30 DC
(a)	--	10	--	<10
(Hz)	50-60	--	50	--
No. of codes	32	70	70	99
Operating temp (°C)	-10 to +50	0 to +40	0 to + 60	-20 to +50
TRANSDUCER OR DIRECTIONAL HYDROPHONE Model	909/105	1120	included as part of Model 301	included as part of Model 201

NOTES:
1. Shelf life of battery important. Time span quoted for standby operation only
2. Unknown, but likely to exceed EMR specifications

a) A ranging capability;
b) A large factor of safety in buoyancy; and,
c) the ability to operate in the specified temperature/pressure regime.

The Oceano unit, although new to the market, was found to be the best alternative of all systems studied by both the U.S. Government and Dome Petroleum Ltd.

2.6 Cable Release

Several methods of releasing the thermistor cable from the DAS have been studied, ranging from explosive releases to simple pressure-sensitive connectors. Representatives of several oil companies expressed concern over an explosive release system as many of the regulations governing the use of explosives around wellheads would make this option virtually impossible in practice. The pressure-sensitive connectors are also of questionable practicality because they present poor reliability in both their release performance and in their long-term conductive integrity.

The system recommended here is electro-mechanical with a simple mechanical fail-safe backup. The electro-mechanical system conceived was similar to the "Squib" cable cutting system, which is an acoustically triggered hydraulic ram that uses an accumulator as a pressure source. Although an appropriate system is not believed to be available "off-the-shelf", several manufacturers, (e.g. High Shear Inc.) have expressed interest in adapting one. The costs included in Section 6 are estimates based on discussions with potential manufacturers. As a back-up, a mechanical "guillotine" activated by the ARS buoy travelling upward on release, would likely be

included in the system to ensure that the cable is parted in the event that the electro-mechanical system fails.

2.7 Data Analysis

Each of the data loggers feature different hardware for data analysis. Sufficient data analysis software expertise exists in commercial computing companies to process digital data recorded on either reel-to-reel or cassette tape formats to a stage where the data is report-presentable. For example, a brochure for Oceanographic Services Inc. is included in Appendix B, but it is understood that EMR has access to either in-house or intra-governmental data processing facilities that are compatible with either of the data acquisition systems considered herein.

3.0 DEPLOYMENT PROCEDURES

3.1 Termination of Drilling Program

Although the individual oil companies differ in their methods of well termination[1], the basic sequence of events is similar, whether drilling from an ice platform or a drillship. A diagram of a typical configuration of an offshore well after completing the cementing phase is shown in Figure 4.1. This sequence comprises removal of the blow-out preventer stack (BOP), removing or dismantling the guidewire system, and placing a corrosion cap on the exposed casing head. Considerable differences in the amount of time available for deploying the thermistor strain and related instrumentation during termination operations were noted in discussion with several oil companies. Therefore, it seemed appropriate to develop deployment methods firstly from either a drillship or ice platform during the final

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1 Well "termination" here refers to either "well abandonment" or "well suspension" as defined in the Canada Oil and Gas Drilling Regulations

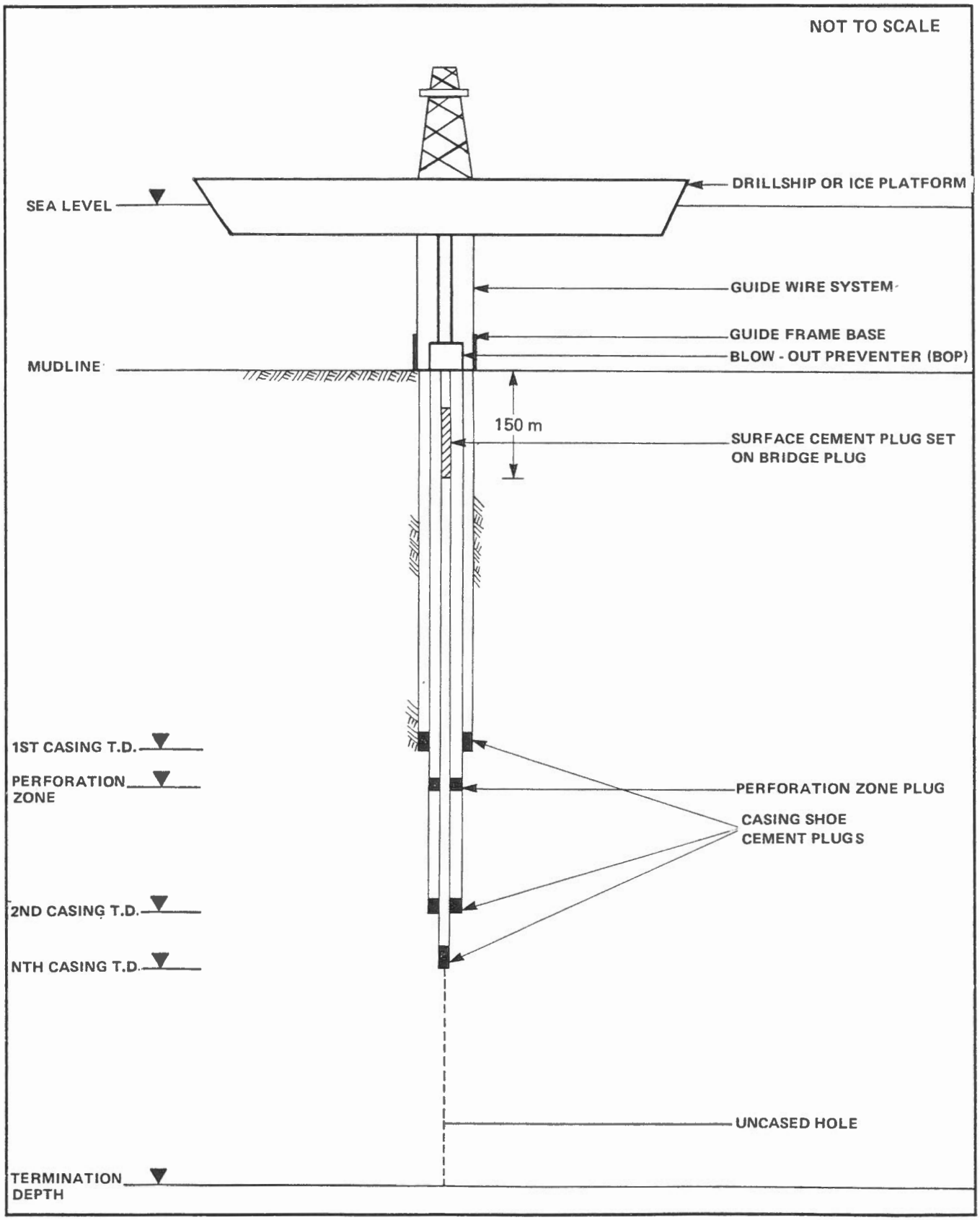

FIGURE 4.1 TYPICAL CONFIGURATION OF OFFSHORE WELL AFTER CEMENTING

disconnection phase and, secondly from a supply vessel sent to the area after the drillship has departed.

3.2 Initialization of DAS

Initialization of the DAS would take place on-board the deployment vessel to ensure that the unit remained fully operational after transport to the job site. As it is forseen that more than one DAS unit would be purchased, two units should be transfered to the site to provide some redundancy against malfunction as a result of damage during transportation.

Initialization procedures for the DAS units described in Section 3.3 are very simple, and require only a system check and loading of the recording tape. This operation could be accomplished in less than one hour.

3.3 Deployment of Thermistor Cable Winch

It is intended that the thermistor cable be transported on a cable winch. Alternatively, the cable could be transported on a reel and transferred to a suitable winch if one was available on-site. Loading the winch with cable in the former case could take place either at the place of cable manufacture or at the warehousing facility where equipment will be stored by EMR. The weights and dimensions for the unit, with 1000 m of cable, would require the use of a large transport aircraft (e.g. Hercules L100-20), or a barge/ship system. Once onboard the deploying vessel, the winch must be compatible with the available power supply connections and be placed with the necessary sheaves to run the cable through the moonpool. It is presumed that the winch would be placed as close as possible to the moonpool, but sufficiently far back to avoid tight curvatures for the cable.

3.4 Deployment from Drillship

A diving system will not be required to deploy the equipment from a drillship. The basic sequence of operations anticipated in this case is shown in Figure C.1, Appendix C. Figure 4.2 shows the wire guide system and casing head that is normally used for running equipment to the seabed. The same system would be used to guide the cable tensioning weight into the casing head. It is anticipated that a wire sling system would be used, but this could be changed subject to consultation with drilling personnel on-site. Once the weight on the bottom end of the thermistor cable has been fed into the casing, the guide can be removed and the remaining thermistor cable deployed from the cable winch. The cable winch would be equipped with both a depth and load indicator intended to allow the operator to detect any hindrances encountered in running the cable to the specified depth. It is anticipated that the rate of cable deployment would be as slow as practicable, not exceeding 300 m/hour (5 m/minute). A minimum of four hours should therefore be allowed for deployment of the full 1000 metres of cable required in the specifications. This presumes no difficulties are encountered during deployment.

When the full length of thermistor cable has been paid out from the winch, the free end of the thermistor cable will be clamped and connections made through the termination block. This connection is shown in detail in Figure 4.3. At the same time, the ARS/DAS system will be assembled and connected to the termination block in a configuration that permits the assembly to float clear when lowered into the water. It is anticipated that deployment of the termination block will utilize a drillship crane or winch positioned to permit lowering within the guide wires. The termination block will be lowered over the casing head by running it down from surface in a

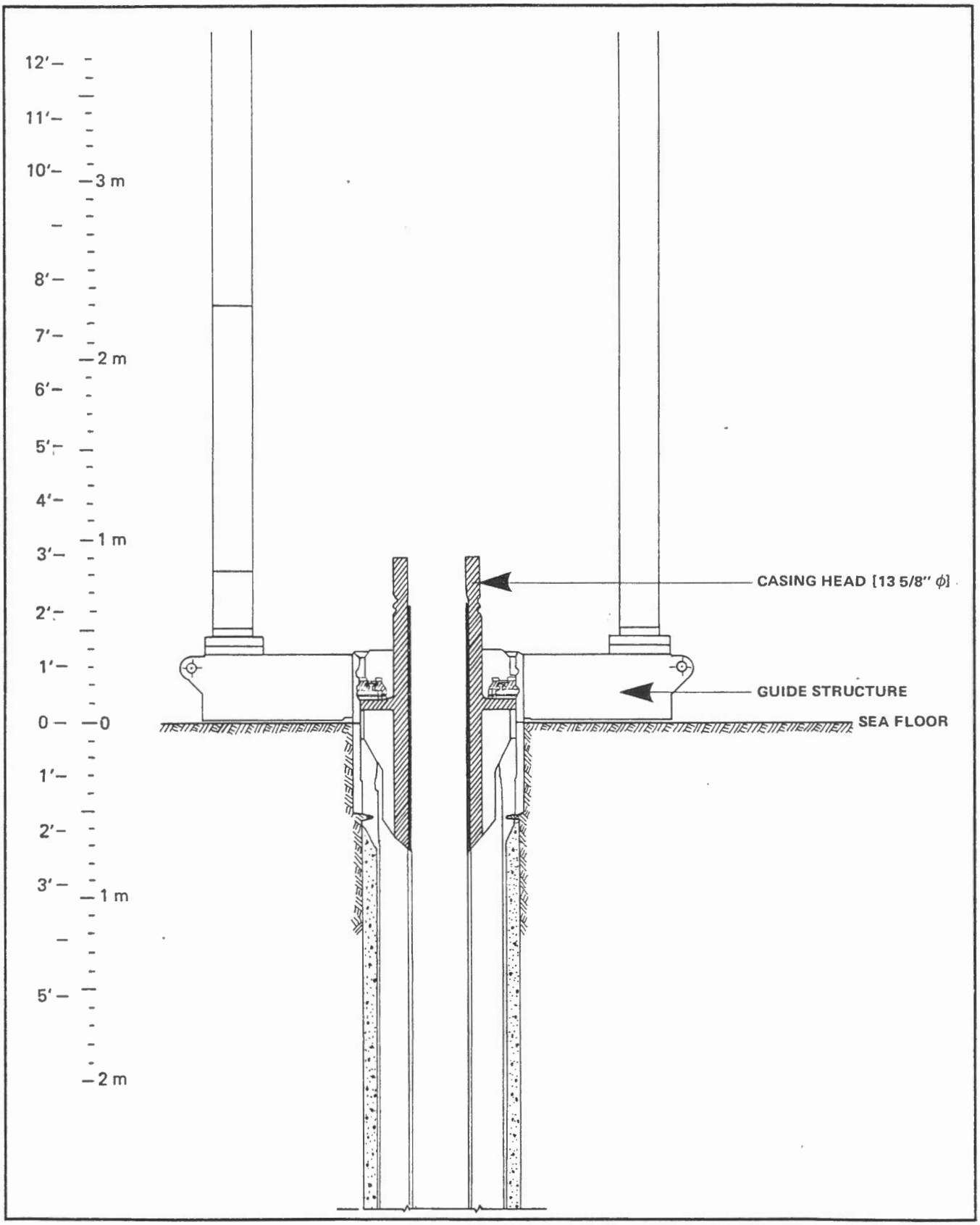

FIGURE 4.2 CASING HEAD TERMINATION

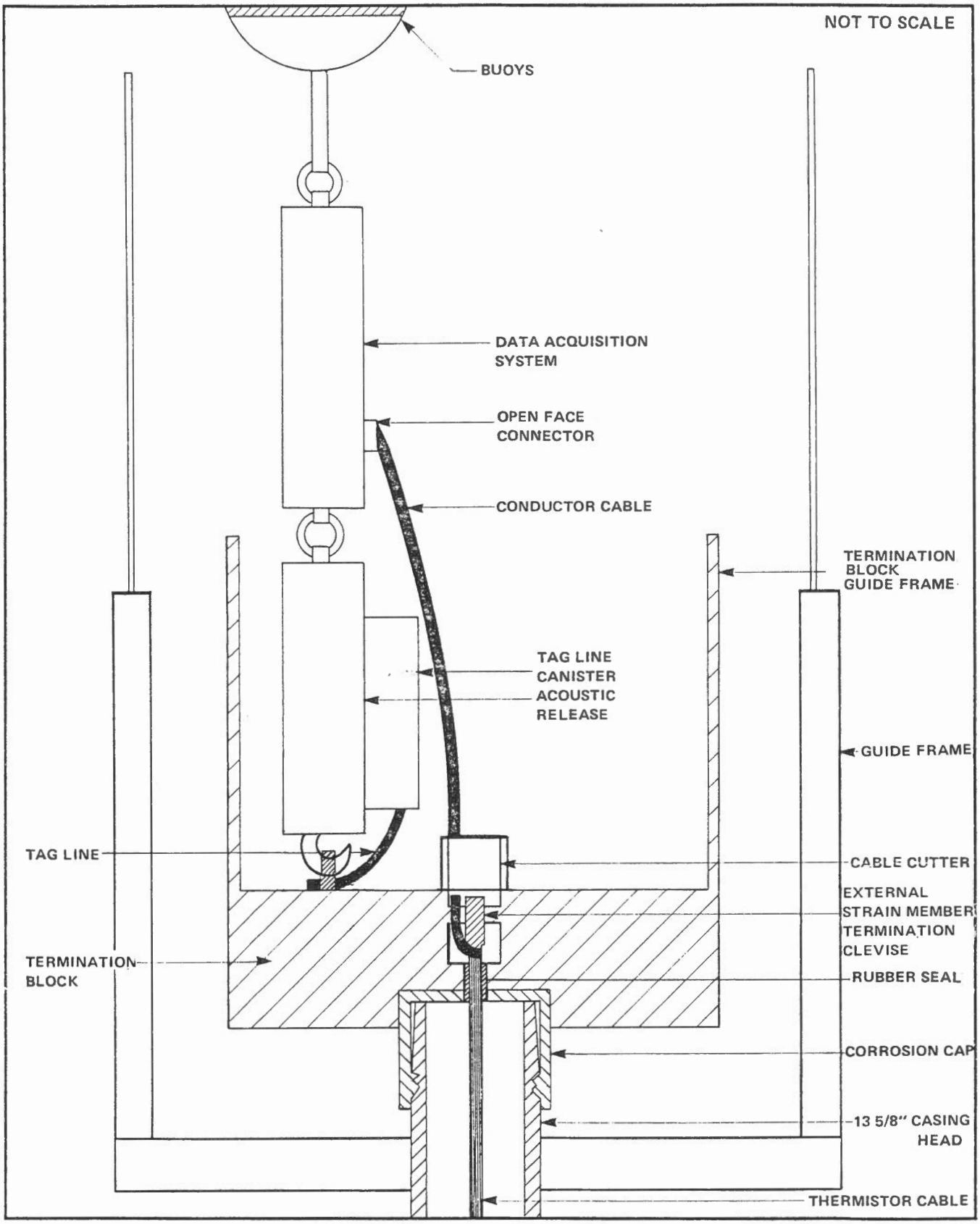

FIGURE 4.3 CONCEPTUAL DETAIL OF TERMINATION BLOCK

sling positioned within the guide wires. It will be necessary to exercise caution at this point to ensure that the cable runs freely into the casing.

Once the termination block has been secured over the casing head, the guide slings can be removed, permitting the process of disconnecting the guide wires from the guide frame to commence.

3.5 Deployment from Supply Vessel

Deployment from a supply vessel will likely be viable only if divers can reach the wellhead. Therefore, this system is restricted to a water depth of 55 metres or less, this being the limit of "wet" diving systems. Beyond this depth, complex and costly submarine support equipment would be required. Introducing this requirement would probably make deployment from a supply vessel uneconomic in comparison with the drillship option. The supply vessel will be equipped with a navigation system capable of accurate positioning over the wellbore. If the equipment deployment takes place within a short period of time after well abandonment, survey systems used for the original borehole placement might still be in place. If the hole has been suspended, a subsea navigation system is usually left in place, and acoustic systems could then be used to position a suitably equipped supply vessel. The sequence of operations for thermistor cable deployment from a supply vessel is shown in Appendix C, Figure C.2.

As this system must be diver-supported, allowances should be made for the amount of time the diver is to work at the seabed. For water depths of greater than 30 m, saturation diving must be employed, and the diver is allowed no more than 1 hour's work time on any shift. Complex and expensive diving and subsurface support equipment including a decompression chamber are required for saturation diving.

Once the supply vessel has deployed a four-point or two-point anchoring system directly over the casing head, the sequence of operations that follows is very similar to that used during the drillship deployment operations. The main exception is that the cable tensioning weight insertion and subsequent positioning of the termination block are carried out by a diver at seabed. Because of the relatively small size or absence of moonpools on supply vessels, the instrumentation package will likely be deployed over the stern.

3.6 Acoustic Telemetry System

Deployment of an acoustic telemetry system (ATS) will follow a procedure similar to the sequence described for deployment from drillship or ice platform in the preceding section. However, a check on the operational system could be made prior to leaving the site to ensure that the unit is functioning properly. Also, steps should be taken to ensure that the unit left on the ice surface is well protected from rig removal operations, and that responsible personnel are informed of its position and purpose.

4.0 RECOVERY PROCEDURES

This section deals with recovery from open water and recovery from below partial or total ice cover separately. Successful recovery from either environment is highly dependant on weather and ice conditions being optimal in the vicinity of the instrumented well. Redundancy built into both the ARS/ATS battery life and DAS recording capability ensures that, should extra time be required beyond the one year stipulated to allow better recovery conditions to occur, the unit would still be usefully active and recoverable.

4.1 Open Water Recovery

A schematic of this recovery operation is shown in Appendix C, Figure C.3.

4.1.1 Long-Range Survey Operations

As with deployment from a supply vessel, the recovery vessel would provide navigation in the target area to within one kilometre. Considering the satellite navigation (SATNAV) coverage in the polar area, this would be the easiest system to use in all the areas considered, although range-range systems such as SYLEDIS, if available, would provide a more accurate instantaneous position.

4.1.2 Short-Range Survey Operations

Short range navigation to within 100 metres would be carried out after preliminary interrogation of the ARS to determine that the correct system has been found. A range and bearing surveying operation using a directional hydrophone and range indicator from the surface would allow the recovery vessel to keep station. A single anchor might be deployed at this stage.

4.1.3 Release Phase

With the recovery ship in final position, the first release signal is sent at a preset frequency to activate the acoustic cable cutter and part the cable. The second release command is then sent to the ARS to free the DAS from the terminator block. The ARS response signal changes frequency after a successful release and begins to 'ping' in the recovery mode.

Upon a successful release, the subsea unit should float to the surface, while still moored to the bottom on a free-running tagline. If a visual fix cannot be made on the unit, range and bearing to the unit will continue to be relayed for several hours after release, which should permit manual retrieval with a smaller inflatable craft.

4.2 Recovery Beneath Ice Cover

A schematic of this recovery operation is shown in Appendix C, Figure C.4.

4.2.1 Long-Range Navigation

As in the previous case, long-range navigation of the recovery transport, be it a helicopter or a tracked surface vehicle, would be by existing navigation systems. In areas of low-distance ice drift, deployment of the recovery system base close to the old rig location would suffice.

4.2.2 Release Phase

If problems are forseen in drilling access holes through the ice, an "IMP" drill could be deployed a day prior to the release phase to drill the site on a suitable grid pattern. Provided freeze-back is minimal, a network of hydrophone holes would then be available for hydrophone deployment, and only the divers' access hole would have to be drilled during the release phase. Once a hole has been drilled in the ice, the directional hydrophone would be deployed, and the seabed unit interrogated for range and bearing. Provided the horizontal distance between the hydrophone and the unit is not greater than about 100 metres, the release phases detailed in Section 5.1.3 could be carried out in the same sequence.

After a successful release, the subsea unit's tagline should keep the unit up to 5 metres below the base of the ice to prevent signal interference due to irregularities on the underside of the ice sheet. Triangulation using two or, possibly, three ice holes could then be carried out to fix the unit's exact location beneath the ice. If necessary, an additional ice hole could be drilled nearer to the unit's location to deploy the diver. However, as drilling ice holes may be a major undertaking, the nearest hydrophone access hole could be used for diver entry and recovery. Once in the water, the diver may not be able to see the unit and a hand-held directional pinger receiver set at the ARS release can be used to locate the DAS package. The unit can then be recovered through the diving hole.

4.3 Recovery of Telemetry System

Recovery of the surface portion of the ATS could be made at practically any time after deployment of the system. The accessibility of the DAS unit would allow frequent data retrieval and longer operation of the unit, dependent on the useful life of the power source with the seabed telemetry unit.

4.4 Data Retrieval

Initial data retrieval should be made as soon as possible after recovery of the unit. Once a preliminary 'hard copy' of the data has been made, the tape should be removed from the unit and stored in an aluminum safe storage container. Secondary data retrieval and analysis could then be made on the return of the unit either to EMR or to a specialist contractor.

5.0 ESTIMATE OF COSTS

The estimate of costs presented here is intended to give a fair representation of the capital cost for equipment and the operational costs for deployment and recovery. The latter costs vary considerably, depending upon location; therefore, figures quoted herein are estimates, sources for these estimates are indicated in parentheses.

5.1 Equipment Costs

The equipment costs shown in Table 6.1 were supplied by either Mar-Del Components Ltd., of Edmonton, Alberta, MSE Engineering System Ltd., of Calgary, Alberta, or T. Thompson Ltd., of Vancouver, B.C.. Prices quoted here are f.o.b. Edmonton, but would not likely change significantly for any other major city in Canada. Certain charges, such as import duty on the thermistor cable, have not been included. With the least expensive proven systems, including 1000 m of cable, the capital cost would be close to $80 000 for the ARS and up to $112 000 for the ATS. Approximately half of these costs would not be recoverable at each new location, this being the cost of the cable, the cable cutter and, in the ATS case, the seabed transmitter.

5.2 Deployment Costs

The figures shown in Table 6.2 are largely dependent on the well location. An assumption has been made that one day is required for transportation in each direction, and that one day's field time only is required. However, the major cost is drillship or drill rig time, which would probably be waived by most operators. In the case of the Panarctic Oils Ltd. operation,

TABLE 6.1 EQUIPMENT COSTS

ITEM	RATE $	Quantity	COST ($ Canadian)
Thermistor Cable (SEADATA CORP)	35/m U.S. plus 5500 US for connectors & thermistors	1000 m	48 600
Winch			
Data Acquisition System			
(SEADATA CORP)	9400(U.S.)	1.2	11 280
(APPLIED MICROSYSTEMS)			6 710
Acoustic Release System			
(OCEANO)			22 446
(EG & G)			42 065
(MESOTECH)			32 025
(INTEROCEAN)	29 805(U.S.)	1.2	35 766
Acoustic Telemetry System			
(OCEANO)	64 000(U.S.)	1.2	77 000
(MESOTECH)			50 000
(CAULFIELD)			52 100
Surface Data Logger (for ATS)			
(SEADATA 1250-6T)	5 100(U.S.)	1	6 120
Cable Cutter	600	1	600*
Shelter for work on the ice (NORSEMAN)	250/m^2	16	4 000

* Field testing not included

TABLE 6.2 DEPLOYMENT COSTS

ITEM	RATE $	No.	COST ($ Canadian)
1 Deployment from Drillship			
1.1 Transportation Costs		2	
Personnel	/person		
Equipment	/kg		
1.2 Drillship Costs (CANMAR)	840 000/day	1/2	420 000
1.3 Return Transportation Costs		2	
Personnel	/person	2	
Equipment	/kg		
1.4 Personnel Costs (incl. transportation time)			
Engineer	660/day	3	1 980
Technician (EBA ENG. CONS.)	440/day	3	1 320
2 Deployment from Supply Vessel			
2.1 Supply Vessel Costs			
Beaufort Sea Explorer	11 500/day	4	46 000
Arctic Sounder	10 500/day	4	42 000
2.2 Transportation Costs			
Equipment	/kg		
Personnel			
Flight Costs	/person	5	
Time (EBA)	1100/day	2	2 200
(CANDIVE)	650/day	2	1 300
Return Equipment	/day		
2.3 Fuel Costs	/day	4	
2.4 Diving Operation Costs			
Diving Superintendant	460/day	1 x 4	1 840
Diver	420/day	2 x 4	3 360
Depth Pay	1$ foot/man	180 x 2	360
Recompression Chamber	250/day	4	1 000
Diving Equipment (CANDIVE)	250/day	4	1 000
2.5 Engineering Personnel			
5.1 Engineer	660/day	4	2 640
5.2 Technician (EBA ENG. CONS.)	440/day	4	1 760

it appears likely that no charge would be made for rig operation while the instrumentation package is being installed on the well.

5.2.2 Deployment from a Supply Vessel

The costs for this operation can be estimated relatively easily. It has been assumed that the site is within one day's sailing time of the supply base and that two days are required on location. With experience, the time onsite can probably be reduced. For a hypothetical operation in the Canadian Beaufort Sea at a site such as Uviluk or Tarsiut the approximate cost of deployment from a supply vessel would be about $65,000.

The availability of marine plant and diving personnel will be highly dependent on operator co-operation, although CANDIVE could mount an operation independent of their present Beaufort Sea commitments.

5.3 Recovery Costs

Recovery operations should be planned for execution during periods of optimal weather conditions in the wellsite area. This is especially important if an ARS operation is to be used in an area of perennial ice cover. A contingency plan for a second recovery attempt in this area should be made.

5.3.1 Recovery by Supply Vessel

Recovery of a seabottom ARS is carried out regularly in most marine operations and only requires good weather and an effective navigation system

to permit completion within two days. Time required on site has been extimated at four to six hours. For a hypothetical recovery operation in the Canadian Beaufort Sea, the approximate cost would be about $25,000, including vessel mobilization. This is itemized in Table 6.3.

5.3.2 Recovery of ARS by Helicopter

The estimated costs for this operation are also shown in Table 6.3. The operation is assumed to take place within two hours' flying time of the supply base. Also the helicopter would return to base during the actual recovery operation. As the duration of this operation is highly dependent on ice conditions, no estimate of time required on the ice can be made. It is assumed, however, that ice time would generally be less than 12 hours, especially if the initial hole drilling operation can be carried out prior to the recovery operation.

Assuming easy access to the water near to the site and/or thin ice cover for an operation located in the Svedrup Basin, the cost for recovery would be approximately $20,000. If it is necessary to drill ice holes through substantial thicknesses of ice, a further $10 000 should be included for mobilization and operation of an ice drill and operator.

5.3.3 Recovery of DAS from the ATS

The recovery of an ice-based DAS used with the ATS would considerably simplify recovery operations (and possibly permit redeployment). The cost estimate has assumed that the site is within about an hours' flying time of the supply base and that the recovery (or exchange) of the DAS could be completed within about an hour on the ground.

TABLE 6.3 RECOVERY OPERATIONS

ITEM	RATE $	Quantity	COST ($ Canadian)
1 Recovery by Supply Vessel			
1.1 Supply Vessel Costs			
Beaufort Sea Explorer	11 500/day	2	23 000
Arctic Sounder (ATL)	10 500/day	2	21 000
1.2 Transportation Costs			
1.2.1 Equipment	/kg		
1.2.2 Personnel			
1.2.1 Flight Costs	/person	2	
1.2.2 Time (EBA)	1 100/day	2	2 200
1.2.3 Return Equipment	/kg		

TABLE 6.3 (continued)

ITEM	RATE $	No.	COST ($ Canadian)
2 Recovery of ARS by Helicopter			
2.1 Transportation Costs			
2.1.1 Equipment	/kg		
2.1.2 Personnel			
2.2.1 Flight Costs	/person	4	
2.2.2 Time (EBA)	1 100/day	2	2 200
(CANDIVE)	650/day	2	1 300
2.1.3 Return Equipment	/kg		
2.2 Helicopter Costs			
(212 Helicopter incl. fuel)	1 500/hr	6	9 000
2.3 Diving Operation Costs			
2.3.1 Diving Superintendant	460/day	1 x 1	460
2.3.2 Diver	420/day	1 x 2	840
2.3.3 Depth Pay	1/foot/man	66 x 2	132
2.3.4 Diving Equipment	250/day	3	750
2.3.5 Hand Held Pinger (CANDIVE)	100/day	3	300
2.4 Engineering Personnel (EBA)	660/day	1	660
2.5 Drilling of Ice Holes	/day	3	
2.6 Power Source & Heating	450/day	3	450

TABLE 6.3 (continued)

ITEM	RATE $	Quantity	COST ($ Canadian)
3 Recovery of DAS from the ATS			
3.1 Transportation Costs			
3.1.1 Equipment	/kg		
3.1.2 Personnel			
1.2.1 Flight Costs	/person	1	
1.2.2 Time (EBA)	440/day	2	880
1.3 Return Equipment	/kg		
3.2 Helicopter Costs			
(206 Helicopter inc. fuel)	500/hour	5	2 500
3.3 Engineering Personnel	440/day	1	440

An approximate cost for this operation at a Svedrup Basin location would be about $6000.

6.0 CONCLUSIONS

The recommendation of specific equipment and suppliers is outside the scope of this report. However, several agencies provided strong recommendations for both the Seadata DAS and the Oceano ARS during the preparation of this report. Also, the development of an ATS specific to our requirements would probably be less expensive than the more sophisticated versions available "off-the-shelf", presuming more than one system will be purchased.

It has become apparent during the study of the various deployment and retrieval operations that certain weak links exist in the operational phases. Where possible, these links have been overcome, notably the replacement of the explosive cable release by the electro-mechanical version. However, the method of below-ice retrieval for the DAS in the High Arctic areas still presents problems. Discussions with Panarctic and studies of available literature (e.g. Hood, Masterson and Watts, 1981; and Baudais, Watts and Masterson, 1976) indicates that drift of the ice pad over a period of one year is in the order of 10 metres. This would mean that more than 6 metres of ice (cf Drake F-76 ice platform) can be expected above the well location at the time of DAS retrieval. In turn, this will make drilling ice holes a major undertaking.

From our conversations with ATS manufacturers, it appears likely that a system could either be bought "off-the-shelf" or developed specifically to provide reliable data telemetry to the surface. Although the cost of leaving the transmitter on the seabed would be high, this cost is still less than half the cost of the thermistor cable (which will necessarily be

abandoned in the well in all recovery operations). This abandonment cost is also less than the cost of retrieving the DAS and ARS units from beneath thick ice cover.

It seems logical that the development of a task-specific ATS would be cost-effective and preferable from an operational point of view for application in the High Arctic.

ACKNOWLEDGEMENTS

The writer would like to acknowledge the co-operation provided by all of the companies and individuals contacted in connection with the production of this report.

Respectfully Submitted,

EBA Engineering Consultants Ltd.

J.P. Ruffell

REVIEWED BY:

W.D. Roggensack, Ph.D., P.Eng.

JPR/dmt

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1. Oil and Gas Production and Conservation Act: Canada Oil and Gas Drilling Regulations, January 22, 1979
(Published in Canada Gazette Part II, Vol. 113, No. 3 (1979)).

2. HOOD, G.L., MASTERSON, P.M., and WATTS, J.S. 1981. Installation of a subsea completion in the Canadian Arctic Islands. Journal of Canadian Petroleum Technology, Oct. - Dec. 1981.

3. BAUDAIS, D.J., WATTS, J.S., and MASTERSON, D.M. A System for Offshore Drilling in the Arctic Islands. Offshore Technology Conference, Paper No. OTC 2622, Houston, Texas, May 1976.

APPENDIX A

APPENDIX A - TABLE A.1

SPECIFICATIONS SUPPLIED WITH THE CONTRACT

CABLE:
- -robust, up to 1000 m long
- -up to 16 sensors at specified intervals
- -appropriate cablehead connector

RECORDER:
- -capable of operation in water depths to 400 m, temperatures as low as -1.5°C.
- -record data from up to 16 channels, plus time
- -data acquisition rate: daily or better selected before deployment.
- -temperature resolution (sensors plus recording capability) $\pm$ 0.01K.
- -temperature range, 40K (-5°C to 35°C)
- -self contained power for operation up to one year

RELATION AND RELEASE EQUIPMENT:
- -capable of finding site when no facilities are in area
- -system to release instrument package from well cable and seafloor.
- -release command from surface
- -retrieval from sea or from beneath ice cover.

APPENDIX A - TABLE A.2

CHRONOLOGY OF COMPANIES AND INDIVIDUALS CONTACTED

26 March

Aanderra Instruments Ltd. 604-386-7783

Ms. Gayle Gable

Seadata Corporation 617-244-3216

Mr. Winfield Hill

Mr. Marco Lanza

Discussed 650-6T DAS and construction of thermistor cable. Willing to supply details of both.

