EMP Measurement Notes

Note II

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Description of Weapons Effects Buoy System (WEBS)

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Abstract

Components of the buoy system and the recording instrumentation are described. The description includes illustrations and outlines the general operating parameters. This note is essentially excerpts from the report WEBS Sea Trials Oct-Nov 65 by the Air Force Weapons Laboratory.

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I. Introduction

The Weapons Effects Buoy System (Fig. 1) development was directed by the Air Force Weapons Laboratory for Defense Atomic Support Agency. The system is intended to be used in the open ocean for gathering data on surface nuclear tests. Emphasis has been placed on designing surface floats which will minimize interference with sensors. Since it is a taut moored system, WEBS can be emplanted in any array geometry required.

The basic procedure for placing a mooring is to lower the anchor to the ocean floor; attach the winch buoy to the end of the anchor wire and cut the system free of the winch used to lower the anchor. This leaves the winch buoy floating on the surface. A small boat then attaches a power cable to the winch buoy and the winch is operated to pull in wire until all the slack is out of the anchor cable and the winch buoy is just beginning to pull under. At this point, the remaining WEBS components (instrument canister, spar mast and catamaran) are launched and towed over to the winch buoy for attachment. A power cable with an internal strength member is connected between the instrument canister and the winch buoy. The system is then commanded to winch down until the instrument canister is 300 feet below the surface of the water and the top thirty-five feet of the spar mast are visible.

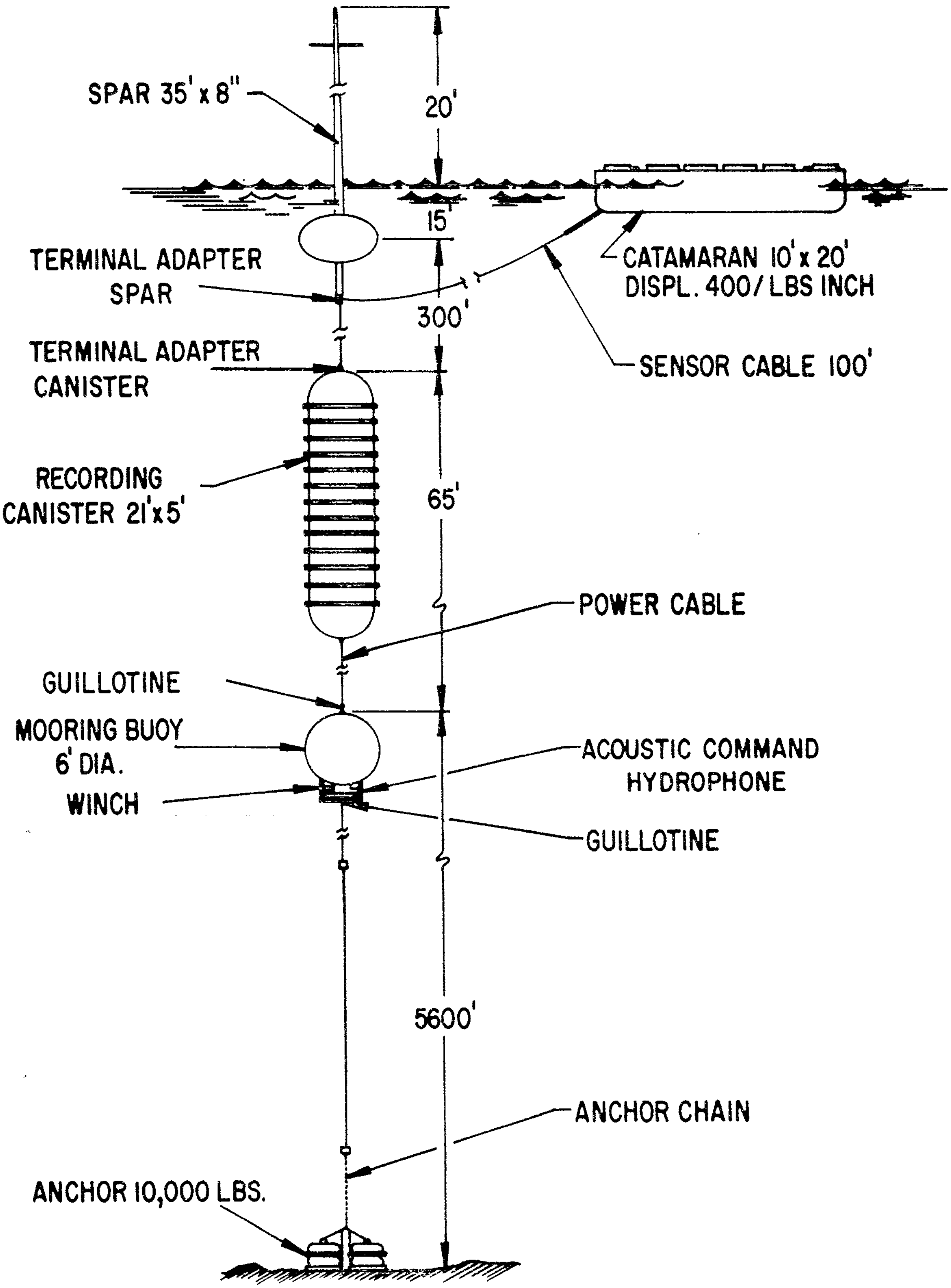
The system can remain on station for several weeks before being turned on and operated by telemetry. After the event, the data is recovered from the instrument canister for reduction.

