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# AQUATIC STUDIES PROCEDURES MANUAL

PHASE I

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DRAFT

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# I. INTRODUCTION

The Susitna River, Southcentral Alaska's major river system, drains into Cook Inlet near the City of Anchorage (Figure 1). The drainage encompasses an area of 19,400 square miles and extends north to Mt. Denali and east almost to the town of Glenallen. The mainstem river and its major tributaries are of glacial origin and carry a heavy silt load during ice-free months. Many of the smaller tributaries are perennially silt-free.

Construction of hydroelectric dams will affect portions of the fish and wildlife resources of the Susitna River Basin. The two dam system proposed would inundate in excess of 50,500 acres of an aquatic and terrestrial habitat upstream of Devil Canyon. Historically, the long and short term environmental impacts of hydroelectric dams have adversely altered the sport and commercial fisheries of affected drainages (Keller, 1980; Hagen et al., 1973). Regulation of the mainstem river will substantially alter the natural flow regime downstream. The transmission line corridor, substations, road corridor, and construction pad sites will also impact aquatic and terrestrial communities and their habitat.

The proposed hydroelectric development necessitates gaining a thorough knowledge of its chemical, physical and biological parameters prior to final dam design approval and construction authorization. Preliminary environmental assessments of the project noted deficiencies in the state of knowledge of the Susitna drainage fisheries (FWS-ADF&G, 1978).

To insure adequate information is available to determine the impacts of the proposed hydroelectric project and to design proper mitigative strategies, a two-phase data collection program has been developed. This manual addresses Phase I (July 1, 1980-December 31, 1981) procedures to be conducted within those study areas outlined in Figure 2.

The following objectives are to be addressed in the Phase I field fisheries studies.

<u>OBJECTIVE 1.</u> Determine the seasonal distribution and relative abundance of adult anadromous fish populations produced within the study area.

Task 1.1 Enumerate and characterize the runs of the adult anadromous fish.

Task 1.2 Determine the timing and nature of migration, milling and spawning activities.

Task 1.3 Identify spawning locations within the study area (i.e., subreaches of the mainstem sloughs and side channels, tributary confluences, lakes and ponds, etc.) and estimate their comparative importance.

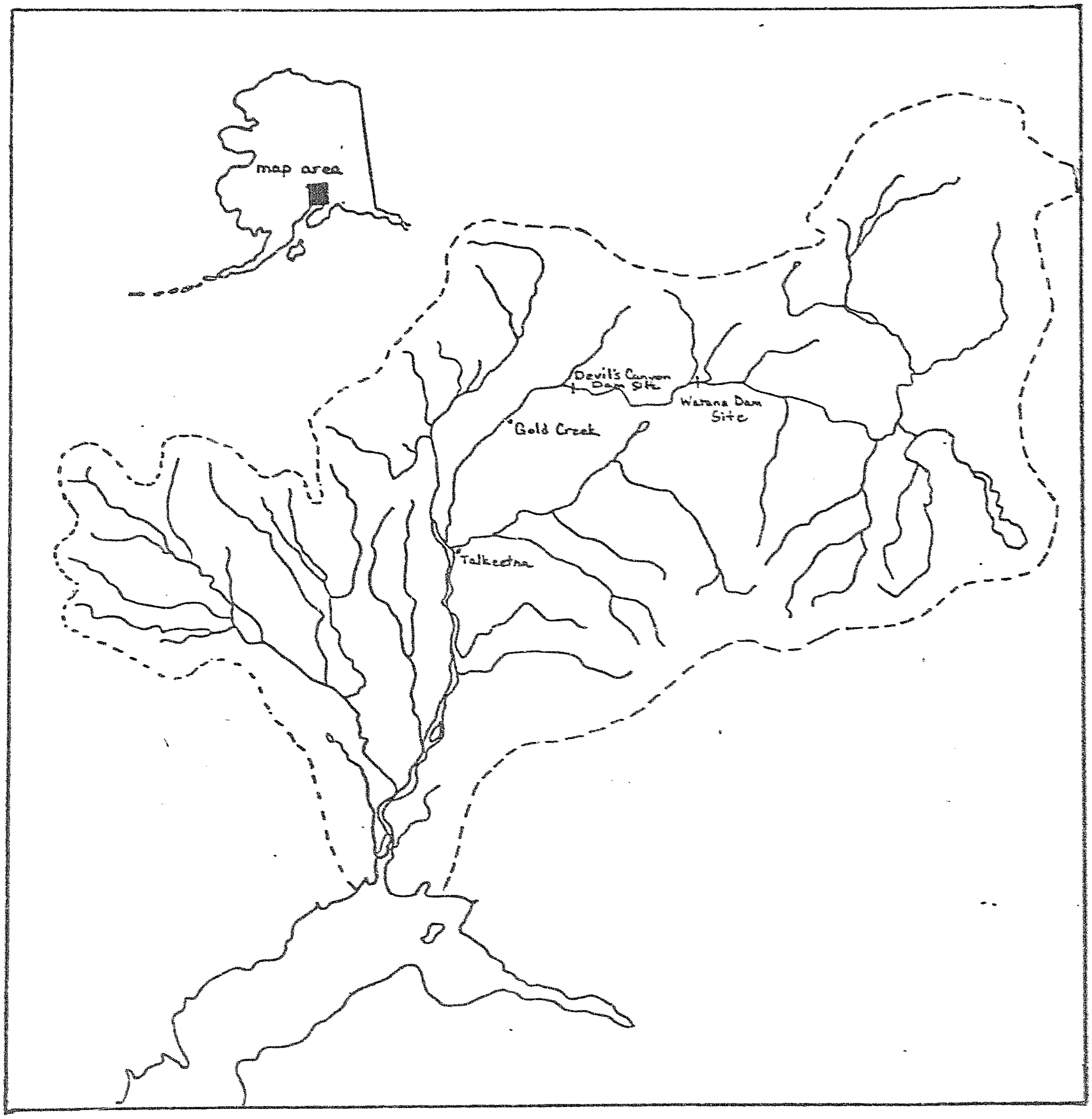



Figure 1. Susitna River Basin (approximate scale 1:2,200,000)

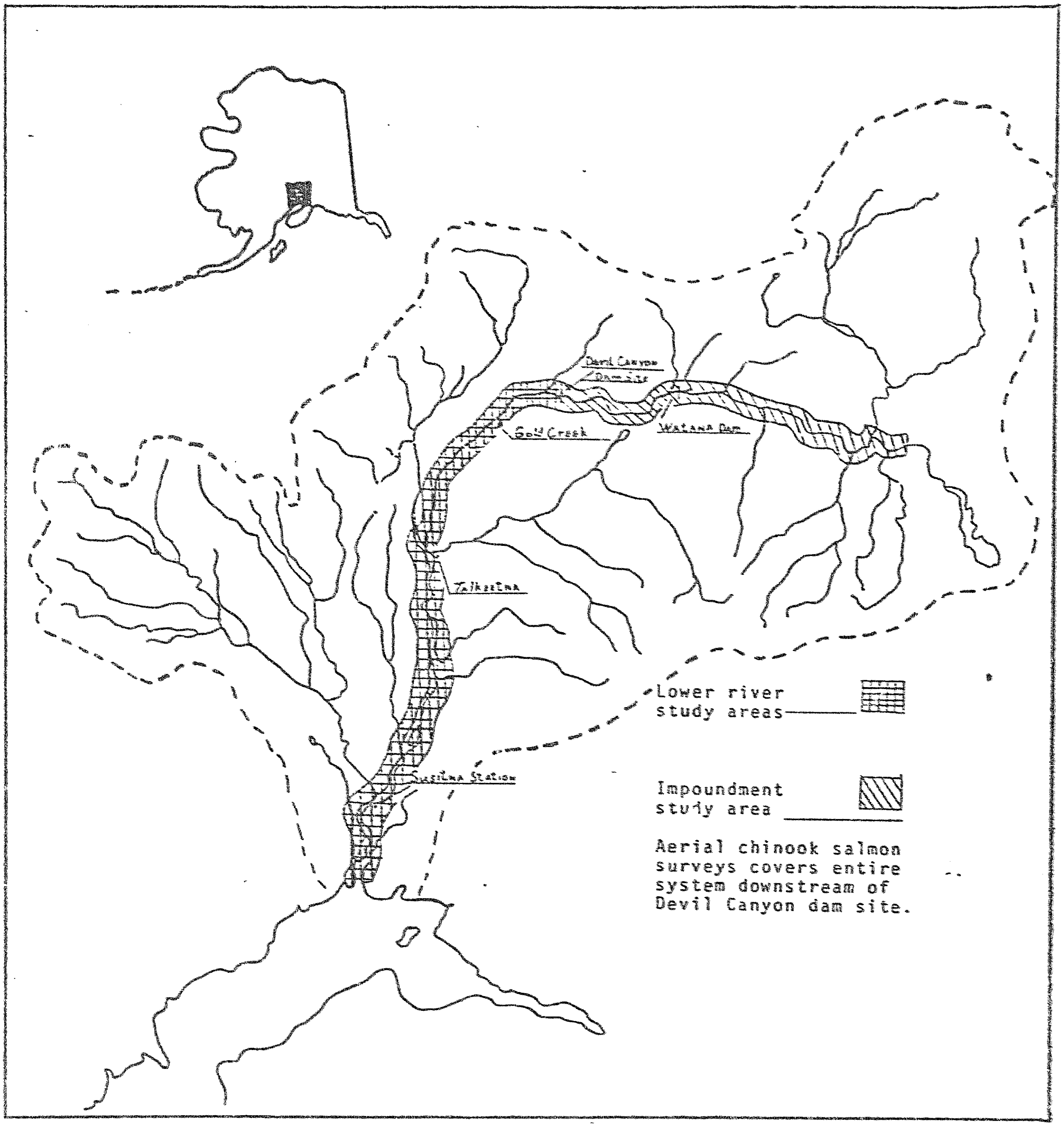



Figure 2. Phase I study areas, Susitna River basin.

Task 1.4 Identify and determine methods, means and the feasibility of estimating the Susitna Rivers contribution to the Cook Inlet commercial fishery.

OBJECTIVE 2. Determine the seasonal distribution and relative abundance of selected resident and juvenile anadromous fish populations within the study area.

Task 2.1 Identify spawning and rearing locations of the resident species and the rearing locations of juvenile anadromous species to estimate their comparative importance.

Task 2.2 Record descriptive information on captured fish (species, location of capture site, age class), and discuss seasonal migration patterns of selected adult resident species.

OBJECTIVE 3. Characterize the seasonal habitat requirements of selected anadromous and resident species within the study area.

Task 3.1 Through direct field observations and measurements identify the physical and chemical conditions which appear to be influencing the suitability of various habitat types for the species and life history stages of interest.

Task 3.2 Through direct field observations and measurements characterize the physical and chemical parameters of the various habitat types found in the study area.

To meet the above objectives, the study program is separated into three sections; Adult Anadromous Fisheries, Resident and Juvenile Anadromous Fisheries, and Aquatic Habitat and Instream Flow Studies. The operations of the Anadromous Adult and Resident and Juvenile Anadromous field investigations will be interrelated to and conducted in cooperation with the Aquatic Habitat and Instream Flow studies. The specific procedures for completion of each section of the program are described in this manual.

## II. TECHNICAL PROCEDURES

### A. ADULT ANADROMOUS FISHERIES STUDIES

#### Study Description and Rationale

Three (3) principal methods will be used to determine the distribution, abundance, timing and migrational activity of adult anadromous salmon in the study area (Tasks 1.1 and 1.2). They are: (1) deployment of side scan sonar (SSS) counters, (2) tag and recapture with fishwheels and (3) aerial surveys. The SSS counters are expected to accurately monitor pink and sockeye salmon escapement and be reasonably effective on the other species with the exception of chinook salmon because returning adults characteristically migrate upstream in mid-channel beyond the operational limits of SSS counters. Tag and recapture data using fishwheels should effectively establish the timing and escapement levels on coho, sockeye, chum and pink salmon. Chinook salmon escapement and distribution will be provided through an aerial survey program covering all known and suspected spawning grounds of this species.