Vector Cable Ltd. 403-468-3121

Mr. David Hay

Robert Davis Splicing 403-892-2510

Mr. Jack Roberts

BIW Ltd. 416-529-7151

Mr. Ed Lodesic

Discussions with various cable construction companies. None seem willing to provide cable required unless more accurately specified.

Mesotech Systems Ltd. 604-980-3474

Mr. David Friedman

Discussed possibility of the modification of their ice keel profiler. He recommends use of the SEADATA unit.

29 March

Mar-Del Components Ltd. 403-467-9813

Mr. Clay Jolly — Mr. Dave Caulfield offered services and distribution of a wide range of equipment including EG&G and SEADATA, and offered expertise in underwater acoustic data telemetry.

T. Thompson Ltd. 604-926-3201

Mr. Douglas Huntington

Discussed costs of the Mesotech ARS.

30 March

Petro-Canada Ltd. 403-232-5693

Mr. Mike Miurhead

Mr. Robert Robbins

Discussed well abandonment procedures carried out in the MacKenzie Delta.

Gulf Canada Resources Inc. 403-233-4271

Mr. Bill Scott

Panarctic Oils Ltd.

Mr. Stephen Dole 403-269-0502

Discussed sub-sea completion systems, the Canadian Oil and Gas Regulations and arranged meeting.

6 April

Seadata Corporation — Meeting, Calgary Convention Centre

Mr. Marco Lanza

In-depth discussion and demonstration of Seadata 650-6T and 1250 data loggers. Also, discussed thermistor cable construction and availability of acoustic telemetry systems.

Panarctic Oils Ltd. — 703, 6th Avenue, Calgary

Mr. Stephen Dole

Discussed in detail subsea completion techniques employed by Panarctic from ice pads with reference to setting plugs and placing cable into casing head. Provided drawings of casing head details.

Gulf Canada Resources Inc. — 401, 9th Avenue, Calgary

Mr. Bruce Lukey

Mr. Bill Scott

Discussed in detail subsea completion techniques from drillship employed by Gulf. They suggest that due to high cost ($850,000 per day) of drillship, deployment from a supply ship would be more cost effective.

Dome Petroleum Ltd. — Place 800, Calgary

Mr. Nam Pui

Discussed same deployment procedures as previously noted. Suggests that cable is not cut, rather is long enough to allow the unit to float to the surface. He feels that deployment from the drillship would not be a problem.

13 April Department of Energy Mines and Resources EBA, Edmonton

Mr. Allan Judge

Mr. Allan Taylor

Mr. Vic Allen

Presented preliminary ideas for deployment and recovery. Also, discussed structure of the report. DEMR suggested that data telemetry system should be considered for use beneath perennial ice cover. Also, suggested OCEANO and APPLIED MICROSYSTEMS equipment.

14 April

Applied Microsystems Ltd. 604-656-0771

Mr. Lawrence Lambert

Discussed capabilities of their GR-12/24 DAS unit.

21 April

MSE Engineering Systems Ltd. EBA, Edmonton

Mr. Robert Fraser

Mr. Thomas Kiddey

Offered services for supply of OCEANO ARS and Squib cable cutter system.

Candive Ltd.

Mr. Don Romanuck

Discussed rates and depth restrictions for diving personnel and plant.

22 April

Norseman Shelters Ltd. 403-465-9395

Discussed price per m^2 of shelter for possible deployment on ice.

23 April

Arctic Transportation Ltd. 403-234-7524

Mr. John Matson

Discussed cost and availability of vessels in the Beaufort Sea.

Mesotech Systems Ltd. 604-980-3474

Mr. Alan Mulvenna

Cautioned PE Costs & difficulties involved with storage of one year's data for later telemetry. Suggested real-time telemetry with data logger on surface would be easier & cheaper. Also suggested alternative of two submerged data loggers, one to be recovered after a first data collection period, leaving the second one operational.

Global Thermoelectric Systems Ltd. 403-472-3512

Mr. Gordon Hungerford.

Discussed power generating system & environment module for surface UMT of ice-mounted telemetry sytem. Cost about $12 000. Delivery 90 to 100 days.

26 April

Mar-Del Components Ltd.

Mr. Clay Jolly

Had talked with Jet Research Labs and had found that a company called High Shear Inc. of San Diego (tel. 213-326-8110) (Mr. Harold Carp) would build a cable cutter unit for $5-600 per unit.

20 May

16 June

Sea Mac Corporation 713-784-1890

Mr. John Schwartz

Mr. J.R. Foster

Discussed design of winch specific to our needs.

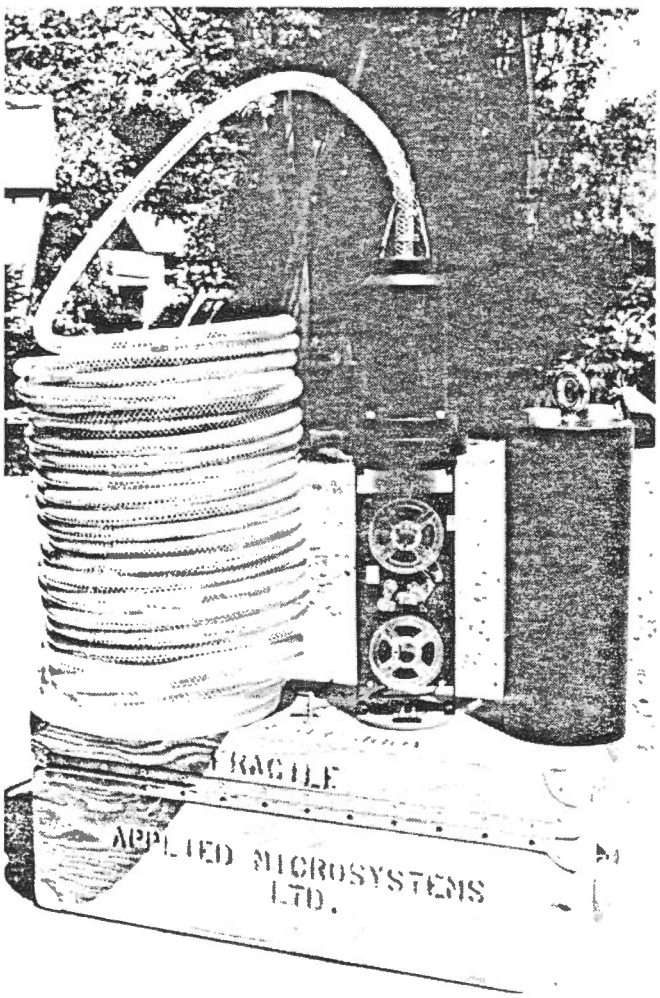
APPENDIX B

SPECIFICATIONS OF SELECTED EQUIPMENT

Applied Microsystems	TR-12	Temperature Profiler
	702	Data Verifier
	769	Tape Reader
Sea Data	650	Data Logger
	12A	Tape Reader
	1250	Data Logger
Mesotech	440	Acoustic Telemetry Module
	411/412	Acoustic Navigation System
	ART 525	Acoustic Release and Transponder
	940	Trainable Hydrophone
Interocean	1900/1901	Offshore Recall Buoy System
EG & G	301	Range/Bearing Acoustic Relocator
		Digital Acoustic Command System
Oceano	DT 122	Acoustic Telemetry System
	RM 201	16 Channel Rangemeter
	TT 101/201	Acoustic Telecommand System
	AM 1X1	Recoverable Transponder
Oceanographic Services		Data Reduction and Processing

APPLIED MICROSYSTEMS LTD.

TEMPERATURE PROFILER
TR - 12



(Fig. 1)

FEATURES

- In situ temperature profiles
- 1m°C resolution
- 12 Thermistors
- Digital recording on magnetic tape
- Time code records
- Mooring depths to 2000 meters

APPLICATIONS

- Continuous diurnal and seasonal plots of vertical temperature structure.
- Thermocline time series records.
- Internal wave studies.

GENERAL DESCRIPTION

The TR-12 TEMPERATURE PROFILER is a sensor chain and data logger configured for mooring vertically in the ocean (fig. 1). Twelve precision bead thermistors are spaced along a pressure balanced cable assembly and terminate in a magnetic tape recording data logger. Daily digital records of the temperature structure are stored for periods exceeding 6 months together with a time code and reference number.

SPECIFICATIONS

SENSORS

TEMPERATURE: Accuracy 0.1°C interchangeable thermistors. Resistance 30,000 OHMS @25°C (YSI#44032)
TIME CODE: 4.19 MHZ crystal time base
1 minute increments. In-situ accuracy ± 5.0 seconds/month

DATA LOGGER

MEASURING RESOLUTION: 1m°C.
MEASURING RANGE: -2°C to 28°C or smaller spans.
SAMPLING INTERVAL: Crystal derived hours, minutes and seconds. Plug programmable.
NUMBER OF CHANNELS: 14.
CIRCUITRY: Micropower digital and linear MSI devices mounted on two single PC boards. (NOT encapsulated.)
OUTPUT: Serial train long/short pulse bursts. (11.7 msec and 3.9 msec respectively.)
DIGITIZER: 12 bit successive approximation A/D.
SIZE: Electronics chassis (two PC board enclosure) nominally 105 mm x 215 mm x 30 mm aluminum cabinet.

RECORDING SYSTEM

TYPE: Reel to reel, stepping motor drive, ¼" magnetic tape, ½ mil, 900 ft.
STORAGE CAPACITY: 80,000 ten bit words. (exceeds 5,000 samples temperature scan, time code and reference number.)
RECORDING SPEED: Nominally 560 msec per channel.)
SPOOL SIZE: 3 or 3¼ inch diameter.
DATA RECOVERY: Magnetic tape from this instrument can be translated using Tape Reader Model 769. (Fig. 2)

POWER

QUIESCENT: 500uW.
BATTERIES: 8 alkaline D cells (5 A-H.)
CAPACITY: Equivalent to 5,000 recorded samples.

CONSTRUCTION

PRESSURE CASE: 6065-T6 aluminum 115mm ID, 140mm OD, 330mm long. (All other external parts 316ss.)
WEIGHT: KGM (including batteries) 5 kgm (in water.)
CHAIN ATTACHMENT: Brantner U/W connector contained within oil filled manifold.

ENVIRONMENTAL

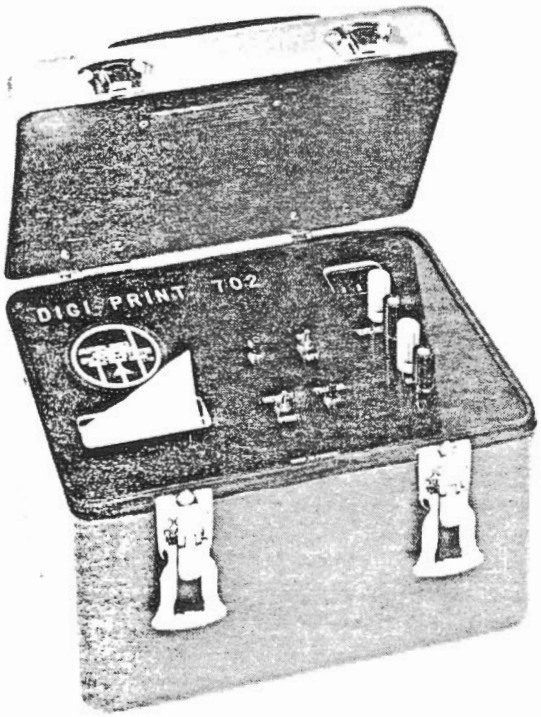
OPERATING: -5°C to 40°C.
STORAGE: -25°C to 45°C.

(Fig. 2)

APPLIED MICROSYSTEMS LTD. 769 Lily Avenue, Victoria, B.C. Canada V8X 3R7 - Telephone (604) 479-8034
OVERSEAS SALES: NORWAY, A/S Tekno Team, Box 313, 5051 Nesttun, Bergen - Telephone 05 22 02 62

APPLIED MICROSYSTEMS LTD.

DATA VERIFIER DIGI PRINT MODEL 702



FEATURES

- 10 OR 12 BIT SERIAL DATA TRAIN CONVERSIONS AND PRINT OUT.
- MICROPROCESSOR BASED (6502)
- POWERED FROM 12V BATTERY OR 110/220 VAC 50/60 Hz
- LIGHT WEIGHT
- LOW COST
- FEW MOVING PARTS
- LARGE PAPER ROLL CAPACITY

GENERAL DESCRIPTION

The Digi Print 702 Data Verifier is a portable battery operated recorder which finds practical uses in field collection of environmental and geophysical data or as a test instrument in the laboratory. The Digi Print is designed exclusively to receive, decode, buffer and print data output from Applied Microsystems series of data recorders i.e. CTD-12, TG-12, Model 750A, etc.

The Digi Print will also decode and print data output from other manufacturers recorders also employing 1:3 ratio pulse length recording format i.e. RCM-4. Other features include a TRIGGER output to turn on the data source, and operation from an external DC power source.

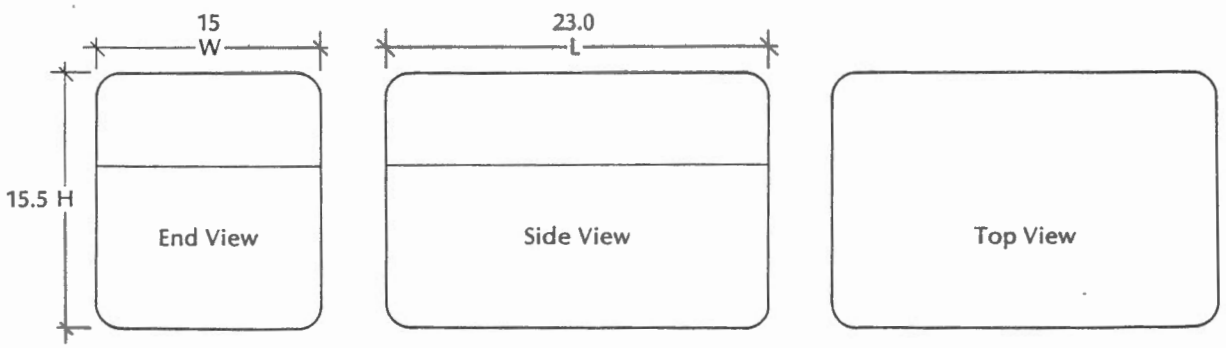
Input signal levels from 100mV to 10V permit data decoding and printing directly from low level tape head circuitry (or high level) signal output connectors.

A unique sinc pulse detector circuit automatically spaces the printed parameters to allow examination of individual groups of sampled data.

Technical Data January, 1982

SPECIFICATIONS

SIGNAL INPUT	1:3 ratio length pulses (10 or 12 pulses/word)
DECODING	10 or 12 bit binary word decoded to 4 digit decimal number (i.e. 1023 or 4095 Full Scale)
OUTPUT TRIGGER	Negative polarity pulse for trigger on of data recorder
TYPE	Thermal electronic printer (Texas Instrument EPN 9112)
CHARACTERS	Matrix 5 x 7
MAX. CHARACTERS PER LINE	4
PRINT SPEED	2 lines/second
PAPER	Thermal blue sensitive (eg. TP-20225 Texas Instruments)
FULL SPOOL DIAMETER	2.75"
PAPER WIDTH	2.25"
PRINTER CAPACITY	4000 prints of 4 characters per row at a rate of 2 rows/second
POWER CONSUMPTION	1 watt
BATTERY	External 12VDC ± 10%
LINE OPERATION	110/220 VAC 50/60 Hz
PERATING TEMPERATURE	-2°C to 30°C
HUMIDITY	20 to 85% for operating and storage
CABINET MATERIAL	Seamless drawn aluminum alloy blue textured finish
WEIGHT	2.5 kgm
DIMENSIONS	(cm)



APPLIED MICROSYTEMS LIMITED, 2035 Mills Road, Sidney, B.C., Canada V8L 3S1 - Phone (604) 656-0771 Telex 049-7181

APPLIED MICROSYSTEMS LTD.

TAPE READER MODEL 769

(Fig. 1)

FEATURES

- Reads and translates all tapes from Applied Microsystems Recorders.
- Decodes 10 or 12 bit word magnetic tape recording formats.
- Compatible Aanderaa and Grundy Environmental Recorders.
- Variety of output modes.
- Microprocessor based.
- Portable battery operation for field use.
- Low cost.

GENERAL DESCRIPTION

The Model 769 TAPE READER is a portable low cost magnetic tape playback system for reading and translating recorded data tapes from Applied Microsystems environmental recorders.
A variety of switch selectable output modes permit data transcription to hard copy print out (teletype, etc.) (Fig. 2) 9 track magnetic tape (mini computer, etc.) or punched paper tape. For portable field use the Model 769 will also output to a Digi Print (Fig. 3).
The Model 769 TAPE READER will process tapes of 10 or 12 bit RZ 3:1 ratio format regardless of record length, tape to tape pulse variation length, sync pulse positioning, and signal inversion.
Being microprocessor based the user can also enjoy the advantages of interactive programming with a central processing system to optimize data transfers, block lengths and formats.

SPECIFICATIONS

PLAYBACK SYSTEM:
Brushless motor, reel to reel ¼ inch tape

REEL SIZE:
Accommodates: 3, 5 & 7 inch diameter spools

INPUT PROGRAMMING:
Switch selectable codes for number of words, number of bits (10 or 12), device select output mode, optimum pulse lengths, sync pulse position, etc.

OUTPUT MODES:
ASCII RS-232C, 20mA Loop, and 3:1 Ratio pulses

OUTPUT DATA RATES:
13 Switch selectable rates from 50 to 9600 baud
3:1 Ratio pulses, selectable rate

INTERACTIVE I/O:
'Continuous' or 'blocks of data' output modes

SIGNAL INVERSION:
Switch for tapes having reverse wired heads

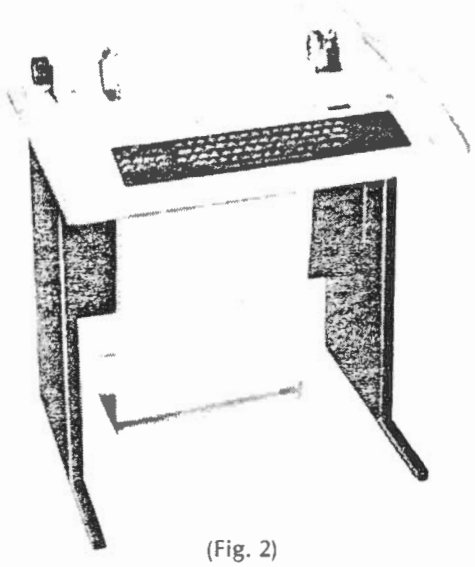
TAPE PLAYBACK MONITOR:
Test points for monitoring tape quality

POWER:
A.C. line or battery operation. Completely portable operation possible with battery operated digiprinter as output device

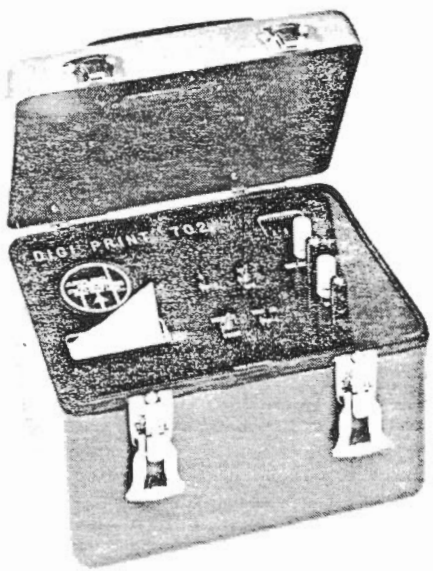
ENVIRONMENTAL:
Storage -20°C to 40°C
Operation - 5°C to 30°C

WEIGHT:
10KGM (with batteries)

DIMENSIONS:
350 mm x 480 mm x 160 mm



(Fig. 2)



(Fig. 3)

APPLIED MICROSYSTEMS LIMITED, 2035 Mills Road, Sidney, B.C. Canada V8L 3S1 - Phone (604) 656-0771 - Telex 049-7181

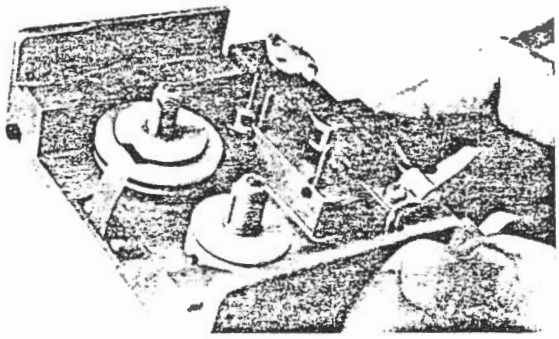
DATA LOGGERS

Take them with you when you go . . . and leave them there with confidence.

Sea Data Corporation offers a wide range of versatile data loggers assuring data in the lab, on the street, in the mud of the Sargasso Sea, or the snow of your favorite mountain.

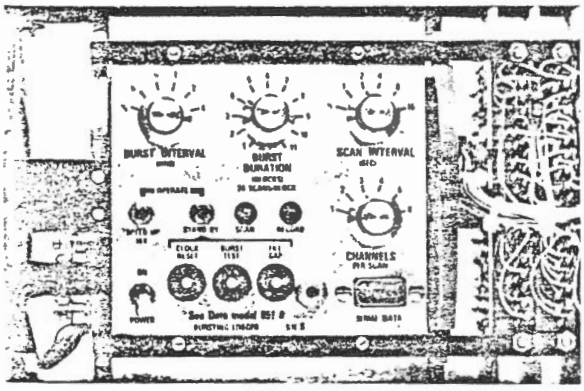
SEA DATA RECORDER

The heart of all Sea Data loggers is our model 610 low-power, 15 megabit cassette recorder. The recorder utilizes a stepping transport with an unusually rugged milled-aluminum casting and a four-track precision head. The recorder uses self-clocking phase-encoding for low error-rate and complete interchangeability. With an 8-year proven track record and over 1200 in the field, it is a highly reliable recorder.



EASY-TO-USE

Sea Data loggers can be programmed directly from switches on a self-explanatory control panel. As an example, the photo shows a panel of one of our burst-recording loggers, the 651-8. All the basic modes of the logger can be selected from the panel, and indicators and test switches aid in checkout.



DEPENDABLE

Sea data loggers feature a ruggedly executed milled-aluminum rack for durability. Teflon wiring is used, along with EDAC fork-contact connectors, sporting four sets of gold-plated wiping surfaces set at 90 degree angles, for high reliability. Alkaline battery packs are sealed in fiberglass cases, thereby avoiding unreliable battery cell holders.

The versatility of Sea Data loggers ends the struggle to find the right data acquisition system for your project. All our data loggers include a time word, and automatic parity-check circuits. Although they include fast scan rates, appropriate for short experiments, they use CMOS electronics and are generally designed to handle up to 16-months deployment duration.

VERSATILE

A variety of special input options are available. Among these options are full-differential inputs, sensor signal conditioning, integrating inputs, parallel inputs, temperature sensing, sub-multiplexing, and frequency counting. Also sensor power switching, remote enable, etc.

However, we have a variety of standard logger types. Below are a few examples:

- **Model 637** Integrating data logger
- **Model 642** Threshold sensing
- **Model 650-46** 64 A/D channels
- **Model 655** Fast - up to 128 scans/sec.
- **Model 651** Capacity: 1 million 12-bit samples
- **Model 1250** Portable fiberglass case. Rechargeable or D-cell battery.

LOW-COST

Sea data loggers come complete with pressure case and connectors of your choice at a cost-effective price. For example, the Model 650-6 is a 16-channel data logger with up to 800,000 sample capacity. It is pictured with the Sea Data AL60-35-17 aluminum case, rated to 2000 psi, for only $6250.00, complete with battery. Delivery is from stock to 90 days.

sea data

Sea Data Corporation
153 California Street, Newton, MA 02158 (617) 244-3216 • TLX 951107

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Sea Data Corporation

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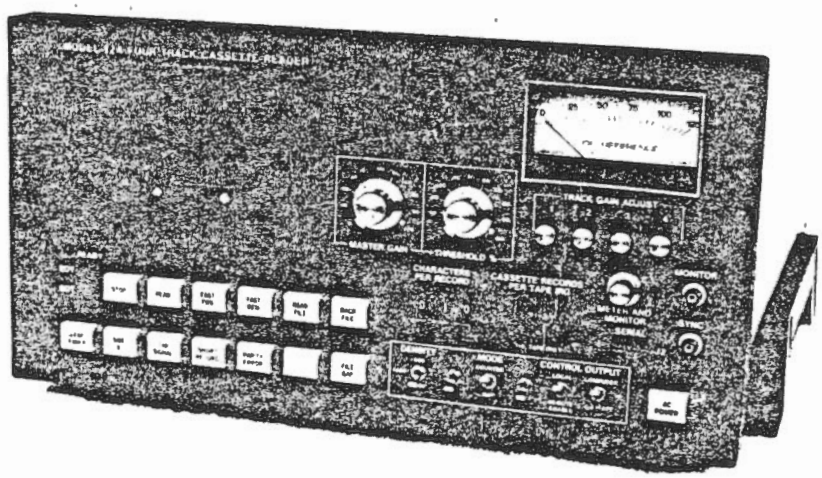
PRELIMINARY SPECIFICATIONS



MODEL 12A READER FOR 4 TRACK CASSETTES

February 10, 1978

The new Sea Data model 12A CASSETTE TAPE READER reads 800 bpi 4-track tapes from all the Sea Data recorders, including the series 610, 613, and 633. Thus the model 12A will read tapes from series 50 and 51 data loggers, VACMs, and the host of specialized instruments our customers have made. Tapes generated north of the Arctic circle, deeper than three miles in the ocean, and higher than 100 miles above the earth (Appollo-Soyez Skylab experiments) have all been read by the advanced circuitry of the model 12A. In addition, the model 12A reader will read 1600 bpi tapes from the new Sea Data super-density recorders.

The model 12A is easy to use. Output options are available for mini-computers and 1/2 inch buffered computer tape drives. The model 12A is semi-portable in its 8 1/4 inch fully-enclosed case with side handles. The strong plywood shipping box provided is designed for a quick truck or plane trip to your experiment site.

Each 12A model reader includes the parity and level circuit options along with a shipping case. But most users also specify either the 16 bit computer interface or the 1/2 inch tape drive options. The standard tape speed is 7 1/2 ips (about 7 minutes to read a 300 foot tape) but a slow speed option is available for those with chart recorder requirements.

Accessories are available for immediate data verification, including chart recorder analysis: ask about our models 15, 17, and 18 displays.

A complete nine-track tape translator system, model 1209, is available in a three foot rack.

model 12A with options 1, 4, 10 and case	$7,500
option 2---16 bits for minicomputer	750
option 5--1 7/8 ips (delete option 10)	500
option 15--tape translator	750
--cable for Digidata	150
option 16--rack ears	50
model 1209 tape translator system, complete	19,500

notes: 1. option 5 not available until mid 1978.
2. option 2 can be specified at 8, 12, or 16 bits parallel.

NEW FEATURES

In addition to all of the controls and status lamps on the old model 12 front panel, the new 12A has READ FILE and BACK FILE controls, a SHORT RECORD indicator, and separate LED's for EOT and BOT. Out model 12A also has a new front panel switch for 800 and 1600 bpi DENSITY and a microprocessor controlled transport.

The new 12A reader has full remote controls for more flexible computer operation. These include remote file controls and indicators. The new transport and 8085 microprocessor allow the use of 120 step (0.15 inch) file gaps, which are much shorter than the previous specification for the model 12.

SPECIFICATIONS

transport	microprocessor controlled SYCOR
start	15 msec (0.04 inches)
stop	35 msec (0.08 inches) including file sense
speed, 7 1/2	8 minutes for 300 foot tape (option 10)
1 7/8	32 minutes (option 5)
track gain	four individual controls
master gain	2 times above or below nominal
threshold	adjustable from 0 to 100%
meter	monitor signal levels to 125% and VCO operation
skew	up to 4000 μ inches acceptable (800 bpi)
dropouts	down to 20% acceptable
record gap	more than .005 inches without flux transitions
file gap	greater than 0.15 inches allows stop/start
power	120/240 volts, 50 to 60 Hz
density	front panel switchable 800, 1600 bpi (3 3/4 ips)

Advanced electronic techniques including phased-locked loops (PLL) with matched digital filters, first-in-first-out (FIFO) memories, and a tri-state logic data bus, are responsible for excellent performance of the model 12A reader. With PLL track synchronization and matched filter (correlator-integrator) phase decoding, the reader is much less sensitive to data phase-jitter (the primary kind of tape noise) than the more common 3/4 cell one-shot decoding. A separate clock signal, derived from each phase-encoded data track on the tape, permits four FIFO memories to electronically re-clock the tracks. Thus there are no skew problems, and tapes may be exchanged and read without adjustments. The reader contains more than 200 integrated circuits, including an 8085 microprocessor.

The model 12A reader contains 22 printed-circuit cards when fitted with all options, but one of the following partial spare card sets are usually sufficient for field repairs. Note that spares for option 2 and 15 are listed separately.

sparse	5 card spares set	$1600
better	10 card spares set	$3000
	option 2 spares set	$ 700
	option 15 spares set	$ 700

COMPUTER REQUIREMENTS (option 2)

Option 2 provides electronics for interrupt mode operation with most computers. A 16 bit minicomputer with 8K or 16K of memory and a nine-track tape transport is a preferred choice. Most minicomputers require only an off-the-shelf parallel interface card to connect to the reader. Several users have interfaced their Sea Data readers to microcomputers.

When operating at 7 1/2 ips the computer must handle 6,000 cassette characters each second. Thus, for a 16 bit computer looking at 12 bit data words from the reader, (with 4 bit flags) the data rate will be as high as 2,000 words/second. Of course, the presence of record gaps on the tape will ease this requirement somewhat. But, since a single cassette tape may hold as many as 900,000 computer words of data the mini-computer must store the data almost as fast as it gets it. And the computer must continue to accept new data from the reader while writing previous data onto either magnetic tape, or disc memory. As much as 6 million bytes of storage may be required for a single Sea Data cassette (450 feet of 1600 bpi tape).

Powerful file reading circuits in the model 12A can be used to simplify computer and I/O requirements. If the data tapes are written with file gaps about every 30,000 bits then the computer can read the tapes a file at a time. The reader can stop in the file gap and wait for the computer to finish processing the data before reading a new file. This greatly simplifies the software since the computer does not have to service input and output peripherals simultaneously. In addition, the computer can ask the 12A reader to backspace one or more files to reread the data to eliminate an error or perform new computations on the data. Finally the computer can rewind the tape to reread it all, or to prepare it for removal. Because the 12A reader has no internal buffer it is still necessary for the computer to accept input data under fast interrupt control. At a later date, Sea Data will introduce equipment with 4000 byte buffers, and we suggest you plan your data lengths accordingly.

TAPE TRANSLATOR (option 15)

A tape translator option provides for writing 1/2 inch IBM type computer tapes with ASCII coded data, readable by FORTRAN programs, etc. This option provides a parallel output for connection to an asynchronous computer tape writer.

Both Kennedy and DigiData sell excellent buffered asynchronous tape systems which are compatible with a model 12A reader with option 15. These tape systems consist of separate 512 character buffer-formatters and 8 1/2 inch synchronous read-after-write tape drives which generate 800 bpi 9-track NRZI computer tapes.

The buffer-formatters are available with a variety of options, but a 512 character buffer is adequate for all tape translation requirements. We strongly recommend 800 bpi 9-track NRZI rather than 7-track tapes or other densities, because these are more widely available and thus better suited for storage and exchange of data.

The tape drives are available in a 7 inch size, but some Sea Data tapes hold more data than can be translated to a 600 foot computer tape. Therefore a 8 1/2 inch drive is a minimum requirement.

	Kennedy	DigiData
buffer	9230c	LC-NS-9HI
drive	9800	1639-8-2-2RW
total cost	$5150	$4650

For those who find all these details an unbearable nuisance, we suggest the Sea Data model R12-09 tape translation system. This system comes complete with model 12A reader, DigiData formatter and drive, model 15-224P-224P display, all mounted in a 19 inch rack with all cables and manuals.

SERIAL BIT DISPLAY AND ANALOG READOUT

The Sea Data model 15 and model 17 data displays are particularly useful with any model 12 reader (no options are required). A brochure is available upon request describing these instruments, which must be purchased separately from the reader.

SERIAL BIT DISPLAY

The serial output of the reader can be fed into a model 15 serial bit display to permit immediate visual observation of the recorded signal. The model 15 can be custom designed to display the data in the same format in which it was recorded, allowing preliminary data analysis or system confirmation without using a computer.

Alternately the model 15 can be ordered with one or more sections of buffered bit display, each position programmable with a thumbwheel switch. This feature allows you to look at data anywhere within large data records, without requiring a full display of the whole record.