II. Description of WEBS

WEBS is a taut moored buoy system which can be implanted in depths up to 3,000 fathoms (18,000 feet). The instrumentation canister and the mooring system are designed to withstand overpressures in excess of 1000 pounds per square inch. The major components of WEBS are a 10,000 pound dead weight anchor, mooring wire, mooring winch, winch buoy, winch power cable, instrument canister, instrument rack, sensor cable, spar buoy and catamaran float, and a remote command and control system.

Anchor: The anchor is simply a dead weight that is lowered to the ocean floor. The anchor is made of scrap railroad wheels mounted on a stand of four pipes. The railroad car wheels have two advantages, they are inexpensive and they permit the weight of the anchor to be adjusted in increments of seven hundred pounds.

Mooring Wire: The mooring wire is 3/8 inch 1X43 torque balanced wire rope. Torque balanced wire rope minimizes unlay or twist when tension is applied to it. The wire unlays 1/13 turn per 100 ft under 7000 pounds tension as compared to 120 turns per 100 feet at the same tension for standard 6X19 wire rope. The mooring wire has an ultimate strength of 19,850 pounds.



WEBS SYSTEM

FIGURE 1

Mooring Winch: The depth of WEBS is controlled by a mooring winch mounted beneath the winch buoy. The winch uses 3/8 inch (3X19) wire rope which is spliced to the anchor wire. The wire is wound on a storage drum by a level winding device. When the winch is paying out wire, the wire is fed off the storage drum and over two traction drums. After passing over the traction drums the wire feeds over an idler sheave and down to the anchor. The present winch is designed to pull down a 7000 pound load at approximately 15 feet per minute. The winch is driven by a 56 volt D.C. electric motor. The motor is powered by two 28 volt nickel cadmium batteries which are connected in series. These batteries are located in the instrument canister and are connected to the winch by a 45 foot power cable. This power cable is shackled to an eye on the top of the winch buoy. The individual conductors are then connected to pigtails which feed from the winch motor and control circuits up through the center of the winch buoy. The cable connection at the top of the winch buoy is equipped with an emergency release device which can cut the power cable free. This device is activated by a pressure switch and is intended to prevent the instrument canister from being pulled down if the winch buoy sinks. Two explosive wire cutters are located beneath the winch. These cutters are fired by the normal release system which can be activated either by hardwire or acoustic command.

Winch Buoy: The winch buoy is a 6 foot diameter sphere constructed of 1/2 inch HY100 steel plate. The sphere is designed to withstand overpressures in excess of 1000 pounds per square inch. The winch buoy has fittings installed so that it may be partially flooded with water in order that a constant net positive buoyancy may be maintained for the varying amounts of mooring wire required for different depths.

Winch Control System: The WEBS winch buoy is one of the four positive buoyancy components in the taut mooring system. The winch on the winch buoy can be commanded to raise or lower a WEBS in its mooring, and, in case of a winch malfunction, a WEBS can be cut free from its mooring by either a sonar signal transmitted from the operations ship or a hardwire signal from the catamaran. In addition to command releases from the surface, a leak detector in the canister and a pressure switch on the winch buoy will release the system if excessive leakage develops or if the system starts to sink.

The sonar link consists of an acoustic signal coder and amplifier driving a sonar transducer on the operations ship and a hydrophone, amplifier and acoustic decoder on the winch buoy. Because the ocean is a noisy acoustic medium, the sonar signal consists of five levels of coding to insure that random noises will not actuate the winch.

A 10 KHz carrier frequency is modulated by a balanced modulator at one of ten modulation frequencies to produce a suppressed-carrier signal. This signal is then gated to obtain a pulse-repetition-frequency (PRF) coding. After amplification by an audio-frequency power amplifier, this signal drives a sonar transducer.

The sonar signal is received by a hydrophone on the winch buoy. (1) The hydrophone drives an amplifier tuned to 10 KHz and equipped with automatic gain control (AGC) to give it an 80 db dynamic range. After amplification, the signal undergoes amplitude detection. (2) If the signal contains the proper modulation frequency, the pulses are standardized by a pulse shaping circuit. The signal then goes through one of three PRF discriminators. (3) If the pulse has the proper duration and (4) is of the correct frequency, it is transmitted to an integrating circuit. Finally, the integrating circuit must count a specific number of pulses (5) before it will turn on a gate indicating that an "up", "down" or "release" command has been received.

An "up" or "down" signal from the acoustic decoder turns on an oscillator in the control circuit which transmits signals on a hardwire link to the motor-control circuit in the canister.