Various types of sampling gear will be used on the Susitna River mainstem and subreaches (sloughs, side channels and tributary confluences) along with ground and waterbourne surveys to assist in determining the extent of salmon spawning activity (Task 1.3). Radio tagging will also be conducted to gather specific information on the migrational behavior, timing and spawning locations of chinook, coho and chum salmon in the upper Susitna River, principally between Talkeetna and Devil Canyon (Tasks 1.2 and 1.3).

Lastly, an evaluation will be made of the various means and methods available for assessing the Susitna River contribution to the Cook Inlet commercial salmon fishery. The emphasis will be directed toward formulating a plan which can be implemented in Phase II that provides stock identification (Task 1.4).

#### Sonar Counters

Operation Dates

A training class on sonar operation will be held from 1 May to 30 May; field activities for sonar enumeration will begin and terminate on the following dates:

| | |
|---|---|
| Susitna Station | 15 June to 7 September |
| Yentna Sonar | 15 June to 7 September |
| Sunshine Sonar | 15 June to 15 September |
| Talkeetna Sonar | 15 June to 15 September |

Methods

Two Bendix side scanning sonars (SSS) will be deployed at each of the four (4) sonar sites (Figure VI-1A). This equipment will be operated by trained ADF&G personnel. A training program for two (2) members of each crew will be conducted on the Kenai River by ADF&G/Commercial Fisheries Division biologists Ken Tarbox and Bruce King; both have several years of field experience each with SSS counters.

Procedures for deployment of the substrate and equipment operation are described in the 1980 Side Sonar Counter Installation and Operation Manual, Bendix Corporation (Appendix I).

Counts of salmon crossing the substrate will be recorded on printer tape each hour of the day. The paper printouts will be removed from the counters and the counts tabulated on a separate form each day. Counter accuracy will be monitored four (4) times daily for 3.5 minutes by hand tallying fish related echos displayed on an oscilloscope (Appendix II). The ratio of visual counts to SSS counts will be used to derive a calibration factor. This calibration factor will then be used to adjust the daily raw sonar counts (III Data Procedures).

A fishwheel will be installed below each SSS counter to provide escapement samples and relative abundance data by species for apportioning sonar counts. The fishwheel will be placed so that its presence does not conflict with or bias the sonar counters performance. All fishwheel captured salmon will be enumerated by species and sampled for the data required below (III Data Procedures).

Sockeye Salmon: Forty (40) sockeye salmon will be sampled daily for age, sex, and length.

Chinook Salmon: Age, sex and length samples will be obtained daily from all captured chinook salmon.

Chum Salmon: Twenty five (25) age, sex, and length samples will be obtained daily from all captured chum salmon.

Coho Salmon: Twenty five (25) age, sex and length samples will be collected daily from fishwheel captured coho salmon.

Pink Salmon: Forty (40) length and sex samples will be collected daily from fishwheel captured pink salmon.

The number of fish sampled for age, sex and length information is adequate to define escapement characteristics and variability based on previous findings by the ADF&G Stock Separation Office. Age samples will not be collected from pink salmon due to there being only one (1) age class involved in the adult return.

Sonar counts and attendant data will be forwarded to the Anchorage office every two (2) weeks.

Tag/Recapture

Operation Dates

Field operations for tag/recapture projects will start and end on the following dates:

| | |
|---|---|
| Sunshine Tag/Recapture | 15 June to 15 September |
| Talkeetna Tag/Recapture | 15 June to 15 September |
| Curry Tag/Recapture | 15 June to 21 September |

Methods

Two (2) fishwheels will be deployed off each bank of the Susitna River at both the Sunshine and Talkeetna sites (Figure VI-1A). Two (2) fishwheels, one on each bank, will be operated at the Curry site. All fishwheels will be operated continuously, 24 hours per day. Fishwheel design and operation is described in Appendix III.

Each fishwheel will be checked five (5) or more times daily to insure minimal holding time and reduce stress. All adult salmon with the exception of chinook salmon will be tagged and released. Chinook salmon escapement will be acertained by aerial survey of all known and suspected spawning areas. Tagging method is outlined in Appendix IV. Floy FT-4 spaghetti tags color coded International Orange and consecutively numbered, will be used exclusively at the Sunshine site. Yellow color coded FT-4 spaghetti tags will be used to mark adult salmon at the Talkeetna site; they will also be consecutively numbered. The Curry site will use one (1) inch diameter Peterson disc tags, similarly consecutively numbered.

Fish recaptured at upstream tagging locations will be immediately released following identification and recording of the tag type, color and number (III Data Procedures).

The tagging crew at the Curry site will also collect age, length and sex data for each species as follows:

Sockeye Salmon: Forty (40) sockeye salmon will be sampled daily for age, sex and length.

Chinook Salmon: Age, sex, and length samples will be obtained daily from all captured chinook salmon.

Chum Salmon: Twenty five (25) age, sex and length samples will be collected daily from captured chum salmon.

Coho Salmon: Twenty five (25) age, sex and length samples will be collected daily from fishwheel captured coho salmon.

Pink Salmon: Forty (40) length and sex samples will be collected daily from fishwheel captured pink salmon.

The number of fish sampled for age, sex and length information is adequate to define escapement characteristics and variability based on previous findings by the ADF&G Stock Separation Office. Age samples will not be collected from pink salmon due to there being only one (1) age class involved in the adult return.

Tag and recapture data will be forwarded to the Anchorage office every two (2) weeks.

Survey

Operation Dates and Survey Reach

Field operations for identifying Susitna River mainstem and slough spawning areas will begin and end on the following dates:

| | |
|---|---|
| Susitna Station Survey | 15 July to 1 October |
| Sunshine Survey | 15 July to 7 October |
| Gold Creek Survey | 15 July to 15 October |

The geographic area of responsibility for each crew is:

Susitna Station Survey - Estuary to Kashwitna River
Sunshine Survey - Kashwitna River to Chase
Gold Creek Survey - Chase to Devil Canyon

Mainstem and slough survey will be performed weekly. The Sunshine and Gold Creek crews will perform the tag and recapture surveys as scheduled below:

| CREW | SURVEY LOCATION | SURVEY PERIOD | SURVEY FREQUENCY |
|---|---|---|---|
| Sunshine | All tributary streams between Chulitna River and Chase | 25 July to 10 Oct. | Weekly |
| | Birch Creek | 1 Aug. to 15 Aug. and<br>7 Sept. to 21 Sept. | Weekly<br>Weekly |
| | Troublesome Cr. | 7 Aug. to 15 Aug. and<br>7 Sept. to 21 Sept. | Weekly<br>Weekly |
| | Byers Creek | 7 Aug. to 15 Aug. | Weekly |
| | Byers Lake | 1 Sept. to 15 Sept. | Weekly |
| | Question Creek | 1 Sept. to 21 Sept. | Weekly |
| | Swan Lake Trib. | 7 Sept. to 19 Sept. | Once |

| CREW | SURVEY LOCATION | PERIOD | FREQUENCY |
| --- | --- | --- | --- |
| | Horseshoe Creek | 7 Sept. to 21 Sept. | Weekly |
| | Clear Creek (lower 2 miles) | 7 Aug. to 15 Aug. | Once |
| Gold Creek | All Tributary streams between Chase and Devil Canyon with exception of Portage Creek and Indian River which, because of their length, will be surveyed only for the first one (1) quarter mile upstream from the mouth. | 25 July to 1 Oct. | Weekly |

From 25 July to 15 September, the Gold Creek crew will also be responsible for fishing gill nets at various locations on the Susitna River between Devil Canyon and a point approximately 1/2 mile above Portage Creek once every five (5) days for four (4) hours. Collections will be made in a manner as uniform and unbiased as possible to assure that the study area is satisfactorily sampled.

Chinook salmon enumeration surveys of mainstem and tributary systems will be conducted from July 15 through August 15, 1981.

All sampling periods and survey frequencies area based upon the results and experiences of previous studies conducted in the Susitna River basin by ADF&G.

Methods

Mainstem Surveys

The following gear will be used to determine the presence of mainstem spawning:

1. Drift gill nets
2. Electroshockers
3. Echo recorders
4. Egg deposition pump

Each crew will have assigned a 20 foot river boat powered by a 75 hp jet outboard.

Drift gill nets will be fished by extending the net out perpendicular to the river channel, with the outside end of the float line attached to a buoy and the other fixed to the boat. The boat will drift under just enough power to keep the net reasonably straight and perpendicular to the current. Mainstem areas fished by this method should be substantially free of surface and subsurface debris and sufficiently shallow enough to allow the net to reach within a foot (or less) of the bottom. Catch data will be recorded as outlined in the drift net form (III Data Procedures). Salmon caught by drift netting will not be assumed spawning at the catch location unless all of the following criteria are met:

1. Fish exhibits spawning maturation colors and morphology.
2. Fish expells eggs or milt when slight pressure is exerted on the abdomen.
3. Fish is in vigorous condition, with 25 percent or more of the eggs or milt remaining in the body cavity.
4. An additional drift produces fish meeting criteria 1 through 3 above.

Each crew will have an echo recorder (depth finder) available which will be used on the Susitna River mainstem in those areas where water depth precludes use of a drift gill net. Method of operating the echo recorder will be in accordance with manufacturer's guidelines except that the transducer beam will be directed horizontially across the river channel instead of vertically. Suspected fish targets will be verified at first opportunity with electroshocking equipment or any other methods which based on site conditions appears feasible.

Two (2) electroshocking boom units will be available for use between the three (3) crews. Operating procedures are outlined in Appendix VI. These units will be worked whenever feasible on the Susitna River mainstem. The same criteria outlined under drift gill netting will be used to ascertain whether captured fish are spawning at the catch location.

Where water depth allows, suspected mainstem spawning areas will be sampled for egg deposition. A standard backpack water pump and two (2) circular standing screen cod nets 18 inches in diameter will be used to sample the river bed. Equipment operating procedures will be demonstrated in the field. Results will be recorded in the appropriate sampling form (III Data Procedures).

Set gill nets will be deployed by the Gold Creek crew in slack water areas and eddies on Susitna River mainstem between Devil Canyon and a point approximately 1/2 mile upstream of Portage Creek. Deploying a gill net is achieved by tying one (1) end of the float line to the shore and "playing out" the net from the side or bow of the boat and then releasing the end of the net with an anchor and buoy attached to the offshore end of the lead line and float line respectively. Properly positioned, the net should extend offshore in a straight line or with a slight downstream arc.

Each survey crew will report the location of suspected mainstem, slough and tributary spawning areas twice weekly to the Aquatic Habitat (AH) crew assigned to that area. This information will be transferred to the AH crew on duplicate sampling forms (III Data Procedures). Each Adult Anadromous (AA) crew will also perform those co-operative duties discussed in the AH technical procedures section.

Slough and Tributary Surveys

Sloughs (clear water) and tributaries listed in the preceeding section will be surveyed in their entirity except as indicated according to the schedule. Surveys will be conducted on foot by two (2) crew members; one counting live fish and one counting carcasses. Observers will wear polarized glasses and use tally counters when enumerating fish. Survey information will be recorded on the appropriate form along with the number of tagged fish, catagorized by tag type and color (III Data Procedures).

Survey data will be forwarded to the Anchorage office every two (2) weeks.

Chinook Salmon Aerial Surveys

Aerial surveys to enumerate individual chinook salmon will be conducted via helicopter over all known and suspected spawning grounds. Data reported will reflect the total number of fish observed.

Eulachon Survey

Eulachon, are known to utilize lower portions of the river for spawning. A survey addressing Eulachon is planned for Phase II operations in the spring of 1982 and will not be discussed further here.

<u>Stock Assessment</u>

Operation Dates

Program will begin and end on the following dates:

1 July to 1 December

Methods

A Fisheries Biologist II will perform a comprehensive literature search on salmon stock identification methodology and procedures. All available fisheries data on each species and stock north of Anchor Point in Cook Inlet focusing on age, size, run timing and abundance will also be compiled. Data sources will include but not be limited to ADF&G Cook Inlet Data Reports, Management and Catch Statistic Reports, Federal Aid Reports, USFWS & NMFS publications, and unpublished data from ADF&G staff and other state, federal and private fisheries scientists.

After compiling available stock information and evaluating proven and suggested stock separation methods, an analysis will be made of the suitability of each stock separation technique in determining the contribution of Susitna River fish to the Cook Inlet fishery. The results will be presented in a final report along with specific recommendations on implementing a stock separation program for Susitna River fish.