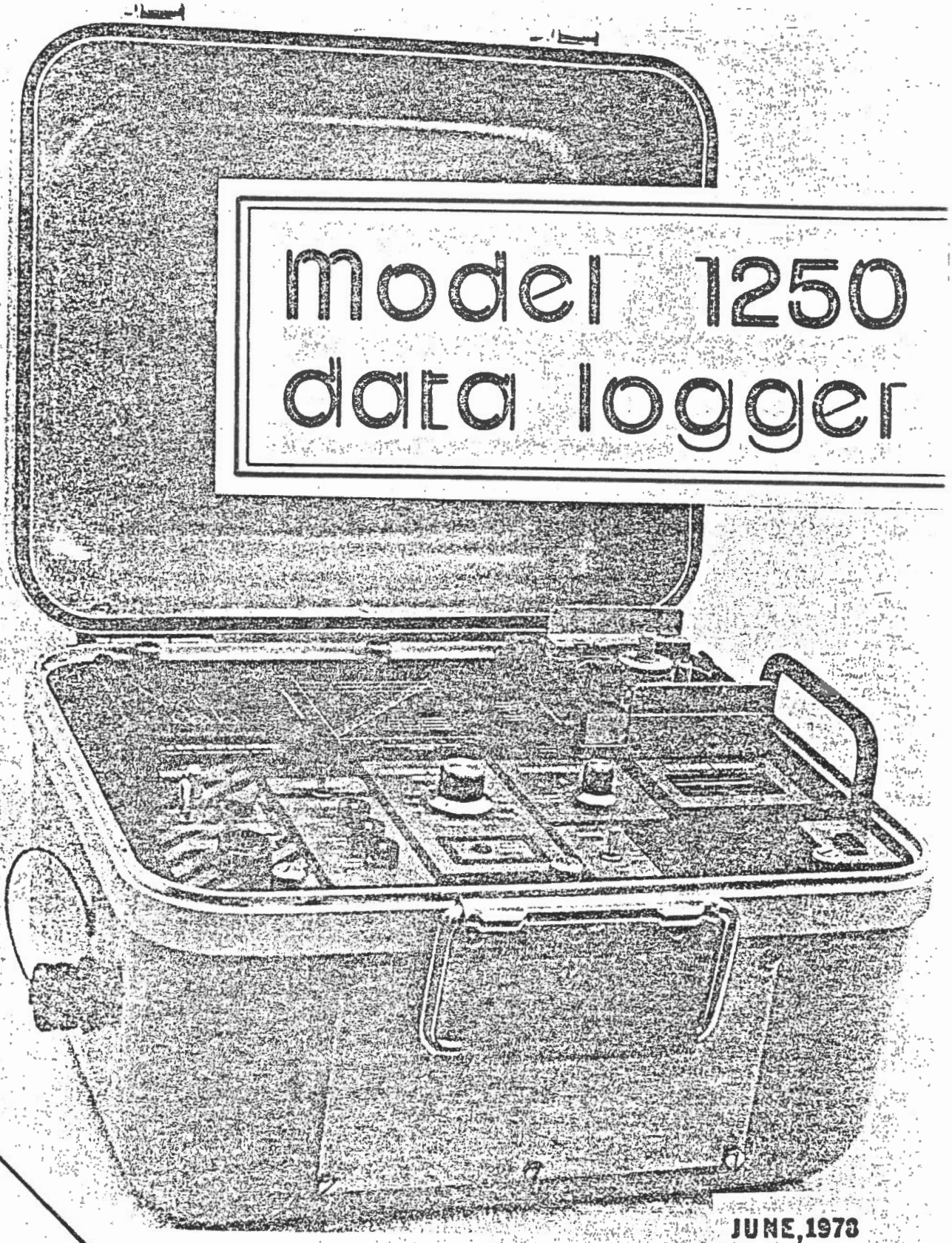
The model 15 is extremely useful, almost mandatory for your overall data aquisition systems. With it you can examine data in the lab as it is recorded, without a reader. Later, before and after the experiment, you can get a quick look at the data without waiting for computer turnaround. This quick-look capability is crucial to efficient trouble-shooting in the event of any component or sensor failures. It may be the best buy you make from Sea Data. Our model 15/17 display brochure explains the details, discussing both standard displays and fancy custom orders.

MODEL 17 D/A CONVERTER

The model 17 D/A converter, frequently built in the same cabinet along with a model 15 display, is aimed at those who wish to generate chart recordings of their recorded data.

Thumbwheel switches set the starting point in each record for a 10 bit buffer memory which drives a D/A converter. A model 17 with up to four individually programmable channels of D/A is available for use with a four channel chart recorder. Our model 17 works best with a 1 7/8 ips model 12A reader, since a typical tape may then update the D/A memory less than 60 times per second. By using a fast chart recorder, you can chart your data without severe distortion or filtering.

model 1250 data logger



JUNE, 1973

sea data

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INTRODUCTION

The Model 1250 Data Logger is designed to record the amplitudes of a number of analog inputs at regular intervals. Both the number of channels to be recorded and the recording interval are determined by the setting of rotary switches on the front pannel of the logger. In the recording process, the analog inputs are first digitized and then recorded on a cassette tape, along with a time word and a record header which is set by thumbwheel switches on the front panel. High density recording methods are used, making it possible to record as many as 8 analog inputs once every minute for a month, without exceeding the capacity of a 300' cassette tape.

This logger, as with all Sea Data products, was designed with high reliability and durability in mind. Set it up and walk away with the confidence that when you return days, weeks, or even months later, your data will be waiting. Straight forward front panel controls make the 1250 easy to set up and check out, helping to eliminate those last minute worries associated with long duration measurements. Use a standard Sea Data cassette reader to write your tapes onto IBM compatible 9-track tapes or directly into your computer for analysis. An immediate visual representation of the data can be generated by connecting the reader to a Model 17 D/A Display, which will provide the drive for a strip chart recorder. A word of caution though, to properly display the data contained on a 300 ft. cassette tape would take several hundred feet of strip chart paper!

HIGHLIGHTS

Digitizes and records up to 16 analog inputs, with 12 bit accuracy.

10 megabit recording capacity on standard 300' cassette tapes (up to 650,000 samples).

Time-word and four parity bits included with each record.

Records up to four 8-channel scans/sec.(32 samples/sec.)

Integral battery is capable of operating logger for 4 months, and is fully rechargable.

Optional battery pack extends operational life beyond 1 year between recharge.

Expandable to handle digital inputs.

Rugged waterproof case and connector.

Data tapes can be read by Sea Data readers directly into your computer for analysis.

GENERAL SPECIFICATIONS

Recording Medium:	* Standard digital certified 300' cassette tapes.
Recording Capacity:	* 10 megabits on 300' cassette yielding 536,000 12-bit data words, plus 67,000 36-bit headers.
Scan Interval:	* 0.25 sec. to 512 sec. in 12 steps
Inputs:	* 8 single-ended analog (optional: 8 differential or 16 single-ended).
Resolution:	* Each channel is converted to a 12 bit offset binary word.
Input range:	* -5 to +5 volts. Other ranges optional.
Channel Scan Rate:	* 15 msec per channel (independent of scan interval).
Data Record Format:	* 3 digit record header set by thumbwheel switch on front pannel. * twenty bit internally generated time word. * 4 or 8 channels--front pannel selected (16 channel option available). * 4 parity bits (one for each track).
Timebase accuracy:	* Stable to +/- 10 ppm over 10°C to 40°C. * Correctable to +/- 20 ppm over -20°C to +65°C.
Built in Thermometer:	* Stable to +/- 0.2°C over range -15°C to +75°C.
Chassis Connectors:	* Waterproof Amphenol series 48 connectors.
Power:	* Internal rechargable 12 volt battery with external charger. * 20 amp hour battery pack mounted in detachable lid available as an option.
Size:	* 12"L X 14"W X 10"H.
Weight:	* 20 pounds.

EASY TO OPERATE

DESIGNED WITH THE USER IN MIND

The Model 1250 front panel was designed very deliberately, with the controls laid out in a manner that minimizes the possibility of the accidental setting of a knob or switch. To ensure that the logger can't be accidentally turned off, locking-type switches have been used for the POWER ON and battery select switches. This feature is particularly important for setting out an array of loggers all synchronized to the same initial time. This synchronization could be implemented by resetting all the clocks, and then leaving them in STANDBY until they are placed in the field. The locking switches provide a tactile warning, helping to prevent the accidental deactivation of the logger.

The 1250's head current light and battery test button provide a last minute check of the logger's operation, and the front panel even includes a plot of the time it takes to fill a cassette against record interval to help you through last minute changes of plan.

VERSATILE OPERATING CONTROLS

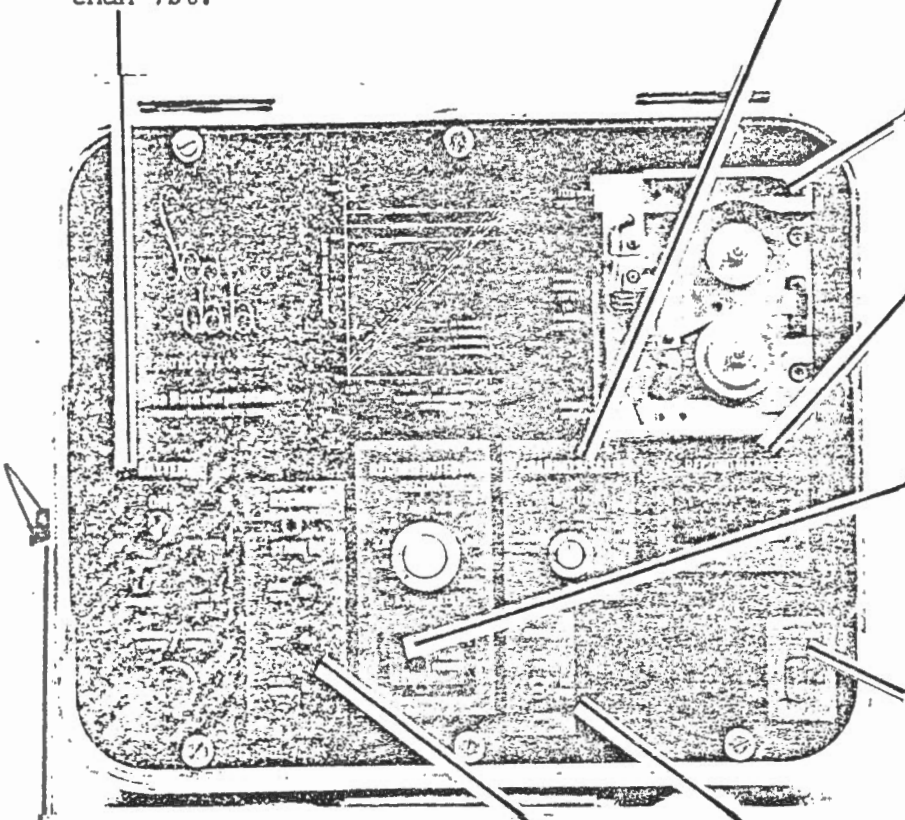
Panel controls for the recorder include a WRITE GAP switch, a RECORD/STANDBY switch, and a recording indicator. The RECORD/STANDBY switch is provided primarily for setup purposes. In STANDBY, all timed activities of the data logger are inhibited, while the CLOCK RESET, GAP and SINGLE SCAN switches are enabled. The GAP switch is provided to let you move the tape several feet past the clear leader after loading (this region of a cassette often has very high error rates), and tension the tape. The GAP switch can also be used to make FILE GAPS by holding the switch for about a second. (A FILE GAP is a gap long enough (.40") for the reader to stop and later restart without losing data). The recording indicator is a red LED which is in series with the head driver circuit. Thus when data is being recorded, current through the head causes this indicator to flash reassuringly. The clocks, A/D converter, and digital shift pulses can all be checked, and sensors can be aligned with a minimum of tape usage, by using the single scan feature and a Model 15 Display.

FRONT PANEL CONTROLS

BATTERY
*locking POWER ON/OFF.
*rechargeable internal 5 Ahr. battery.
*external battery option.
*press-to-test glows when charge is more than 70%.

SIGNAL CHANNELS
*each scan consists of 4 or 8 channels recorded during a 120 msec. scan duration.
*12 or 16 channels optional.

RECORDER
*our famous 610-2 recorder.
*200 steps/rev. stepping motor, 200 steps/sec.
*10 megabits on 300 ft cassette.
*rugged milled aluminum casting.



IDENTIFICATION
*a 3 digit word recorded on each data record.
*an additional 4 bits showing record interval setting is also recorded.

MEASUREMENT RATE
*time interval between full scans of the analog inputs.
*stable quartz crystal clock.
*slower positions not provided since the one year mission would be exceeded.
*HEAD CURRENT provides a visual indication that recording is actually taking place.
*4 bit code is recorded giving switch position.

TEST OUTPUT
*test lines connection to model 15 display or model 17 D/A converter for system checkout without reading tapes.

SIGNAL INPUT CONNECTOR

(On side of logger-- see front cover)

*provides connection points for differential inputs.
*supplies +/- 7V @ 4 mA (max.) switched on 35 msec. before ch.1 conversion .

RECORD ENABLE/STANDBY
*SINGLE SCAN records one data record.
*WRITE GAP advances tape without writing data.
*CLOCK RESET zeros the system clock.
*while in RECORD, the three standby controls are disabled for protection.

THERMOMETER
*three position switch so that ch. 1 measures external signal or temperature.
*standard internal temperature, range -15 to +65 degrees.

HOW IT WORKS

Figure 2 is a block diagram of the 1250 showing the details of its operation. The RECORD INTERVAL switch on the front panel sets the scaling ratio of a crystal oscillator-driven divider. When this divider overflows, it sends a pulse to the controller, signaling it to start a scan. This output pulse from the divider both increments the recorder's 20-bit time-word, and starts the recorder. By the time the recorder has written the gap and preamble, the first 12-bit conversion is complete and the serial data stream begins to be clocked into the recorder. The first three data steps load the three BCD digits from the RECORD HEADER thumbswitch on the front panel. This is followed by a 4-bit character showing the setting of the RECORD INTERVAL rotary switch, the 5 character time word and 3 data chracters for each of the channels selected by the CHANNELS/SCAN switch. The recorder completes the record by writing a 4-bit parity character. This whole sequence is snown in Table I.

INPUTS

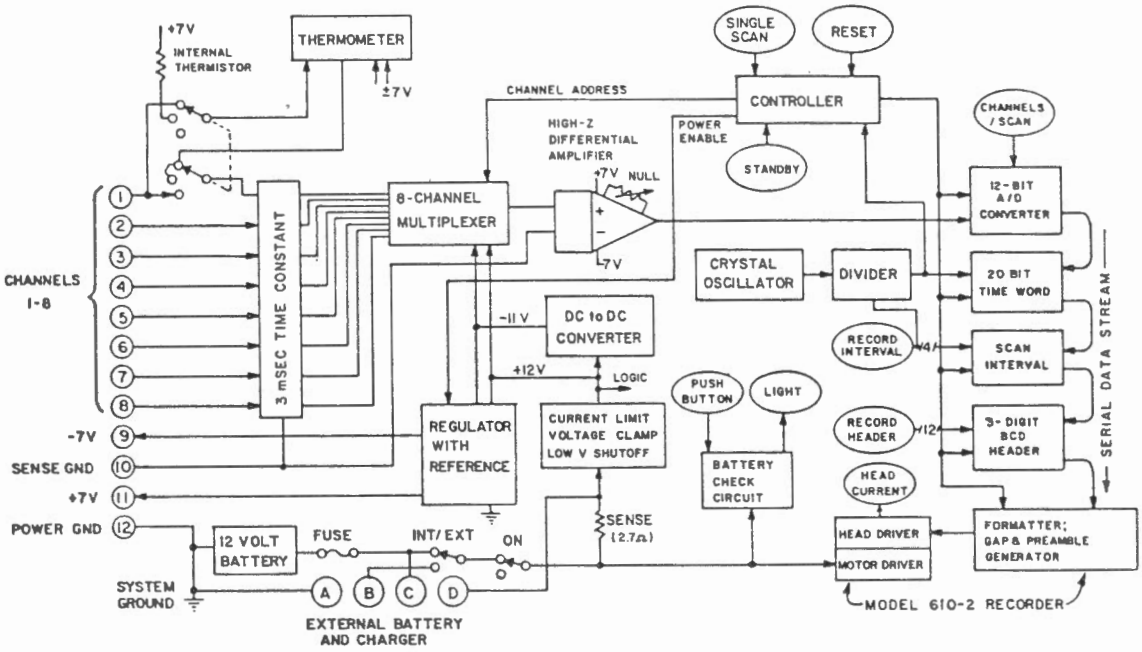
All inputs to the logger are filtered by 3 msec. time constants to help reduce noise. The high quality multiplexer is input protected so it will survive accidental connection to any voltage that YOU can survive connection to! The 12-bit binary successive-approximation C-MOS analog-to-digital (A/D) converter has a conversion time of just 0.3 msec. per channel---necessary for the fast scan rates of the 1250.

A FAST HIGH CAPACITY RECORDER

Many of the capabilities of this Data Logger derive from the use of our proven Model 610-2 Digital Cassette Stepping Recorder (see brochure for the Model 610 for details). These capabilities include scan intervals as fast as 1/4 sec. and scan capacities of 41,000 scans (16 channels) to 84,000 scans (4 channels) on a 300' cassette tape. This tremendous data capacity translates to 3 hours of recording while logging a 16 channel scan every 1/4 sec., or to over a year of recording an 8 channel scan every 512 sec. The recorder uses very little power when not scanning, since C-MOS integrated circuits are used for all of the logger's digital circuitry. With the internal 5 amp hour, 12 volt sealed rechargeable battery, the logger has sufficient energy for a 4 month experiment.

BATTERY CIRCUITS

The rechargeable 12 volt battery is protected against over discharge by a low voltage shutoff circuit which also provides a current limit and a voltage clamp protecting the 1250's circuits from high battery voltage during recharge. The battery check circuit provides a state-of-charge indications lighting when the battery has more than a 70% charge.



MODEL 1250 DATA LOGGER SEA DATA CORP. NEWTON, MASS. 02158

Figure 2. Block diagram of the Model 1250. Data Logger in the 8-channel configuration. The 16-channel version uses two input connectors and a 16-channel multiplexer.

TABLE I. TAPE FORMAT FOR THE MODEL 1250 DATA LOGGER
Each step records 4 bits and takes 5 msec. in the standard logger.

STEPS	BITS	EXPLANATION
10	-	GAP tensions tape before writing
2	8	Synchronization PREAMBLE.
3	12	Record header, 3 BCD digits.
1	4	Scan interval (0 = 1/4 sec to 11 = 512 sec.).
5	20	Time in scan intervals since clock reset (clock increments independent of Record/Standby).
3	12	Channel 1.
3	12	Channel 2.
:	:	:
3	12	Last channel.
1	4	Parity bits for each track.

DATA CAPACITY

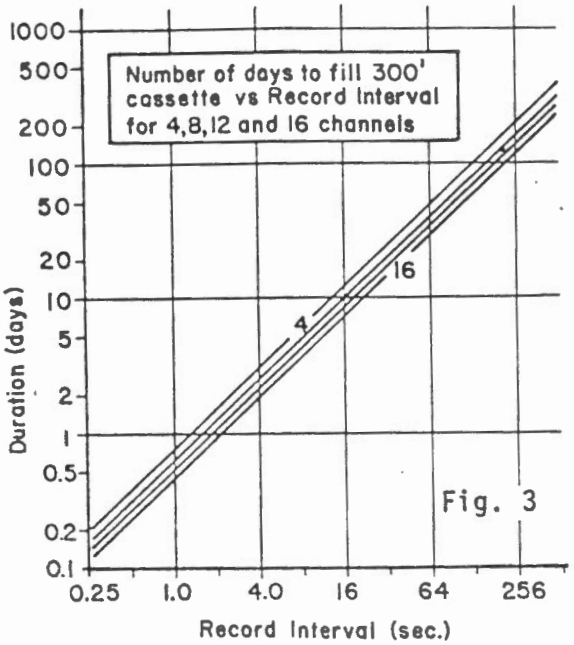


Fig. 3

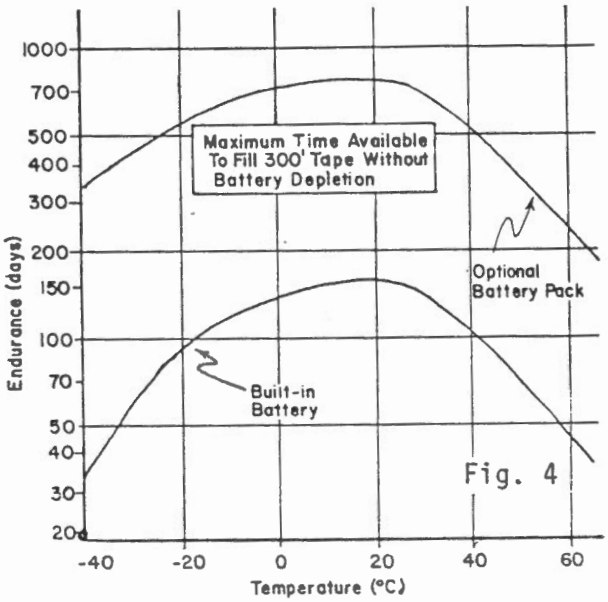


Fig. 4

The long mission capability of the 1250 is graphically shown in Figures 3 and 4. Use of longer tapes (450' or 600') would increase the run duration, but would decrease its endurance, dictating the optional battery pack for measurements requiring an endurance of greater than 60 days. These curves were derived from the data in Table II below, and the self-discharge characteristics of the batteries.

TABLE II. TAPE CAPACITY AND POWER SOURCE CHARACTERISTICS

	Number of Analog Input Channels			
	4	8	12	16
Scan capacity, 300 feet	84,000	62,000	49,000	40,000
450 feet	126,000	93,000	73,000	61,000
600 feet	168,000	124,000	98,000	81,000
Multiplexer scan time, msec.	64	124	184	244
Current used per record, mA-hr.	.013	.018	.023	.027
Model 12A reader setting	21	33	45	57
Recording time, msec.	170	230	290	350
Minimum scan interval, sec.	0.25*	0.25*	0.5**	0.5**

* Optional to .125 second ** Optional to 0.25 second

Internal battery ------ 5 AHr 12 volts sealed rechargable.
Lid-pak battery ------ 20 AHr 12 volts sealed rechargable.
Standby power ------ 0.8 mA steady drain (C-MOS electronics).
User power out ------ +/- 7 volts @4 mA (max) 35 msec. before scan begins.
charger supplied ------ small line-operated box external to logger.

WATERPROOF INPUT CONNECTOR

(Located on side of logger---see front cover)

The pin connections for the Amphenol series 48 external connector on the 1250 logger are shown in Table III. A switch on the front panel converts Channel 1 from signal input to a thermometer with a range of -15 C. to +75 C. The switch selects an internal sensor (supplied) or an external temperature transducer (special 30K thermistor) supplied in a 3/8 inch long 1/4-20 bolt for mounting with your other sensors.

The standard full-scale input range of the data logger is +/- 5 volts, with an input impedance of 100 Megohms, but the signal should have a source impedance under 5000 ohms. Other input voltage ranges are available, although special cards are required for full differential inputs or multiple scale ranges below +/- 2.5 volts.

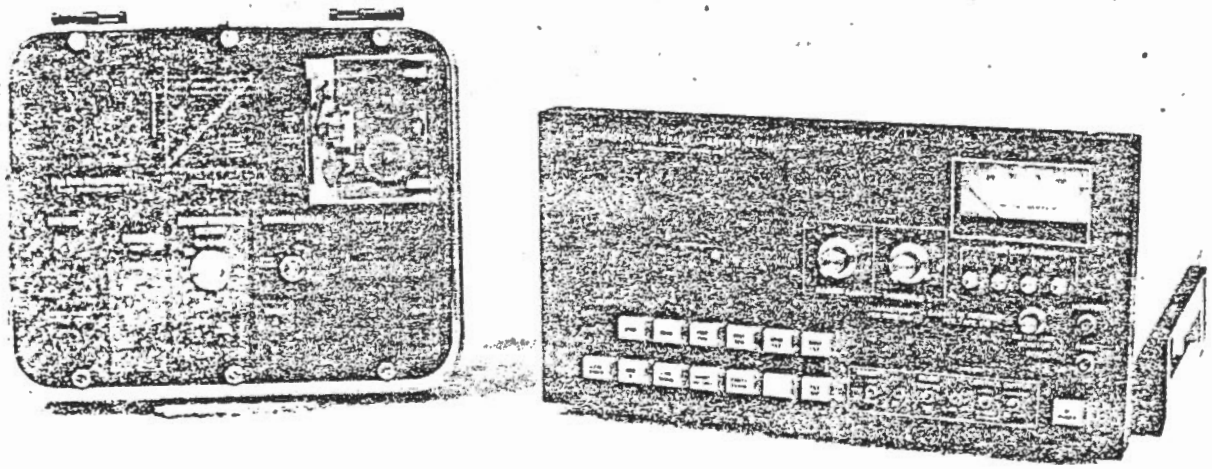
Pins 9 and 11 provide regulated power to the user's sensors (4mA max). These supplies come on 35 msec. before the first channel is sampled, and turn off after the scan is completed. Accordingly, their use presents no significant current drain to the logger. Since the A to D channel inputs have a 3 msec. time constant, the inputs must be valid within about 25 msec. after the supplies come on.

TABLE III. PIN CONNECTIONS TO SENSOR INPUT CONNECTOR
(Cap and mating connector provided)

PIN#	FUNCTION
1	Channel 1 voltage/temp sensor input
2	Channel 2 voltage
3	Channel 3 voltage
4	Channel 4 voltage
5	Channel 5 voltage
6	Channel 6 voltage
7	Channel 7 voltage
8	Channel 8 voltage
9	-7 volts regulated output
10	Signal ground (sense)*
11	+7 volts regulated output
12	Power ground*

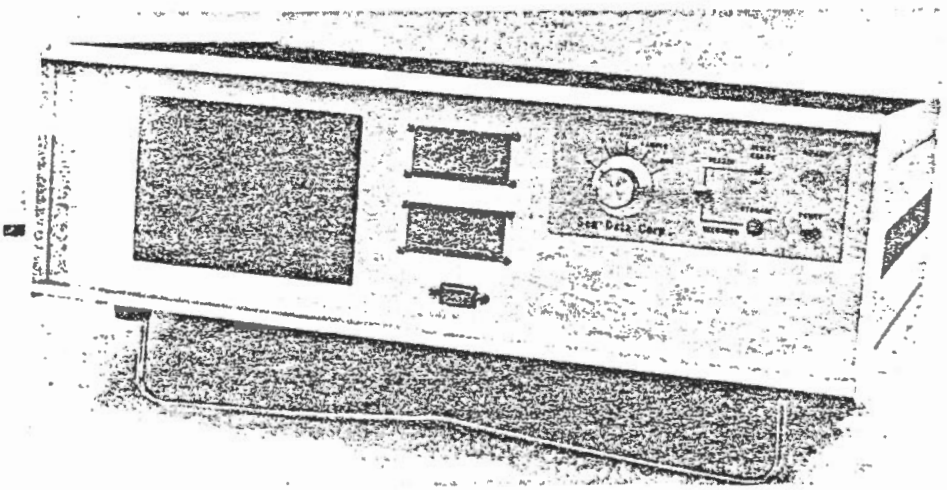
*IMPORTANT! For minimum pickup, signal ground and power suply ground should be connected at the sensor. To implement this, the connection between these two grounds is not made in the logger; rather, both of the grounds are made available at the input connector. FOR PROPER LOGGER OPERATION, THESE GROUNDS MUST BE CONNECTED TOGETHER!

MODEL 12A TAPE READER



The Model 12A Reader, pictured above, is designed to read the high density tapes written by the logger. Options are available for writing the data to 9-track IBM tapes or for reading the data directly into your computer. The Model 12A also has a serial output which can be used to output your data to the Model 15 Bit Box (pictured below) for immediate digital display, or to a Model 17 Display Box for D to A conversion —returning it to exactly the form it had as an input to the 1250.

MODEL 15 BIT DISPLAY



The Model 15 Bit Box picks off the input data to the recorder, just before it is put onto tape, and displays it along wih the parity word on rows of LED's. This display simplifies system checkout since it permits monitoring total system performance, including sensors and data acquisition electronics, without writing tapes.

STANDARD INPUTS

Input ranges	+/- 5 volts, +/- 2.5 volts, 0 to +5 volts, and 0 to +10 volts (internal thermometer works only with +5 volt range).
Input impedance	greater than 100 megohms.
Common-mode range	+/- 3 volts (with +/- 5 volt input range).
A/D converter	
resolution	12 bits.
format	offset binary, MSB first (bipolar) or binary, MSB first (unipolar).
accuracy	1 LSB and 40ppm/°C.
Thermometer	
range	-15 C to +65°C.
accuracy	+/-0.1°C.
resolution	+/-0.02°C.

OPTIONAL INPUTS

SIGNAL PRECONDITIONING: Provision has been made for addition of signal-preamp circuits inside the logger.

ADDITIONAL INPUTS: Each 1250 Logger has 3 uncommitted card slots which may be used to expand the logger's capability.

-ANALOG INPUTS: Up to 48 additional analog inputs can be added using standard low-power cards.

-FREQUENCY INPUTS: Cards are available for slow switch closure counting as from a rotor, or higher frequency counting as from a quartz crystal sensor or weinbridge oscillator.

-DIGITAL INPUTS: Parallel inputs in 16 bit increments.

-OTHER CAPABILITIES: Other cards provide for burst mode logging or multi-mode recording. Special circuits can be provided for event recording wih adjustable thresholds.

Many of these options require more input connectors, and/or, new front panel controls (space has been provided). Call the factory for details on special versions of the 1250.

CONCEPT OF HIGH DENSITY, HIGH RELIABILITY RECORDING

High density recording is accomplished by using four cassette tracks, and shortening inter-record gaps through the use of a stepping motor drive. These two devices make it possible to write 10 megabits of data on a 300' cassette without increasing the writing density per channel above 800 bpi, or sacrificing reliabiliy. The recorder electronics employs all C-MOS circuitry to minimize power drain, yielding a typical power-off drain of less than 1.0 mA for the 1250.

The cassette transports are built on precision machined castings, ensuring the close tolerances necessary for high reliability. In addition, the unusual four-track head is mounted with cast and precision-ground guides for accurate tape guiding. Finally, a tough industrial 200 step per revolution stepping motor with unique 8-phase current-source drive yields trouble-free tape motion for the 800 bpi phase-encoded recording.

A unique cassette tape reader takes advantage of the phase-encoded data to recover the bit cell clock separately for each of the four tracks and de-skew (or recombine) the data electronically with four FIFO registers. The Sea Data high-density recording system has been optimized to protect the integrity of your data.

Sea Data Corporation was formed in 1972 to provide the oceanographic field with high reliability, high density recording systems for remote instrumentation, and has since become known throughout the oceanographic community as a supplier of high quality instrumentaton. Sea Data products have found a wide range of application outside of oceanography, recording temperature in the mountains of Alaska, suspension-bridge strain measurements and magnetic field strengths throughout the USA, to mention a few.

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TELEPHONE (604) 980-3474 • TELEX: 04-352773

MODEL 440 GENERAL PURPOSE UNDERWATER ACOUSTIC SYSTEM

The Model 440 is a flexible programmed system designed to communicate acoustically underwater.

With multiple microprocessors, a comprehensive selection of underwater modules, cassette tape storage and ergonomic input (keypad) and output (CRT), users can perform a wide range of standard tasks or easily customize a system to their special requirements.

The 440 can be used for the precise navigation of surface vessels, rigs, etc., or submersibles (whether manned or remotely controlled) over considerable areas, using long or short baseline methods.* It can also communicate with remote sites - transmitting commands to operate releases, valves, etc., and receiving data such as pressure, temperature, tilt, strain, etc.

The CRT displays all the numerous modes of operation in a logical sequence of "menus" so neither the modes nor their sequence need to be memorized. The operator selects the required mode of operation and also inputs data when prompted by the computer. Input is via a rugged sealed keypad with only 16 keys so no typing ability is required.

*
"Long baseline" operation uses the simultaneous measurement of range to a minimum of 2 transponders (usually 3 or 4 are used) from a single transducer of the 440 system. The distance between the transponders, up to several kilometres, is the long baseline.

"Short baseline" operation is the simultaneous measurement of range and bearing to a single transponder from an ultra-short baseline transducer array of the 440 System. The distance between the transducers of the array, up to a few hundred millimetres, is the short baseline.

Specifications subject to change without notice.

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THE MODEL 440 ACOUSTIC COMMAND SYSTEM

The MODEL 440 ACOUSTIC COMMAND SYSTEM is a general purpose acoustic language that enables the Model 440 System to perform a large variety of underwater tasks involving position measurement and data transmission. The acoustic command system uses a combination of frequency sequence and pulse position modulation. A total of 8 frequencies are used, divided into 2 bands of 4 frequencies each.

Each command or reply is the equivalent of 12 bits of information, and is encoded as 3 pulses, each of a different frequency, but always in the same band. The second pulse must occupy 1 of 16 positions and the third pulse must occupy 1 of an additional 16 positions. The frequency sequence identifies 4 bits, and the pulse positions identify the other 8 bits.

The 8 frequencies used are in the range from 15.625 KHz to 20.000 KHz.

MESOTECH MODEL 440 SYSTEM FEATURES

128 Transponders may be used in a single array.

Any of the 128 transponders can be enabled to operate as any of Channel A, B, C, or D.

Four transponders can be enabled at one time.

Only one transponder may be enabled on each Channel at one time.

Any transponder can be enabled as a relay transponder. In this mode it can operate with three other enabled transponders.

Two complete systems can operate simultaneously in a transponder array.

The complete system is compact, lightweight, operates on 24 V DC and may be installed in a small submersible.

The system allows operation through long cables to remote controlled vehicles, trenching plows etc.

No program loading required. Programs stored on E-PROM's.

Menu type mode selection and display prompting guides operator.

Data stored on tape cassettes for permanent records and later analysis.

Specifications subject to change without notice.

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MODEL 440 PROCESSOR

The MESOTECH MODEL 440 PROCESSOR is the main control unit for the Model 440 Acoustic System. It monitors the keyboard for data entry, controls the transducer assembly functions via the main cable telemetry system, supplies power to the transducer assembly, collects data, performs calculations, generates the display, and controls the input and output interfaces to such devices as a ship's gyro, an external computer and a plotter. Included in this package is a cassette tape recorder for data storage, thumbwheel switches for transducer position offsets, and a battery powered digital clock for time of day.

The unit contains two Intel 8080 processors, the PROM's which contain the complete system program, the video display electronics, and the main cable power supply and telemetry terminal.

The system is controlled by the operator using the CRT display and a 16 key keyboard. The system generates "menu" type displays which allow the operator to select the desired mode of operation, and prompts him to enter any required data.

The Model 440 program includes three different methods of long baseline transponder array calibration. These are: calibration using the least squares method of fitting surface fix data; calibration using the relay transponder method; calibration using the baseline crossing method.

After array calibration, the system performs position calculations and generates displays showing the vessel position and transponder position. The format of the displays can be varied to suit particular operations by the operator.

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Also included are displays which show data received by telemetry from the transponders, and bearing and range measurements from selected transponders.

The Model 440 Processor has been designed to use 24 V DC power directly. This allows minimum size, weight and power consumption when used in a submersible. When operation from 120 V 50/60 Hz power supplies is required, as in a typical shipboard installation, the MESOTECH MODEL 315 power supply must be used.

SPECIFICATIONS

DISPLAY:	512 x 512 Display
KEYBOARD:	16 Key
POWER REQUIRED:	24 - 30 V DC 5 Amp Max.
MAIN CABLE TELEMETRY SYSTEM:	Serial Tone Burst TRANSMIT: 250 KHz RECEIVE: 350 KHz
INTERFACES:	GP-IB Serial RS 232
TAPE STORAGE CAPACITY:	4 hours of data at 10 second interrogation rate
PLOTTER:	Compatible with HP9872A
MEMORY:	48 K (E-PROM)
SIZE:	19" Rack Mount 19" (48.3 cm) w x 7" (17.8 cm) h x 16" (40.6 cm) d
WEIGHT:	32lb (14.5 kg)

Specifications subject to change without notice.