The command box on the catamaran also contains oscillators that transmit at the same frequencies as the oscillators on the winch buoy. Both the link from the catamaran and from the winch buoy are de-coupled by resistors so that a failure in either circuit will not prevent a command on the other circuit from operating the motor control.

The motor control circuit consists of detectors to determine whether the command frequency is "up" or "down" and a pair of power relays that turn on the power and control its polarity to the winch motor. The relays automatically switch on a braking load when they turn off power to the winch motor. An ammeter in the control box on the catamaran indicates how much current the motor is drawing.

A sonar "release" command turns on a circuit which fires two explosive wire cutters, severing the mooring cable below the winch. The command box on the catamaran and the leak detector in the canister both turn on oscillators that transmit on a hardwire link to the winch buoy where the signal is detected and fires the explosive wire cutters. The pressure switch on the winch buoy fires both the two wire cutters on the mooring cable and another explosive cutter on the power cable between the winch buoy and the canister.

Instrument Canister: The instrument canister is a 22 foot long 5 foot diameter reinforced cylinder weighing approximately 14,000 pounds with hemispherical end bells bolted on each end. The canister is made of 5/8 inch thick HY 100 steel. Electrical conductors enter the canister through flanges on the ends of these hemispheres. The instrument canister is reinforced on the outside by "T" shaped stiffening rings. These rings are designed to strengthen the canister to exterior overpressures. One of the instrument canisters was tested by the Structural Mechanics Laboratory of the David Taylor Model Basin in Washington, D.C. The test results confirm that the instrument canister is able to withstand an external static pressure of at least 1500 psi. The instrument canister contains the recording instrumentation, the command, control and calibration electronics, and the system power sources. All these components are mounted in a 33"X33"X173" shock isolated aluminum instrument rack. The recording instrumentation includes 14 dual tube fiber optics oscilloscopes and two 14 channel FM tape recorders. These instruments give the system 28 channels each of 100 MHz, and 1.2 MHz data recording capability. The command, control and calibration electronics, upon reception of a telemetered command signal turns the system on, calibrates the recording instrumentation after a preset warmup time, and arms the system in preparation for data recording. The status of the instrumentation is transmitted to the control center up to zero time. After the data is recorded the recording instruments are automatically recalibrated and the system turns itself off to await recovery. The system power sources are four 150 ampere hour 28 Volt NiCd batteries. Two are connected in parallel to power the instrumentation and two are connected in series to provide power for the mooring winch.

Description of Oscilloscope - Fairchild Type 977: The oscilloscope is primarily designed to display high frequency transient signals with frequency components up to 100 MHz, and in conjunction with a specially designed film transport mechanism, produce a permanent recording of the displayed signals. The oscilloscope is a dual channel device employing two fiber optic faceplate cathode ray tubes. Independent signal channels drive each CRT although the sweep for both CRT's is obtained from common time base circuits.

The oscilloscope is enclosed in a metal case. On the front of the oscilloscope is a housing that encloses the film transport mechanism. The front of the housing is equipped with a removable hinged door to permit access to the film transport. The two CRT's are mounted in a vertical plane behind the transport housing.

The front panel of the oscilloscope contains the controls, indicators and signal input connectors required for operation of the oscilloscope. The sweep controls are all tamper-proof, shielded by a metal bar at the lower portion of the front panel.

The rear panel contains the input power connector and a remote control input connector, as well as the low voltage power supply input fuse. The rear, side, and top panels are removable.

Input signals may be applied to a 30 MHz preamplifier, which drives the CRT deflection amplifier. When preamplification is not needed the signal may be applied directly to the deflection amplifier. The preamplifier increases the gain but limits the frequency response to 30 MHz. The deflection amplifier requires a greater input signal but extends the frequency response to 100 MHz.

When internal triggering is selected, a portion of the input signal is used to trigger the sweep of the CRT's. The sweep circuits generate a preselected linear or exponential sweep to produce the time base on each CRT. There are thirteen exponential sweep speeds. The exponential sweep travels 35 times faster at the start of the sweep than at the end. Four modes of sweep operation are available: single sweep; recurring at one sweep per second; recurring at 80 sweeps per second; and driven at a selected rate.

Trigger pulses to initiate the sweep may be obtained either externally or internally from the signal channels. External triggers are applied directly through a front panel connector. Trigger pulses from the internal source are obtained either from the channel 1 or channel 2 deflection amplifiers or from both channels. When the source is both channels, the first trigger pulse to arrive initiates the sweep. A minimum input signal of 100 millivolts to the deflection amplifier will produce a trigger pulse. A front panel selector switch allows the operator to select both external and internal trigger sources. In this mode, the first trigger pulse to arrive triggers the sweep circuits. Independent of the trigger source selected, positive and/or negative trigger pulses are capable of initiating the sweep.

Control of the film transport mechanism for advancing the film is accomplished either locally by front panel push buttons or remotely by externally applied signals. The film transport can be made to advance the film a single frame at a time or continuously. In single sweep operation, the film transport has the capability of automatically advancing the film a single frame at the completion of the single sweep. During the exposure period, the film is pressed against the two fiber optics faceplates. Prior to film advancement, the film is lifted off the faceplate surfaces to prevent the film from being scratched, and to reduce wear of the fiber optic surfaces.