Radio Tagging

Operation Dates

A training class will be held from 15 May to 1 June on the Kenai River for personnel assigned to the radio tagging program.

Field activities for radio tagging and tracking will begin on the Susitna River and terminate on the following dates:

15 June to 1 October

Methods

The training class will be conducted under the direction of Carl Burger. All personnel assigned to the radio tagging program will be trained in the use of proven techniques to sample, tag and radio track salmon. Carl Burger is a biologist with the U.S. Fish and Wildlife Service and has considerable radio tagging expertise.

Following training, project personnel will radio tag approximately 40 adult salmon. The salmon will be collected at the Talkeetna fishwheel site which is far enough upstream of the Talkeetna/Chulitna/Susitna River confluence to insure that radio-tagged individuals are actually utilizing the drainage upstream of this point.

| SPECIES | NUMBER RADIO TAGGED | TAGGING PERIOD |
|---|---|---|
| Chinook | 15 | 15 June-15 July |
| Chum | 13 | 1 August-7 September |
| Coho | 12 | 15 July-1 September |

All tags used will be low frequency (40 MHz) and will have a life expectancy of 90 days or more, with a reception distance of not less than one (1) mile.

The fish will be selected from fishwheel captures at the Talkeetna tag/recapture site. There will be no attempt to bias selection other than no fish will be tagged with a transmitter that has been tagged previously with either Floy or Peterson disc tag or is lethargic or shows any external injury. Once a fish has been selected it will be transferred to a water tight box containing a fish anesthetic to subdue the specimen. The fish will be ready to tag within about two (2) minutes.

The cigar-shaped radio transmitter to be used is next tested for signal reception in water. Thence, it is coated with water soluble glycerin, and with the help of plexiglass tubes, is slid through the mouth and esophagus and into the stomach. Prior to release of the fish, the transmitter is tested again. The salmon is gently transferred to the river near shore, where it is held until consciousness is regained and the fish can forcefully swim away. Preliminary tracking studies will commence from a boat.

When several fish have been tagged and released, periodic boat trips and flights will commence to document their new locations. In this study, boat tracking will occur at least twice weekly. At least two (2) tracking flights will also be made per week (weather permitting), with fixed wing aircraft and/or helicopters. Both manual and scanning radio receivers will be used. From the boats, fish will be pinpointed to 20 ± feet of their actual locations.

Data will be recorded on the appropriate forms (III Data Procedures) and will be forwarded to the Anchorage office every two (2) weeks.

## B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

### Study Descriptions and Rationale

Phase I of Resident and Juvenile Anadromous (RJ) field operations will extend over one summer and two partial winter seasons. The following discussions outline seasonal work plans to be implemented.

### Summer Field Operations

Summer field operations will be conducted from May through October utilizing riverboats, rafts, fixed-wing aircraft, helicopters and pick-up trucks as the primary means of transportation. A total of four riverboats, crewed by Resident and Juvenile (RJ) and Aquatic Habitat and Instream Flow (AH) biologists, will operate on the Susitna River from the Estuary to Devil Canyon.

The riverboat crews will be based at the Yentna, Sunshine and Talkeetna Adult Anadromous (AA) Studies fishwheel/sonar camps and at the Gold Creek RJ Camp. Basing the boats at these locations will provide the necessary security and logistical support required for project implementation. Each riverboat will be staffed by one to three RJ biologists accompanied by one AH biologist as indicated in Figure 2. The responsibilities assigned to the four RJ riverboat biologist crews will include:

Systematic sampling of resident and juvenile anadromous populations using established techniques including gillnets, minnow traps, adult traps, hook and line, seines and electrofishing.

Design an effective downstream migrant trap to be deployed during Phase II.

Tag and release adult resident .ish and attempt recapture.

Conduct informal interviews of sport fishermen between Talkeetna and the Tyone River and record the following information:

Date and location of catch.

Species, number of fish and number of hours fished.

Method of access to the area.

Carry out those co-operative duties discussed in the AH procedures section.

A fifth crew consisting of three RJ biologists and one AH biologist will operate in the upper Susitna River Basin. This crew will enter the study area as soon as practicable after break up. They will be provided both fixed-wing and helicopter air support in addition to two (2) inflatable rafts for primary river transportation. These biologists will be mobile; moving their base of operation between habitat locations every one (1) to three (3) days. Emphasis will be placed primarily at tributary mouths, tributary reaches and natural lakes which would be inundated after impoundment.

## Winter Field Operations

Winter field operations were initiated in December 1980 along the Susitna River from the estuary to Devil Canyon. This period of the field program will continue to such time as ice-out (April) and begin the following November or December. Two to three crews as required to complete sampling objectives, are operating from base camps at Gold Creek and Montana Creek. Primary river travel is by snowmachine with support from fixed or rotary wing aircraft as necessary. Field camps and local lodging facilities are being used as appropriate.

Winter field crews are assigned as depicted in Figure 3.

Study Habitat Locations

Resident and Juvenile Anadromous Fisheries Studies sampling locations are depicted by number in Appendix VI, Figures 3-8. The general area of each habitat location is indicated by a corresponding number in the map code column of Table 1, Appendix VI. More specific locations follow each numerical group code. An explanation of the system of specifying geographic locations is included in Appendix VI.

Due to the inherent variability of a dynamic system such as the Susitna River, actual placement of gear can not be precisely defined. However, every effort has been made to insure that the reproducability necessary for the acquisition of meaningful data has been incorporated into the sampling site selection scheme.

Selection of individual sites at habitat locations is based on the following criteria. Each site will be sampled bi-weekly.

Tributary Stream Mouth Sites

Selection of sites at tributary stream mouths will include up to three (3) sites within the back-water pools commonly found at tributary/mainstem confluences. They are:

Mainstem river/tributary interface (a).

Approximately one half (1/2) the distance up the back-water pool (b).

Interface of back-water pool and tributary flow (c).

On many smaller tributaries only sites (a) or (a) and (c) will be sampled, while it is anticipated that on larger tributaries all three sites will be sampled. This will be necessary to insure that the sampling gear is not spaced so close to influence overall gear effectiveness.

Slough Sites

Selection of sampling sites at sloughs will include up to three (3) sites, depending on the size of the slough. They are:

Slough mouth.

Approximately one half (1/2) the distance up the slough.

Slough head.

Mainstem River Sites

Mainstem river sites will be selected in areas suitable for effective deployment of the various gear types. The actual location of mainstem sites will be marked on a prominent shoreline object (tree) by blazing and/or placing an aluminum plate with the site location and number inscribed thereon.

Upper Susitna River Tributary Sites

Preliminary ground reconnaissances of upper Susitna River tributaries which will be affected by the proposed impoundment were conducted by the U.S. Fish and Wildlife Service (1974) and the Alaska Department of Fish and Game (Williams, 1976). Based on these findings, eight major tributaries have been selected for in-depth studies of fish populations. These streams, with the mile which may be inundated, are listed in Table 1.

A typical tributary stream is shown in Figure 1 with sampling sites defined. Preliminary ground and aerial surveys have shown that prime fish habitat occurs primarily in the lower one mile of tributaries. A distance of one mile will be measured relative to the thalweg of the stream. Starting from the stream mouth, every other 500 foot section of stream will be sampled within this mile. Proceeding upstream, the sites will be numbered one (1) through five (5). A non-sampling area of 500 feet will follow each site sampled.

At site one (1), gear fished will initially include the following: Five (5) minnow traps, five (5) trot lines, one (1) set for burbot variable mesh gillnet, seines, electric shocker, and rod and reel. Gear fished at sites two (2) through five (5) will include: seine, electric shocker, and rod and reel.

Jumbled

Set gear will be fished for 48 hours. A maximum of one (1) hour will be spent fishing seines and/or shockers at sites two (2) through five (5) to yield a qualitative and quantitative indication of fish present. At site six (6) extending from the end of mile one (1) to the upper flood level any or all of the non-fixed gear will be fished to determine the presence or absence of fish.

Sample sites will be blazed and tagged to insure the same areas are sampled each time.

Why stop there – why not evaluate entire course of river – will need to know displacement habitat character I would think – on rivers having no migratory barriers of course

Selective Sampling of Fish Concentrations

To augment the tag and recapture portion of the project, areas of observed fish concentrations will be sampled without regard to sampling design or quantitative comparison. It is envisioned that this sampling selection method will insure that adequate numbers of resident species are tagged for study of migratory behavior.

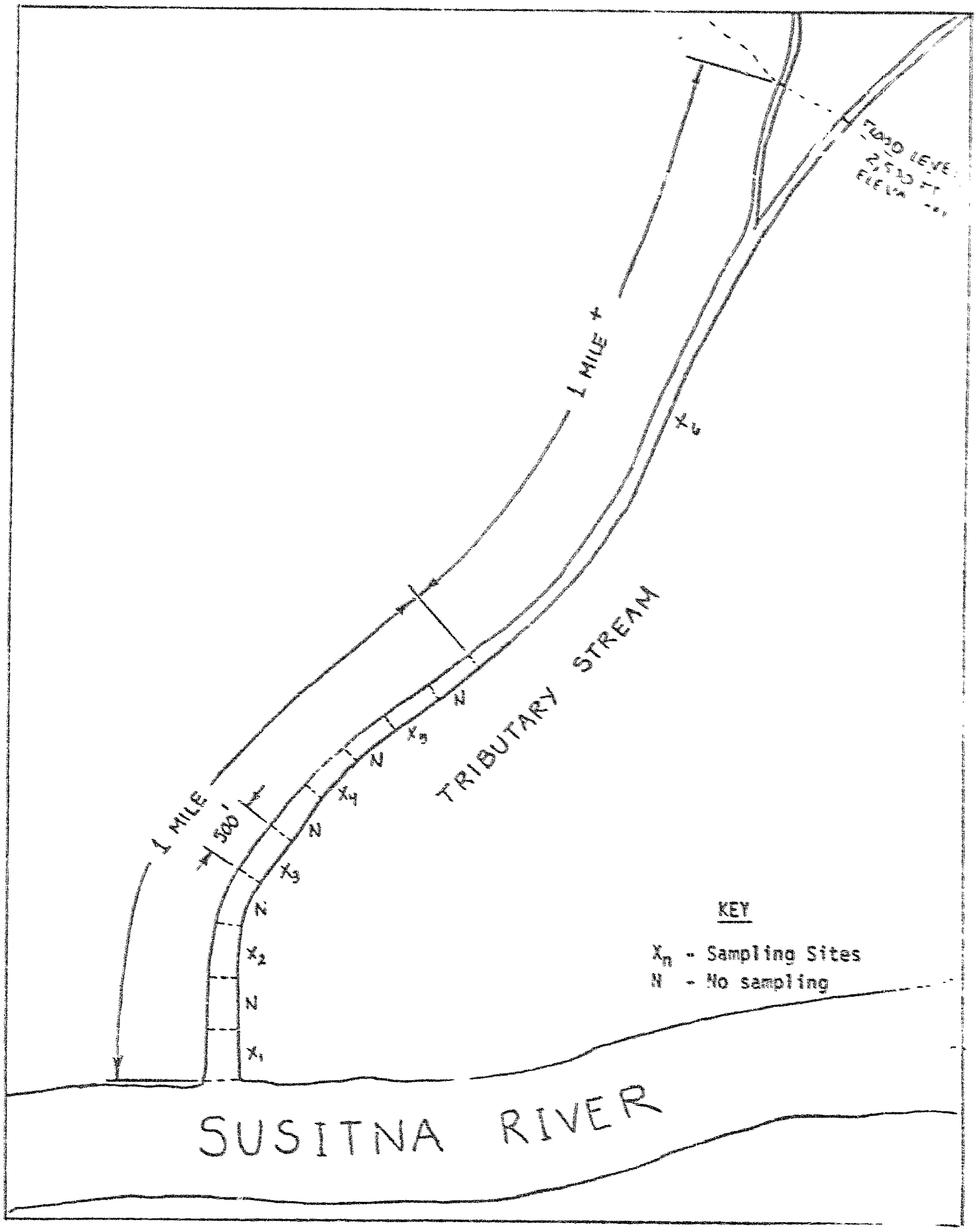



Figure 1. Sampling sites in a typical impoundment stream.