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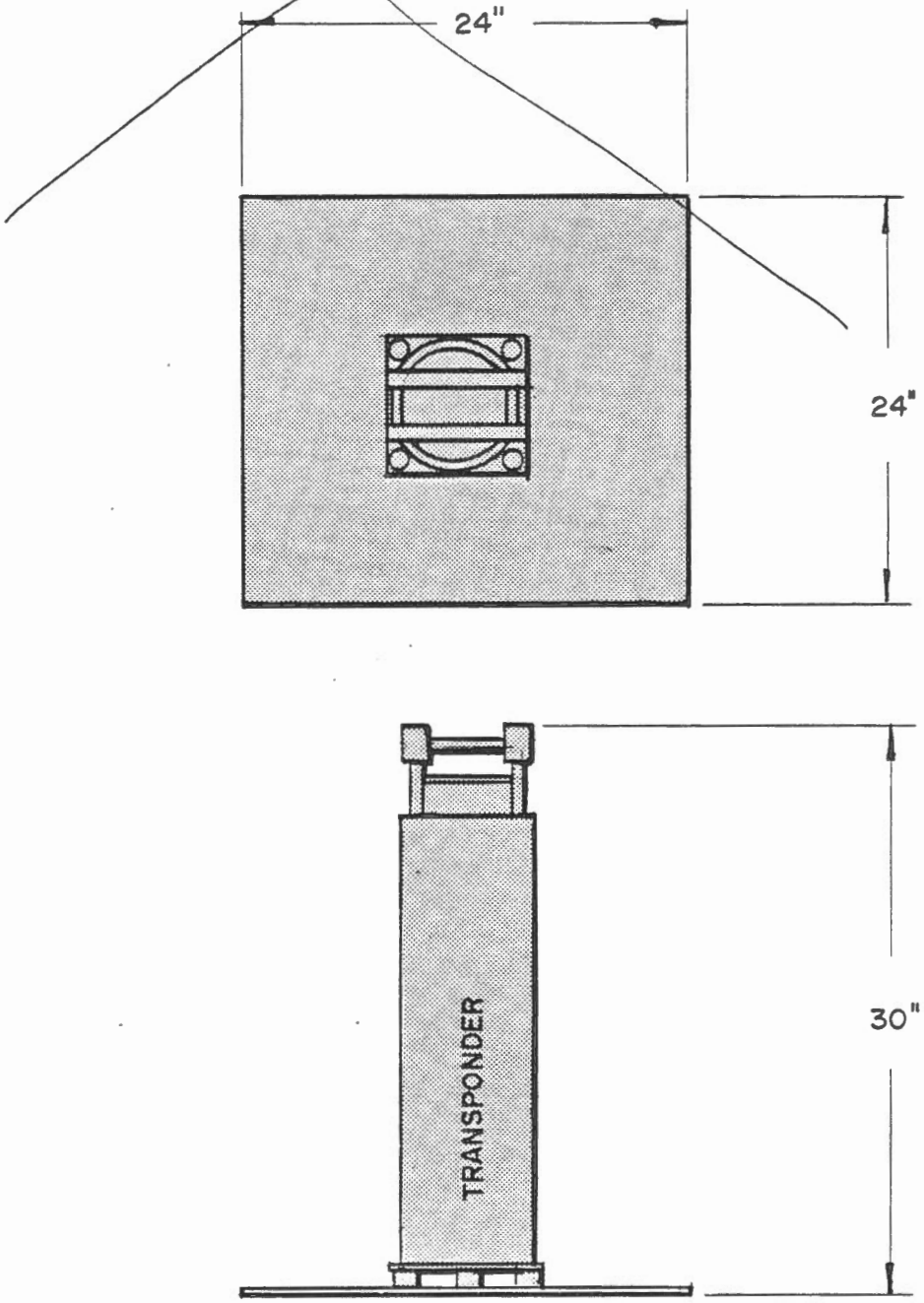
MODEL 514 ICE KEEL PROFILING SYSTEM

SATELLITE UNIT.



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MODEL 411/412 ACOUSTIC NAVIGATION SYSTEM

This system was designed for use in navigation and positioning of small submersibles. A map of the submersible's position and path is displayed on a television screen to a resolution of 1 meter. This allows the pilot to conduct precise pattern searches and to return to a specific location quickly and easily. Mesotech has provided a simple, rugged system which provides information the pilot can easily interpret.

Inside the submersible are four compact packages:

- CRT Display Screen
- Model 470 Display Control
- Model 411 Transponder/Interrogator
- Model 412 Transmit/Receive Unit

Mounted outside the pressure hull is a small transducer assembly. Seven conductors are required through the pressure hull.

The complete system requires 200 watts at 120V 60 Hz (± 10% voltage and frequency). Total weight is 76 lbs. Volume required 2¼ FT^3 or 18" high x 12" deep x 19" relay rack.

*From two to four Model 501 Acoustic Transponders are used in an array. The system will operate at ranges of up to 2 km from the transponders.

The range information displayed on the Model 411 Digital display can be recorded manually for a permanent record of the submersible position. This range information is also available electrically for interfacing with a tape recorder.

Although the 411/412 System was designed specifically for use in small submersibles, it can also be used for navigation and positioning of surface vessels, underwater remote controlled vehicles, towed bodies, and instrument packages, diving bells and wellhead service capsules. If the CRT and associated hardware are mounted on a surface vessel, the position and track of a Model 501R Acoustic Relay Transponder may be displayed, *using an array of three Model 501 Acoustic Transponders.

If hard copy is required, the 411/412 is interfaced with an HP 9825A Calculator and HP 9872A Plotter.

*The system will also operate with ART 525 mini acoustic release transponders with slightly reduced range.

Specifications subject to change without notice.

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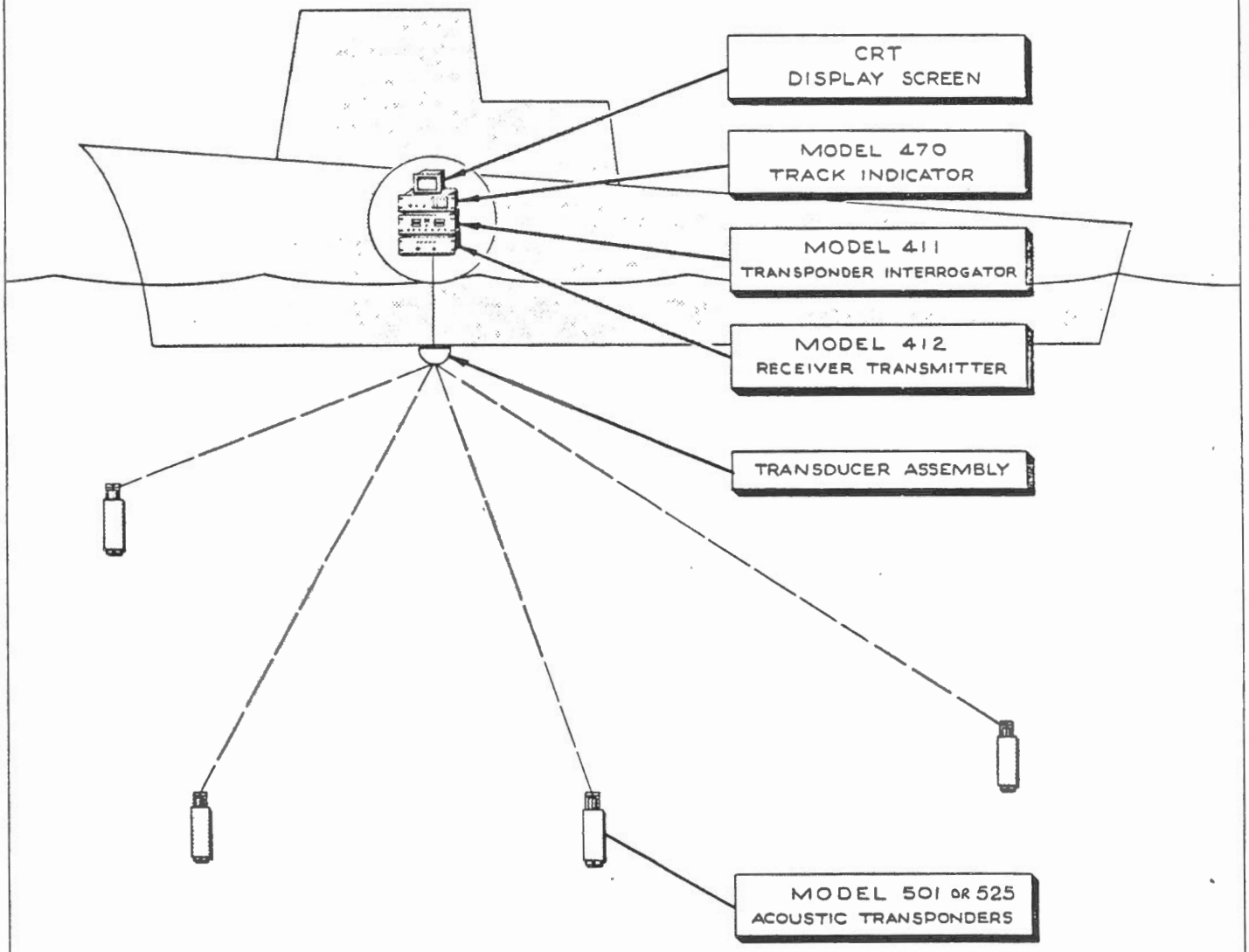
MODEL 411/412 ACOUSTIC NAVIGATION SYSTEM

ON-BOARD NAVIGATION OF SURFACE VESSEL



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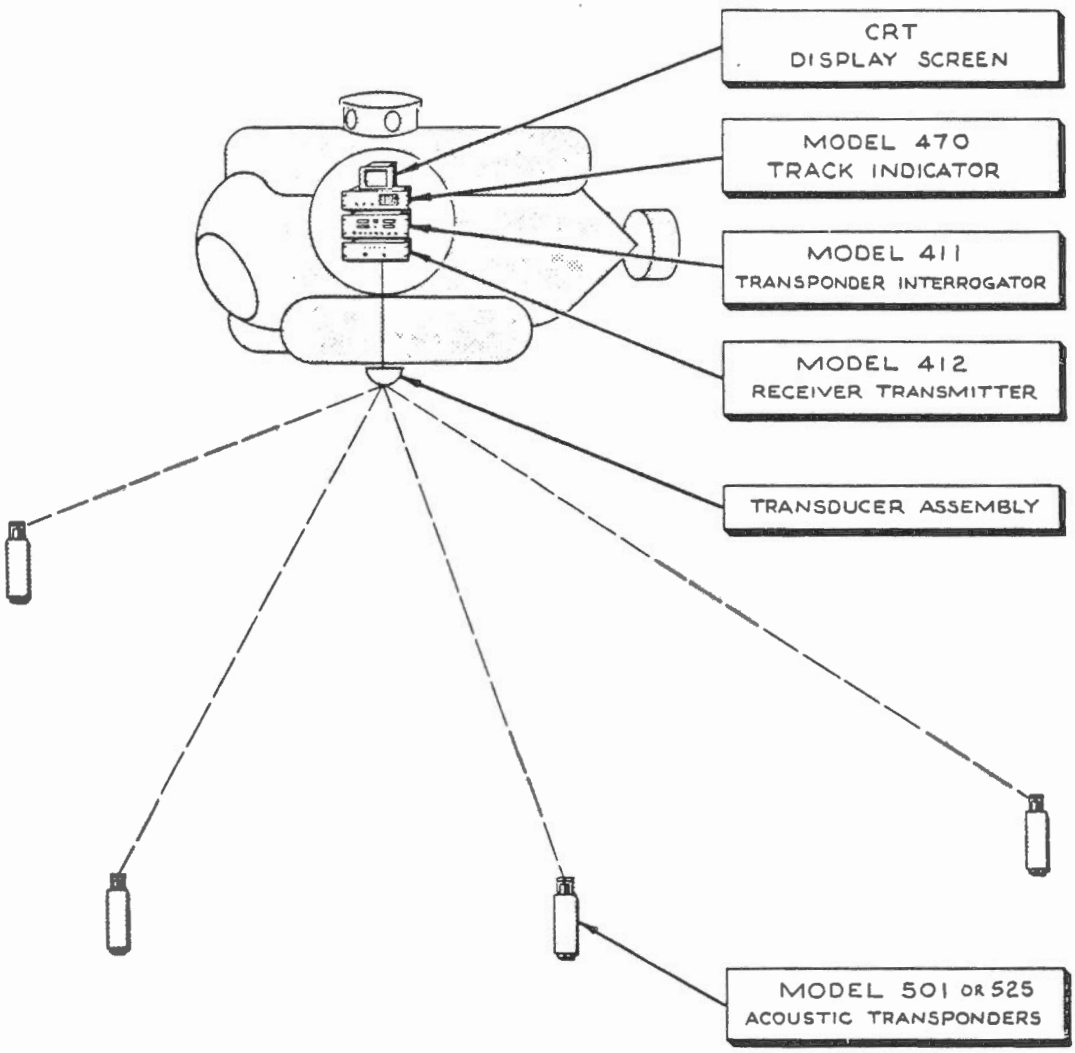
MODEL 411/412 ACOUSTIC NAVIGATION SYSTEM

ON-BOARD NAVIGATION OF SUBMERSIBLE



DATA for SUBMERSIBLE OPERATORS and MANUFACTURERS

EQUIPMENT In BOAT

Total Weight:	76 lb. (34.5 Kg.)
Volume:	2 ¼ ft.³ (.064 m.³)
Power:	200 W 120 V 50/60 Hz
Penetrator:	Seven (7) Conductors

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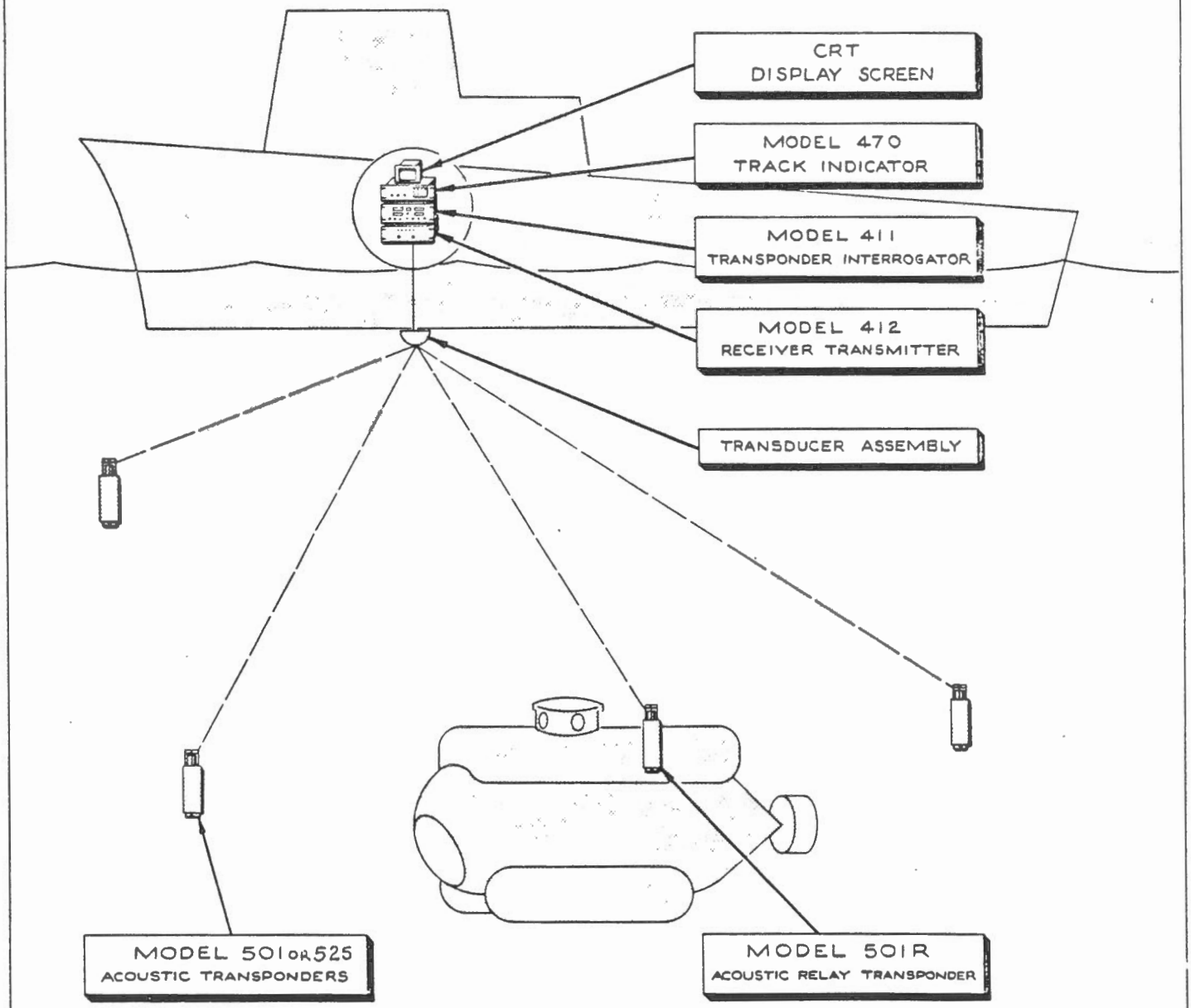
MODEL 411/412 ACOUSTIC NAVIGATION SYSTEM

TRACKING UNDERWATER VEHICLE FROM SURFACE



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MODEL 411 TRANSPONDER INTERROGATOR

Displays slant range in meters to four Model 501 Acoustic Transponders simultaneously. These ranges may be used to plot the position of the Model 411 manually. When used with the HP 9825A Calculator and HP 9872A Plotter each position is plotted giving a permanent record of position and track.

The Model 411 also operates as an acoustic release command unit, generating 32 unique release codes for use with Model 501 AR Acoustic Release Transponders.

The Model 411 Transponder Interrogator must be used in conjunction with a Model 412 Receiver Transmitter to form a complete slant range measuring system.

Microprocessor controlled system provides maximum performance with minimum complexity, size and power consumption.

NOTE: Where the 501 AR Acoustic Release Transponder is mentioned, the ART 525 mini transponder may also be used.

Specifications subject to change without notice.

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SPECIFICATIONS - MODEL 411

INTERROGATION RATE:	Manually, or automatically every 5,10, 20,30,60 or 120 seconds or when triggered by external equipment.
OPERATING MODES:	Mode I - Slant range to individual transponders. (maximum of four) Mode II - Round trip slant range from Interrogator to Model 501R Relay Transponder to Model 501 Transponders to Interrogator (maximum of three) Mode III - Slant range from Model 501R Relay Transponder to Model 501 Transponder (maximum of three) REL - Commands Model 501 AR Acoustic Release Code Select by thumbwheel switch, key switch to prevent accidental release EXT - External control of interrogation rate.
VELOCITY OF SOUND:	From 1400 to 1550 in 15 meter/second steps.
ACCURACY:	± 1 meter.
CALL PING:	Commands Transponder call pinger by push button.
TEMPERATURE:	-20C to +50C
POWER REQUIRED:	120V, 50/60 Hz.
SIZE:	17" wide (19" rack mount) X 7" high X 12" deep.
WEIGHT:	26 lbs.
NOTE:	Where the 501 AR Acoustic Release Transponder is mentioned, the ART 525 mini transponder may also be used.

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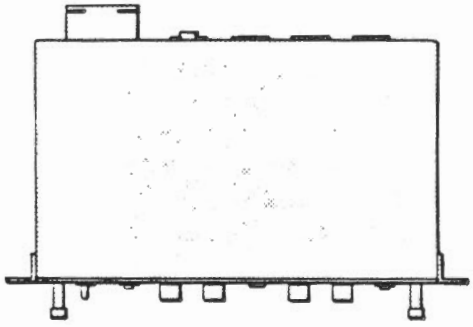
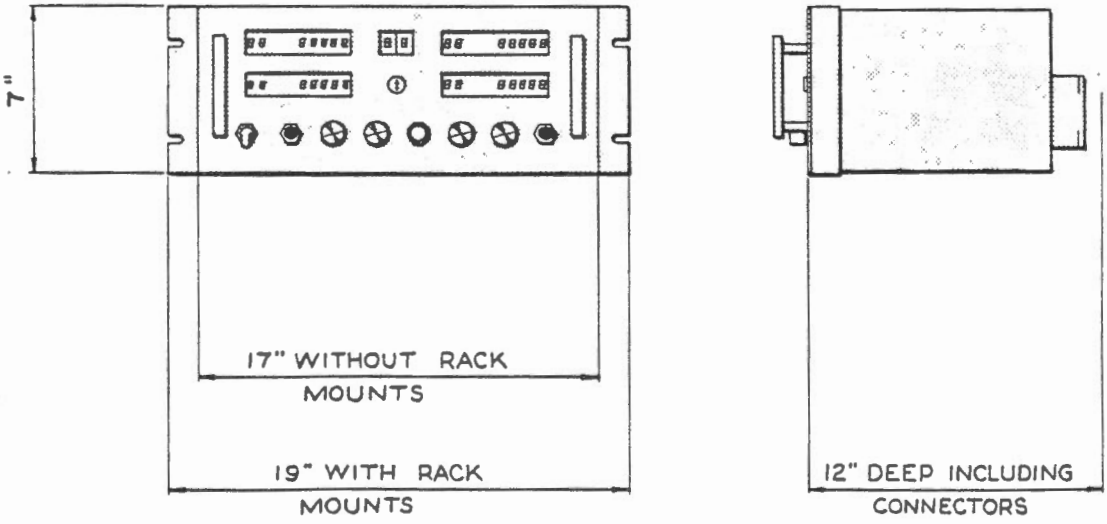
MODEL 411 TRANSPONDER INTERROGATOR





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MODEL 412 RECEIVER TRANSMITTER

The Model 412 Receiver Transmitter contains a crystal controlled frequency generator and a power amplifier to produce transmit pulses as commanded by the Model 411 Transponder Interrogator and a sensitive receiver and filter section to detect returning pulses from Transponders.

SPECIFICATIONS

OPERATING FREQUENCIES:	Transmit: 15.625 KHz, 16.667 KHz 16.129 KHz, 17.241 KHz Receive: 17.857 KHz, 18.518 KHz 19.231 KHz, 20.000 KHz.
TRANSMITTER OUTPUT:	nominal 100 W electric
RECEIVE SENSITIVITY:	20 microvolts
SIZE:	17" wide (19" rack mount) X 5¼" high X 11" deep.
WEIGHT:	10 lbs.

Specifications subject to change without notice.

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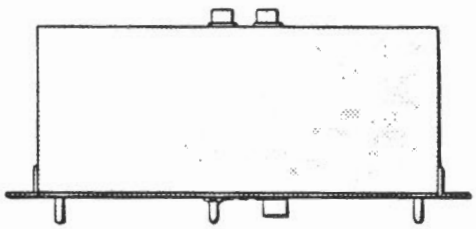
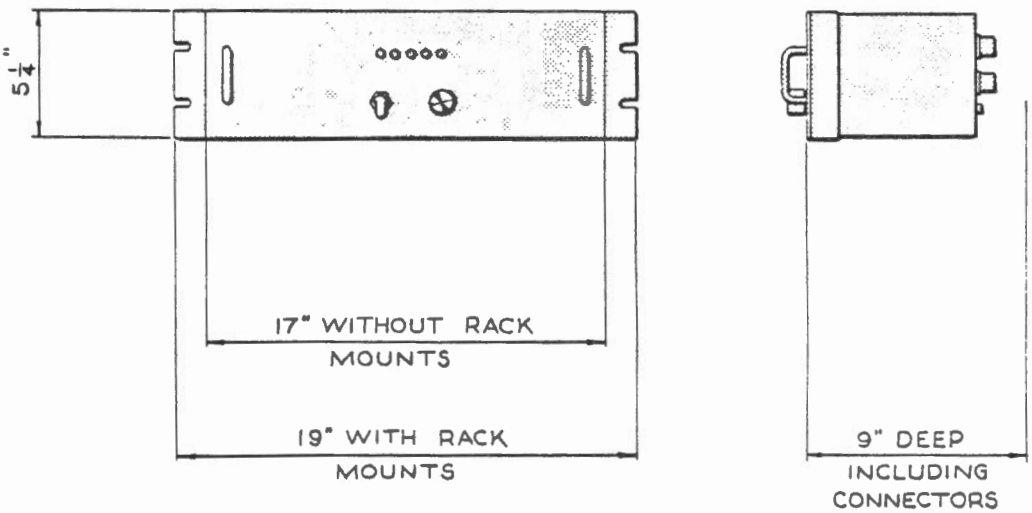
MODEL 412 RECEIVER TRANSMITTER

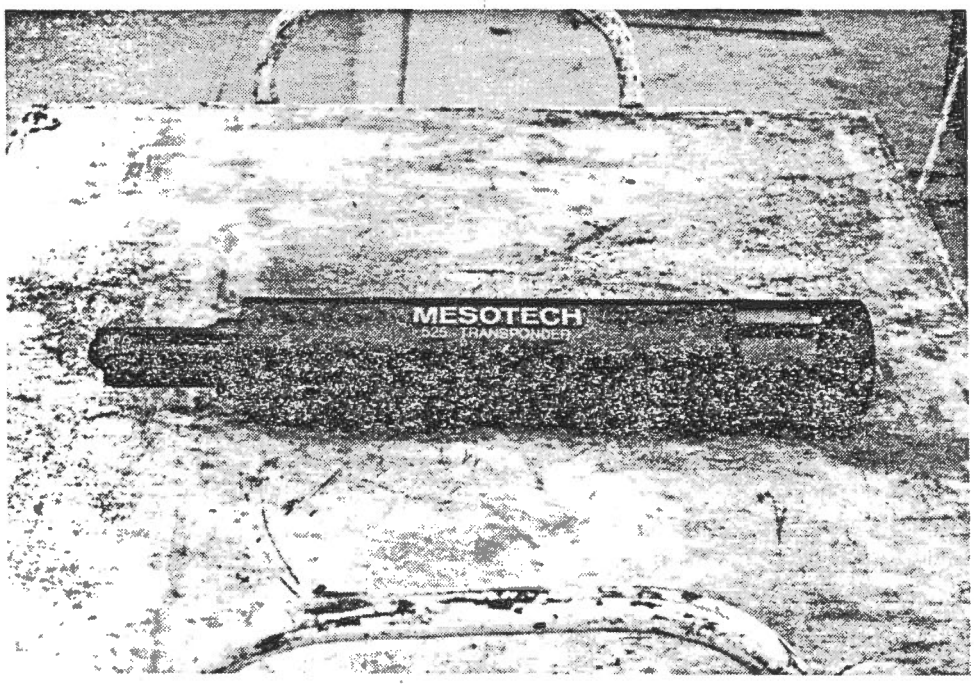




MESOTECH

MODEL ART 525

MINIATURE ACOUSTIC RELEASE TRANSPONDER



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MODEL ART 525 ACOUSTIC RELEASE TRANSPONDER

The MESOTECH ART 525 ACOUSTIC RELEASE TRANSPONDER (A.R.T.)is an acoustically operated combination of a remote control release and navigation transponder in one lightweight, miniature package.

Among its many uses are: the controlled release of loads to the sea floor or surface, as a location or area navigation transponder, and combinations of both functions.

A slim, tough, aluminum tube houses a sensitive receiver, a CMOS MICROPROCESSOR, a powerful transmitter, a release drive motor, a magnetically actuated ON/OFF switch and a replaceable battery. At the ends are mounted the receive/transmit transducer in its protective cage, and the release hook.

The A.R.T. is tuned to accept the frequencies and codes of the 411/412 Navigation System and 601, 601P Release Command Units. Error detection and correction logic in the A.R.T. ensures that both acceptance of correct codes and rejection of false codes and noise is greatly enhanced.

When a correct Transpond code is received, the Model 525 transmits a coded pulse back to the 411/412 which then calculates the slant range to the A.R.T. The 601P gives an audio output for each received pulse.

When the "Call Pinger" command is used, the A.R.T. transmits a pre-programmed train of pulses, up to 64, at one pulse per second. This signal can be used to locate the A.R.T. using a pinger receiver and a directional hydrophone.

When Release is commanded, the release motor operates, opening the hook and allowing the A.R.T. to rise to the surface with suitable attached buoyancy.

While the release motor is rotating, the A.R.T. pings at 1 pulse per second, confirming recognition of the correct release code. When the motor stops, the A.R.T. reverts to its original state, ready to accept transpond or call pinger codes to assist in its recovery.

After recovery, the release mechanism may be reset, and the A.R.T. immediately re-deployed if required.

The release mechanism is simple, positive and corrosion resistant. It can be reset externally using only a screwdriver, without opening the housing.

Specifications subject to change without notice.

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SPECIFICATIONS - MODEL ART 525

OPERATING FREQUENCIES Note: Compatible with 411/412 and 601, 601P	Receive: 15.60 kHz, 16.70 kHz Transmit: All frequencies ±0.15 kHz Channel 1 17.90 kHz 2 18.50 kHz 3 19.20 kHz 4 20.00 kHz Call Pinger 14.90 kHz
RECEIVE SENSITIVITY	20 microvolts
TRANSMITTER OUTPUT	Nominal 50 W electrical
CALL PINGER (Standard is 2 pulses)	Programmable, 1 pulse per second for up to 64 pulses
RELEASE CODES	32 unique codes available
BATTERY	Alkaline, replaceable, AA cells
BATTERY LIFE	6 months standby and/or 10,000 interrogations
HOUSING MATERIAL	Anodized aluminum, polyvinylchloride
OPERATING DEPTH	1500 m (5,000 ft) max.
RELEASE LOAD CAPABILITY	450 kg (1,000 lbs) max.
SIZE	76 mm (3") dia x 480 mm (19") long
WEIGHT	In air 4.5 kg (10 lbs) In water 2.3 kg (5 lbs)

Specifications subject to change without notice.

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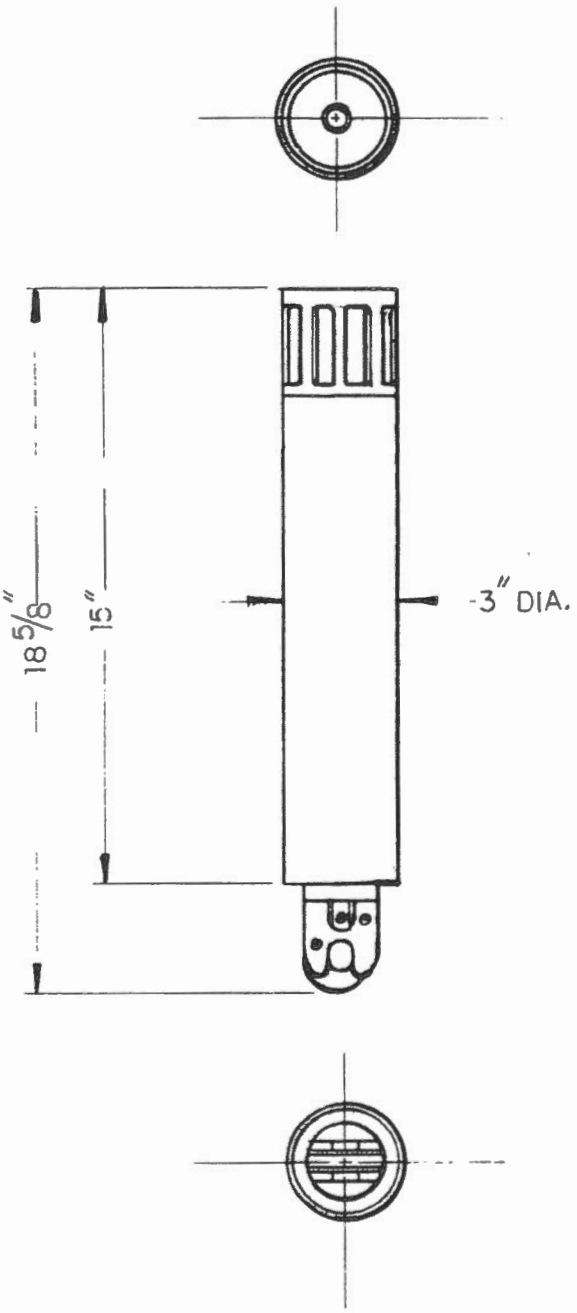
ART 525 - TRANSPONDER



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MODEL 940 TRAINABLE HYDROPHONE

The MESOTECH MODEL 940 TRAINABLE HYDROPHONE consists of a directional hydrophone which can be steered in elevation and bearing using a single lever control. Using a suitable pinger receiver, (Model 600, Model 601 P or Model 703 A) it can be used to determine the direction of an underwater sound source.

The Model 940 is constructed of aluminum and fiberglass for minimum weight. A clamp is provided for mounting and the unit tilts and slides in its mount so that it can be quickly and easily deployed and retracted.

SPECIFICATIONS

DIRECTIONAL ACCURACY:	± 5 degrees elevation and bearing.
SIZE:	89 inches long (other lengths as required).
WEIGHT:	35 lbs.

Specifications subject to change without notice.