Signal Input Characteristics with 30 Megahertz Preamplifier

a. Bandwidth	15 Hz to 30 MHz
b. Rise Time:	12 nanoseconds
c. Sensitivity	25 mv for full-scale (25 millimeters) deflection
d. Input Impedance:	50 ohms (nominal)
e. VSWR:	1.05 or less to 30 MHz thereafter down 6 db per octave to 200 MHz.
f. Signal Delay:	40 nanoseconds minimum after start of sweep.
g. Maximum signal Input Without Overload:	2.5 volts (x100 attenuation factor)

h.	Attenuation Factors:	X1, X2, X4, X10, X20, X40, X100
i.	Gain:	100 (X1 Attenuation Factor)
j.	Overload Capability	Transients of 200 volts for 1 millisecond (exponential decay). If exceeded, amplifier will be permanently damaged.

Signal Input Characteristics Direct to Post Deflection Amplifier

a.	Bandwidth:	D.C. to 100 MHz
b.	Rise Time:	3.5 Nanoseconds
c.	Sensitivity:	2.5 volts for full-scale deflection
d.	Input Impedance	50 ohm (nominal); 100 ohm differential
e.	VSWR:	1.02 or less to 50 mc; thereafter down 6 db per octave to 200 mc.
f.	Signal Delay:	40 nanoseconds minimum after start of sweep.
g.	Maximum Signal Input Without Overload:	2.5 volts
h.	Attenuation Factors:	None
i.	Gain:	Approximately 4 depending on crt deflection.
j.	Overload Capability	Transients of 200 volts for 1 millisecond (exponential decay). If exceeded, amplifier will be permanently damaged.

Sweep Characteristics

a.	Sweep Speeds	Linear: 10, 1, 0.5, 0.2, and 0.1 milliseconds; 50, 20, 10, 5, 2, 1, 0.5, and 0.2 microseconds.

	Exponential: 10 and 1 milliseconds. Ratio of slope at start of sweep to end of sweep= 35:1.
b. Sweep Repetition:	Single; recurring at 1 or 80 sweeps per second, or at the rate of an externally applied trigger. Exponential: Single, recurring at 1 or 80 sweeps per second, or at the rate of an externally applied trigger

Triggering

a. Polarity	Positive or negative or both whichever comes first.
b. Source:	External or internal pickoff from either channel or all sources whichever comes first.

Trigger Polarity			Trigger Selection					Trigger Amplitude
+	Either	-	Channel 1	Channel 1 or 2	Channel 2	Ext	All	Minimum
X			X					100 mv
X				X				200 mv
X					X			100 mv
X						X		300 mv
X							X	300 mv
	X		X					200 mv
	X			X				200 mv
	X				X			200 mv
	X					X		300 mv
	X						X	300 mv
		X	X					100 mv
		X		X				200 mv
		X			X			100 mv
		X				X		300 mv
		X					X	300 mv

c. External:	10 volts maximum
d. Internal:	0.5 volt peak (at post deflection amplifier input) Rise time 10 nanoseconds or greater.

Cathode Ray Tube (2)

a. Type:	F9770-0-P11, 22-3/8 ± 1/4 inches long, 2 3/4 ± 1/32 inch round fiber optic faceplate, 10 KV post accelerator with P11 aluminized phospher screen.
b. Resolutions:	350 trace widths full vertical (25 millimeters) deflection and 450 trace widths full horizontal (32 millimeters) deflection.
c. Writing Speed:	$3\text{X}10^{10}$ trace widths per second with Kodak type 2475 film.

Camera and Film Transport

a. Film Size:	35 mm sprocketed or non-sprocketed.
b. Frames:	18 minimum including three frame leader.
c. Recorded Data:	Frame number, oscilloscope number, time of day, and reference marks.
d. Camera Control:	Remote or local for film advancement. Automatic single sweep mode after initial arming.

Power Requirements

a. Voltage:	28 volts dc nominal with a tolerance of + 6, -2 volts dc.
b. Power	Less than 110 watts.
c. Fuse Requirements:	4 ampere slow blow.
Operating temperature:	-30 degrees C to +60 degrees C.
Operating Humidity:	0 to 95% relative humidity.
Physical Dimensions:	Height: 13 inches; Width: 13 inches; Depth: 26 inches.
Weight:	46 pounds with film transport.

Description of Tape Recorder - Genisco Type 10-126: This tape recorder is designed to record asymmetric pulses of unknown initial polarity and unknown duration. The tape recorder will produce an accurate record of the signal pulse shape and amplitude.

The system consists of one Genisco 10-126 basic tape recorder with associated electronics for recording fourteen tracks of DC to 0.8 MHz data (by wideband FM techniques) on one inch wide instrumentation tape.

Two direct record modules are supplied which may be substituted for any two VCO's to provide two tracks of 1 KHz to 2 MHz data by direct record processes.