Table 1 . Sampling Streams Proposed Susitna Impoundment.

| Sample No. | Impoundment - Lower 2,050 |
|---|---|
| (1) | Fog 6.5 miles in impoundment. Talkeetna D4. Trib. to Rt (South) side of Susitna to Next site 5 miles. |
| 1/ (2) | Tsusena 4.5 miles in impoundment. Talkeetna D4. Left (North) side trib. to next site 4.5 miles. |
| | Impoundment - Upper 2,200 |
| 1/ (3) | Deadman 2.0 miles in impoundment. Talkeetna D3. Left (N) side trib. to next site 7.0 miles. |
| (4) | Watana 8 miles in impoundment. Talkeetna D3. L side trib. to next site 12 miles. |
| (5) | Kosina 4.0 miles in impoundment. Talkeetna D2. Rt. side trib. to next site 1.5 miles. |
| 1/ (6) | Jay 2.5 miles in impoundment. Talkeetna D2. Left side trib. to next site 21 miles. |
| (7) | Goose 1.5 miles in impoundment. Talkeetna C1. Rt side trib to next site 2.0 miles. |
| (8) | Oshetna 3.5 miles in impoundment. Talkeetna C1. Rt side trib. to next site 11 miles. |

1/ High falls in lower river likely preclude all upstream fish passage to upstream sampling areas.

## Study Methods

A variety of sampling techniques and equipment will be used to capture resident and juvenile fish. The transactions of the American Fisheries Society have through the years presented articles on the relative effectiveness of gear types. Discussions and illustrations of gear along with fishing techniques are presented by Lagler (1959) and illustrated by Sundstrom (1957). The use of the rod and reel in the capture of the various fish species is discussed at length by McClane (1965).

Gear types are divided according to season of intended use and mobility of deployment. Minnow traps, burbot sets, trot lines, jigging sets and under-ice gillnets are intended for winter use while minnow traps, trot lines, burbot sets and set gillnets are intended for summer use. Beach seining, hook and line angling, electro-shocking and drift gillnetting are primarily mobile techniques intended for summer use.

Detailed instructions on the assembly, use (setting) and checking of the various gear types used is in Appendix VII.

### Tagging of Resident Adult Species

Efforts will be made to capture up to 3,000 resident adult fish for tagging. Species to be tagged are Arctic grayling, burbot, rainbow trout, round whitefish, humpback whitefish, and suckers.

The Floy Tag and tagging system described in Figure IV-1 will be utilized in all tagging except for burbot. Tagging of burbot will be accomplished with a disk dangler type tag (Figure IV-2; Figure IV-3) using methodology described by Mauney, (1965) and Rounsefell, (1963). Abbreviated instructions for attaching the disk-dangler are in Appendix IV section B.

### Resident Adult Tag Recovery

Recovery of tags placed on adult resident fish will be accomplished by the following means:

The angling public will be requested to return recovered tags to Fish and Game or if captured fish is released, to report the tag number. The public will be informed of the tagging program by: (1) news releases to the media, and (2) posters placed in locations frequented by anglers.

Resident and Juvenile Anadromous field operations.

Radio Telemetry

An experimental telemetry program will be conducted with large resident species. The purpose of the program will be to determine if resident fish can be successfully tagged and monitored. Ten (10) tags will be employed with tagging commencing just prior to freeze-up. The movement of resident fish will be monitored to determine intra-system migration patterns. The limited data will provide a basis for determining feasibility of more extensive studies during Phase II.

Details of tagging procedures are discussed in the Adult Anadromous section.

### Level of Effort

Schematics of study personnel by primary area of responsibility are given in Figures 2 and 3 the full staff of RJ will include: 1 Fisheries Biologist III, 1 Fisheries Biologist II, and 10 Fisheries Biologist I's. Personnel of AH staff will participate in field operations.

## C. AQUATIC HABITAT AND INSTREAM FLOW STUDIES

### Study Description and Rationale

Phase I of the Aquatic Habitat and Instream Flow Study (AH) will be subdivided into two segments (Figure 4): 1) fishery habitat evaluations of the principal resident fish, and juvenile and adult anadromous salmon sampling areas to include point specific and general habitat evaluations; and 2) selected habitat evaluations which represent similar habitats in the study area in addition to those slated for fish sampling.

### Fishery Habitat Evaluations

Fishery habitat evaluation studies will be performed during the winter and summer field seasons and are subdivided into point specific and general habitat evaluations (Figure 5).

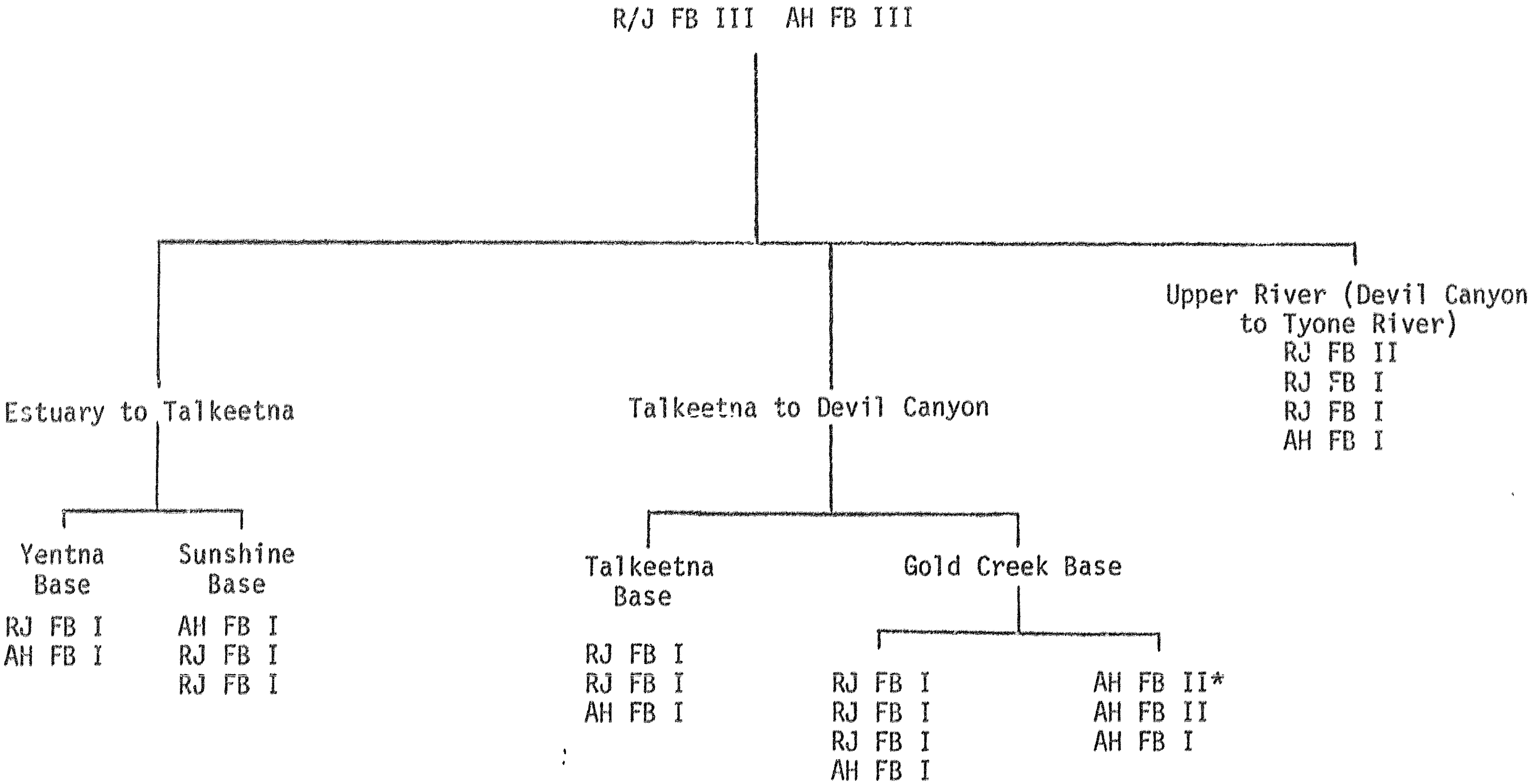
Point Specific Evaluation

Velocity, depth, and substrate data will be collected at the gear placement sites (gps) ~~to~~ characterize the range of streamflow dependent characteristics which appear to be influencing the suitability of various habitat types for the species and life stages of interest. Velocity, depth, and substrate data will also be recorded at points where fish are observed. These data will be collected according to the AA ground survey and RJ sampling schedules.

RESIDENT AND JUVENILE ANADROMOUS (RJ) AND AQUATIC HABITAT AND INSTREAM FLOW (AH) STUDY
PERSONNEL DEPLOYMENT - ICE FREE MONTHS

Figure 2.

RESIDENT/JUVENILE - AQUATIC HABITAT
PROJECT LEADERS




*Selected Habitat Evaluation Study Crew.

RESIDENT AND JUVENILE ANADROMOUS (RJ) AND AQUATIC HABITAT AND INSTREAM FLOW (AH) STUDY

PERSONNEL DEPLOYMENT - ICE COVERED MONTHS

Figure 3.

RESIDENT/JUVENILE - AQUATIC HABITAT
PROJECT LEADERS

FB III FB III

RJ FB II

Estuary to Talkeetna
Montana Creek Base

RJ FB I
RJ FB I
AH FB I

Talkeetna to Devil's Canyon

Talkeetna Base

RJ FB I
RJ FB I
AH FB I

Gold Creek Base

RJ FB I
RJ FB I
AH FB I

Upper River

Personnel will include project leaders and FB I's shifted as required

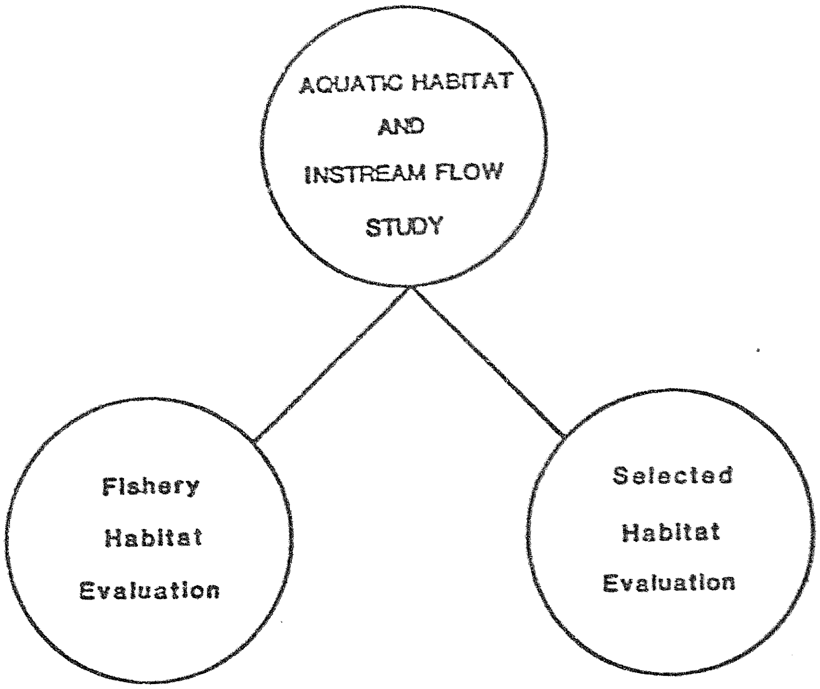



Figure 4. Aquatic Habitat and Instream Flow Study Program Components.