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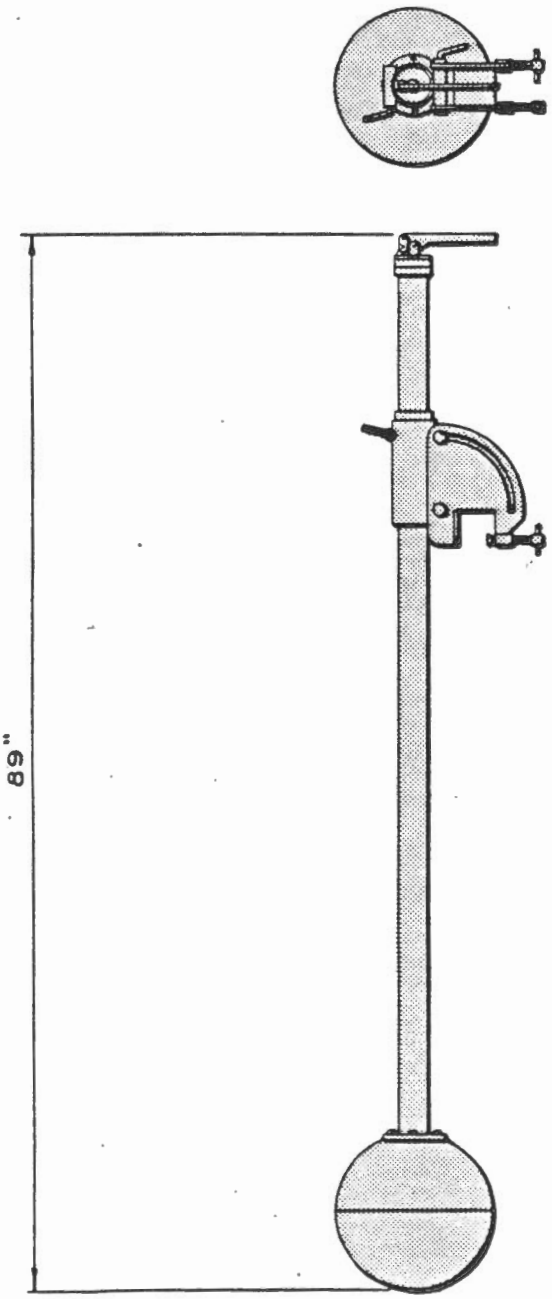
MODEL 940
TRAINABLE HYDROPHONE



MODELS 1900 & 1901

OFFSHORE RECALL BUOY SYSTEM

- **RELIABLE, PROVEN PERFORMANCE**
- **FULLY INTEGRATED SYSTEMS**
- **SECURE CODING**
- **TRANSPONDER OPTION FOR RELOCATIONS**
- **MODULAR FOR VERSATILITY**
- **LIGHTWEIGHT, COMPACT**
- **FULLY REUSABLE RELEASE WITHOUT DISASSEMBLY**

SYSTEM

The InterOcean **Offshore Recall Buoy** provides a reliable means to mark underwater sites or equipment. When desired, the site can be relocated quickly and the unit recalled to the surface with the tagline remaining attached to the object, equipment, etc. on the bottom. The Recall Buoy has a variety of applications such as wellhead or pipeline marker, scientific equipment installations and recovery survey marker, and to aid in positioning of equipment or vessels onto an underwater location.

The Recall Buoy System is comprised of field proven equipment. All items are standard products. The modular design allows the user to tailor the equipment to his specific needs, and minimize his cost without sacrificing performance.

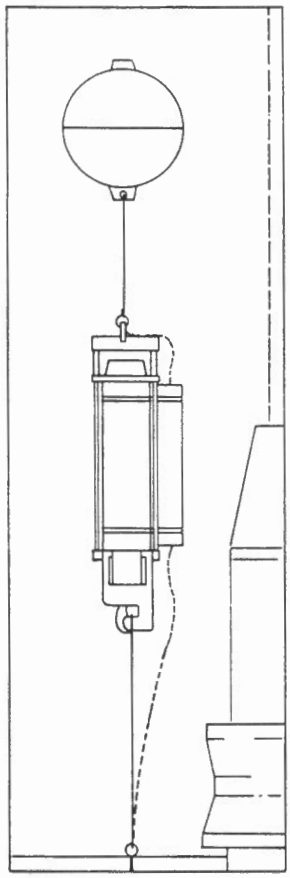
MODEL 1901 RECALL AND RELOCATION BUOY SYSTEM

This system is used to relocate and recall the Subsurface Release System. It consists of the following equipment:

The **Model 1100A-3 Acoustic Command Transmitter** is a portable unit, complete with internal rechargeable batteries and Command Transducer with 30 meters of cable.

The **Model 1300 Digital Range Indicator** is used in conjunction with the Model 1100A-3 to provide a convenient means of obtaining the slant range between the surface command unit and the underwater Recall Buoy.

The **Model 1090 Acoustic Transponding Release** provides a transponder/pinger feature for relocation of the Recall Buoy and to confirm its release upon command. This is a small, lightweight unit convenient to handle and install, even from small vessels.



Acoustic Release used as a Recall Buoy system for marking wellheads, pipelines, drilling sites or other similar requirements. Provides a tagline marker which when recalled permits divers to return to the site or send other equipment to the bottom site.

The **1800 Series Subsurface Buoy** provides positive buoyancy for the Acoustic Release and Tagline Cannister for the recovery sequence. The buoys are available in various sizes to accommodate varying net buoyancies and water depths.

The **Model 1910 Tagline Cannister** is designed to accommodate the appropriate length tagline. Where required, a heavy duty tagline can be provided as a means of recovering objects from the bottom with the tagline or to retrieve heavier duty recovery line. The cannister is reusable and the tagline is easily installed for repeated usage.

The **Model 1930 Rigging Hardware** includes all necessary parts to rig the assembly and make attachment to the anchor or equipment to which it is to be fastened.

MODEL 1900 RECALL BUOY SYSTEM

This system is used for similar applications but where relocation is not necessary (sites which have accurate navigation fixes or clear shore identification would fall into this category). This system consists of the following equipment:

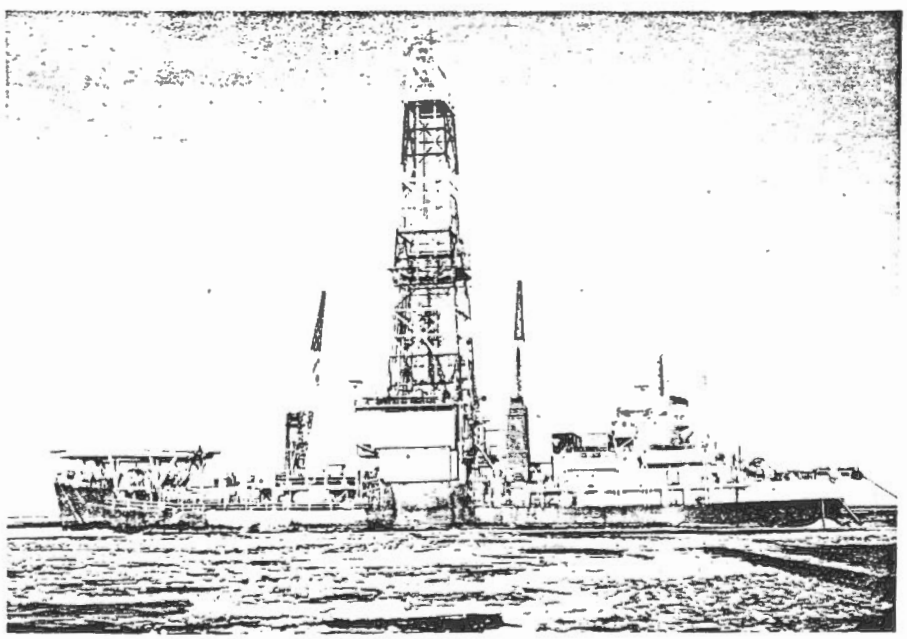
The **Model 1100A-1 Acoustic Command Transmitter** is a portable unit, complete with internal rechargeable batteries and Command Transducer with 30 meters of cable.

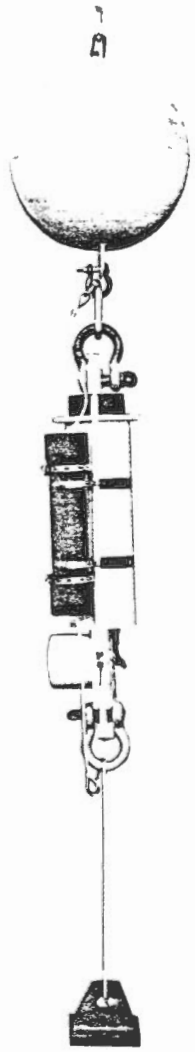
The **Model 2090 Acoustic Release** is used and can be mixed with systems which include the Model 1090 transponding releases as each Acoustic Release unit has a unique command code.

The **Model 1800 Series Subsurface Buoy** provides positive buoyancy for the Acoustic Release and Tagline Cannister for the recovery sequence. The buoys are available in various sizes to accommodate varying net buoyancies and water depths.

The **Model 1910 Tagline Cannister** is designed to accommodate the appropriate length tagline. Where required, a heavy duty tagline can be provided as a means of recovering objects from the bottom with the tagline or to retrieve heavier duty recovery line. The cannister is reusable and the tagline is easily installed for repeated usage.

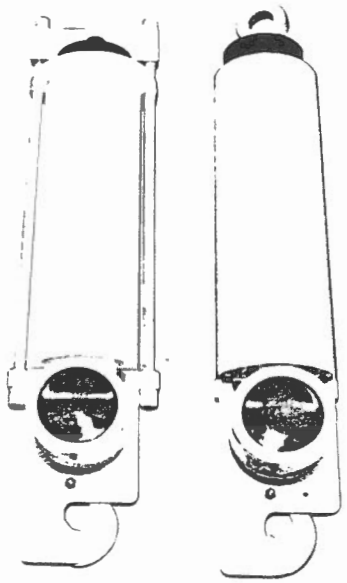
The **Model 1930 Rigging Hardware** comes complete with all necessary hardware to rig the assembly and make attachment to the anchor or equipment to which it is to be fastened. Shackles, rings and thimbles are provided.





MODEL 1090

ACOUSTIC TRANSPONDING RELEASE



The **Model 1090 Acoustic Transponding/Pinger Release** is used to relocate and recover underwater equipment or to act as a seafloor positioning and navigation marker.

Features of the Model 1090 include the release function, the command rearm function and Transponder for relocation or positioning. The confirmation pinger function is a time pinger initiated upon activation of the Release. The unit uses a non-explosive motor driven release which is completely reusable requiring no disassembly or parts replacement.

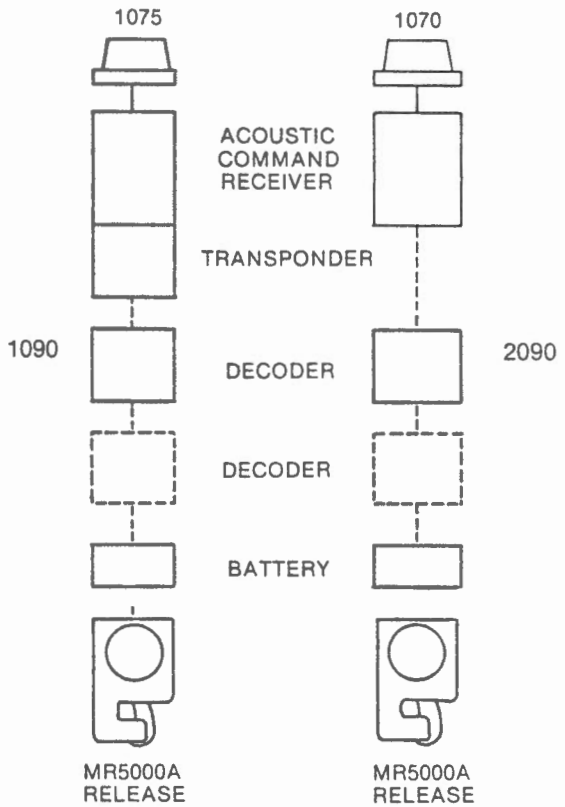
The small size (31 inches) and light weight (36 lbs.) of the Model 1090 provide operational advantages by reducing the buoyancy necessary for recovery and in the ease of handling the equipment.

The unit is available in two basic versions, the Model 1090, to 2500 meters and the Model 1090D a deep version, to 8000 meters. The Model 1090 uses advanced, rugged, high reliability digital circuits. It is compatible with all existing InterOcean Acoustic Command Transmitters and can be used with early models of releases.

MODEL 2090

ACOUSTIC RELEASE

The **Model 2090 Acoustic Release** is a basic underwater recovery unit for equipment and recall operations. The unit has the release and command rearm functions. The Model 2090 uses a motor driven release mechanism which is non-explosive and completely reusable. With the command rearm function, a total check of the release function is possible. This gives the operator the confidence that the equipment is working properly prior to its deployment. The release is available in two basic versions, Model 2090 to 2500 meters and the Model 2090D a deep version to 8000 meters. The Model 2090 uses advanced high reliability digital circuits and is compatible with existing InterOcean Acoustic Command Transmitters. This small, rugged, acoustic release is ideal for all applications requiring secure marking and recovery of underwater equipment and sites coupled with field-proven performance.



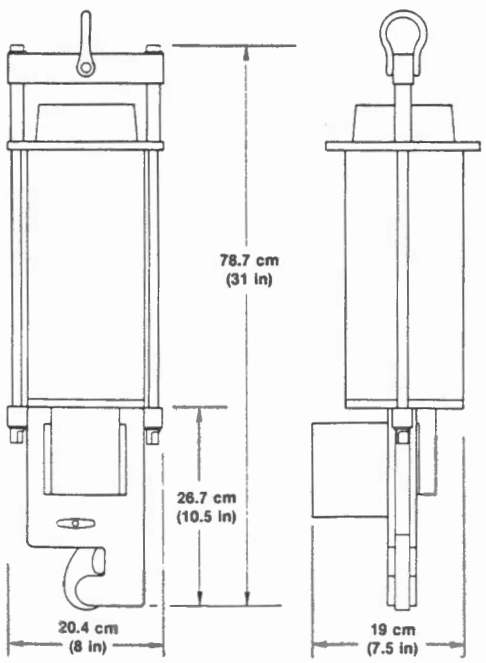
The Acoustic Releases are modular designs for ease of manufacturing, servicing, and expansion. The units utilize "mother" boards instead of cable harnesses. The various functions are sub-assemblies on small P.C. boards which are attached to the "mother" board. The Model 2090 Acoustic Release can be upgraded to the Model 1090 Acoustic Transponding Release by the addition of the printed circuit board, battery holder and other components. The size of the two models is the same so such conversions and expansion can be easily done.

SPECIFICATIONS

MODEL NO.	1090	1090D
WEIGHT Air Water	 16.3 kg (36 lbs) 10 kg (22 lbs)	 20 kg (44 lbs) 12 kg (27 lbs)
POWER	dry cell pack	dry cell pack
OPERATING DEPTH	2500m (8000 ft)	8000m (26,000 ft)
MAXIMUM AXIAL LOAD	2300 kg/4600 kg optional (5000 lbs/10,000 lbs)	2300 kg/4600 kg optional (5000 lbs/10,000 lbs)
FREQUENCY Command Transpond Interrogator Transpond Reply & Pinger	 12.5 to 14.5 kHz 12.0 kHz others 8.192 kHz available	 12.5 to 14.5 kHz 12.0 kHz others 8.192 kHz available
SOURCE LEVEL Transpond Reply Receive Sensitivity Pinger, Timed	 Nominal 90 ± 3db re 1μ bar at 1 yd. – 10db re 1μ bar Nominal 90 ± 3db re 1μ bar at 1 yd.	 Nominal 90 ± 3db re 1μ bar at 1 yd. – 10db re 1μ bar Nominal 90 ± 3db re 1μ bar at 1 yd.
TRANSDUCER BEAM PATTERN	Torodial	Torodial

SHALLOW CONFIGURATION

MODEL 1090/2090

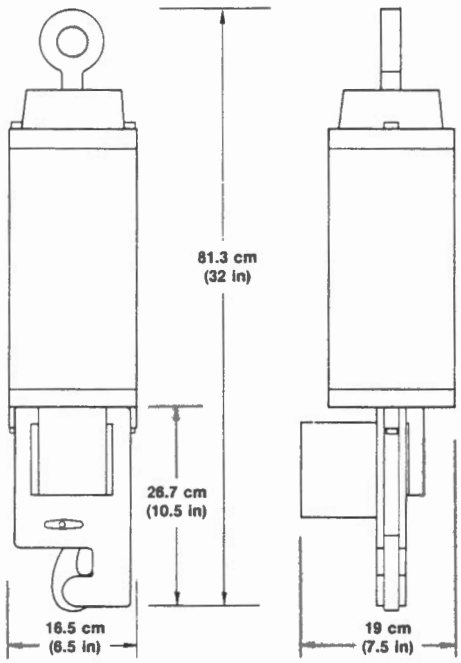


MATERIAL MODEL 1090 6061-T6 alum alloy
2090 6061-T6 alum alloy

FINISH Hard anodized, epoxy paint

DEEP CONFIGURATION

MODEL 1090D/2090D



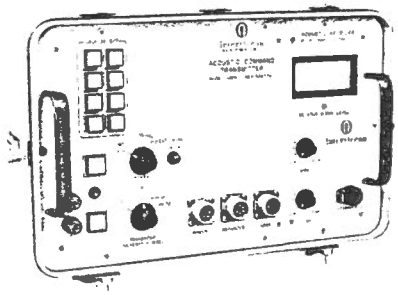
MATERIAL MODEL 1090D 7075-T6 alum alloy
2090D 7075-T6 alum alloy

FINISH Hard anodized, epoxy paint

SPECIFICATIONS

MODEL NO.	2090	2090D
WEIGHT Air Water	 16 kg (35 lbs) 9 kg (20 lbs)	 19 kg (42 lbs) 11 kg (25 lbs)
POWER	dry cell pack	dry cell pack
OPERATING DEPTH	2500m (8000 ft)	8000m (26,000 ft)
MAXIMUM AXIAL LOAD	2300 kg/4600 kg optional (5000 lbs/10,000 lbs)	2300 kg/4600 kg optional (5000 lbs/10,000 lbs)
FREQUENCY Command	12.5 to 14.5 kHz	12.5 to 14.5
RECEIVE SENSITIVITY	– 10db re 1V/μ bar	– 10db re 1V/μ bar
TRANSDUCER BEAM PATTERN	Torodial	Torodial

SHIPBOARD EQUIPMENT



MODEL 1100A

COMMAND TRANSMITTER

The **Model 1100A** is a portable, DC operated Acoustic Command Transmitter designed to transmit a full set of 70 unique underwater coded acoustic commands. With its small size and weight it can operate from vessels of all sizes. The Command Transmitter contains a programmable code generator, a high powered audio amplifier and regulated power supplies. The Model 1120 Command Transducer is supplied with a 30 meter cable.

The system uses a sequential tone coding technique which is a highly secure coding scheme making accidental or false triggering of the Command Receiver virtually impossible.

The individual codes are made up of 4 out of a possible 8 frequencies which are selected on the front panel.

TRANSPONDER INTERROGATOR

The **Transponder Interrogator** provides a signal to interrogate the acoustic releases equipped with a transponder, i.e., Model 1090. The standard interrogate frequency is 12 kHz with other frequencies available. The Transponder Interrogator also provides the start signal for the Model 1300 Digital Range Indicator. Used in conjunction with the 1300, the Transponder feature allows the operator to determine the slant range from the command unit to the underwater transponder. The Transpond pulse-width selector permits the user to select the optimum pulsewidth depending upon the range to the transponder.

MODEL 1200

ACOUSTIC RECEIVER

The **Model 1200 Acoustic Receiver** is used to detect and indicate receipt of the transponder reply signals and the confirmation pinger signals.

The Model 1200 is a high gain receiver equipped with independent manual gain control, volume control, meter indication of relative signal strength and headphone jack. The Receiver is normally tuned to a receive frequency of 8 kHz. Other reply frequencies are available and the acoustic receiver can be provided with multiple frequency selection.

The Model 1200 provides a logic level which can be used to gate a counter enabling the user to determine slant range of the underwater transponder i.e., Model 1090. This can likewise be utilized in conjunction with the small mini-computer utilizing the counter circuits normally found in these computers to determine range, thereby providing a position capability, or for relocation.

SPECIFICATIONS

MODEL NO.	1100A	1120
DESCRIPTION	Command Transmitter	Command Transducer
POWER, INPUT	24V DC at 10 amps	From Model 1100A
FREQUENCY Command	12.5 to 14.5 kHz	8 to 15 kHz
SOURCE LEVEL Command		90 ±3db re1μ bar at 1 yd.

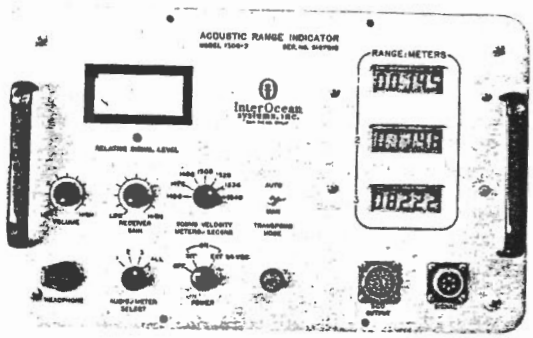
MODEL NO.	1130
DESCRIPTION	Transpond Interrogator
POWER	From Model 1100A
FREQUENCY Transpond Interrogator Transpond Interrogate Pulsewidth	12.0 kHz ±3 Hz 1, 2, 5, 10, or 20 msec. ±20%
SOURCE LEVEL Transpond Interrogate	Nominal 90 ±3db re 1μ bar at 1 yd.

MODEL NO.	1200	
DESCRIPTION	Acoustic Receiver	
POWER	24V DC (From Model 1100A)	
RECEIVE SENSITIVITY Bandwidth Audio Output	−110db re 1V rms for audio output 1000 Hz to 3db points 0.5 watts max.	
OPERATING TEMPERATURE Range	−10°C to 40°C	−10°C to 40°C

MODEL 1300

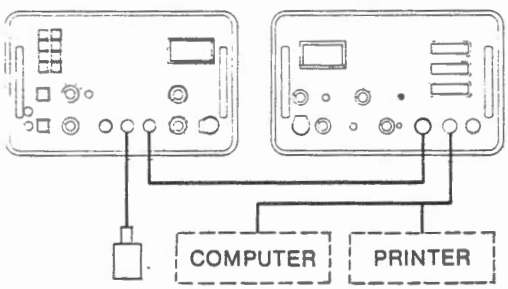
DIGITAL RANGE INDICATOR

The **Digital Range Indicator** provides a five digit display of slant range to the underwater transponders. The Model 1300 is available with one or more channels. The display is five digit, in one-half inch high numerals which can be read in full sunlight. The Model 1300 Digital Range Indicator is internally powered by eight D cells or from an external 24 volt DC power source. The Model 1300 is equipped with an independent Acoustic Receiver tuned to the reply frequency or frequencies on the transponders. The slant range is digitally indicated directly in meters for each transponder. A sound velocity correction switch is provided to compensate for the variations in the sound propagation velocity. The Range Indicator has manual and automatic operation. In the automatic mode the transponder system is manually initiated to start the first transponder interrogation. After displaying the range upon receipt of the reply pulse a reinterrogation is automatically performed. The automatic update of range data will continue until the control switch is returned to the manual position. This mode of operation allows automatic unattended interrogation which is used in the relocation of underwater sites as well as in a completely automated Acoustic Positioning System.



SPECIFICATION

MODEL NO.	1300
RANGE INDICATORS	
Display	5 Digits, each channel
Channels	One or more, as required
Controls	A) On/Off B) Manual/Automatic C) Sound Velocity Correction, 7 position switch
Output	Digital BCD; 8, 4, 2, 1
Power	Internal 8 "D" cell or External 24V DC
RECEIVER	
Receive Sensitivity	−110db re 1 V rms for audio output
Receiver Bandwidth	1000 Hz
Receiver Frequencies	8.192 kHz std., other frequencies available
Controls	A) Volume B) Gain C) Headphone Jack
Operating Temperature Range	0°C to 40°C



AUTOMATIC ACOUSTIC POSITIONING/ NAVIGATION SYSTEM

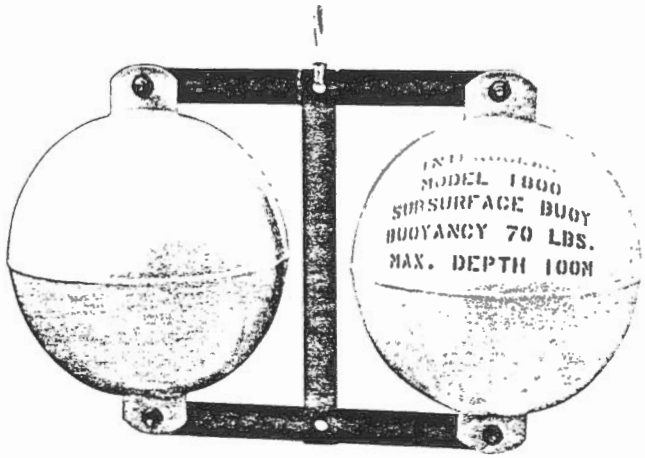
The combination of the Model 1100A Command Transmitter and 1300 Digital Range Indicator provides the basis of the shipboard equipment of an automatic position/navigation system. Utilizing three or more Model 1090 Transponding Releases, the user can position or navigate the surface vessel, relative to these ocean bottom mounted transponders. The Model 1300 has an automatic mode of operation which allows virtual unattended operation of the system. A transpond interrogate signal from the Model 1100A interrogates the various Model 1090 Transponding Releases. Upon receipt of the individual reply signals from the transponders the Model 1300 displays the slant range to each transponder, and provides this range as an output to a recorder or computer. Automatically another interrogate signal is transmitted. This is repeated for as long as required. This provides a compact automated positioning/navigation system as well as a simple ranging system for relocation of multiple transponders.

SERIES 1800

ALUMINUM SUBSURFACE BUOYS

InterOcean **Series 1800 Subsurface Buoys** provide buoyancy for taut mooring of instrument packages in coastal waters, bays, rivers, harbors, lakes, and reservoirs. When used with InterOcean Acoustic Releases, or the Model 5000T Timed Release, the subsurface buoy provides a complete underwater instrument recovery package.

The 1800 Series is a light-weight rugged and reliable group of flotation buoys which can be used individually or in tandem to provide desired buoyancy for all types of subsurface flotation requirements.



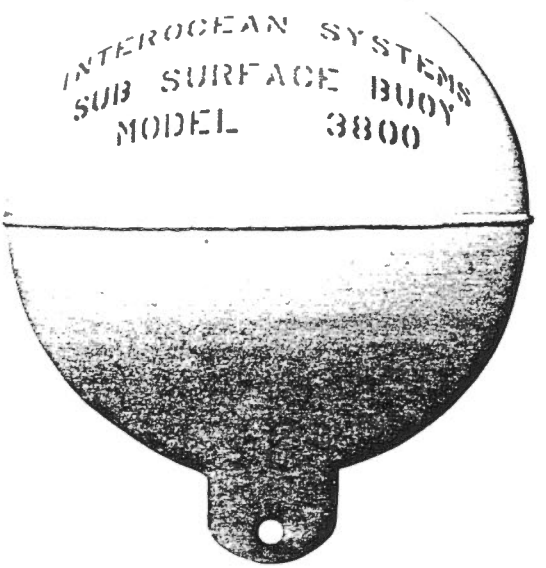
STANDARD SIZES

SPECIFICATIONS

MODEL NO.	RATED DEPTH	NET BUOYANCY	WEIGHT IN AIR	DIAM. INCHES/CM	THICKNESS
1800	100M	32 Kg	8.2 Kg	40 Cm	0.32 Cm
	328 Ft.	70 lbs.	18 lbs.	16 In.	0.13 In.
1805	500M	45 Kg	32 Kg	50 Cm	1.3 Cm
	1640 Ft.	100 lbs.	70 lbs.	20 In.	0.51 In.
1820	300M	45 Kg	14 Kg	51 Cm	0.64 Cm
	985 Ft.	100 lbs.	27 lbs.	20 In.	0.25 In.
1825	300M	180 Kg	73 Kg	76 Cm	1.11 Cm
	985 Ft.	400 lbs.	160 lbs.	30 In.	0.44 In.
1830	500M	163 Kg	109 Kg	79 Cm	1.91 Cm
	1640 Ft.	360 lbs.	240 lbs.	31 In.	0.75 In.
1840	1000M	180 Kg	180 Kg	86 Cm	2.54 Cm
	3280 Ft.	400 lbs.	400 lbs.	34 In.	1.0 In.
1850	1000M	318 Kg	250 Kg	101 Cm	2.54 Cm
	3280 Ft.	700 lbs.	550 lbs.	40 In.	1.0 In.

SERIES 3800

STEEL SUBSURFACE BUOYS

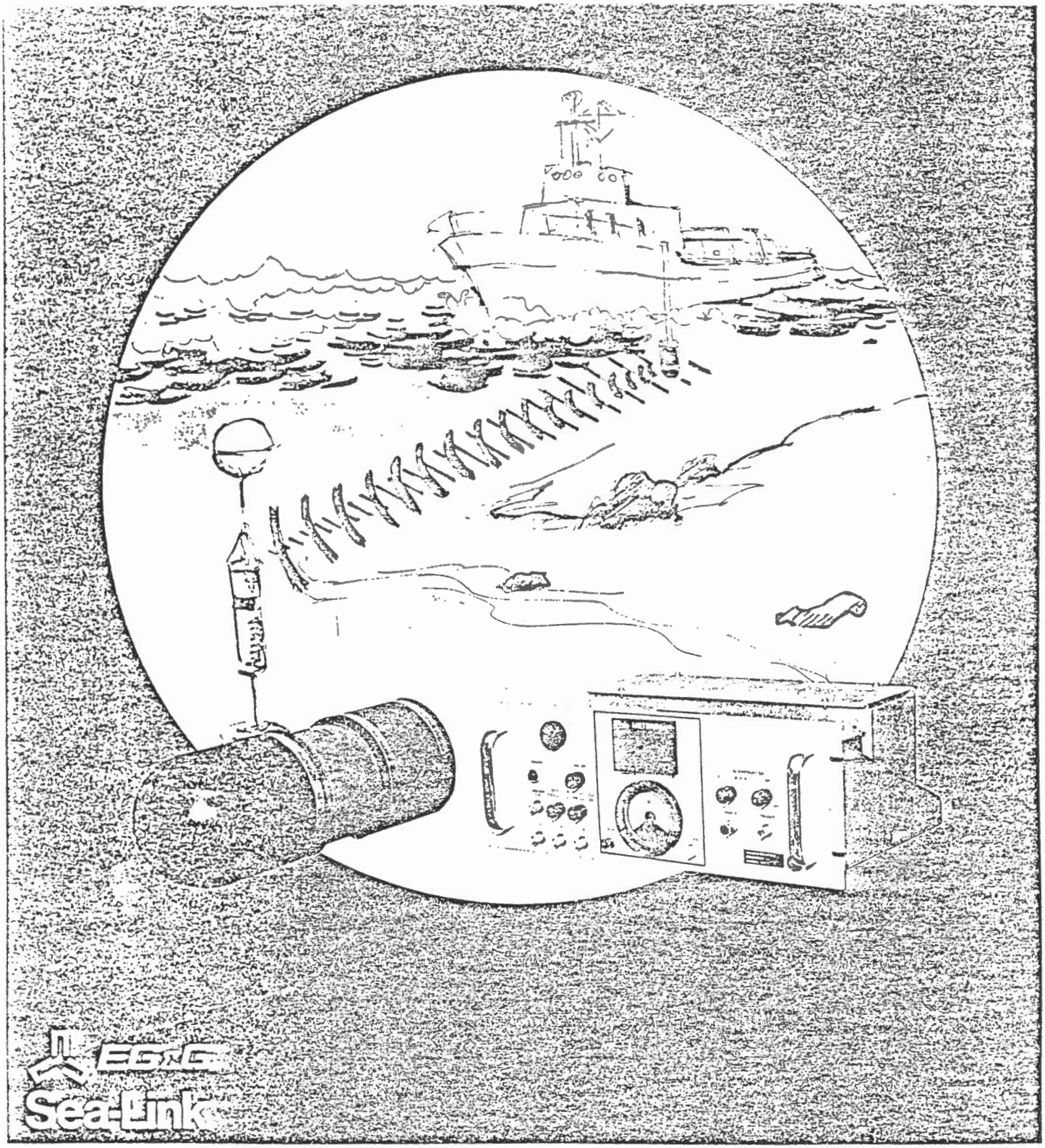


InterOcean offers a line of steel subsurface buoys to provide rugged flotation for a variety of offshore and oceanographic applications. Designed with a safety factor of 3 in operating depth the buoys are fabricated under stringent control and fully tested to assure you of long term reliable performance. These buoys are constructed of steel, leak tested, and painted with marine rated primer and durable epoxy paint.

The buoys are used in the Model 1900 and 1901 Offshore Recall Buoy Systems. They are also used in a variety of instrumentation systems where recovery buoyancy is required.

SPECIFICATIONS

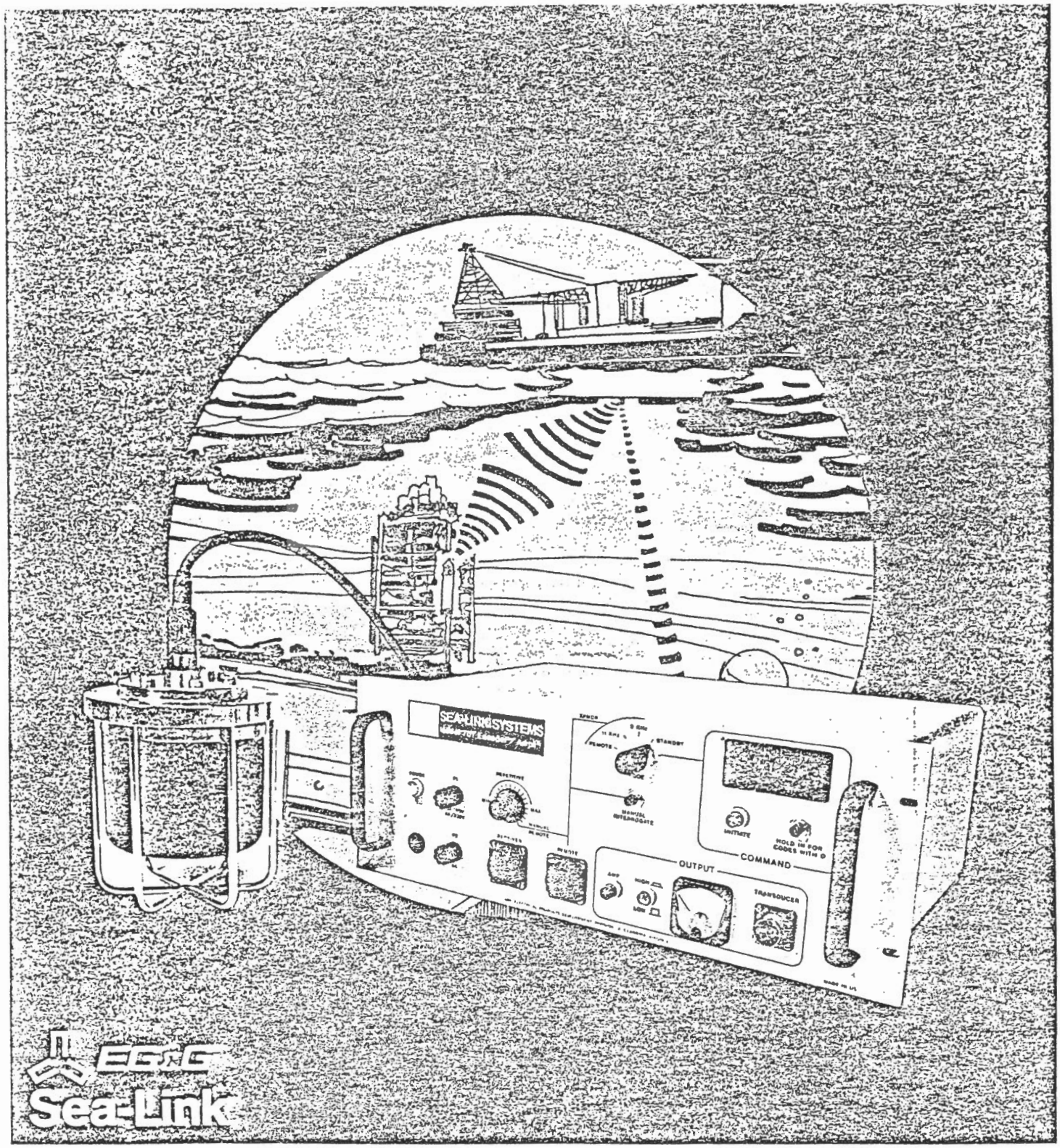
MODEL NO.	RATED DEPTH	NET BUOYANCY	WEIGHT IN AIR	DIAM. INCHES/CM	THICKNESS
3800	300M	45.4 Kg	22.2 Kg	51 Cm	0.34 Cm
	990 Ft.	100 lbs.	49 lbs.	21 In.	0.134 In.
3810	300M	285.8 Kg	139.7 Kg	93 Cm	0.64 Cm
	990 Ft.	630 lbs.	308 lbs.	36.5 In.	0.25 In.
3820	500M	65.8 Kg	63.5 Kg	62 Cm	0.64 Cm
	1640 Ft.	145 lbs.	140 lbs.	24.5 In.	0.25 In.
3830	600M	308.4 Kg	385.6 Kg	10.9 Cm	1.27 Cm
	1970 Ft.	680 lbs.	850 lbs.	43 In.	0.5 In.
3840	750M	408.2 Kg	635 Kg	125 Cm	1.59 Cm
	2460 Ft.	900 lbs.	1400 lbs.	49.25 In.	0.625 In.
3850	1500M	292.6 Kg	771.1 Kg	125.7 Cm	1.90 Cm
	4925 Ft.	645 lbs.	1700 lbs.	49.5 In.	0.75 In.
3860	1000M	530.7 Kg	970.7 Kg	141 Cm	1.90 Cm
	3280 Ft.	1170 lbs.	2140 lbs.	55.5 In.	0.75 In.