A fiducial signal may be used to interrupt the FM carrier for the purpose of establishing a time base reference.

Recording is accomplished at a tape speed of 180 ips. However, an additional speed of 60 ips is available for tape loading and tape stacking.

The tape capacity will allow five cycles of operation, each cycle consists of several seconds for the tape to reach recording speed, five seconds of multilevel calibration and a fiducial marker followed by twelve seconds of data recording; and then turn off of the transport and electronics.

The transport may be operated locally through the use of controls on the transport housing or remotely though the application of ground returns to the appropriate pins on the transport remote control connector. The transport logic is controlled by magnetic latching relays which maintain the last selected position after power is removed. Therefore, the desired mode of operation may be selected prior to the operating period, and the transport will enter the preselected mode upon the application of power and the appropriate (ground return) start command.

Electrical Specifications

a. Frequency response - 1 KHz to 2 MHz direct record DC to 0.8 MHz FM Record.

b. Center Frequency (FM) - 1.4 MHz.

c. Linearity - Within 3% - FM Record
Within 5% - Direct Record

d. Deviation (FM) - ± 20%

e. Harmonic Distortion - Less than 1%

f. Phase Response - FM Record risetime less than 0.4 microseconds.
Less than 5% overshoot on square wave response.
Direct record risetime less than 0.25 microseconds.

g. Input Dynamic Range - + 0.5 volts to + 5 volts for full deviation (FM) or normal record level (Direct Record).

h. Crosstalk - Down 40 db or more.

Mechanical Specifications

a. Tape Capacity - 2400 ft. of 1 mil instrumentation tape

b. Tape Width - 1 inch

c. Tape Speed - 180 ips for record operation, 60 ips for controlled loading and rewind.

d. Recording Tracks - 14 on 1" tape.

e. Track width, numbering, track spacing - Per IRIG Spec No. 106-60.

f. Start/Stop Time - 3 seconds each, at 60 ips

g. Tape speed accuracy - Within 0.5% from nominal

h. Flutter (static) - Less than 0.5% peak-to-peak
Flutter (vibration) - Less than 2.5% peak-to-peak at 180 ips.
Dynamic Skew - Less than ± 0.3 microseconds between adjacent tracks on the same head stack at 180 ips.
Size - 9"X10 3/4" X 15"
Weight - 50 pounds.

Environmental Specifications

a. Temperature - 40 degrees F to + 165 degrees F.

b. Vibration - 10g's (0-10 Hz) with 2 inch peak-to-peak excursions.

c. Shock - 20g's, 20 milliseconds.

d. Humidity - 0-95% Relative humidity.

e. Altitude - From below sea level to 10,000 feet above sea level.

FM System

a. The DC to 0.8 MHz data signal is applied as a differential input to the voltage controlled oscillator (VCO).

b. The VCO produces a 1.4 MHz center frequency which can be varied ± 40% by the data signal.

c. The frequency modulated carrier is applied differentially to the record head. The VCO module contains a head driver circuit which furnishes sufficient power to produce saturation recording of the FM carrier.

d. A fiducial input signal may be used to interrupt the carrier for timing purposes.

e. The gain control varies the frequency deviation which will be achieved with a given input amplitude. With maximum gain, 0.5 volts input will produce 40% deviation of the carrier.

f. The symmetry balance adjustment provides a means of ensuring time base symmetry of the carrier to prevent the generation of spurious frequencies.

g. The center frequency adjustment is used to set the quiescent (zero volts in) frequency of the VCO as desired. The center frequency is adjustable from 840 KHz to 1960 KHz.

h. In terms of deviation percentage, the sensitivity will remain the same regardless of what center frequency is used. If the center frequency is set at the lower band edge, it will be possible to deviate the carrier frequency unidirectionally to the upper band edge. This represents a deviation of 133% and will require a proportional increase in input voltage, in this case, 1.66 volts.

i. The record current adjustment is used to optimize the head current so as to achieve saturation recording without exceeding the head current limitations.

Analog System

a. The Hi side of the data and fiducial inputs are connected to opposite ends of the differential input circuit of the 20-257 Direct Record Amplifier.

b. The 9 MHz bias signal is mixed with the data and fiducial signal and applied to the record head.

c. The gain adjustment varies the amplitude of both the data signal and the fiducial signal. This control should be used to establish the data signal at the normal or desired record level, and the fiducial amplitude should be adjusted external to the record system. The required fiducial input amplitude will depend upon how much attenuation must be applied to the data signal in order to obtain nominal record level.

d. The bias level adjustment varies only the amplitude of the 9 MHz bias signal, and is used to optimize the bias level.

Shock Mounting System: The aluminum instrument rack is supported in the vertical position by bellows shock absorbers and horizontally by two special air filled rubber tires. This shock mounting system is designed to reduce the dynamic loading on the recording instrumentation to 10g's at 10 Hz. The instrument rack is equipped with a set of wheels which can be brought into contact with the canister walls. The instrument rack is then rolled out on to a rack handling stand from which it is transferred to a special trailer for maintenance. The reverse procedure is used to assemble the rack and the canister.