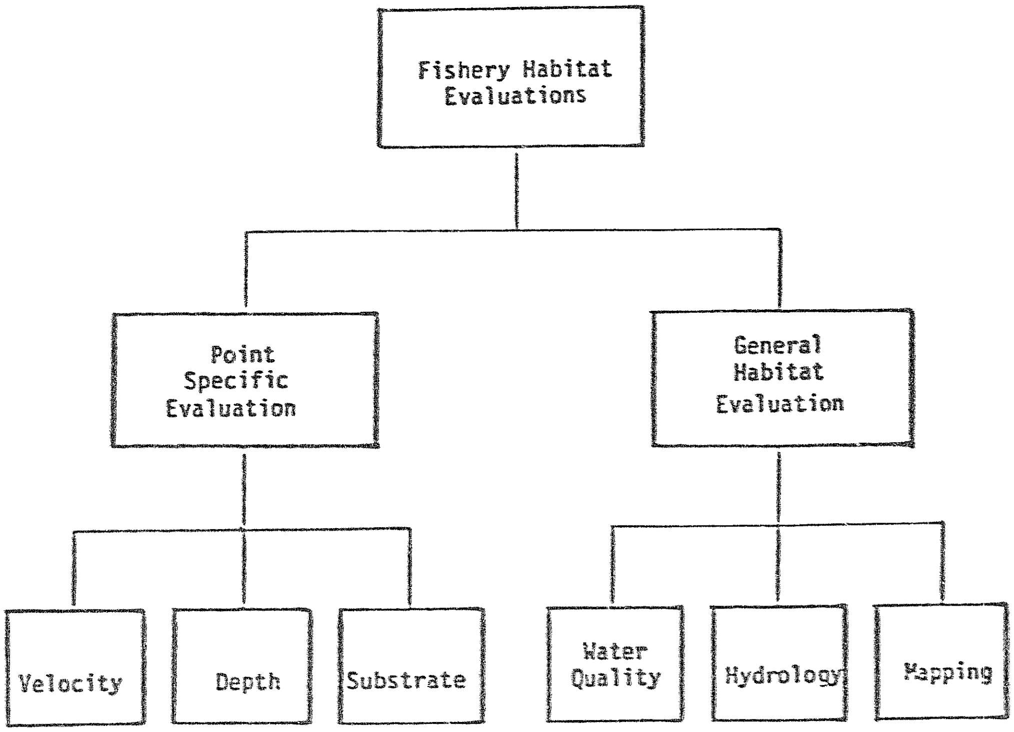



Figure 5. Fishery Habitat Evaluation Components.

General Habitat Evaluation

General habitat evaluations will provide the necessary data to describe and map the overall habitat characteristics of each RJ and AA study site. These data will be collected in the study area below Devil Canyon on a twice per month basis with the exception of discharge. Discharge will be measured three times, once per seasonal period of low, medium, and high flows based on existing flow records. Data will be collected in the study area above Devil Canyon, according to the schedule detailed in the RJ section. Data collected will include the parameters listed in Table 2.

Table 2. General Habitat Evaluation Parameters.

| Water Quality | Hydrology | Mapping |
|---|---|---|
| temperature (air, water, and intra-gravel*) | velocity | photography |
| pH | stage* | substrate |
| dissolved oxygen | discharge* | cover |
| specific conductance | substrate | pools |
| turbidity | | riffles |
| | | dimensions (aerial and cross sectionals*) |
| | | gear placement sites |

*Note: these parameters will not be measured in the study area above Devil Canyon.

Selected Habitat Evaluation

Habitat locations which can be used to represent areas between Talkeetna and Devil Canyon that have comparable physical and chemical characteristics will be evaluated one time per seasonal low, medium, and high flows. These data will be used to determine how many miles or what percent of this section of the river has similar characteristics (Figure 6).

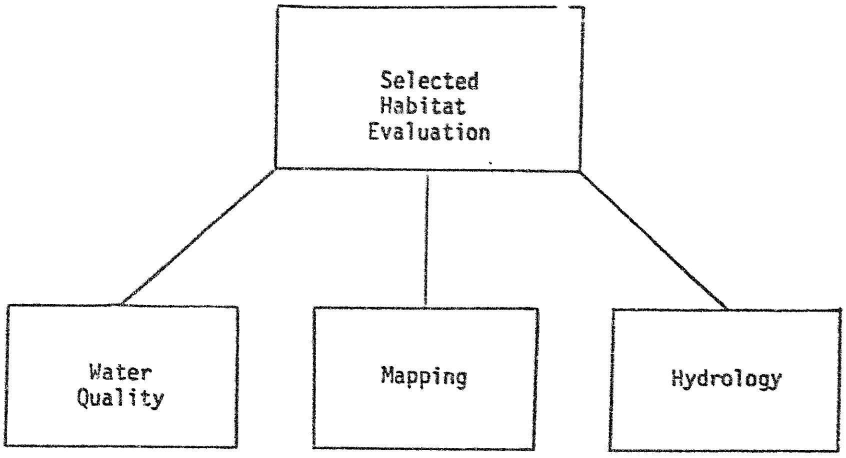



Figure 6. Selected Habitat Evaluation Components.

Data collected on maps and evaluations of these sites will include the parameters listed in Table 3.

Table 3. Selected Habitat Evaluation Parameters.

| Water Quality | Mapping | Hydrology |
|---|---|---|
| temperature (air, water, and intra-gravel) | photograph | velocity |
| pH | substrate | stage |
| dissolved oxygen | cover | discharge |
| specific conductance | channel dimensions | substrate |
| turbidity | pools | |
| | riffles | |
| | morphometry | |
| | gear placement sites | |

Additional water quality data will be jointly collected by AH and U.S. Geological Survey (USGS) personnel (Table 4).

Table 4. ADF&G/USGS Additional Water Quality Measurements.

## Nutrients And Organics

| | |
|---|---|
| $NO_2 + NO_3$ dissolved | $NH_4$ Organic N Total |
| $NH_4$ dissolved | Phosphorus Dissolved Total |
| $NH_4$ + Organic N dissolved | Phosphorus Total |
| $NO_2 + NO_3$ Total | Dissolved Organic Carbon |
| | Suspended Organic Carbon |

## Inorganic Constituents

| | |
|---|---|
| Silica | Chloride |
| Calcium Magnesium | Fluoride |
| Sodium | Sulfate |
| Potassium | Turbidity |
| | Dissolved Solids (residue at 18°C) |

## Minor Elements Dissolved and Total

| | |
|---|---|
| Arsenic | Iron |
| Barium | Lead |
| Cadium | Manganese |
| Chromium | Mercury |
| Cobalt | Nickel |
| Copper | Selenium |
| Zinc | |

## Field Parameters

Specific conductance, alkalinity, pH, temperature, dissolved oxygen.

## Sediment Analysis

Suspended sediment concentration and complete particle size analyzed.

## Study Site Locations

### Fishery Habitat Evaluation Sites

Point specific measurement sites data will be collected at each RJ gear placement sampling site location. Data will also be collected at the AA sonar and fishwheel sites and spawning sites which will be identified by the AA ground survey crew.

General habitat evaluation sites will be the same as those described in the AA and RJ Study Habitat Location Sections of this manual.

### Selected Habitat Evaluation Sites

Project personnel will review and analyze aerial photographs, topographic maps, and the water surface profile analysis of the study area between Talkeetna and Devil Canyon to identify five representative habitat locations. These locations will be selected in May, 1981. Additional sites will be added at a later date if they are determined to have value to the Phase I study.

## Methods

### Water Quality

Water Quality will be evaluated at the fishery habitat evaluation and selected habitat evaluation staff gage placement sites in the study area below Devil Canyon. Water quality data will be collected from the center of each index area in the study area above Devil Canyon. General habitat evaluation water quality data will be collected twice monthly below Devil Canyon and once per month above Devil Canyon. Selected habitat evaluation water quality data will be collected one time per seasonal period of low, medium, and high flows.

Dissolved oxygen (DO), pH, temperature, and specific conductance of surface waters will be measured in the field with a Hydrolab model 4041 multiparameter meter or a combination of instruments (YSI model 57 dissolved oxygen meter, a YSI model 33 S-C-T meter and a Digi-sense model 5985-40 pH meter). Intragravel water temperatures will be measured with a combination Digi-sense thermistor C-8522-10 and YSI 400 series semi-solid insertion probe system. The instruments will be operated following the manufacturers' instructions (Appendix 8) and when applicable calibrated according to the procedures established by the USGS in 1981 (USGS, 1981). Water samples for turbidity analysis will be collected at the same time the preceding water quality field parameters are measured. Samples will be collected in 250 ml plastic bottles filled two-thirds full and stored in a cool, dark location prior to analysis. Turbidity samples will be returned to Anchorage once per week for analysis on a Hach model 2100A turbidimeter. Air temperature will be measured at these sites with a thermometer shielded from the direct rays of the sun.

Surface water temperatures will be continuously monitored at staff gage placement sites by Model J-90 Ryan thermographs to identify thermal characteristics within the study area. These sites will include, but not be limited to the four (4) AA sonar and eight (8) fishwheel sites, and the mouths of major tributaries below Devil Canyon. Thermographs will be enclosed within minnow traps, weighted with stones and attached to the staff gage with wire. The traps and wire will be concealed to prevent tampering with by the public. Thermographs will be inspected twice monthly and the time, date, and temperature recorded on the chart to calibrate the instrument. The "O" ring seal will be cleaned and greased lightly with vaseline to prevent leakage before resealing the thermograph. Charts will be replaced every ninety days. In addition to surface water temperatures, intragravel temperatures will also be continuously monitored by thermographs buried in the gravel to characterize the relationships between surface and ground water temperatures.

not the same

Hydrology

Mean column, point velocity, and depth measurements will be measured with Marsh-McBirney, Price AA, or Pygmy flow meters and top-setting wading rods according to the respective manufacturers' instructions and procedures approved by the USGS (Smoot and Novak, 1977; Buchanan and Somers, 1973). Point velocities are measured at the same depth as the organism (i.e. fish) or object (i.e. minnow traps, spawning redd, etc.) of interest. The mean column velocity is the measurement of the average velocity in the same vertical plane as the preceding point velocity. In water with a depth of three feet or less, as measured with a top-setting wading rod, the mean column velocity will be measured at the one point located .6 of the total depth from the surface of the water. For depths greater than three feet, two velocities will be measured to compute the mean column velocity. They will be measured at .2 and .8 of the total depth from the surface of the water and averaged. If the channel bottom is soft, care must be taken to avoid submerging the foot of the wading rod or the sounding weight into the substrate material.

When using a Price AA or Pygmy flow meter, the velocity at the point of the current meter is determined by counting the number of signals ("clicks") per unit of time. Each meter is calibrated by the commercial supplier and an equation for the relationship between velocity and revolutions per unit time is derived. To facilitate field use, the equation is solved for a number of revolutions ("stop counts") and various time steps. A rating table (Figure 7) which shows the velocity for a given number of revolutions per time interval is provided with each meter. The real trick in using the rating table is to memorize the "stop counts". One should count clicks for at least 40 seconds, remembering to stop counting at one of the stop counts in the rating table. Failure to do so will negate the ability to obtain the velocity directly from the rating table. One cannot simply interpolate between stop count values given in the table; the rating curve equation must be solved.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