EG&G

Sea-Link

Model 301: Range/Bearing Acoustic Relocator



EG&G SeaLink

Digital Acoustic Command System-DACS

EG&G Sea-Link Digital Acoustic Command System — DACS

A versatile system for underwater control, relocation and navigation applications.

The EG&G Sea-Link Digital Acoustic Command System (DACS) is an acoustically linked underwater control system. It generates a digital acoustic code from a shipboard unit that is transmitted through water to an underwater unit. If the code or codes are accepted by that unit a command function is actuated. This command function may be a mechanical release of the underwater unit, a command to shutdown or turn on the underwater unit or an "external" control signal to actuate a valve, for example. The system consists of a shipboard unit with transducer and one or more underwater units. The standard underwater units incorporate a Transponder with release mechanism and have three additional commands available. Optional underwater units can contain additional command decoders for external command functions.

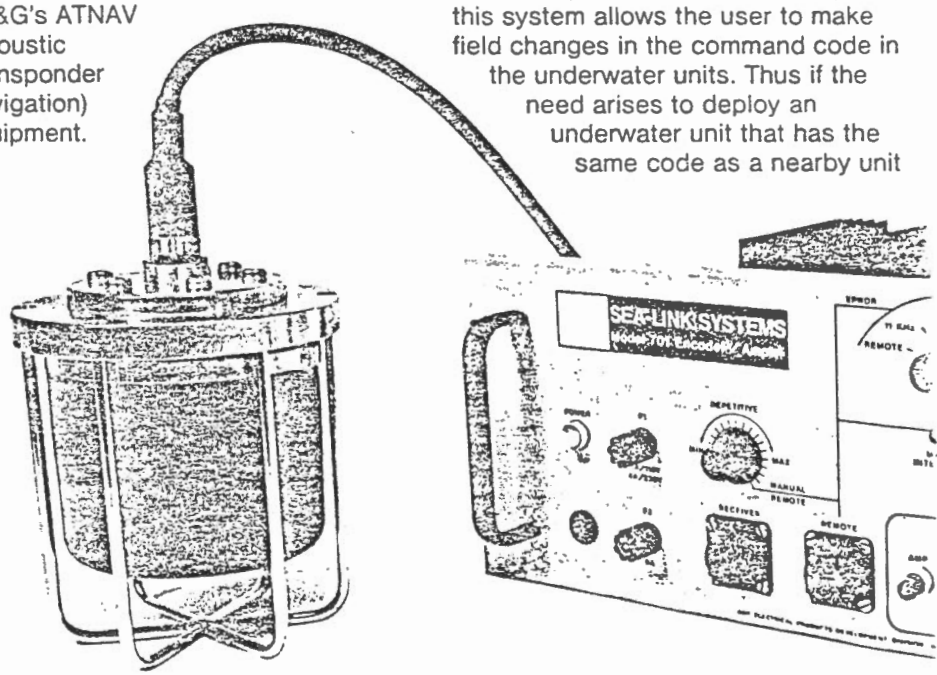
Typical Applications

The EG&G Sea-Link DACS equipment performs three basic functions. Its command, release and transponder functions make it a versatile system for many underwater control, relocation, and navigation applications.

DACS SYSTEM FUNCTIONS

Remote Command	Valve Control
	Wellhead Control
	Motor Control
	Power ON/OFF
	Transponder ON/OFF
Release Command	Pipeline Buoyancy Release
	Transponder Release
	Mooring Release
	Instrument Recovery
Transponder	Homing Systems
	Relocation
	Navigation Systems
	Site Marking

When used with transponders the Sea-Link DACS shipboard unit can be supplemented with other Sea-Link shipboard receiver display units. For homing, relocation and course navigation the Range/Bearing Receiver (Model 301) gives range and bearing to the underwater unit. For ranging and navigation applications the Ranging Receivers (Models 206 and 706) will give the precise range to multiple DACS underwater units. This ship set can further be expanded to a full navigation system by incorporating EG&G's ATNAV (Acoustic Transponder Navigation) equipment.



FEATURES

Seventy Secure Command Codes

The Sea-Link DACS equipment provides seventy discrete command codes. The code used is a four letter code system that has a demonstrated superiority in high noise fields without sacrificing the security inherent in Sea-Link Command Systems.

High Noise Immunity

The DACS Command System was developed specifically for operation in high noise fields. The decoding technique used provides greater noise immunity than other acoustic command systems. This makes it most useful for high noise environments, such as wellhead control. This code system has much better immunity from multipath interference. This allows secure transmission where there is a large number of underwater structures that might otherwise mask commands from competitive command systems.

Field Code Changing

Unlike previous acoustic equipment this system allows the user to make field changes in the command code in the underwater units. Thus if the need arises to deploy an underwater unit that has the same code as a nearby unit the user can, in the field, change to a different code to prevent interference.

Simplified Servicing

The DACS Command System has eliminated the "select at test" components and simplified the alignment problems that have plagued similar equipment and made field service complicated and expensive.

NEW DACS-A UNDERWATER UNIT

- SHORTER
- LIGHTER
- EXTERNAL FREQ. SELECT
- ON-OFF SWITCH
- TILT SWITCH

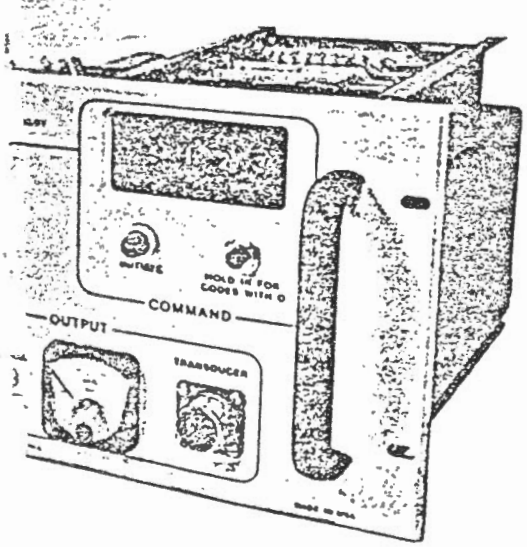
Portability

The DACS shipboard unit is a single self-contained package. It is readily portable, being approximately 19 inch (48 cm) x 7 inch (18 cm) x 13 inch (33 cm) and weighing 35 lb (16 kg). Its code System simplifies circuitry resulting in a smaller size unit.

Shipboard Digital Acoustic Command System (DACS)

The shipboard DACS equipment consists of an Encoder/Amplifier (Model 701) and Transducer (Model 702). The Encoder/Amplifier generates the 70 digital commands and the transponder interrogate pulses. The unit has a Mode switch that allows selection of either a Transpond Mode or Command Mode. The transducer converts the electrical signals to acoustic signals.

In the Command Mode the user can send up to 70 mutually exclusive digital commands to the underwater units. Selection of the particular digital code



is made via a 4-digit thumbwheel switch. The transmission of the code is accomplished by depressing a push button switch.

In the Transpond Mode the Shipboard Command System can interrogate any Sea-Link Transponder at either 9 or 11 kHz, as selected. The interrogate frequency can be selected manually by the Mode switch or remotely via a connector — open contact gives 9 kHz, closed contact gives 11 kHz. This remote selection is useful when operating with EG&G's ATNAV System that often operates on two interrogate frequencies. The frequency selection is then done by the ATNAV System's computer.

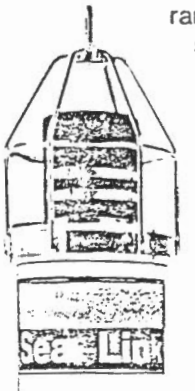
The shipboard unit is supplied in a rugged waterproof container with a sealed lid but can also be mounted in a 19-inch rack. It is thus readily portable and well protected from the elements. The transducer is supplied with a protective cage. It can either be lowered over the side for hove to operation, or can be hull mounted as desired for permanent installation. In hull mounted installations it is recommended that the transducer be placed away from major machinery noise and kept away from the wake. A sea chest (gate valve and stem assembly) is recommended so that the transducer can be retracted in shallow water or removed in case of damage without drydocking.

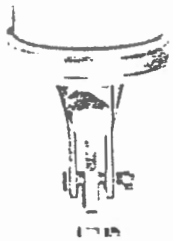
New Underwater Units

There are two standard underwater units available, the Models 722A and 723A. Both are Release/Transponders. The Model 722A has a 3000 foot depth rating and the Model 723A is rated for 20,000 feet. Both units have the widely used and field proven Sea-Link 2,500 Pound Recockable Release. This Release load capability can be increased to 10,000 pounds by adding an optional clamp-on tension rod assembly. This option can be added in the field.

The Transponder portion of the underwater DACS-A unit is identical to other EG&G Sea-Link Transponders and therefore, compatible with existing Sea-Link Range Bearing Receiver (Model 301), Ranging Receivers (Models 206 and 706) and the Acoustic Transponder Navigation System, ATNAV. The Transponder is interrogated by the shipboard unit at either 9 kHz or 11 kHz.

An external reply frequency selector switch permits the operator to select up to eight different reply frequencies. Units are supplied for operation with one of three reply frequency bands covering the 7.5 to 15 kHz range as described in the specifications. The reply frequency selector switch is also used to turn the DACS-A unit off when not in use to conserve battery life.





The underwater DACS-A units are packaged in hard coated aluminum housings that are painted with a durable baked-on epoxy coating. Additional corrosion protection is provided by a highly refined, Sea-Link developed, galvanic protection system using selective grounding and insulation of dissimilar metals. This is implemented with sacrifical anodes. This protection system has proven over the years to be a most effective technique in the most severe environmental conditions.

To learn more about the EG&G Sea-Link Digital Acoustic Command System (DACS), or any other EG&G Sea-Link product, please write or call.

Specifications:

MODEL 701 SHIPBOARD UNIT

Number of Discrete Codes: 70 via 4 digit thumbwheel switch.
Code Acoustic Source Level: 189 db re 1μPa at 1M.
Transponder Interrogate Frequencies: 9 and 11 kHz.
Transponder Acoustic Source Level: 190 db re 1μPa at 1M. (10 kHz)
Power: 105-125 VAC; 47-400 Hz
210-250 VAC; 47-400 Hz
20 Watts — standby
300 Watts — transmit
Temperature: 0° to 60°C operating; −20°C to +85°C storage.
Size: 19inch/48cm Wide x 7inch/18cm High x 13inch/33cm Deep.
Weight: 35lb/16kg.

Option

- -1 Portable Case
- -2 Rear Entry Power Cord
- -3 230 VAC Operation

UNDERWATER DACS RELEASE/TRANSPONDERS

Operating Depth:
Model 722A: 3,000ft/900m.
Model 723A: 20,000ft/6000m.
Release Lead: 2500lb/1100kg, externally recockable.

TRANSPONDER:

Interrogate Frequencies: 9 or 11 kHz (others available).
Minimum Interrogate Pulse Width: 5ms.
Turn Around Time: 12.5ms.
Sensitivity: 82 db re 1μPa.
Noise Field Performance: Signal to noise spectrum level ratio required for 100% probability of detection: 44 db.
Reply Frequencies:

F1 Band — Rated Output: 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0 kHz

F2 Band — 7.5, 8.0, 8.5, 9.0, Rated Output: 9.5, 10.0, 10.5, 11.0 kHz

F3 Band — Rated Output: 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0 kHz

Reply Pulse Width: 20ms standard (allows use with EG&G Model 301); others available.
Output Source Level: 192 db re 1μPa @ 1M 75° from vertical. Omni-directional within ±3 db in upper hemisphere.
Number Replies: $2X10^5$ ($5X10^5$ for 8ms pulse width).

COMMAND:

Frequency Range: 9.3–10.7 kHz standard.
Sensitivity: 81 db re 1μPa.
Noise Field Performance: Signal to noise spectrum level ratio required for 100% probability of detection: 34 db.
Commands:

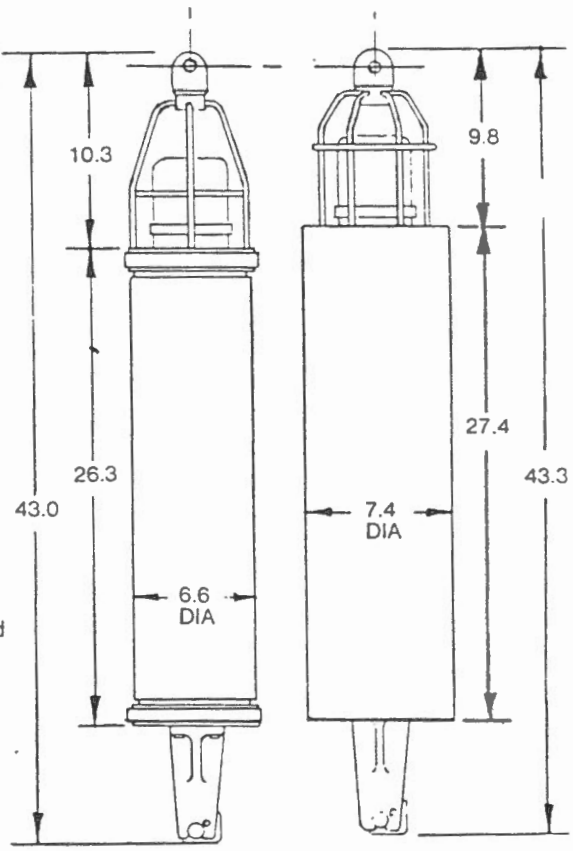
- A - Release/Timed Pinger. The release is confirmed by a shift in the timed pinger rate from 1 pulse per 2 seconds to 1 pulse per second.
- B - Disable/Timed Pinger. Turns the transponder off and causes the timed pinger to respond.
- C - Enable—turns the transponder on.

Tilt Switch: Actuation 45°±15° causes timed pinger duration to increase from 16 to 32 seconds.
Battery Life: 24 Months (Lithium).
10 Months (Mercury/Alkaline).
Temperature: Operating −10° to +60°C.
Storage −20° to +85°C.
Weight:
Model 722A: 48lb (21.8kg)/Air; 12.7lb (5.8kg)/Water.
Model 723A: 70lb (31.8kg)/Air; 25lb (11.25kg)/Water.

Option

- -1 Clamp-on Tension Rod Release Assembly that allows up to 10,000lb loads.

Specifications subject to change without notice.



MODEL 722A MODEL 723A

NOTE: DIMENSIONS SHOWN IN INCHES

ORDERING INSTRUCTIONS:

72XA — X — X — X

72XA	X	X	X
Deep or Shallow	Interrogate Frequency	Frequency Band	Option(s)

Example:
722A — 11 — F2 — 1 — 2

Note 1. For rated operational life, batteries should be stored at approximately 25°C.

CAUTION: Batteries should not be exposed to temperature greater than 70°C.

EG&G
Sea-Link Systems

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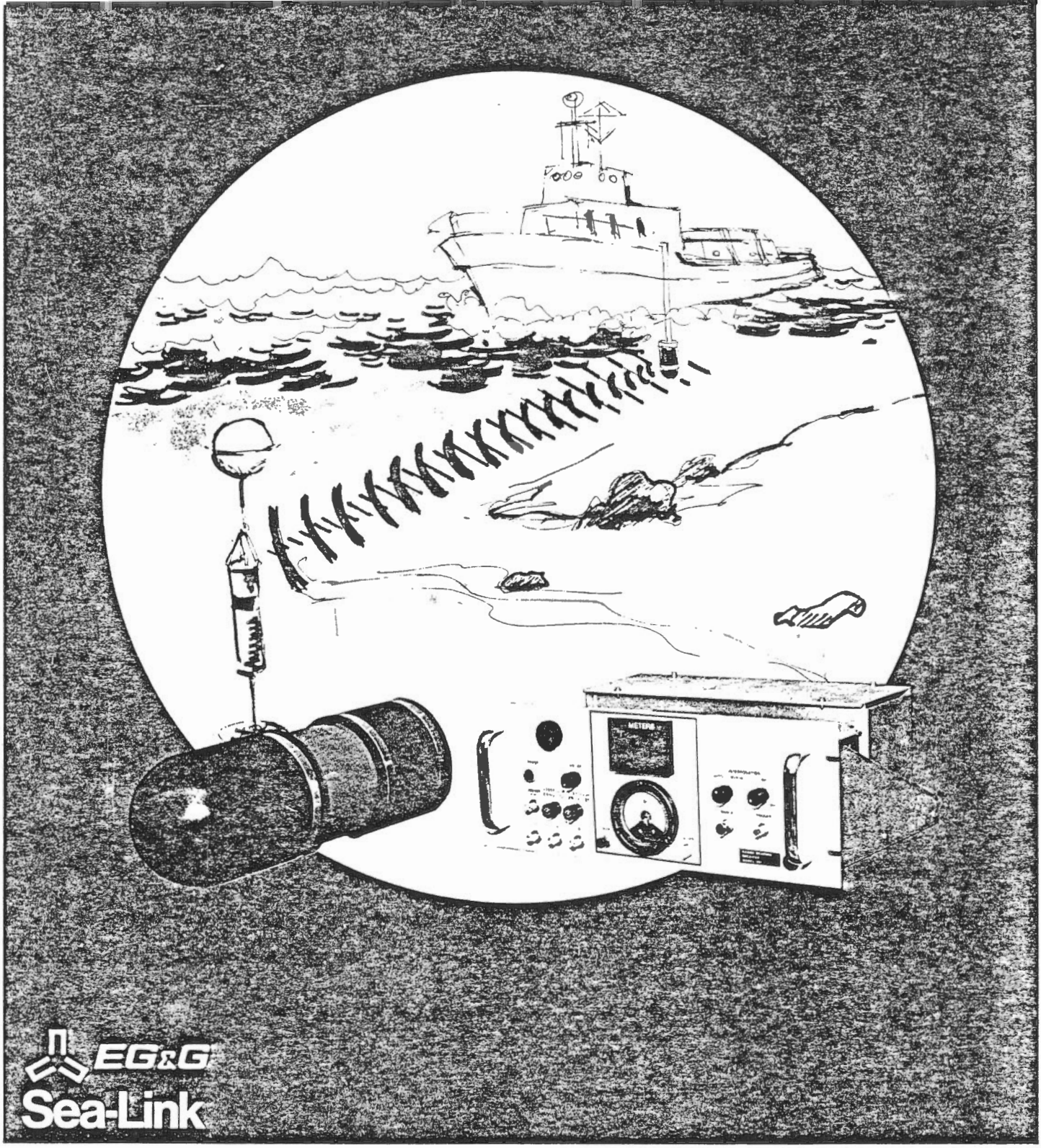
EG&G Sea-Link Systems offers a broad line of dependable oceanographic products, including:

- Acoustic Releases
- Acoustic Pingers/Beacons
- Acoustic Transponders and Distance Measuring Systems
- Acoustic Transponder Navigation Systems (ATNAV)
- Acoustic Telemetry Systems
- Current Meters

Printed in U.S.A. Form No. 03281-1

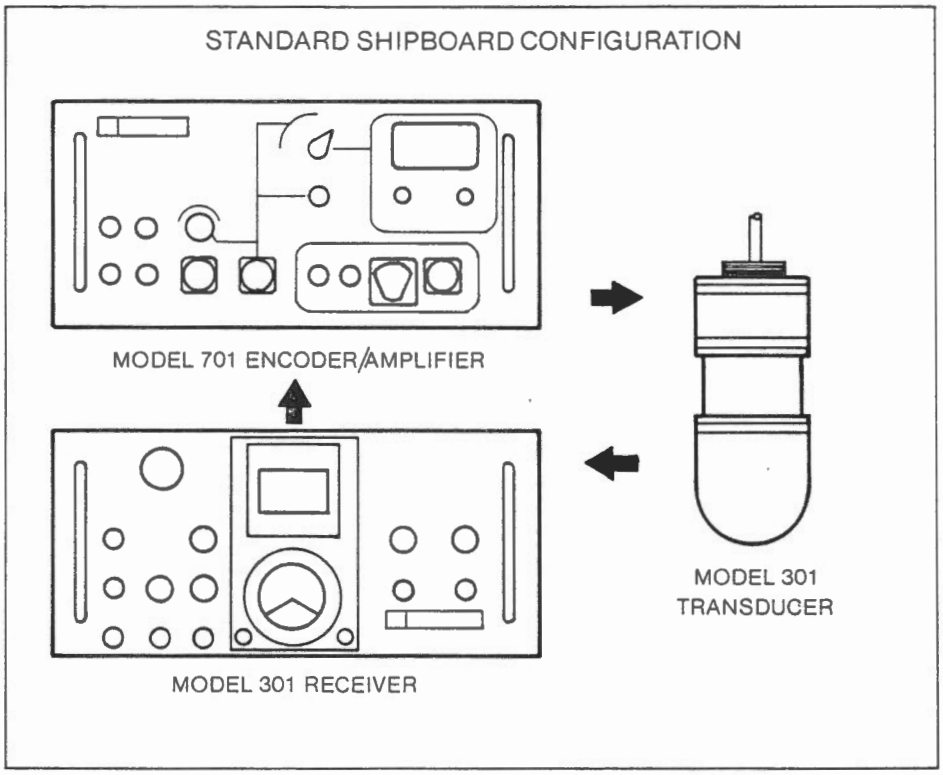


Model 301: Range/Bearing Acoustic Relocator

Model 301: Range/Bearing Acoustic Relocator

EG&G Sea-Link Systems' Model 301 shipboard acoustic relocator system is the answer anytime you need to return to, or relocate an underwater transponder, pinger or beacon. Typical applications include

- Recovery of Moorings
- Relocation of
  - Wellheads
  - Drilling sites
  - Pipeline valves
  - Fishing traps
  - Salvageable equipment
  - Mineral deposits
- Tracking of submersibles



Specifications

Interrogation

Modes: (1) Manual–Pushbutton (2) Repetitive–Continuously adjustable from 1 interrogation per 2 seconds to 1 interrogation per 30 seconds.
TRIGGER OUTPUT: Pulse, +12V, 1 millisecond
POWER REQUIREMENTS: 90 to 130 VAC, 50 to 60 Hz, 250 watts
TEMPERATURE RANGE: 0° to 60°C Operating

Configurations

STANDARD RACK MOUNT: 19" width panel, 8-3/4" high by 14" deep
OPTIONAL: Suitcase

Receiver

FREQUENCY: 10 kHz standard
INPUT BANDWIDTH: 4 kHz
MINIMUM INPUT PULSE DURATION: 20 milliseconds
TIMING ACCURACY: ±0.5 millisecond at 3σ limits
BEARING ACCURACY: ±5 degrees
INPUT SIGNAL-TO-NOISE SPECTRUM-LEVEL-RATIO
RANGING: 44 db for specified timing accuracy
BEARING: 50 db for specified bearing accuracy
OUTPUTS:

VISUAL: (1) Range-digital display (3 digits). Kiloyards standard, other units optional.
(2) Bearing-Full 360° (Analog meter displays 180° sector with bow and stern reference lights.)
AUDIO: For detecting a reply signal.

Transducer

HYDROPHONE PREAMPS: Mounted in transducer housing to provide flexibility in length of interconnecting cables.
PROJECTOR: Provides source level of 189 db ref 1 μ Pa at 1 m. when used with Sea-Link Model 701 Encoder/Amplifier
CONFIGURATION: Standard is for either hull mounting or for portable clamp-on, over-the-side operation. (Portable boom is optional).

Specifications subject to change without notice

EG&G
Sea-Link Systems
2818 Towerview Rd.
Herndon, Virginia 22071
Telex: 89-9435
Telephone: (703) 471-6703

OCEANO INSTRUMENTS, U.S.A., INC.

P.O. Box 55489 / 17544 Midvale Ave. N. / Seattle, Washington 98155
Cable: OCEANOUSA Telephone: (206) 542-7637 Telex: 152156

21 April 1982

Terry Jordan
EBA ENGINERRING CONSULTANTS
1435 118th Ave
Edmonton, AB
Canada T5L 2M7

Terry:

Enclosed you will find brochures and data sheets covering the components you will need for the data telemetry system we discussed on the phone this morning.

For the seabed end of the telemetry link, I would propose linking a standard RT 121 Recoverable Transponder to a standard DT 122 Data Transmission Unit. The RT 121 would then serve three functions. First, in the transponder mode it could be used to relocate the instrument pack. Second in release mode, it could be used to recover the instrument pack. And third, the "spare" code could be used to switch the DT 122 on and off.

The RT 121 also meets or exceeds all the requirements we discussed. It has a 2½ year battery life utilizing standard alkaline batteries, (D cell). The battery life can be extended to 4 years using lithium batteries. It has a depth rating to 2000 meters which is well in excess of the 400 meters we discussed.

The DT 122 Data Transmission Unit would be linked to the recording device via an RS 232C bus. Operating at 320 BOD, it would take about 2½ minutes to acoustically transmit a years worth of data assuming a three digit temperature value; for example, ~~10.3~~ degrees. NO

16 variable : 1 octet per variable
16 octets/day X 365 days = 5840 octets
5840 octets ÷ 40 octets/second = 2.43 minutes/transmission

The system would be set up to read and transmit the data five to ten times and then erase and re-initialize the data tape. This application is almost identical to one we have used for retrieving information from current meter strings.

Using standard D size alkaline cells, we could give the whole system (RT 121 and DT 122) a battery life of about 2½ years.

The DT 122 is a very high integrity data transmission system. It was originally designed as a control/monitoring system for BOP stacks, and presently that is its primary use.

From a reliability and data integrity point of view, you will not find a better system. As you will see from the enclosed quotation, it is also a very expensive system.

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ACOUSTIC DATA TRANSMISSION

DT 122

Preliminary Specifications

1. DATA LINK INFORMATION

- Data input format : Compatible RS 232C (IEEE 488 or other on option.)
- Type of coding : FSL - NRZ 4 states
- Each octet is transmitted as 1 synchro + 5 data pulses
- Cyclic redundant code is used (10 bits for an octet versus 8 useful)
- Primary synchronization pulse every 10 s.
- Secondary synchronization pulse every octet
- Pulse width : 4 ms
- Pulse repetition rate : 4 ms
- Total duration for 1 octet : 24 ms
- Octet repetition rate : 24 ms
- Data transmission rate : 40 octets/s or 320 bits/s

2. ACOUSTIC SPECIFICATIONS

- Frequencies used : 21 to 24 kHz
- Transducer : Beam pattern hemisperical (on option, directional transducer for greater ranges)
- Acoustic Source level : 95 dB ref/1 microbar at 1 m

3. ELECTRICAL SPECIFICATIONS

- Power Supply : 48 VDC
- Consumption : ≤100 mW in standby
  500 W during consumption
- Electrical power applied to transducer : 250 W

4. EXPECTED PERFORMANCES

With low noise, ranges greater than 10 km may be expected.

With heavy noise, for instance, noise equivalent to sea state 6 + 40 dB, error rate per bit should be :

- at 1500 m : $7.5 - 10^{-42}$
- at 2400 m : $1.4 - 10^{-10}$
- at 3000 m : $7.7 - 10^{-7}$

5. MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

Dimensions :

Diameter : 130 mm approx.

Length : 600 m approx

Weight : 35 kg.

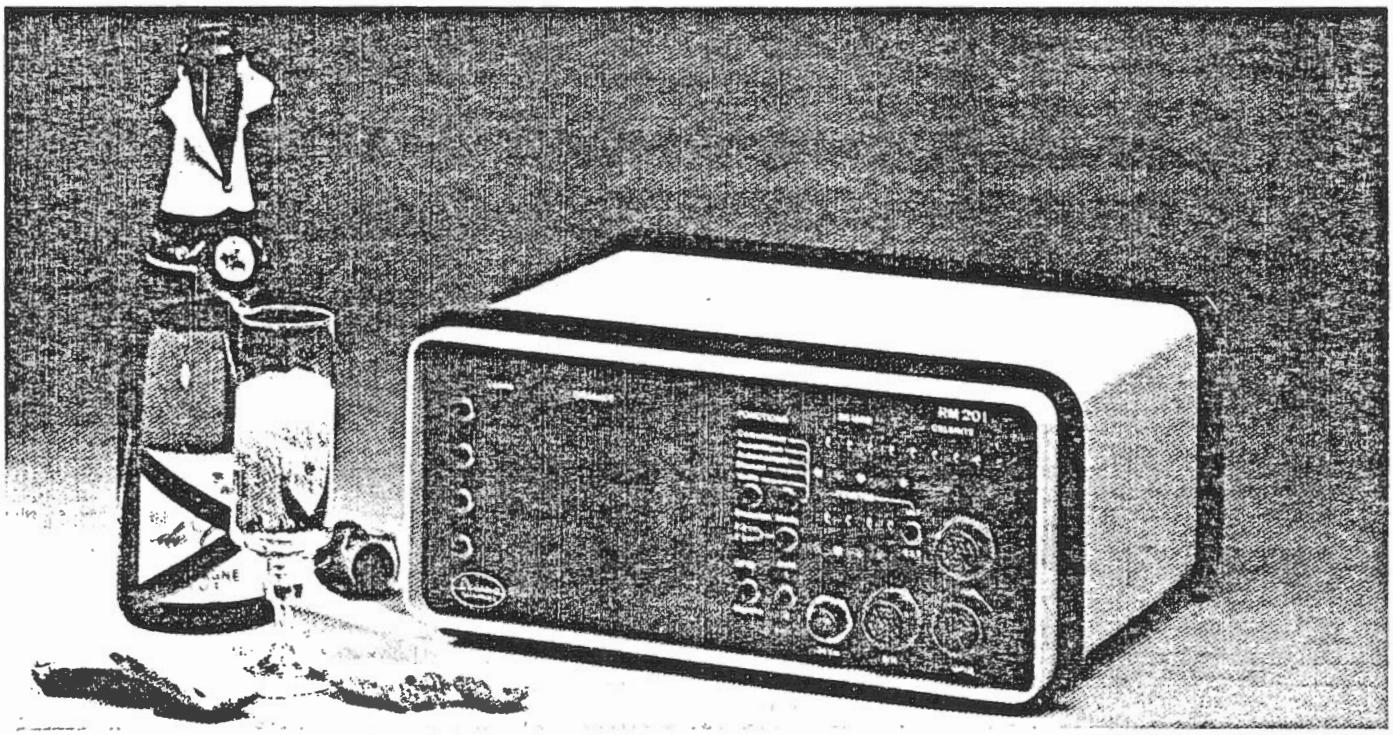
Operating temperature range : - 5°C to + 50°C

Storage temperature range : - 40°C to + 70°C

Operating Depth : 2000 m (option 4000 and 6000 m)

OCEANO INSTRUMENTS

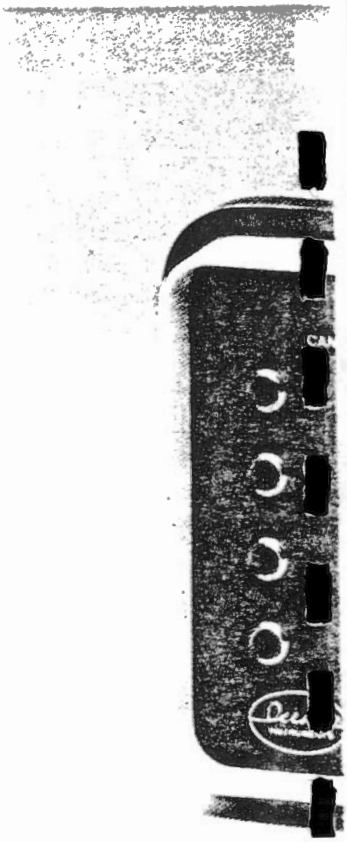
RM 201: 16 CHANNEL RANGEMETER
FOR LONG RANGE BASELINE ACOUSTIC POSITIONING



* ULTRA-LONG BASELINE NAVIGATION
* LONG BASELINE POSITIONING
* SUBMERSIBLE NAVIGATION
* DRILL RIG POSITIONING
* SUB SEA PIPELINE POSITIONING

Océano
INSTRUMENTS

THE RM 201 RANGEME
ACCURACY, RELIABI



ACCURACY:

Thanks to an advanced receiver circuit called TIME INTEGRATED FILTERING, the RM 201 is possibly the most accurate ranging device available today. Ranges can be displayed in feet, meters, fathoms, milliseconds, or any other desired unit of measurement.

RELIABILITY:

The RM 201 is designed and built to operate efficiently in one of the harshest environments in the world. Like all OCEANO INSTRUMENTS' products, it has been tested and proven in the extreme conditions of the unpredictable North Sea.