WEBS Sensor Cables: The WEBS sensor cable assembly is the data link for all transmission of information between the instrument canister and the surface components. The sensor cable assembly is a 400 foot long cable designed to withstand a 1000 pounds per square inch pressure pulse and to be non-hosing (longitudinal water seepage) at 400 pounds per square inch static pressure. The sensor cable assembly consists of four major components. These components are the spar conductor cable, the catamaran conductor cable, the strength member, and the termination fittings.

The spar conductor cable consists of high frequency triaxial cables, high frequency twinaxial cables, low frequency coaxial cables, command/control conductors, and power conductors. The high frequency triaxial cables (Class I Type A) are similar to RG 213 in electrical characteristics. The impedance of the Class I Type A cables is 50± 1/2 ohms. Their attenuation is 4 db per 100 ft at 400 MHz. Their pulse reflection coefficient is specified as no more than 2.5 percent. The major differences between the Class I Type A cables and RG213 are: (1) Class I Type A is triaxial while RG213 is coaxial; (2) Class I Type A uses flat strip braid for improved attenuation characteristics and for improved non-hosing characteristics while RG 213 uses round wire braid; and (3) Class I Type A has a solid center conductor while RG213 has a stranded center conductor.

The high frequency twinaxial cables (Class I Type B) were specially developed for use on WEBS. For the first time a twinaxial cable has been built with both the differential and common mode impedances specified at convenient values for EMP measurements. The differential impedance is 100 ± 1 ohms. The common mode impedance is 50 ± 1/2 ohms. The differential attenuation is 3.5db per 100 ft at 300 MHz. The pulse reflection coefficient is specified as no more than 2.5 percent in the differential mode. The diameter of this cable is close to that of RG22 so that connectors for RG22 may be used until better connectors are developed. The braid on this cable is flat strip and the center conductors are solid. The center conductors have a one turn per foot lay for flexibility. The method of laying the center conductors is unique in the twinaxial cable field. The dielectric is extruded over the two center conductors with the conductors parallel. When the outer conductor is braided both the dielectric and center conductors are twisted to provide the lay. This method eliminates the center conductor spacing variations that are found in most twinaxial cables.

The low frequency coaxial cables (Class II Type A) are similar to RG58C/U. The major difference between Class II Type A cables and RG58C/U is the use of solid center conductors in the Class II Type A cables. The command/control conductors are number 20AWG solid copper wire. The power conductors are number 12AWG solid copper wire.

The spar conductor cable contains three Class I Type A cables, three Class I Type B cables, three Class II Type A cables, eight command/control conductors, and five power conductors.

The spar conductor cable is jacketed with a .100 inch (nominal) extruded polyurethane jacket. There is a braid of .008 inch stainless steel armor over the jacket and a second .100 inch (nominal) polyurethane jacket extruded over the braided armor. The outside diameter of the spar conductor cable is approximately 1.5 inches.

The catamaran conductor cable consists of two Class I Type A cables, seven Class I Type B cables, one Class II Type A cable, eleven Class II Type B cables, command/control conductors and power conductors. The Class II Type B cable is a 75 ohm coaxial cable similar to RG59/U. The major difference between Class II Type B Cable and RG59/U is the use of solid center conductors in the Class II Type B.

The catamaran conductor cable is jacketed in the same manner as the spar conductor cable. The outside diameter of the catamaran conductor cable is approximately 2 1/4 inches.

The strength member for the WEBS sensor cable has two segments. One segment connects the canister and the spar mast and the other segment connects the spar mast and the catamaran. The strength member segments are 1 x 43 torque balanced wire rope. This is the same type of wire rope that is used for the WEBS mooring. The strength member segments are jacketed in the same manner as the spar and catamaran conductor cables. The outside diameter of the jacketed strength member is 5/8 inch. Eye bolt terminations are swaged on each strength segment.

There are two types of termination fittings. The termination fitting for the catamaran is simply the strength member eye bolt shackled to a padeye on the end of the catamaran towing yoke. The conductors fan out underwater from the termination to their destinations. The terminations at the spar mast and the canister are essentially identical. Each fitting consists of a flange with tapered holes for conductor penetration, two molded boots, a housing for the external boot and U bolts for strength member termination. The flange is 1 1/4 inch hot rolled steel plate polished to a machine finish (RM64 or better) on its mating side. The conductors fan out for flange penetration in the external molded boot. The polyurethane molding compound fills the tapered portion of the conductor penetration holes so that as the pressure on the outside of the flange increases the tightness of the seal also increases. After passing through the flange the conductors are recabled and the penetration point is protected by the second polyurethane boot. The housing for the external boot is a 30 inch high by 18 inch diameter bell of 1/4 inch steel. There are access holes in the housing to allow wrenches to be inserted for attaching the termination assembly to its mating flange.