RATING TABLE FOR TYPE AA CURRENT METER

EQUATIONS: V=2.180R + .020 (2.200) 2.170R + .030 — Std Rating No. 1

| Time in Seconds | VELOCITY IN FEET PER SECOND | | | | | | | | | Time in Seconds |
|---|---|---|---|---|---|---|---|---|---|---|
| | Revolutions | | | | | | | | | |
| | 3 | 5 | 7 | 10 | 15 | 20 | 25 | 30 | 40 | |
| 40 | .183 | .292 | .401 | .565 | .837 | 1.11 | 1.38 | 1.65 | 2.20 | 40 |
| 41 | .180 | .286 | .392 | .552 | .818 | 1.08 | 1.35 | 1.62 | 2.15 | 41 |
| 42 | .176 | .280 | .383 | .539 | .799 | 1.06 | 1.32 | 1.58 | 2.10 | 42 |
| 43 | .172 | .273 | .375 | .527 | .780 | 1.03 | 1.29 | 1.54 | 2.05 | 43 |
| 44 | .169 | .268 | .367 | .515 | .763 | 1.01 | 1.26 | 1.51 | 2.00 | 44 |
| 45 | .165 | .262 | .359 | .504 | .747 | .989 | 1.23 | 1.47 | 1.96 | 45 |
| 46 | .162 | .257 | .352 | .494 | .731 | .968 | 1.20 | 1.44 | 1.92 | 46 |
| 47 | .159 | .252 | .345 | .484 | .716 | .948 | 1.18 | 1.41 | 1.88 | 47 |
| 48 | .156 | .247 | .338 | .474 | .701 | .928 | 1.16 | 1.38 | 1.84 | 48 |
| 49 | .153 | .242 | .331 | .465 | .687 | .910 | 1.13 | 1.35 | 1.80 | 49 |
| 50 | .151 | .238 | .325 | .456 | .674 | .892 | 1.11 | 1.33 | 1.76 | 50 |
| 51 | .148 | .234 | .319 | .447 | .661 | .875 | 1.09 | 1.30 | 1.73 | 51 |
| 52 | .146 | .230 | .313 | .439 | .649 | .858 | 1.07 | 1.28 | 1.70 | 52 |
| 53 | .143 | .226 | .308 | .431 | .637 | .843 | 1.05 | 1.25 | 1.67 | 53 |
| 54 | .141 | .222 | .303 | .424 | .625 | .827 | 1.03 | 1.23 | 1.63 | 54 |
| 55 | .139 | .218 | .297 | .416 | .615 | .813 | 1.01 | 1.21 | 1.61 | 55 |
| 56 | .137 | .215 | .292 | .409 | .604 | .799 | .993 | 1.19 | 1.58 | 56 |
| 57 | .135 | .211 | .288 | .402 | .594 | .785 | .976 | 1.17 | 1.55 | 57 |
| 58 | .133 | .208 | .283 | .396 | .584 | .772 | .960 | 1.15 | 1.52 | 58 |
| 59 | .131 | .205 | .279 | .389 | .574 | .759 | .944 | 1.13 | 1.50 | 59 |
| 60 | .129 | .202 | .274 | .383 | .565 | .747 | .928 | 1.11 | 1.47 | 60 |
| 61 | .127 | .199 | .270 | .377 | .556 | .735 | .913 | 1.09 | 1.45 | 61 |
| 62 | .125 | .196 | .266 | .372 | .547 | .723 | .899 | 1.07 | 1.43 | 62 |
| 63 | .124 | .193 | .262 | .366 | .539 | .712 | .885 | 1.06 | 1.40 | 63 |
| 64 | .122 | .190 | .258 | .361 | .531 | .701 | .872 | 1.04 | 1.38 | 64 |
| 65 | .121 | .188 | .255 | .355 | .523 | .691 | .858 | 1.03 | 1.36 | 65 |
| 66 | .119 | .185 | .251 | .350 | .515 | .681 | .846 | 1.01 | 1.34 | 66 |
| 67 | .118 | .183 | .248 | .345 | .508 | .671 | .833 | .996 | 1.32 | 67 |
| 68 | .116 | .180 | .244 | .341 | .501 | .661 | .821 | .982 | 1.30 | 68 |
| 69 | .115 | .178 | .241 | .336 | .494 | .652 | .810 | .968 | 1.28 | 69 |
| 70 | .113 | .176 | .238 | .331 | .487 | .643 | .799 | .954 | 1.27 | 70 |
| | 3 | 5 | 7 | 10 | 15 | 20 | 25 | 30 | 40 | |

UNITED STATES
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Water Resources Division

RATING TABLE FOR TYPE AA CURRENT METER

Actual Rating Limits: 0.25 to 8.0 feet per second — Date: 03-05-70

| Time in Seconds | VELOCITY IN FEET PER SECOND | | | | | | | | | Time in Seconds |
|---|---|---|---|---|---|---|---|---|---|---|
| | Revolutions | | | | | | | | | |
| | 50 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | |
| 40 | 2.74 | 3.28 | 4.37 | 5.45 | 8.17 | 10.88 | 13.59 | 16.30 | 19.02 | 40 |
| 41 | 2.68 | 3.21 | 4.26 | 5.32 | 7.97 | 10.62 | 13.26 | 15.91 | 18.55 | 41 |
| 42 | 2.61 | 3.13 | 4.16 | 5.20 | 7.78 | 10.36 | 12.95 | 15.53 | 18.11 | 42 |
| 43 | 2.55 | 3.06 | 4.07 | 5.08 | 7.60 | 10.12 | 12.65 | 15.17 | 17.69 | 43 |
| 44 | 2.50 | 2.99 | 3.98 | 4.96 | 7.43 | 9.89 | 12.36 | 14.83 | 17.29 | 44 |
| 45 | 2.44 | 2.92 | 3.89 | 4.85 | 7.26 | 9.67 | 12.09 | 14.50 | 16.91 | 45 |
| 46 | 2.39 | 2.86 | 3.80 | 4.75 | 7.11 | 9.46 | 11.82 | 14.18 | 16.54 | 46 |
| 47 | 2.34 | 2.80 | 3.72 | 4.65 | 6.96 | 9.26 | 11.57 | 13.88 | 16.19 | 47 |
| 48 | 2.29 | 2.74 | 3.65 | 4.55 | 6.81 | 9.07 | 11.33 | 13.59 | 15.85 | 48 |
| 49 | 2.24 | 2.69 | 3.57 | 4.46 | 6.67 | 8.89 | 11.10 | 13.32 | 15.53 | 49 |
| 50 | 2.20 | 2.63 | 3.50 | 4.37 | 6.54 | 8.71 | 10.88 | 13.05 | 15.22 | 50 |
| 51 | 2.16 | 2.58 | 3.43 | 4.28 | 6.41 | 8.54 | 10.67 | 12.79 | 14.92 | 51 |
| 52 | 2.12 | 2.53 | 3.37 | 4.20 | 6.29 | 8.38 | 10.46 | 12.55 | 14.64 | 52 |
| 53 | 2.08 | 2.49 | 3.31 | 4.12 | 6.17 | 8.22 | 10.27 | 12.31 | 14.36 | 53 |
| 54 | 2.04 | 2.44 | 3.24 | 4.05 | 6.06 | 8.07 | 10.08 | 12.09 | 14.09 | 54 |
| 55 | 2.00 | 2.40 | 3.19 | 3.98 | 5.95 | 7.92 | 9.89 | 11.87 | 13.84 | 55 |
| 56 | 1.97 | 2.35 | 3.13 | 3.90 | 5.84 | 7.78 | 9.72 | 11.65 | 13.59 | 56 |
| 57 | 1.93 | 2.31 | 3.08 | 3.84 | 5.74 | 7.64 | 9.55 | 11.45 | 13.35 | 57 |
| 58 | 1.90 | 2.27 | 3.02 | 3.77 | 5.64 | 7.51 | 9.38 | 11.25 | 13.12 | 58 |
| 59 | 1.87 | 2.24 | 2.97 | 3.71 | 5.55 | 7.39 | 9.22 | 11.06 | 12.90 | 59 |
| 60 | 1.84 | 2.20 | 2.92 | 3.65 | 5.45 | 7.26 | 9.07 | 10.88 | 12.69 | 60 |
| 61 | 1.81 | 2.16 | 2.88 | 3.59 | 5.37 | 7.14 | 8.92 | 10.70 | 12.48 | 61 |
| 62 | 1.78 | 2.13 | 2.83 | 3.53 | 5.28 | 7.03 | 8.78 | 10.53 | 12.28 | 62 |
| 63 | 1.75 | 2.10 | 2.79 | 3.47 | 5.20 | 6.92 | 8.64 | 10.36 | 12.07 | 63 |
| 64 | 1.72 | 2.06 | 2.74 | 3.42 | 5.12 | 6.81 | 8.51 | 10.20 | 11.90 | 64 |
| 65 | 1.70 | 2.03 | 2.70 | 3.37 | 5.04 | 6.71 | 8.38 | 10.05 | 11.71 | 65 |
| 66 | 1.67 | 2.00 | 2.66 | 3.32 | 4.96 | 6.61 | 8.25 | 9.89 | 11.54 | 66 |
| 67 | 1.65 | 1.97 | 2.62 | 3.27 | 4.89 | 6.51 | 8.13 | 9.75 | 11.37 | 67 |
| 68 | 1.62 | 1.94 | 2.58 | 3.22 | 4.82 | 6.41 | 8.01 | 9.60 | 11.20 | 68 |
| 69 | 1.60 | 1.92 | 2.55 | 3.17 | 4.75 | 6.32 | 7.89 | 9.46 | 11.04 | 69 |
| 70 | 1.58 | 1.89 | 2.51 | 3.13 | 4.68 | 6.23 | 7.78 | 9.33 | 10.88 | 70 |
| | 50 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | |

Figure 7. USGS Type AA Current Meter Rating Table.

After 40 seconds has elapsed it is only necessary to concentrate on stopping at a "stop count". The rating table is usually contructed in one-second steps from 40 seconds to 70 seconds. When using a Marsh-McBirney electronic flow meter, allow the meter to calibrate, place in the proper location and read the meter.

Locations of point and mean column velocity measurements will include minnow traps, salmon redds, gillnets, and trot line sites. Velocities will also be measured at sites where fish are observed.

Minnow trap velocities will be measured at the upstream mouths of traps each time they are set and reset. Location and identification of salmon redds where velocity and depth will be measured are based on standards established by the ADF&G (Estes, Hepler, and Hoffmann, 1981) and the Arctic Environmental Information and Data Center, AEIDC (Baldridge, 1981). Biologists will select vantage points within study sites that allow both good visability for observation and create the least disturbance to the fish. Polarized sun glasses will be worn to screen out reflected glare from the water and increase the observer's efficiency. Redds will be defined by direct observation of the repeated fanning and digging actions of the female at the same site. Redds will also be located by observing characteristic spawning behavior including biting and chasing of intruders by a male-female pair, or an individual adult remaining over a distinct excavated depression in the streambed. When a redd is located, the site will be marked by methods similar to those used by Bovee and Cochnauer (1977). After all of the redds within a sampling site have been identified, the velocities and depths will be measured.

Velocities at set gillnet and trot line sites will be measured at three (3) foot intervals along the length of the initial set when set perpendicular to the flow. When set parallel to the flow, one velocity measurement will be taken immediately upstream of the net or trot line. Measurements will be recorded each time the gillnets and trot lines are set and the locations of fish captured noted.

Every attempt will be made to obtain velocity measurements. When location of fish sampling gear and water depth make these measurements impossible to obtain, this will be noted on the point specific habitat evaluation form.

Staff gages, will be installed at fishery habitat and selected habitat evaluation sites in the study area below Devil Canyon. Specific placement will be determined by the crew in charge of selected habitat evaluation. Staff gages will be read twice monthly to determine the stage/discharge relationship between sloughs, side channels, and the mainstem river with the exception of side sonar and fishwheel site staff gages which will be read every six (6) hours when the sites are manned by AA crews.

A transect will be surveyed and the stream bed profile determined in a plane perpendicular to the flow of water at each gage site prior to installing a gage. Staff gage elevations in the study area between Talkeetna and Devil Canyon will be determined from the R&M Consultants datum used to establish streambed elevations. The staff gage will be read before and after collecting the discharge data. This information will be used to develop stage/discharge rating curves and to estimate reach specific streamflows. Where applicable, mainstem discharge information will be obtained from the closest USGS gaging station as a control.

Discharge will be measured at staff gage placement sites during three seasonal flow periods (high, medium, and low). These measurements and the following discussion are based on procedures developed by the USGS (Smoot and Novak, 1977; Buchanan and Somers, 1973), and USFWS Instream Flow Group (Bovee and Milhous, 1978; Trihey and Wegner, 1981).

Discharge will be computed from the mean column velocity and depth information recorded at vertical columns (verticals) collected along the transects surveyed when placing the staff gages. A tagline will be stretched across the water parallel to the transect. One should attempt to subdivide the channel such that no more than 5% of the total flow passes between successive verticals. The spaces between verticals are termed cells. Verticals are to be placed such that they best describe velocity distribution and changes in the cross sectional channel geometry. If the direction of flow is not at right angles to the cross section, find the velocity vector normal to the section. Measure the cosine of the horizontal angle (Figure 8) by holding the discharge measurement note sheet in a horizontal position with the point of origin (0) on the left edge over the tag line, bridge rail, or any other feature parallel to the cross section. With the long side parallel to the direction of flow, the tag line or bridge rail will intersect the value of the cosine of the angle (a) on the top, bottom, or right edge. Multiply the measured velocity by the cosine of the angle to determine the velocity vector component normal to the measuring section.