FLEXIBILITY:

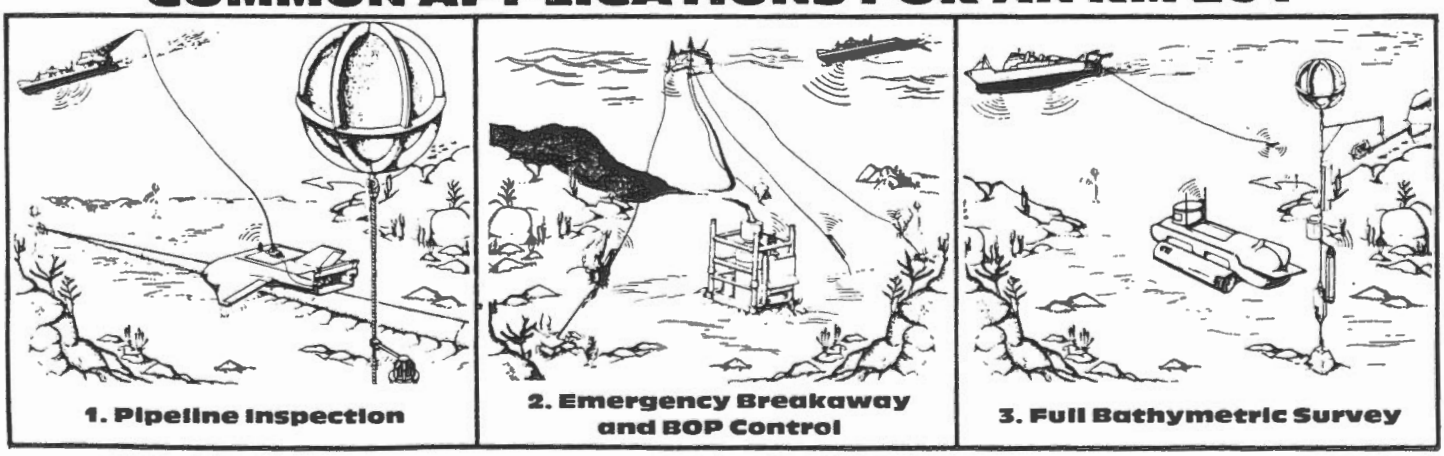
The RM 201 Rangemeter, in conjunction with other OCEANO INSTRUMENTS' products, is capable of a wide variety of tasks:

- geophysical and site surveys
- ultra long baseline navigation
- positioning for pipeline installation, inspection, and maintenance
- positioning of underwater structures such as wellheads
- offshore positioning systems for oil drilling and exploration
- locating and positioning of manned and unmanned submersibles

The rangemeter and transponders are the heart of any navigation system. Whether you need to keep track of manned or unmanned submersibles, position underwater structures, monitor pipe layings, track pig trains through pipelines, position a vessel dynamically, or any other precision requirement, an acoustic reference system is needed.

With OCEANO INSTRUMENTS you can steam onto your site, drop an array of three or more transponders and accurately calibrate the field in as little as two hours. The field can then be interfaced to a surface navigation system and referenced geodetically by using complimentary OCEANO INSTRUMENTS' products.

COMMON APPLICATIONS FOR AN RM 201



1. Pipeline Inspection

2. Emergency Breakaway and BOP Control

3. Full Bathymetric Survey

ER: 16 CHANNELS FOR TY AND FLEXIBILITY

Five operational modes

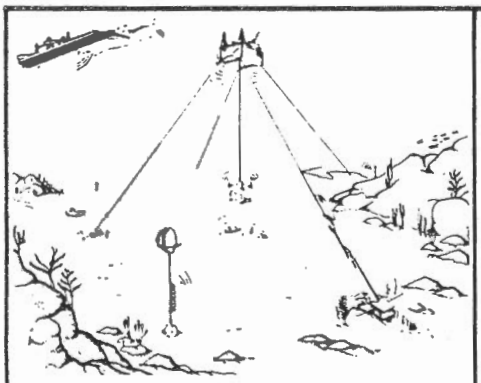
- computer control
- acoustically triggered
- automatically triggered
- manual control
- standby listening

Accurate

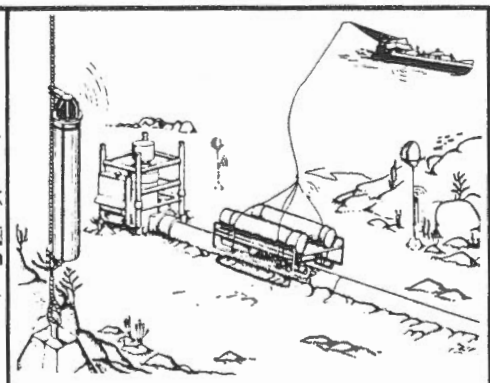
Depending on your knowledge of the sound velocity profile in surrounding water, overall accuracy can vary from 0.3 meters to a few meters.
Mean velocity and transponder delay is selected by thumbwheel switches on the front panel.

Powerful

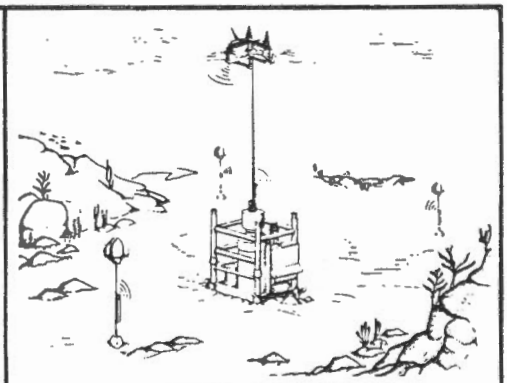
Though only 4 distances are displayed on the front panel, 16 channels are permanently available at different or identical frequencies. Customers may arrange these channels either to get redundancy (several channels on the same frequency) or to compute up to 12 positions of subsea mobiles at the same time (every 20 seconds to 40 seconds).



4. Template re-entry



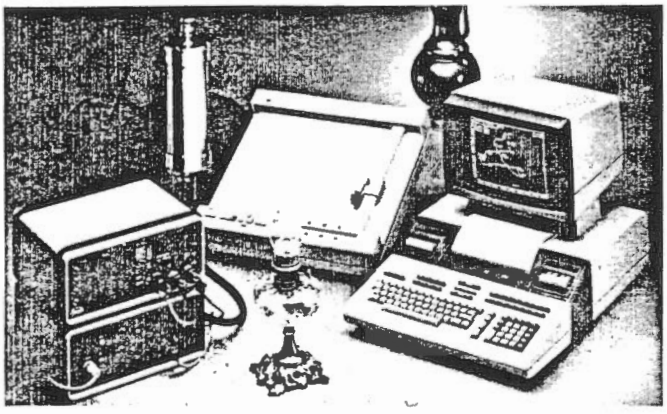
5. Pipeline maintenance



6. Dynamic positioning, Riser angle monitoring

16 CHANNEL RANGEMETER RM 201

FOR LONG BASELINE ACOUSTIC POSITIONING



TYPICAL SURFACE SHIP SYSTEM

Durable

Designed to meet the most hostile environmental conditions of temperature, humidity, shock, vibration and power variations, this unit will operate with the same reliability on ships, platforms, manned submersibles or even rubber boats.

Hands-off operation

Operator has no gain or threshold to adjust, thanks to new detection techniques and automatic noise rejection.

SPECIFICATIONS

(Subject to change without notice.)

— Operating

- 5 modes:
  - Stand-by
  - Manual
  - Internal Automatic
  - External Acoustic Trigger
  - Computer control
- Alternate triggering of two different transmission frequencies possible
- Pulse rate internally selectable from 1 s to 99 s (15 steps)
- Transponder turnaround delay offset: 0 to 99.99 ms (0.01 ms step)
- Mean velocity of sound input: 0 to 9999.9 units per second (0.1 unit step)
  Note: counting units may be in meters, feet, ms, or any other.
- Resolution: 0.01 unit (1 cm if unit is meter)
- Standard reception filters: 8 to 16 kHz (0.5 kHz step)
- Bandwidth: 200 Hz
- IEEE 488 compatible

— Electrical

- Power supply: 20 to 30 V DC
- Maximum consumption: 25 W including AM 1X1
- Full isolation between power input and electronic circuitry.

— Mechanical

- Width: 320 mm / 13.2 inches
- Height: 140 mm / 5.4 inches
- Depth: 290 mm / 11.2 inches
- Weight: 13 kg / 28 pounds

— Environmental

- Operating temperature range: —20 °C to + 50 °C
- Storage temperature range: — 40 °C to + 70 ° C
- Splashproof

Portability

Extremely small size and very low consumption with possibility of battery operation makes the RM 201 ideal for easy transportation and use in confined space and with limited power supply.

How to order

Specify:

- Number of channels required (16 max.)
- Frequency of each channel
- Frequency of acoustic trigger
- Internal pulse rate

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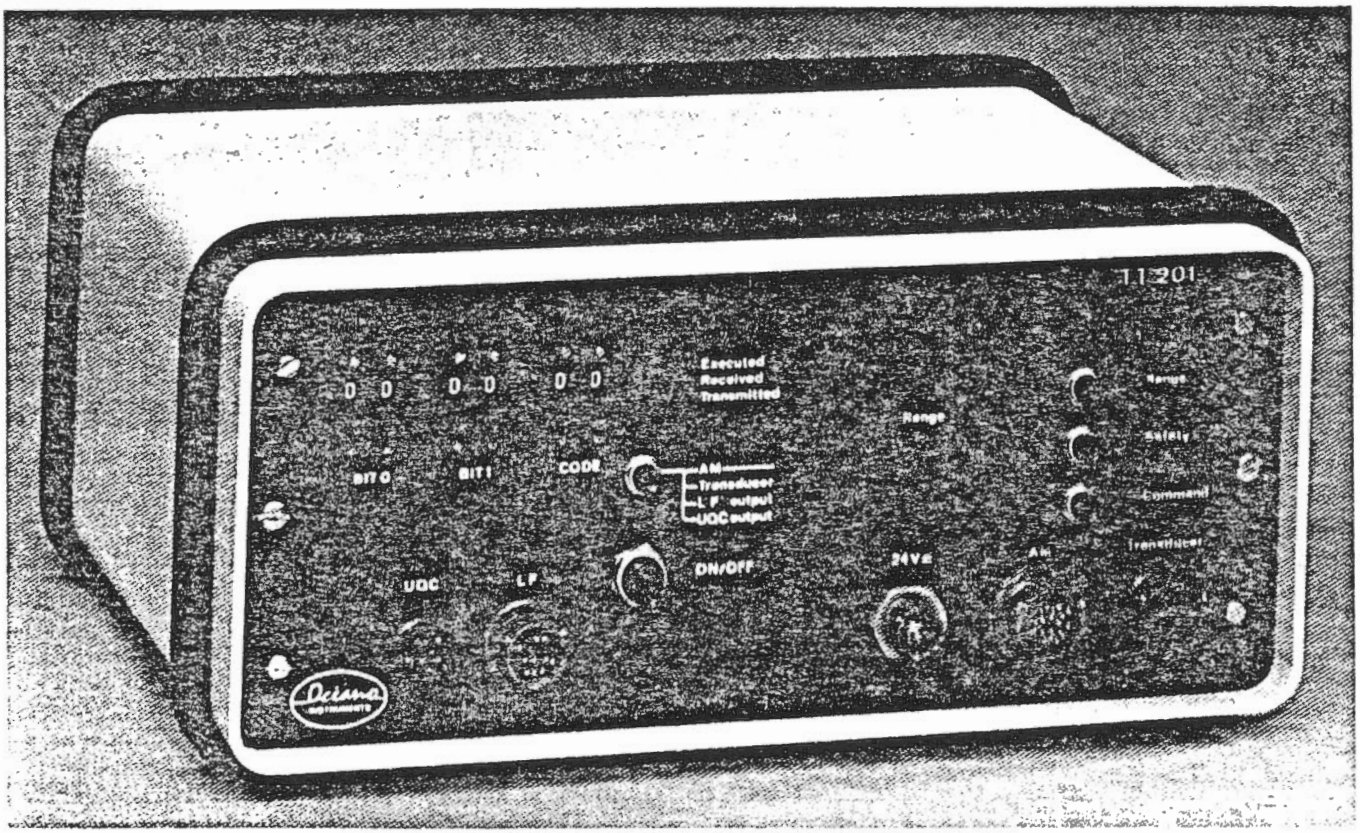
Seattle, Washington 98155
(206) 542-7637 Telex 152156 Cable: OCEANOUSA

OCEANO INSTRUMENTS

TT 101: ACOUSTIC TELECOMMAND
TT 201: SYSTEMS FOR UNDERWATER EQUIPMENT REMOTE CONTROL



* OVER 12,500 CODES FOR SYSTEM SECURITY AND USER PROTECTION
* MONITORS SIGNAL RECEPTION AND COMMAND EXECUTION
* FREQUENCY SHIFT KEYING (F.S.K.)
* VARIOUS TRANSDUCER OUTPUTS (TT 201)
* RANGE METER FUNCTION (TT 201)

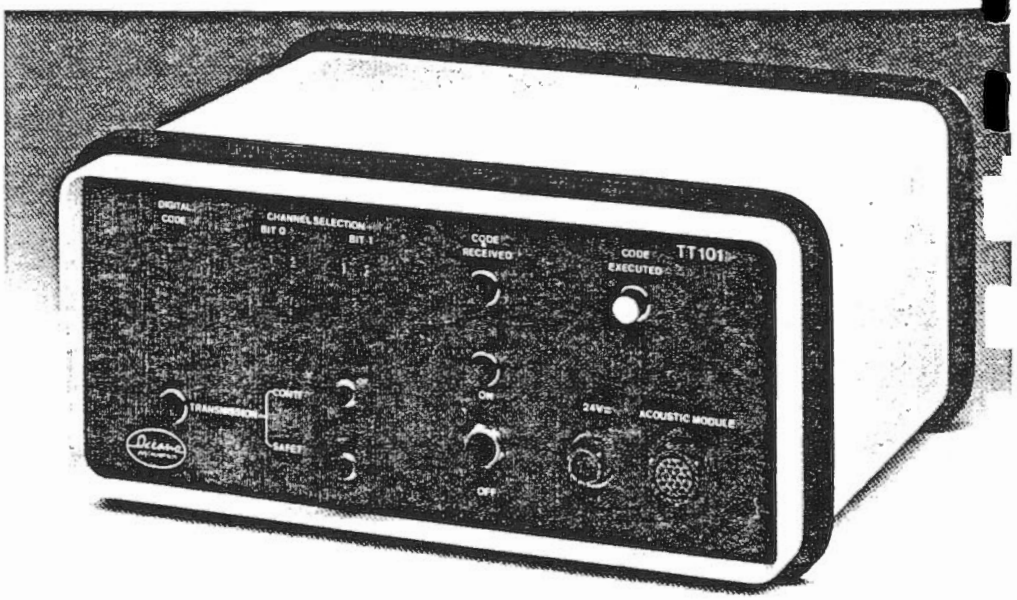
Océano INSTRUMENTS

12,512 UNIQUE CODES GUA

TT 101:

Safe and easy operation

Here is the operating procedure of TT 101:
- connect the Acoustic Module AM 1X1,
- connect the 24 V DC source,
- switch unit on,
- select the digital code (00 to 99) on two rotary thumbwheel switches,
- select the carrier frequency channel for bit "1" (00 to 16) on two rotary thumbwheel switches,
- do the same for bit "0"
- press safety key,
- press transmit push-button,
- check on first indicator that the command has been received,
- check on second indicator that the command has been executed,
- switch unit off,
- disconnect.

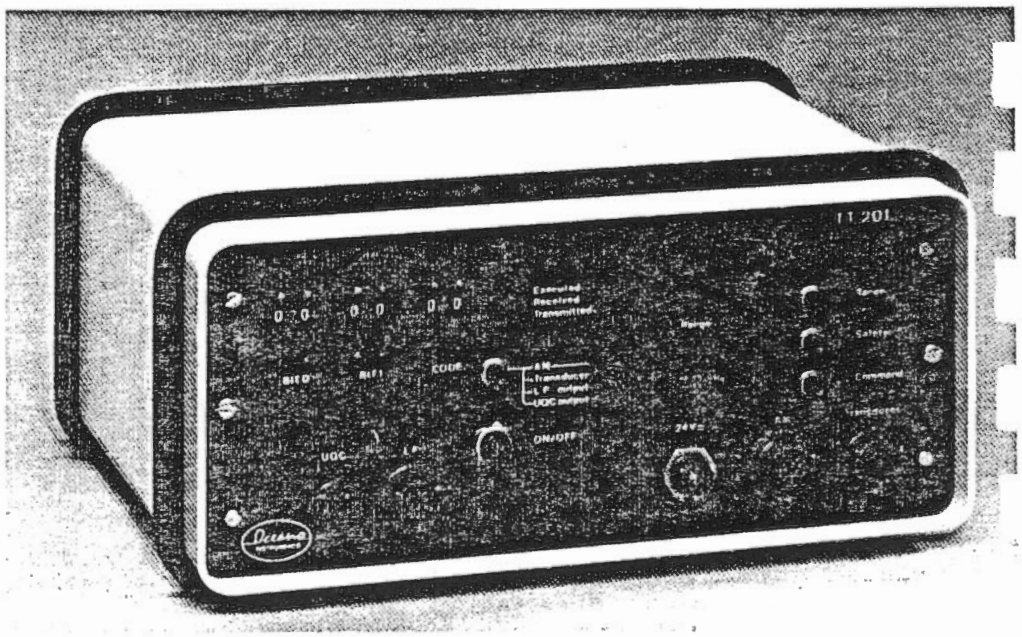


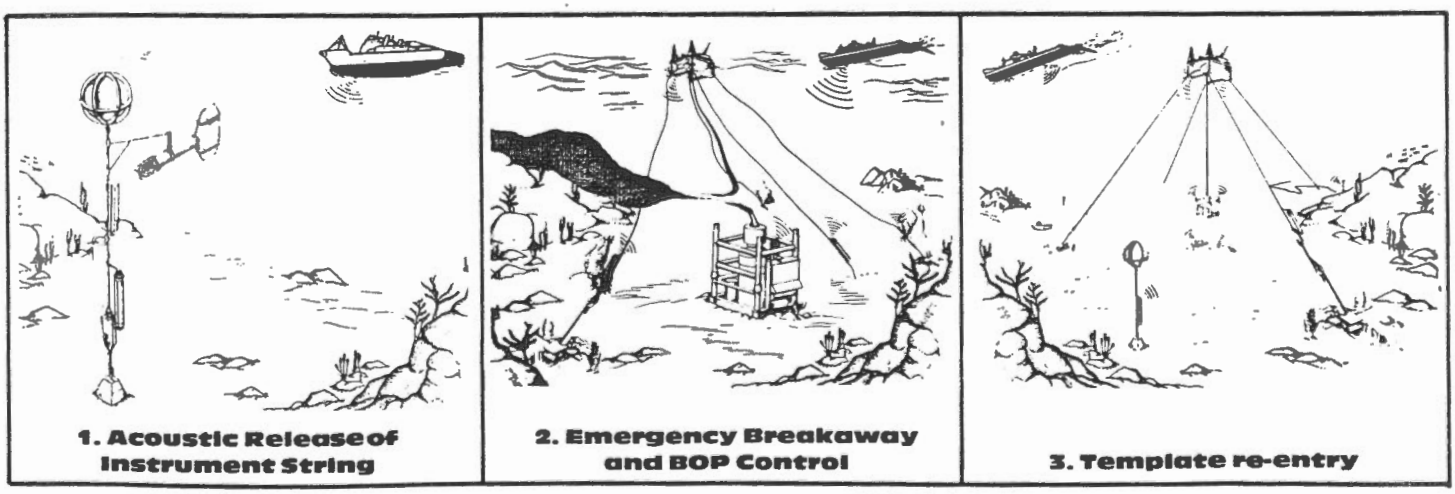
TT 201:

Can be used with:

- Oceano Acoustic Module
- 3013 Transducer
- U.Q.C. Transducer

Includes a single range channel. By interrogating transponder through proper bit "0" setting slant or surface range to transponder can be determined.





1. Acoustic Release of Instrument String

2. Emergency Breakaway and BOP Control

3. Template re-entry

ANTEE FAILSAFE SECURITY

Controlling an underwater device from a surface vessel can be accomplished through either a tethered cable or with acoustics.

As the operating water depth increases, so does the feasability of using acoustical electronics. Yet the sea is a hostile environment for sound waves . . . natural and artificial noises distort command signals and limit the effectiveness of systems without advanced design features.

To insure efficient and reliable operation of the TT 101/202 and related systems manufacured by Oceano Instruments, specific attention is paid to both the transmission and reception phase of every acoustic signal.

When connected to an acoustic module AM 1X1, the TT 101 can generate a serial ultrasonic sequence which corresponds to a preselected code. By alternating from a total possible pool of 17 different frequencies, the command for a specific function can be drawn from a total of over 12,500 codes. The TT 201 can also be used with a standard ITC 3013 Transducer, or a U.Q.C. Transducer as it contains its own power supply.

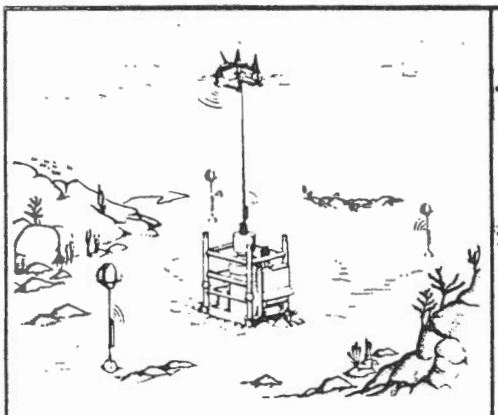
Using a screening process called differential filtering the RT 1X1 Transponder receiver looks at every signal and reacts only to the command issued in the proper code and fitting the necessary time base.

The TT 101/201 issues a command, indicates it has been received and then, that the command has been executed.

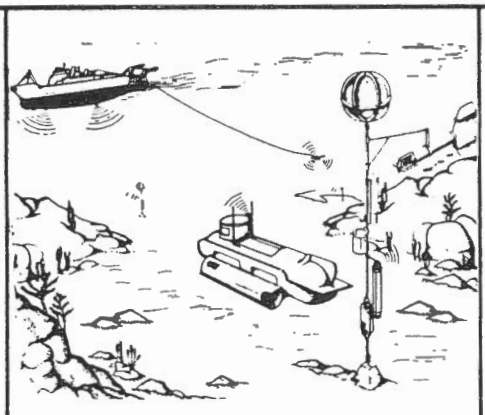
There are many applications where the TT 101 and 201 can be used. Perhaps the most important and common of these is the activation and release of the RT 1X1 Recoverable Transponder.

You receive confirmations
If the underwater device is filled with a complimentary transmitter, the Acoustic Telecommand TT 101/201 will give the operator acknowledgement of command reception and later, confirmation of command execution.

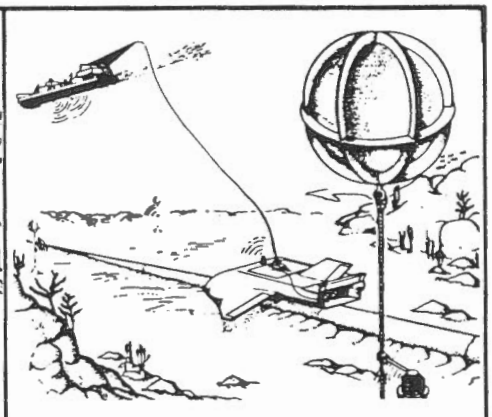
Save time with TT 101/201
The pulse repetition rate during the sequence is accurately fixed at 10 ms. One complete command takes only 810 ms.



4. Dynamic Positioning



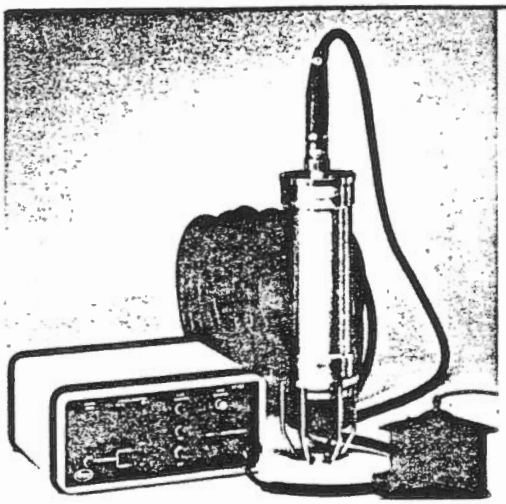
5. Full Bathymetric Survey



6. Pipeline Inspection

ACOUSTIC TELECOMMAND TT 101 / TT 201

FOR UNDERWATER EQUIPMENT
REMOTE CONTROL



Command System TT 101 + AM 121

Ask about our full family of component products. If we don't already have what you want we will design it for you.

Simple coding

The Acoustic Telecommand transmits - through an Acoustic Module AM 1X1-an eight bit serial word. Bit "1" is represented by one frequency; bit "0" is represented by a different frequency. This "Frequency Shift Keying" (F.S.K.) is probably the most reliable coding method under any conditions, especially where multipath propagation is encountered.

Powerful

The digital code is selected from 00 to 99 (8 bits, BCD coded).
The carrier frequency for bit "1" is chosen from 17 different channels (8 kHz to 16 kHz in 0.5 kHz step). The carrier frequency for bit "0" is chosen from the remaining 16 channels.
The combination of the three above parameters allows the operator to select 12,512 unique codes.

SPECIFICATIONS

SPECIFICATIONS (Subject to change without notice).

—Electrical (TT 101)
- Supply voltage: 20 to 30 V DC
- Consumption:
  200 m A on stand-by
  8 A during transmission including Am 1x1
- Protection against reverse polarity
- Full isolation between power source and electronic circuitry.

—Electronic
- Coding: F.S.K. 8 bit word
- Number of possible words: 100
- Number of carrier channels for bit "1": 17
- Number of carrier channels for bit "0": 17
- Total number of different codes: 12.512
- Pulse repetition rate: 100 ms
- Duration of one command transmission: 800 ms
- Minimum repetition rate of commands: 4 s

—Mechanical
- Width: 320 mm / 13.5 inches
- Height: 140 mm / 5.5 inches
- Depth: 290 mm / 11.5 inches
- Weight: 11 kg / 29 pounds

—Environmental
- Operating temperature range: -20°C to +50°C
- Storage temperature range: -40°C to +70°C
- Splashproof cabinet.

In addition to the above specifications the TT 201 includes:

—Output specifications
- Acoustic module: compatible with AM 121
- Transducer: Acoustic level 90"/-3 DB RE 1 microbar at 1 m.
- Beam pattern: omnidirectional "/-3 DB
- Power amplifier: 12 V PP in 150 ohms/minute
- Frequencies translated down of 8.0875 kHz

—Receiver
- Min pulse width 6 ms.
- Min. detectable signal: -20 DB ref 1 microbar
- Sensitivity: automatically adjusted 15 DB above noise in the reception bandwidth
- Reception bandwith: 250 Hz

—Transducer size
- Diameter 100 mm. height: 80 mm supplied with 10 meters cable

The range is measured with an internal clock based on a sound velocity of 1492 ms.

OCEANO INSTRUMENTS

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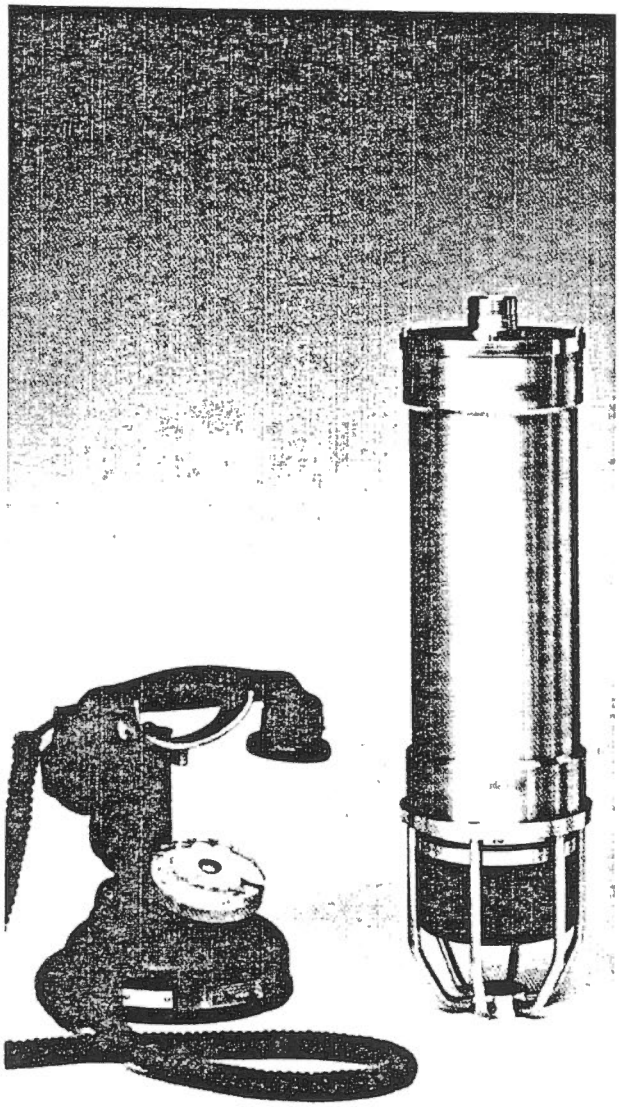
OCEANO INSTRUMENTS

ACOUSTIC MODULE AM 1X1
FOR WIDE FREQUENCY RANGE INTERROGATION AND RECEPTION



THE CONCEPT

A self-contained hydro-acoustic transmission/reception device, with integrated power/pre-amplifier.

THE ANSWER

The AM 1X1 Acoustic Module, a complete acoustic transmission reception system. Designed and manufactured to operate reliably in one of the most hostile environments in the world, the AM 1X1 Acoustic Module is an integral part of a number of OCEANO INSTRUMENTS' Acoustic Systems. As such it is used in a wide variety of applications.

- Long Baseline Acoustic positioning
- Positioning of underwater structures such as wellheads
- Pig tracking during pipeline maintenance.
- Acoustic telemetry and telecommand functions.

The AM 1X1 Acoustic Module is a complete electronics package, virtually noise free, and unaffected by interconnection cable length. It includes:

- transmission frequency synthesizer
- Broadband receiving section
- Automatic Gain Control
- Depth capability to 6000 meters

Océano INSTRUMENTS

ACOUSTIC MODULE AM 1X1
FOR WIDE FREQUENCY RANGE INTERROGATION AND RECEPTION

Signals from 7 kHz to 17 kHz are amplified and limited to 4 volts p.p. They are then ready to be processed in the upper unit.

Multifrequency operation

Two different transmission frequencies may be internally selected: F^1 is triggered by a positive pulse, F^2 is triggered by a negative pulse.
External selection of the transmission frequency is possible (with priority over F^1 and F^2) by programming an 8 bit digital word on a parallel input and sending a triggering pulse.
The Acoustic Module AM 1X1 is available in two different versions:
- 4 pin connector for dual frequency operation only,
- 19 pin connector for full multifrequency operation.

Noise immunity

Automatic gain control (AGC) is adjusted so that background noise always remains at a level of 1 V p.p. on the output.
Transient noises are also eliminated by the effect of differential filtering combined with hard-limiting.
Because of the close contact of transducer and receiving section, no radiated electrical noise affects the system.

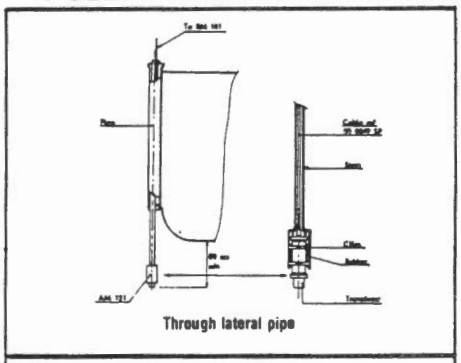
Easy maintenance

Easy maintenance is achieved by using one mother board supporting all the plugged-in cards, including power amplifier.
The Acoustic Module AM 1X1 is fitted with an underwater pluggable connector and can be quickly replaced.

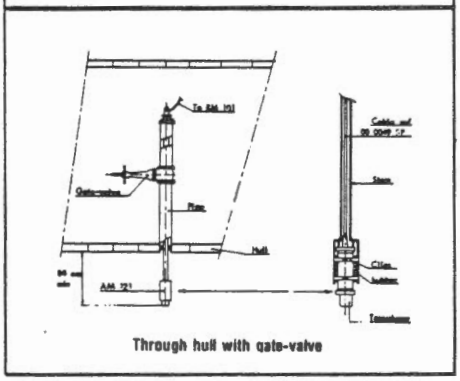
Wide reception frequency-range

The receiving section of the Acoustic Module AM 1X1 is composed of a broadband filter, an amplifier with AGC and hard limiter, and an output buffer amplifier.

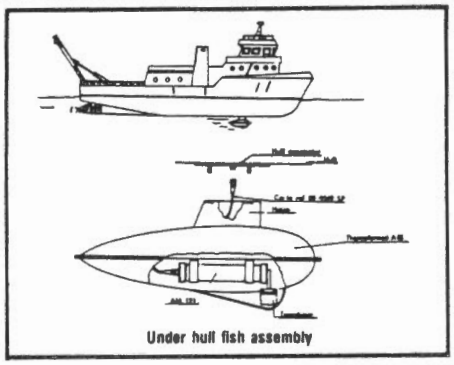
POSSIBLE SHIP INSTALLATIONS OF ACOUSTIC MODULE AM 1X1



Through lateral pipe



Through hull with gate-valve



Under hull fish assembly

Wide transmission frequency

Due to a high quality transducer and to a new power amplifier design, the Acoustic Module AM 1X1 is able to transmit at any frequency from 8 kHz to 16 kHz without tuning.

How to order

- Specify F^1 and F^2 internally selected transmitting frequencies (between 8 and 16 kHz).
- Specifiy operating depth.
- Specify 4 pin connector or 19 pin connector.