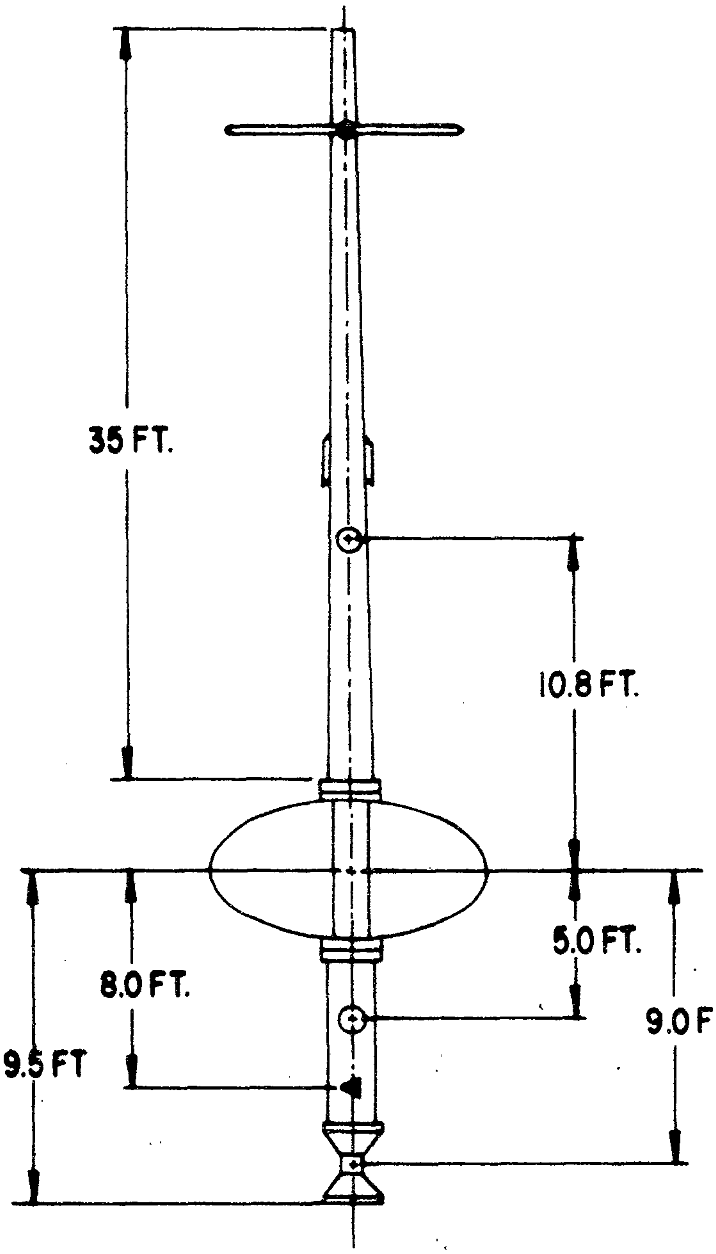
There is a 1 1/4 inch U bolt on the top of the housing for attachment of the canister to spar mast strength member. There is a 1/2 inch U bolt on the side of the spar mast termination housing for attachment of the spar to catamaran strength member. The eye bolts on the strength members are shackled to their U bolts.

The two conductor cables and the strength member are joined by a plastic welding technique that was recently developed for the WEBS cable assembly. The canister to spar mast segment of the WEBS cable assembly is 300 feet long measured from flange to flange. The spar mast to catamaran segment of the cable assembly is 100 feet long measured from eye bolt to eye bolt. The conductors extend ten feet beyond the canister termination flange, sixty feet beyond the spar termination flange and sixty feet beyond the catamaran eye bolt. The rated breaking strength of the WEBS cable assembly is in excess of 20,000 pounds. The polyurethane jacketing compound is abrasion, oil, acid, and ultraviolet resistant.

Spar Buoy: (Fig 2) The spar buoy consists of three components: the mast, the float and the base. The mast consists of two fiberglass sections which fit together to make a tapered cylinder 35 feet long. A ten foot yardarm is located five feet down from the top of the spar mast and is steadied by nylon line. The spar mast section is bolted onto an ellipsoidal buoyancy float. The float is foam filled fiberglass and is roughly 6 feet by 3 feet. This float is normally pulled down under the water 12 to 18 feet and supports the weight of the sensor cable. The base of the spar buoy is a seven foot long length of standard 10 inch pipe. This pipe bolts on the bottom of the float and houses the command telemetry transceiver. The sensor cable termination mates with a flange on the bottom of this pipe. The spar mast is designed to provide a sensor platform which is stable in the vertical axis. It also supports the instrumentation command and control telemetry antennas. These antennas are located at the top of the spar mast and are connected to the transceiver in the base of the spar by coaxial cables running down the inside of the spar mast. When the system is moored the spar mast is vertically stable with a roll and pitch of less than ± 5 degrees in calm sea conditions (3-5 foot waves).