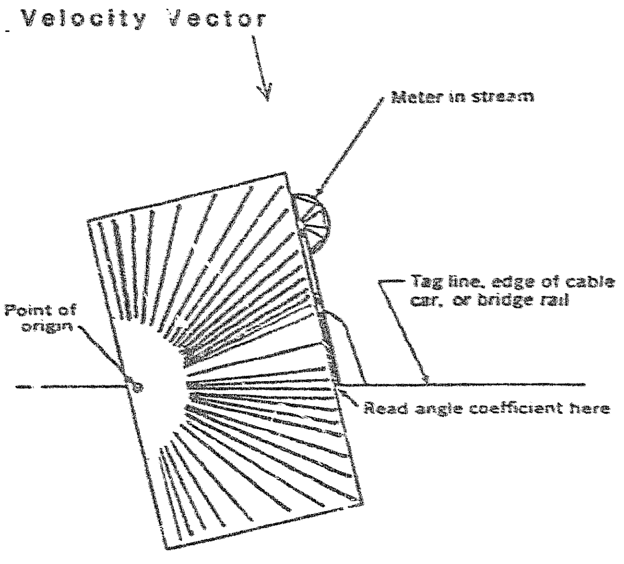



Figure 8. Measurement of Horizontal Angles (from Buchanan and Somers, 1973).

Substrate data will be collected based on procedures used by the AEIDC (1981), ADF&G (Estes, Hepler, and Hoffmann 1981) and Shirazi (1979), at fishery habitat evaluation (point specific and general habitat) and selected habitat evaluation sites.

General habitat and selected habitat evaluation substrate data will be collected along the discharge measurement transect(s) at each velocity and depth measurement site. Point specific habitat evaluation substrate data will be collected from a 2 foot radius around the velocity and depth measurement site.

Substrate classes will be assessed by selecting up to three predominant substrate groups and recording the percent of each. The size and type of substrate are grouped into the following classes:

0. Organic Detrius
1. Silt Clay
2. Sand
3. 1/16"-1/4"
4. 1/4"-1"
5. 1"-3"
6. 3"-5"
7. 5"-10"
8. 10" +
9. Bedrock

Notes will also be made as to the absence or presence and amount (% cover) of periphyton (attached algae) and other aquatic vegetation. The degree of embeddedness will also be recorded. Embeddedness is defined as the filling of interstitial space by fines between substrate of Class Five (5) or greater (Figure 9).

| Code | Degree of Imbededness (%) | Illustration |
|---|---|---|
| 2 | 25 | |
| 5 | 50 | |
| 7 | 75 | |
| 9 | 90 to 100 | |

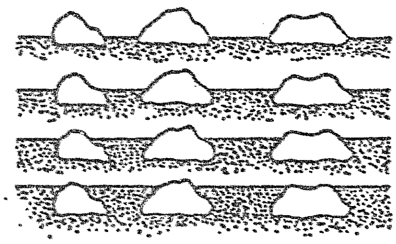


Figure 9. Embeddedness Classification System (from AEIDC, 1980).

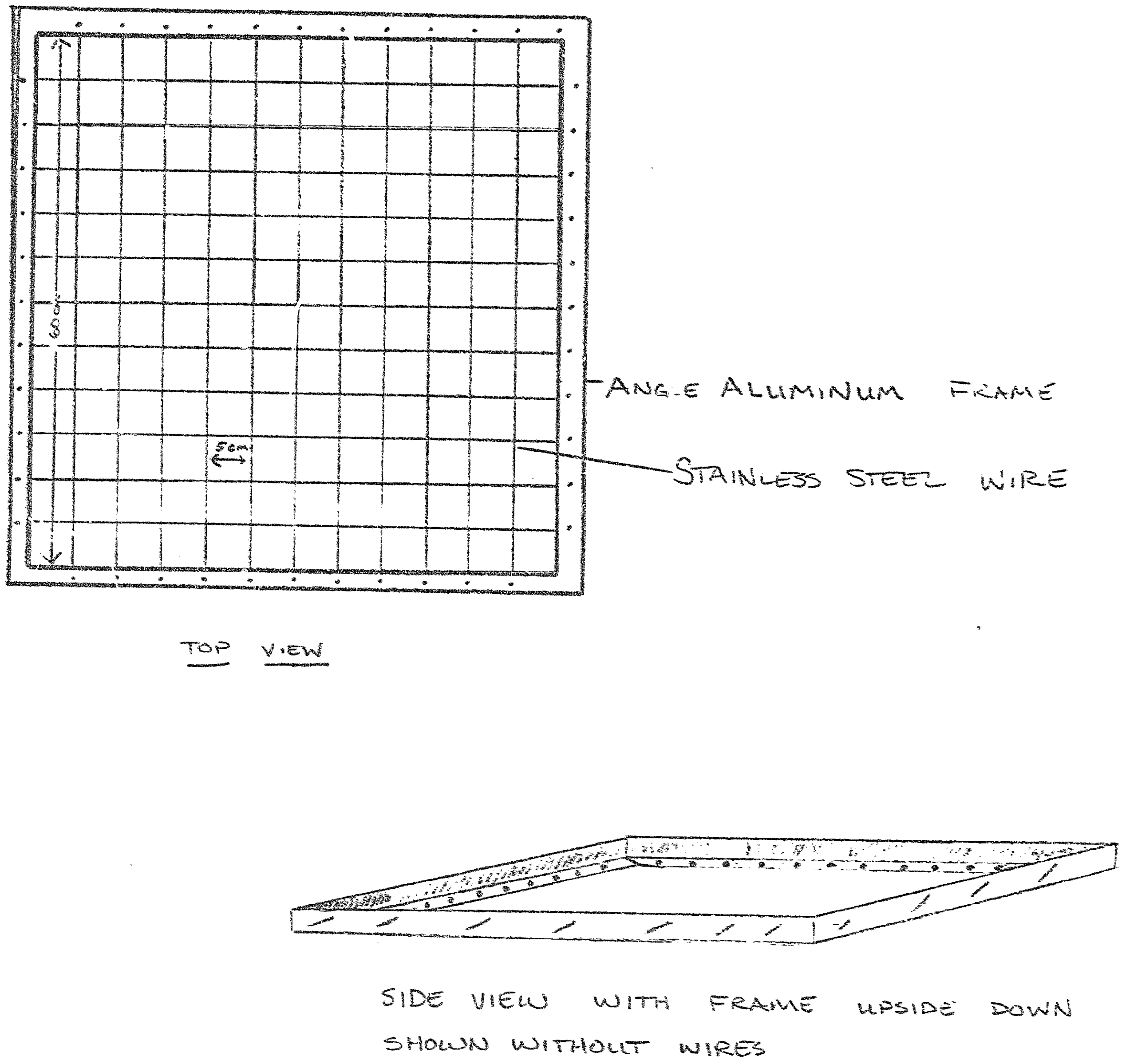



Figure 10. Substrate Grid Diagram.

Maps will be drafted which identify substrate data sampling sites and the locations of various substrate classes (III. DATA PROCEDURES). The boundary between each distinct substrate class area within the sampling site will be delineated on the Aerial View Map form (AH-81-03). The substrate classification within each of these distinct areas will also be identified and recorded on the map. Substrate from each of these areas will be photographed and mapped. Three (3) photographs will be taken at one third intervals along each transect using photography procedures similar to those used by R&M Consultants (Griffiths 1981). A 60 X 60 cm grid subdivided into 5 X 5 cm squares (Figure 10) will be placed on top of the substrate and photographed (Kellerhals and Bray, 1970; Griffiths, 1981).

Mapping

An upstream view cross sectional profile map will be drafted for each staff gage transect (Figure 11). The staff gage location and the channel dimensions; top width, wetted perimeter, bankfull top width, and water's edges, of the cross sectional profile will be included. Definition of terms follow:

Top Width: The top length of the water surface of a channel cross section measured in a plane perpendicular to the direction of the flow between the two water's edges.

Wetted Perimeter: The length of the submerged portion of a channel cross section measured in a plane perpendicular to the direction of flow between the two water's edges.

Bankfull Top Width: The top width of a channel cross section measured in a plane perpendicular to the direction of the flow between the two highest water's edgemarks.

Water's Edge: The point where the water surface comes into contact with the bank.

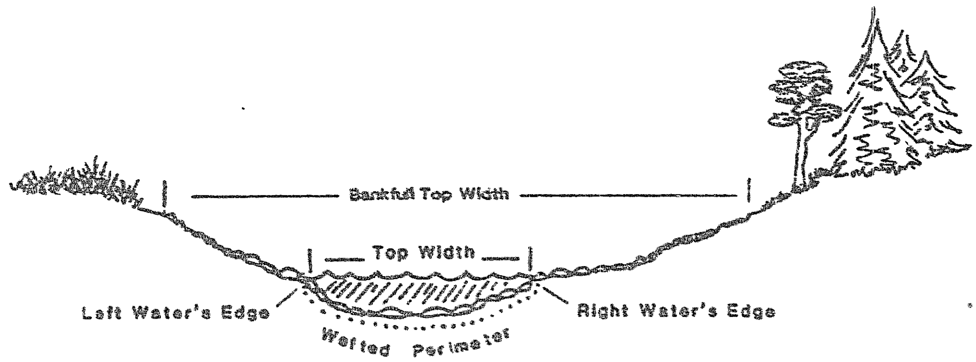



Figure 11. Cross Sectional Profile Diagram.

An aerial view map will be drawn for each sampling site and will include the following (III. DATA PROCEDURES):

Substrate Types: The boundary of areas covered by a distinct substrate composition using the substrate classification system. The degree of embeddedness of Class Five (5) and larger substrate, and the percent of area covered by attached algae and higher aquatic plants.

Cover: Overhanging vegetation, trees, dead fall obstructions, large boulders, and undercut banks.

Channel Dimensions: The boundaries of the water's edges and the bankfull water's edges.

Pools and Riffles: The locations of pools and riffles within study areas. Pools will be defined as a deeper, placid, and slower moving section of a stream and riffles as the shallow rapids in an open stream, where the water surface is broken into waves by obstructions wholly and partly submerged (Stalnaker and Arnette, 1976).

Compass Direction: Orientation to the magnetic north.

Sampling Points: The position of each gear placement site, and staff gage and transect locations.

Selected habitat evaluation sites will be morphometrically mapped (Figure 12). A tag line will be stretched along transects to determine horizontal distances between the two banks and the position of each vertical depth measurement between them. An electronic distance finder (EDF) will be substituted for taglines when the distance between the bank is greater than 150 feet. Depths will be measured from a boat with a Raytheon Model DE 719B portable survey fathometer or on foot with a wading rod depending upon depth and accessibility. Where use of the tag line and/or wading rod is not feasible due to the length of transect and depth of water, the following method will be used. A person located on the shore will operate an EDF and direct the boat operator via two-way radio. When the boat crosses the transect, a distance will be registered on the EDF and manually recorded. At the same time that distances are measured, a radio signal will be transmitted to the boat and a marking device will be triggered by the boat operator to record the depth on the fathometer chart.

At least one photograph will be taken at each of the fishery habitat and selected habitat evaluation sampling sites which represents the general habitat. Additional slides will be taken to depict a unique situation or habitat type.