SPECIFICATIONS

(Subject to change without notice)
— Electrical
- Power supply: 15 to 28 V DC
- Power consumption: 2 W max. (1 transmission/5 s)
- Peak electric power: 500 W

— Acoustic (8 kHz to 16 kHz range)
- Acoustic level: 92 ± 3 dB/ubar at 1 m.
- Beam pattern: omnidirectional ± 3 dB
- Pulse length: 10 ± 0.5 ms

— Mechanical
- Housing: stainless steel 316 L (AM 121)
- Length: 490 mm / 19 inches
- Diameter: 132 mm / 5.2 inches
- Weight in air: 15 kg / 33 pounds
- Weight in water: 10 kg / 22 pounds

—Environmental
- Operating depth
  -2,000 m ref: AM 121
  -4,000 m ref: AM 141
  -6,000 m ref: AM 161
- Operating temperature range: -5°C to + 50°C
- Storage temperature range: -40°C to + 70°C

OCEANO INSTRUMENTS

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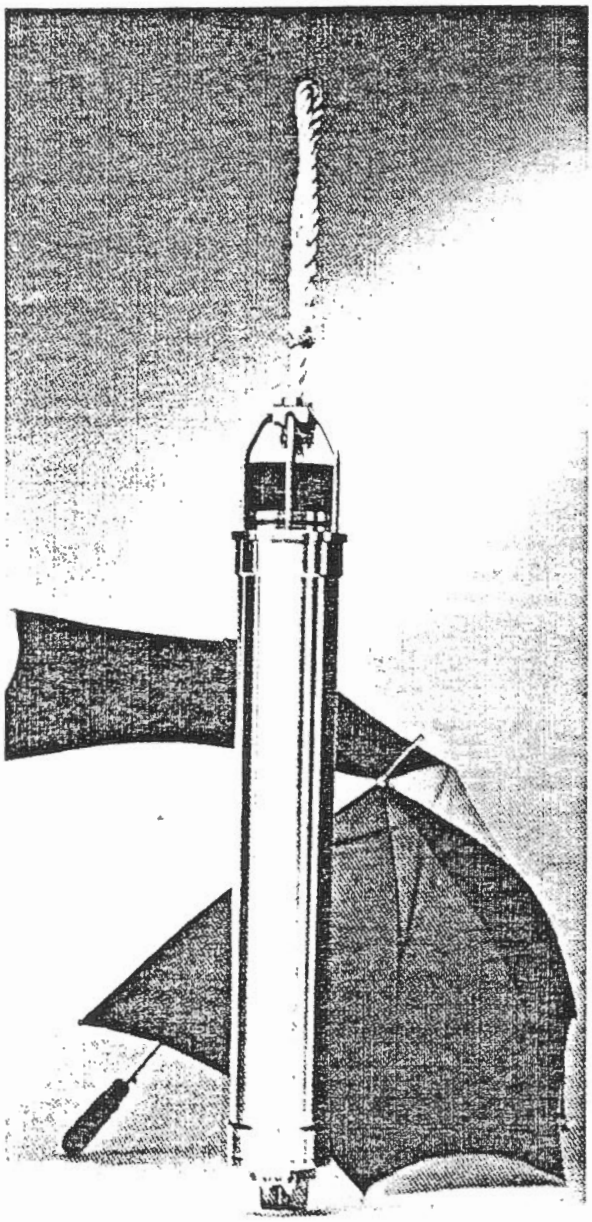
OCEANO INSTRUMENTS

RECOVERABLE TRANSPONDER RT 1X1
FOR DEEP WATER POSITIONING REFERENCE OR ACOUSTIC RELEASE



* DUAL TRANSPONDER
  — TWO INTERROGATE FREQUENCIES
  — TWO REPLY FREQUENCIES
* FIELD PROGRAMMABLE
* FOUR COMMAND FUNCTIONS
* NO PURGING NECESSARY
* POSITIVE ACTION RELEASE

Océano
INSTRUMENTS

ABSOLUTELY THE FINES

AT THE HEART OF EVERY OCEANO SYSTEM IS A SERIES OF RT 1X1 TRANSPONDERS

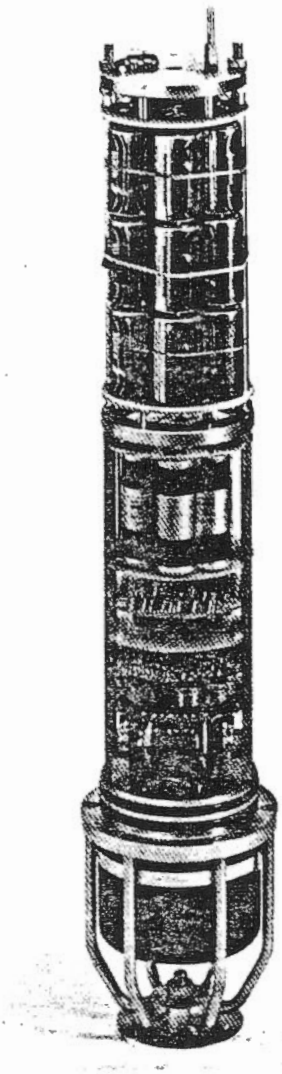
This is because each OCEANO INSTRUMENTS' RT 1X1 transponder is an extremely versatile, dual channel acoustic instrument.

There are actually two separate transponders in each instrument. This means the system can be interrogated by two individual signals and the transponder will reply in two separate, field selectable frequencies.

In addition, there are four command channels which are factory coded using one of 12,512 available codes. This makes each transponder command code unique.

The RT 1X1 is a recoverable transponder with a positive action release. Upon processing the required command from a TT 101 or TT 201 telecommand unit, the RT 1X1 will release from its anchor and return to the surface.

Once on the surface the transponding function of the RT 1X1 can be used to bring the surface ship within recovery range.



Typical Construction

STANDBY BATTER' FOR EMERGENC'' RELEASE

WORM GEAR FOr POSITIVE RELEA

BATTERY PACK (STANDARD D CELLS)

CAPACITOR BAN

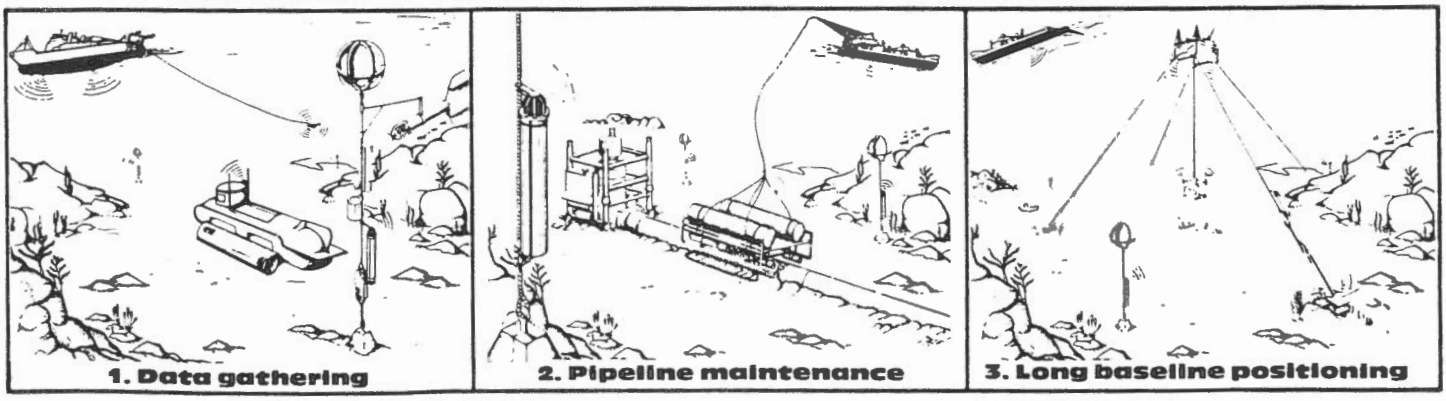
4 PLUG IN P.C. BOARD FOR EAS' MAINTENANCE

OMNI DIRECTIOI WIDE BAND TRANSDUCER

STURDY PROTECTION CAGE

1 ATMOSPHERE INTERIOR

TYPICAL APPLICATIONS FOR A TRANSPONDER



1. Data gathering

2. Pipeline maintenance

3. Long baseline positioning

TRANSPONDER MADE

Field programmable reply frequencies
The two reply frequencies are field programmable (by soldered straps for reliability) without tuning. This is the result of the use of a high quality wide-band transducer and special design of the power amplifier.

Mutual interrogation
With an appropriate choice of interrogate and reply frequencies, several reference transponders RT 1X1 can mutually interrogate each other, under the operator's control. A rapid calibration of the array can be done this way.

Noise immunity
Automatic gain control (AGC) maintains a constant threshold to sea-noise ratio. Transient broad spectrum noises are also eliminated by differential bandwidth filtering combined with hard limiting.

F.S.K. command codes
Command codes are composed of eight pulses representing an eight bit digital word. One frequency represents logic level "1"; a different frequency represents logic level "0". These two carrier frequencies may be chosen from seventeen (8 to 16 kHz, 0.5 kHz step). Pulses are separated by 100 ms. A synchronized gate eliminates spurious reception between pulses.

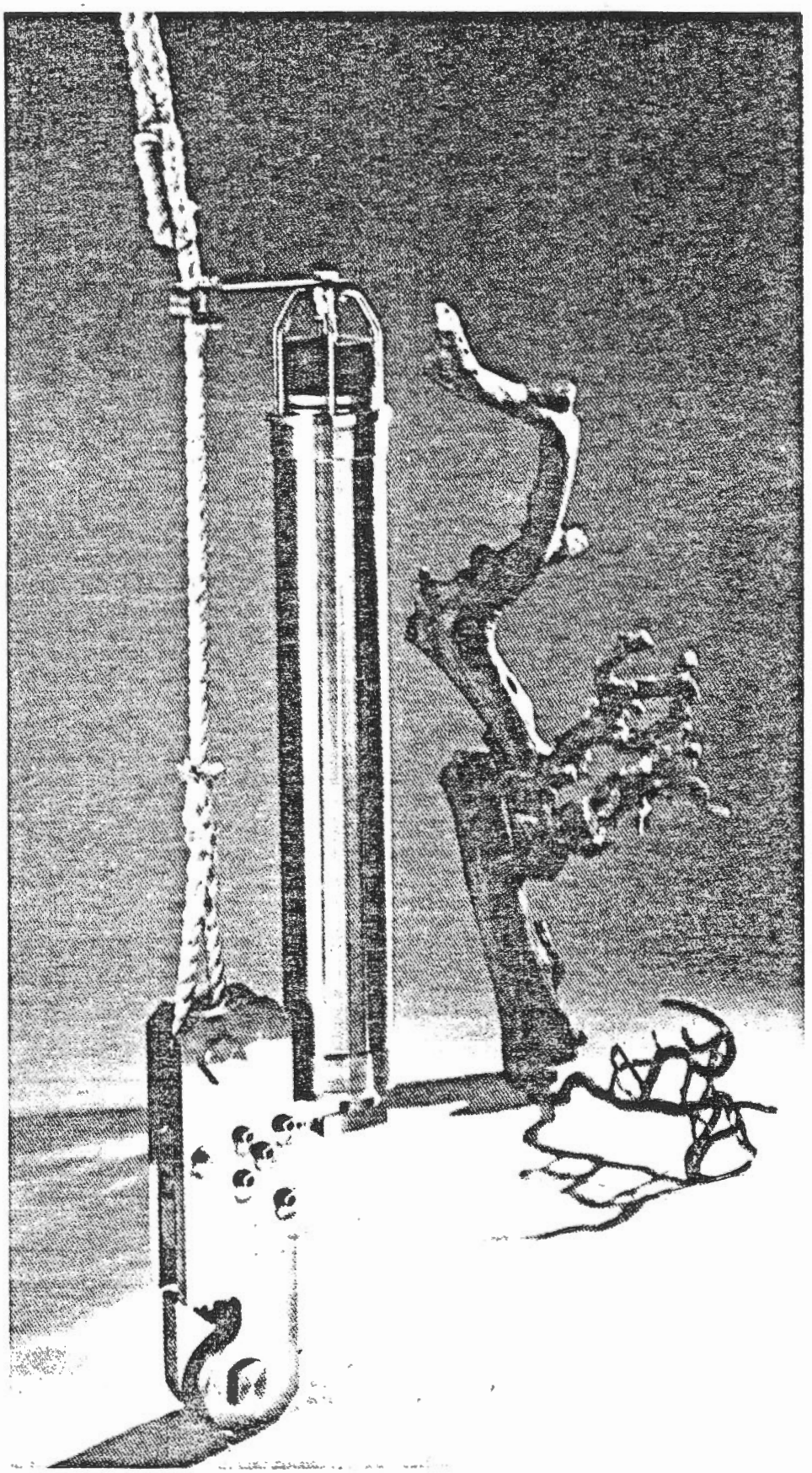
Four different programmable codes
Each Recoverable Transponder RT 1X1 can detect four different codes to activate four different functions:
- code 1: enable transponder reply
- code 2: disable transponder reply
- code 3: release
- code 4: spare code for external switch.

All these codes are field programmable by soldered straps.

Multipath propagation
The F.S.K. coding system has a proven efficiency where multipath acoustic propagation restricts the use of all other systems.

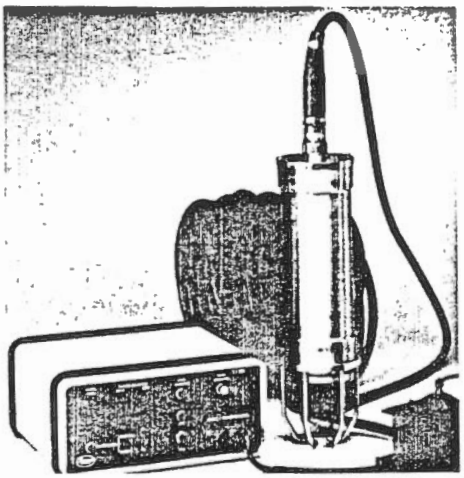
Receipt and execution acknowledgments
The Transponder RT 1X1 acknowledges receipt of a code by sending a specific reply pulse to the surface unit, and confirms execution of the code by sending a second pulse.

Easy maintenance
- Plug-in cards only.
- Battery replacement in less than 45 minutes.
- Automatic opening of housing.
- Standard D cells (dry or alkaline)



RECOVERABLE TRANSPONDER RT 1X1

FOR DEEP WATER POSITIONING REFERENCE OR ACOUSTIC RELEASE



Release safely "at no cost"

No lost parts, lateral effort axis, one hand re-arming, loads from 0 to 20,000 kg, are the main features of this unique active release mechanism.
An auxiliary battery provides safety power for release in case of flat main pack.

COMMAND SYSTEM TT 101 + AM 121 activates the 4 command channels within the RT 1X1.

How to order

- Specify the two interrogate frequencies (8 to 16 kHz)
- Specify the two reply frequencies (8 to 16 kHz)
- Specify turnaround delay (8 to 25 ms)
- Specify blanking time (4 to 12 s)
- Specify operating depth (2,000, 4,000, 6,000 or 8,000 meters)
- The two command carrier frequencies (8 to 16 kHz) and the four digital codes (00 to 99) will be selected by OCEANO INSTRUMENTS for security.

SPECIFICATIONS

(Subject to change without notice.)

— Electrical
• Reception circuits supply
- 3 D cells
- nominal voltage: 4.5 V
- consumption: 380 uA nominal
• Power circuits supply
- 15 D cells
- nominal voltage: 22.5 V
- consumption: 50 uA permanently + 66 uAH/reply + 560 uAH/release (shallow water)
- safety release supply
  - 2 MN 1604 cells
  - nominal voltage: 18 V
  - no consumption
- Battery life
  - receiver pack: 2.5 years max.
  - power pack: 150,000 replies or 18,000 releases (shallow water)
• Interrogate
- two factory adjustable frequencies from 8 kHz to 16 kHz, in 0.5 kHz step
- minimum pulse width: 6 ms
- minimum detectable signal: — 20dB/ubar
- reception bandwidth: 300 Hz
- threshold automatically adjusted approximately 26dB above noise level
• Reply
- two field programmable frequencies from 8 to 16 kHz
- frequency stability: ± 30 Hz
- pulse width: 10 ms ± .05 ms
- turnaround delay: factory adjustable from 8 ms to 25 ms
- delay stability: ± 0.1 ms
- blanking time: factory adjustable from 4 s to 12 s
• Acoustical
- acoustical source level: 92 ± 3 dB/ubar at 1 m
- beam pattern: omnidirectional ± 3 dB
• Physical
- overall length: 950 mm / 37 inches
- outside diameter: 124 mm / 5 inches
- weight in air: 29 kg / 64 pounds
- weight in water: 21 kg / 46 pounds
- housing: stainless steel 316 L (RT 121)
• Environmental
- operating temperature range: —5 °C to + 50 °C
- storage temperature range: —40 °C to + 70 °C
- operating depth:

2,000 m for RT 121	6,000 m for RT 161
4,000 m for RT 141	8,000 m for RT 181

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Oceanographic Services, Inc.

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(805) 685-4521
Telex 658-450 OSI GLTA

OCEANOGRAPHIC SERVICES, INC.

DATA REDUCTION AND PROCESSING SERVICES

For over a decade and half, OSI has been involved in oceanographic instrumentation and measurement programs. During this period, OSI has developed a variety of in-house capabilities for the translation, reduction, and processing of oceanographic field data. Translation capabilities include equipment to translate data from field-deployed magnetic media (such as cassettes and cartridges) onto computer-compatible magnetic tape. For reduction and processing of data, OSI has an HP2100 computer system in-house and a dedicated link to an IBM 4341 system based in Los Angeles. OSI's data processing staff has developed through the years an extensive library of programs that convert field data to physical units, perform error-checking, analyze the data, and present it in a variety of tabular and graphical forms. This combination of proven hardware/software tools and a staff experienced in analyzing oceanographic data enables OSI to provide rapid and reliable service for the reduction of oceanographic field data.

For all oceanographic and other measuring instruments making use of Datel, Memodyne, or Sea Data cassette recorders, OSI offers the following standard data reduction service:

- Cassette translation to IBM-compatible tape
- Error report and conversion to physical units

Optional services including tables and plots are listed below by instrument.

OSI 915/4400 Wave Data Logger

- Wave profile traces and spectrum plots
- Time history and scatter plots of wave parameters
- Statistical summary and persistence tables

Sea Data Wave/Tide Gauge

- Spectral transformation from subsurface pressure to surface displacement
- Wave trace and spectrum plots
- Time history plots of tide and wave parameters
- Frequency distributions of tide and wave data
- Harmonic analysis of tides

Current Meters (including Neil Brown, Hydro Products SeaTrak, and EG&G Vector Averaging Types:

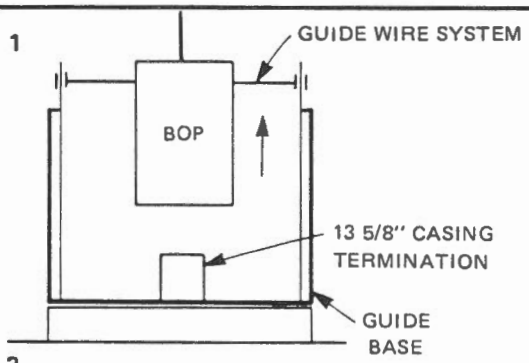
- Time history plots
- Current roses
- Frequency distributions
- Progressive vector and current vector plots
- Harmonic analysis

For further information including price and delivery schedules, contact:

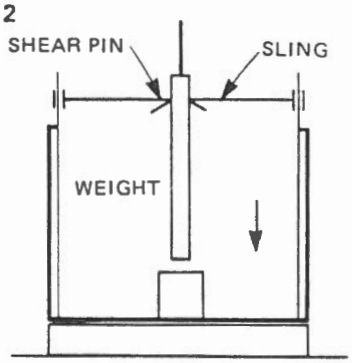
Data Processing Department
Oceanographic Services, Inc.
25 Castilian Drive
Goleta, CA 93117
Telephone: (805) 685-4521
Telex: 658 450, OSI GLTA

APPENDIX C

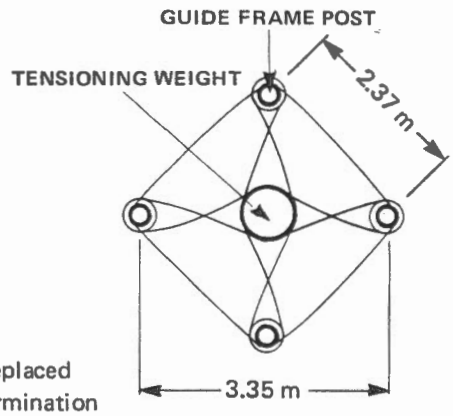
DEPLOYMENT AND RECOVERY PROCEDURES



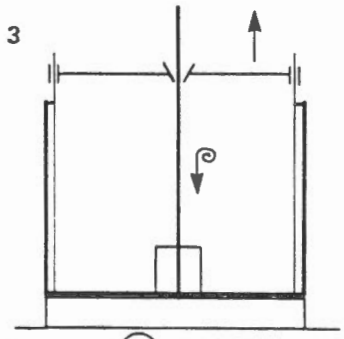
Last drilling system removed using guide wires



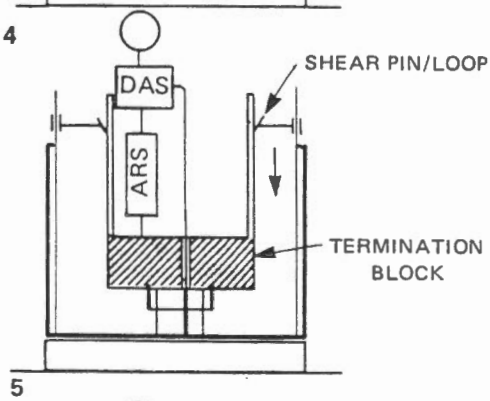
Guide wire/sling system guides cable tensioning weight into casing



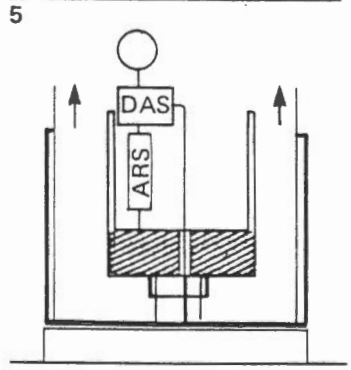
SLING SYSTEM



Sling system removed and replaced by larger system to guide termination block into place

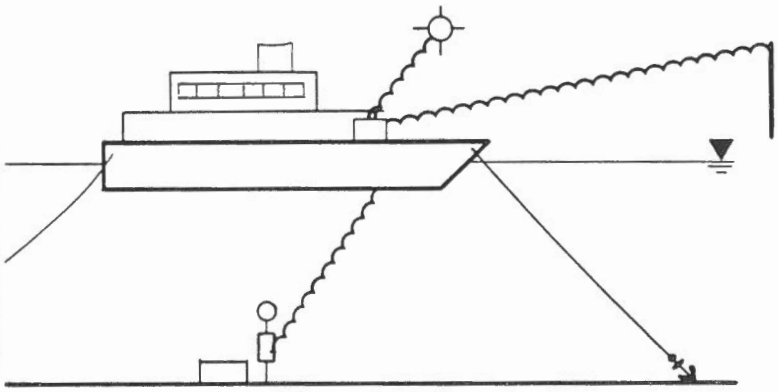


Termination block and subsea system lowered over casing using guide wires

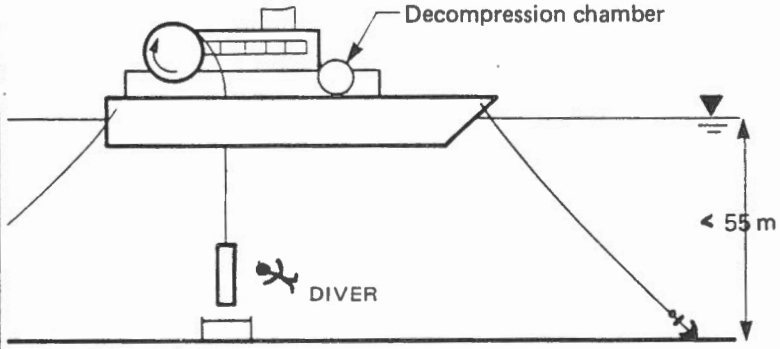


Guide wires removed

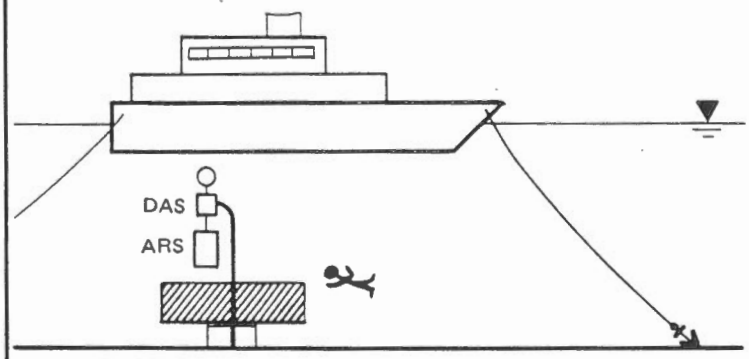
FIGURE C.1 DEPLOYMENT BY DRILLSHIP SYSTEM



Ship on station by SATNAV/SYLEDIS system
possible seabed transponder positioning
Four-point anchoring deployed

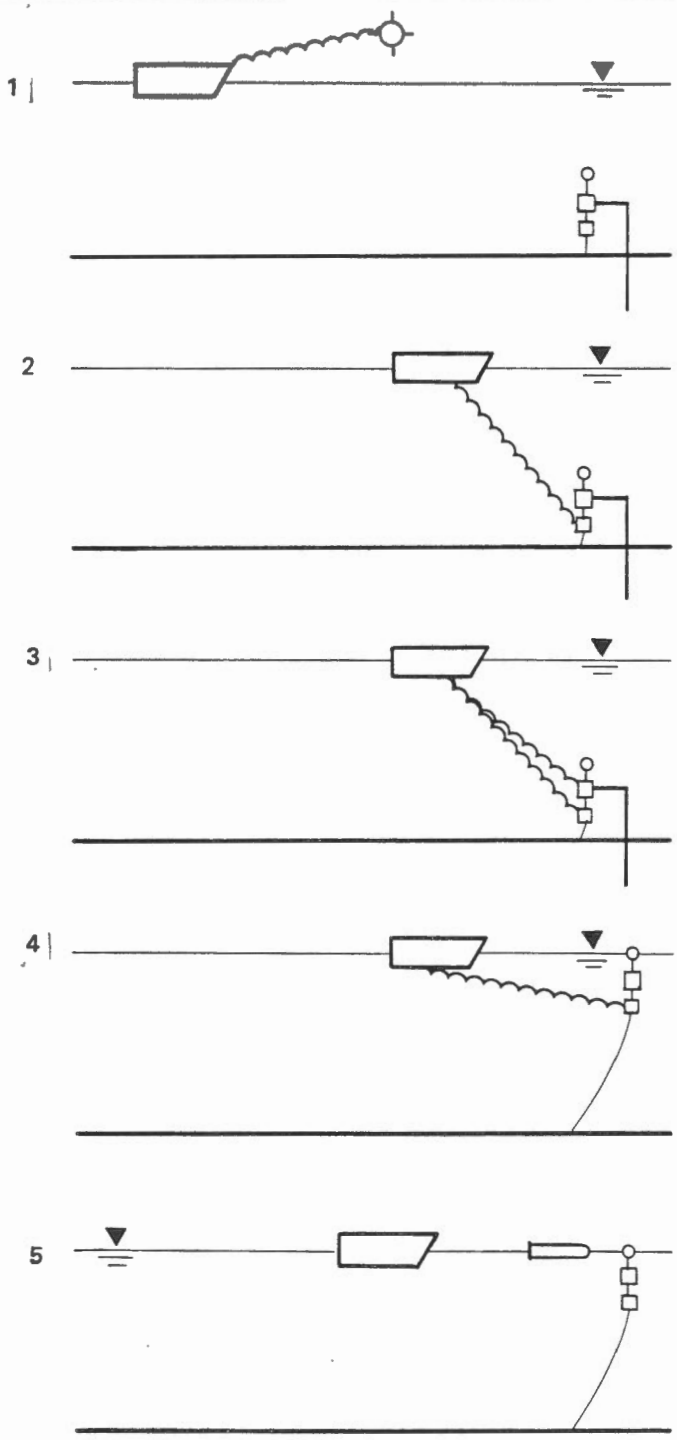


Tensioning weight guided into hole (remove corrosion cap?) by diver. Diver returns to surface during placing of cable if long time is expected. Cable deployed through large moonpool or over stern



Termination block fitted over casing by diver and all equipment checked and connected

FIGURE C.2 DEPLOYMENT BY SUPPLY VESSEL



1 Initial navigation carried out by SATNAV or SYLEDIS systems in place in area to ±1 km or better

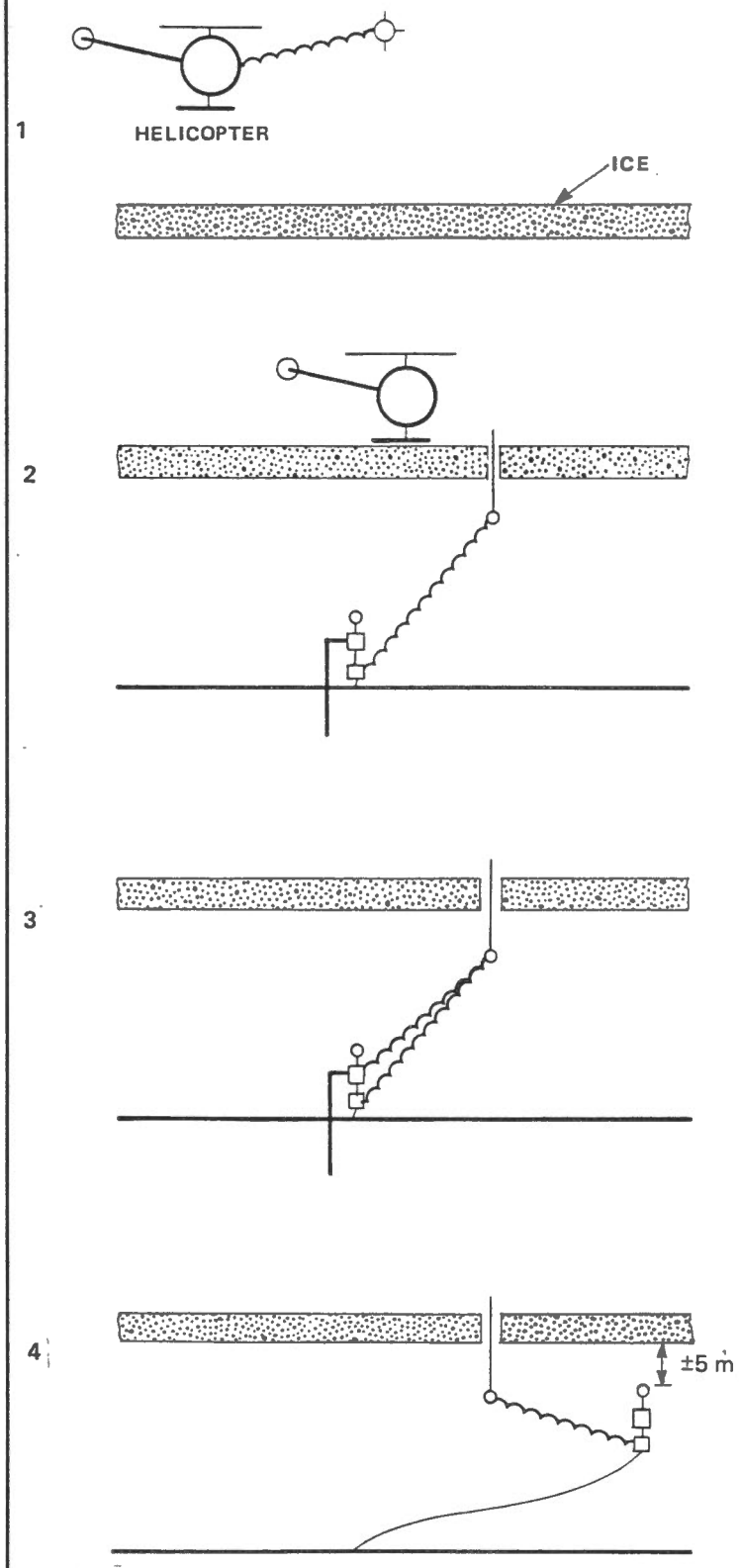
2 Interrogation of unit in two phases:
1. Fine navigation to ±0.1 km or better
2. Unit check response

3 Release phase in two stages:
1. Cable cutter actuated to disconnect cable. Guillotine backup actuated after buoy release
2. Acoustic release actuated to release sub-sea unit from termination block

4 Unit floats to surface with attached tag line to prevent excessive drift. Acoustic release continues to define position

5 Inflatable craft used to recover unit

FIGURE C.3 RECOVERY IN OPEN WATER



Initial navigation of helicopter carried out to ±1 km or better by existing systems. Possibly, majority of ice holes can be drilled prior to recovery operation

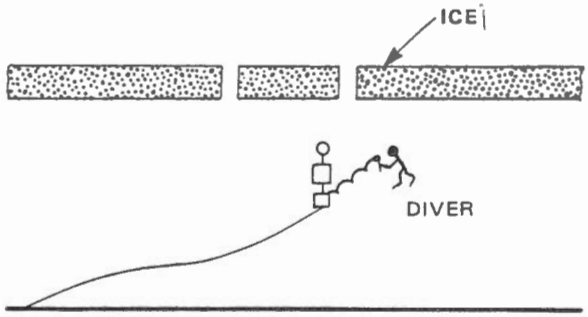
Ice hole drilled and directional hydrophone deployed. Acoustic sea bed unit interrogated for range and bearing. Helicopter either returns to base or remains throughout operation. In the former case, shelter required

Release phase in two stages:

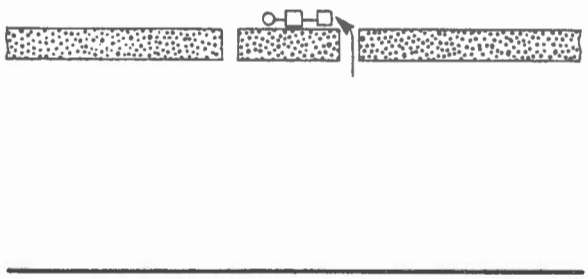
1. Cable cutter parts thermistor cable from data acquisition system
2. Acoustic release parts sub-sea unit from termination block

Unit floats to within 5 m of surface. Triangulation of unit's position carried out through two or three ice holes. Tag line prevents excessive drift.

FIGURE C.4 RECOVERY BENEATH ICE COVER



Ice hole drilled as close as possible to sub-sea unit's position. Diver sent in to recover unit either visually or with hand-held directional pinger receiver



Unit recovered through nearest ice hole after disconnection from tag line

6

FIGURE C.4 RECOVERY BENEATH ICE COVER (cont.,)