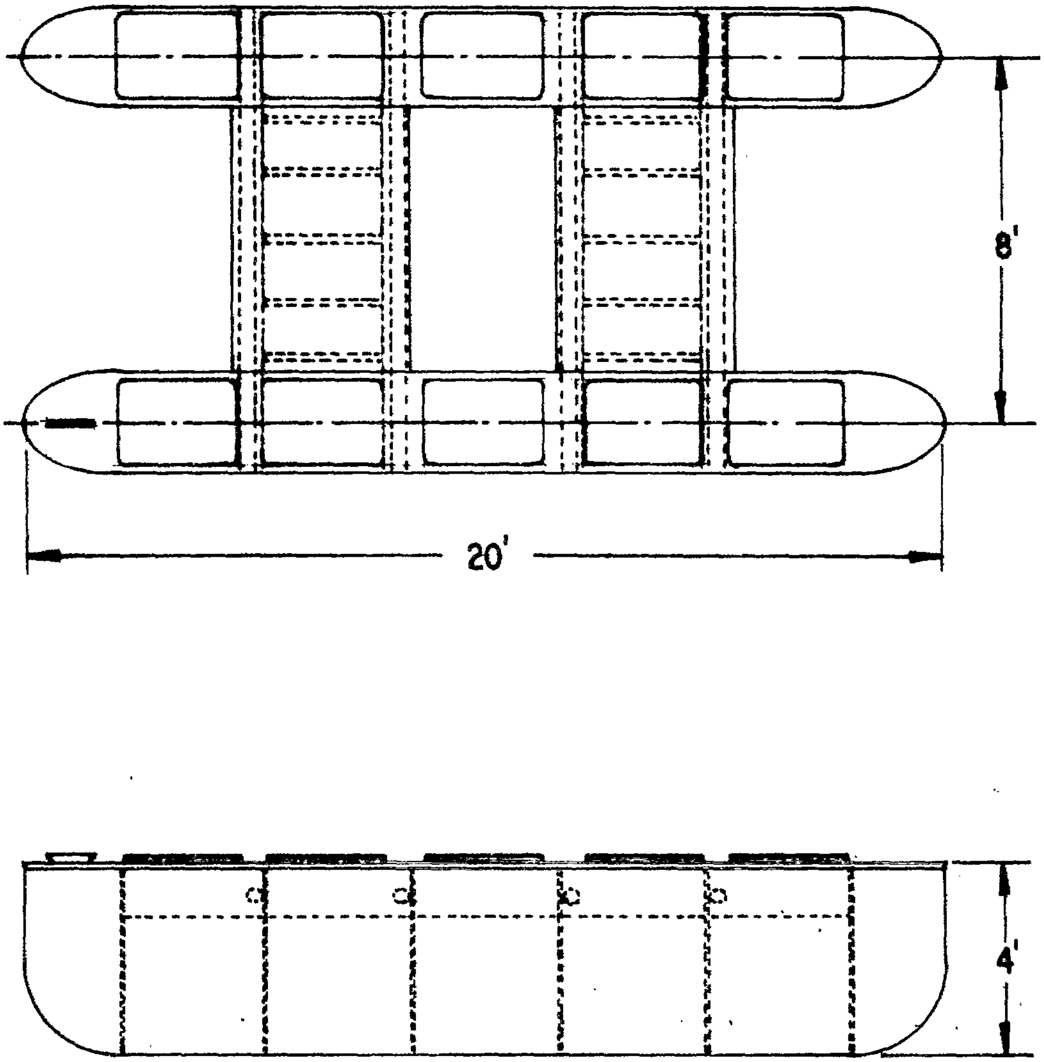
Catamaran: (Fig 3) The catamaran is a twin hulled float approximately 20 feet long and 10 feet wide. The hulls are joined by two deck pieces 6 feet by 3 feet. Each hull has five watertight compartments. The hulls are 4 feet deep and 2 feet wide. Hatches provide access to the watertight compartments. Two inch pipes are used as braces and fit between the hulls below the waterline. The forward pipe is fitted with a yoke to which the signal cable from the base of the spar buoy is tethered. The catamaran is constructed of plywood and fiberglass. The catamaran will follow the motions of the sea surface and will align itself with the wind and current.

Orientation System: The catamaran can be equipped with a sensor orientation system which will provide azimuthal control of directionally sensitive sensors to within three degrees of any given heading. The system is basically



SPAR BUOY

FIGURE 2



CATAMARAN
FIGURE 3

a gyro stabilized compass system similar to the compass systems used on most aircraft. The "compass repeaters" in the orientation system are four 22 inch diameter polyvinylchloride tables. The tables can be aligned to any heading through the use of a differential synchro in each repeater's servo loop. The gyro unit is the three axis data generator from the F5 autopilot system used on the F84F and F86D aircraft. The servo motors and other components of the repeater servo loop are also from the F5 autopilot system. The use of an autopilot instead of a simple gyro compass system provides catamaran attitude data for recording purposes. Thus far only one orientation system has been fabricated. The orientation system is presently being evaluated with respect to the various sensors that will be used with it.

III Summary

The Weapons Effects Buoy System is currently being used on underground nuclear tests. The major components of the system are being tested and modified to improve their performance. Future tests of the system will include an at sea exercise to determine the system's ability to record actual data after varying times at sea.