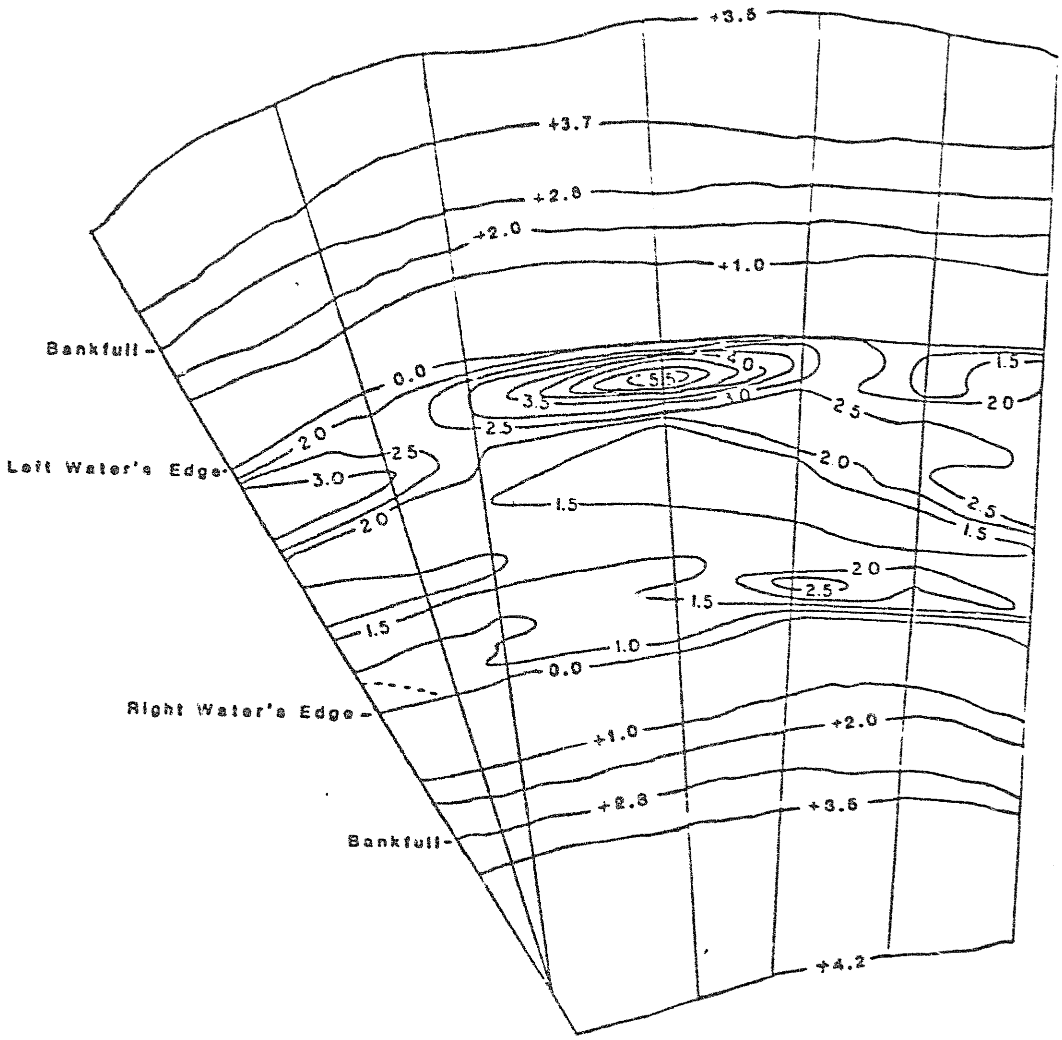



Figure 12. Example of morphometric map with depths and elevations in feet (modified from Bovee and Cochnauer, 1977).

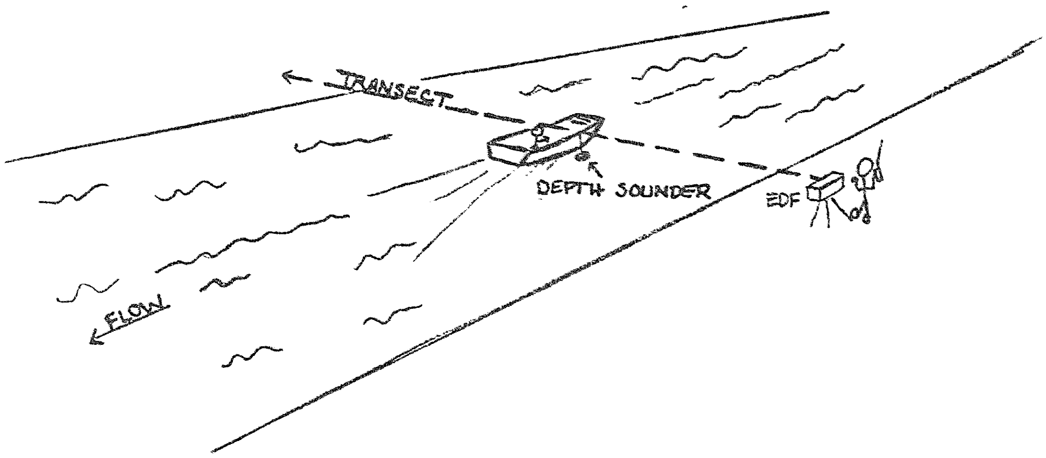



Figure 13. Large River Velocity and Depth Procedure Diagram.

The information recorded on the top section of the General Aquatic Habitat form (AH-81-01) will be photographed for site identification prior to photographing the sampling site. Each AH crew member will maintain a personal log book and establish a section to record the photography information. Orientation (i.e. upstream view, downstream view, etc.), subject, time, and date will be noted. Each roll of film and canister will be assigned a number before use. As an example, the first roll of film being used by Jim Doyle in 1979 would be labeled JD-79-01, the second JD-79-02, etc. He would list each photo under this number in his logbook, identify the date, stream name, survey area, and section number. The roll and canister number and the quantity of photos taken will also be recorded in the related data column space of the General Habitat Evaluation form (AH-81-01).

Level of Effort

Aquatic Habitat personnel will be distributed within the study area as illustrated in Figures 2 and 3. The AH staff will include one (1) FB III, two (2) FB II's and six (6) FB I's. Aquatic Habitat, RJ and AA crew members will jointly collect data as indicated in this manual.

# III. DATA PROCEDURES

Essential to this program are data analysis procedures. Due to personnel constraints, this segment of the project has been delayed. An amendment to this manual will be filed once the biometrics program becomes operational.

will data be analyzed? by whom

worked up? by whom?

## A. ADULT ANADROMOUS FISHERIES STUDIES

### Sonar Data Collection and Preparation

#### Daily Procedures

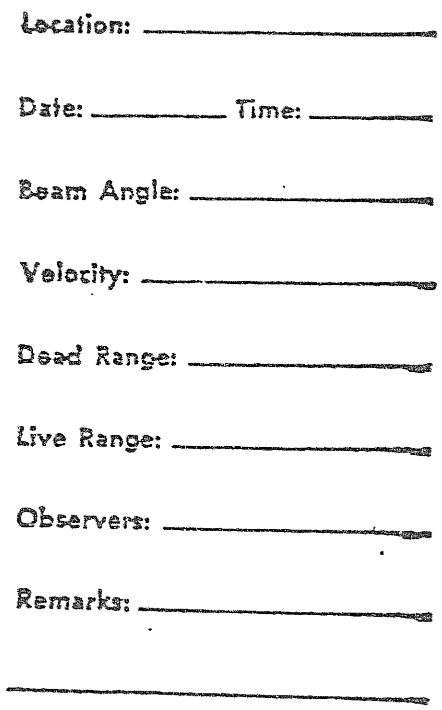
1. PRINTER TAPE STAMP: Each day's printer tape should be stamped (Figure 1) at the beginning and end of the tape as well as anytime during the day that control settings are changed. Each morning the tape is removed from the counter, stamped on both sides of the tear and filled with the same information on each stamp.

2. DAILY LOG FOR SSS CONTROLS: This is a summary of changes in controls which should be updated daily (Table 1). The information is necessary when interpreting raw counts and calibration factor data.

3. SIDE SCANNER COUNTER LOG: Details the mechanics of operation of the counter, substrate and related equipment (Table 2). Any apparent malfunctions should be recorded with description, frequency, and consistency noted. Also, changes in sensitivity, spare card changes, raising or moving of substrate, anticipated problems, and needed repairs on equipment. This is the place where suggestions on improving operations, notes on river conditions which might have an effect on the equipment, and general comments should be noted.

4. SIDE SCANNER COUNTS: Raw counts from printer tapes are entered by hour and sector (Table 3). Counts which register debris or are skipped in printing should be noted with a "d" or "s" in the appropriate hour-sector box. Enter "0" if there are no counts. To tabulate data: An average of the hour on each side of a skip should be used for the skip and counts should be totaled for each sector and each hour. The grand total is the total of all sectors or all hours (they should be equal). This is known as the "daily raw count". In addition the percent of total raw count by sector and hour should be recorded in parentheses next to the total. After each day's counts are tabulated and reported, printer tapes and SSS count forms should be placed in notebooks until sent to the main office.

5. FIELD COUNTER CALIBRATION: Raw counts will be calibrated in season by visual monitoring of the counters with an



Location: ____________

Date: ______ Time: ______

Beam Angle: ____________

Velocity: ____________

Dead Range: ____________

Live Range: ____________

Observers: ____________

Remarks: ____________

______________________

Figure 1. Printer tape stamp.

River: ____________ Bank: ____________ S/N: ____________ Year: ____________

| Date | Time | Fish Velocity | Beam Angle | Dead Range | Counting Range | Command Print Time | Printout Time | Auto Test. Time |
|---|---|---|---|---|---|---|---|---|
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Location ____________________ Year ______

| Date | Time | Remarks |
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Table 3. Daily Sonar Counts

Location:______________ Bank:______________ Date:______________

| Hour | Sector 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1:00 am | | | | | | | | | | | | | |
| 2:00 am | | | | | | | | | | | | | |
| 3:00 am | | | | | | | | | | | | | |
| 4:00 am | | | | | | | | | | | | | |
| 5:00 am | | | | | | | | | | | | | |
| 6:00 am | | | | | | | | | | | | | |
| 7:00 am | | | | | | | | | | | | | |
| 8:00 am | | | | | | | | | | | | | |
| 9:00 am | | | | | | | | | | | | | |
| 10:00 am | | | | | | | | | | | | | |
| 11:00 am | | | | | | | | | | | | | |
| Noon | | | | | | | | | | | | | |
| 1:00 pm | | | | | | | | | | | | | |
| 2:00 pm | | | | | | | | | | | | | |
| 3:00 pm | | | | | | | | | | | | | |
| 4:00 pm | | | | | | | | | | | | | |
| 5:00 pm | | | | | | | | | | | | | |
| 6:00 pm | | | | | | | | | | | | | |
| 7:00 pm | | | | | | | | | | | | | |
| 8:00 pm | | | | | | | | | | | | | |
| 9:00 pm | | | | | | | | | | | | | |
| 10:00 pm | | | | | | | | | | | | | |
| 11:00 pm | | | | | | | | | | | | | |
| Midnight | | | | | | | | | | | | | |
| Totals | | | | | | | | | | | | | |
| Percent | | | | | | | | | | | | | |
| Auto Test | | | | | | | | | | | | | |

Dead Range:__________ ft. Live Range:__________ ft. Mode:__________

Remarks:

| Date | Time In | Time Out | Total Time | Visual Count | Electronic Count | Total Over-Counts | Total Sub-Threshold | Range | | Beam Angle | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Begin | Live | | |
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Table 4. Field counter calibration.

oscilliscope. Field crews will be instructed by permanent staff in the procedure for visual counting and filling out the FIELD CALIBRATION FORM FOR SIDE SCANNING SONAR COUNTER (Table 4).

6. DAILY DATA REPORTS: Side scanner counts and field counter calibration results should be recorded on the DAILY ESCAPEMENT DATA form (Table 5). Data should be recorded by bank and the four (4) daily calibration counts should be recorded individually.

## Escapement Sampling - Age & Length Data

### Fish Sampling Procedures

1. Check species of each intended sample (see Pacific Fishes of Canada, Fisheries Research Board of Canada, Bulletin 180, Ottawa 1973).

2. A scale should only be taken from the left side of the fish (see Figure 2).

3. The "preferred scale" is located two (2) rows above lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.

4. If the preferred scale is missing take a scale, again on the left side of the fish, within the area behind the dorsal fin but forward of the ventral fin, and no more than four rows above the lateral line.

5. If no scales are present in this area, discard the fish.

6. If the scale is stuck or dried, moisten and pull toward the head of the fish gently rather than straight back.

7. Clean all slime, grit, skin and silver pigment from the scale by moistening and rubbing it between the fingers. The scale should be completely clean and transparent.

8. Mount on gum card after moistening. Scales are mounted on the gum card number which corresponds to Age Weight Length (AWL) form number containing the length, weight and sex information for that fish. Place it directly over the number on the gum card with the anterior edge facing the bottom of the card (Figure 3). The ridged side of the scale must be facing upward or no impression will be made in the acetate card. This is the same side that is exposed on the salmon.

9. Cover completed gum cards with wax paper after drying, if possible.

10. Length measurements should be taken from mid-eye to fork of tail and recorded to nearest millimeter.

River: ______________________ Year: ______________________

Table 5. Daily escapement data.

| Year | Month | Day | Bank | Raw Sonar Count | Visual Count | Electronic Count | No. Wheels | Hours Open | Red | Pink | Chum | Coho | King |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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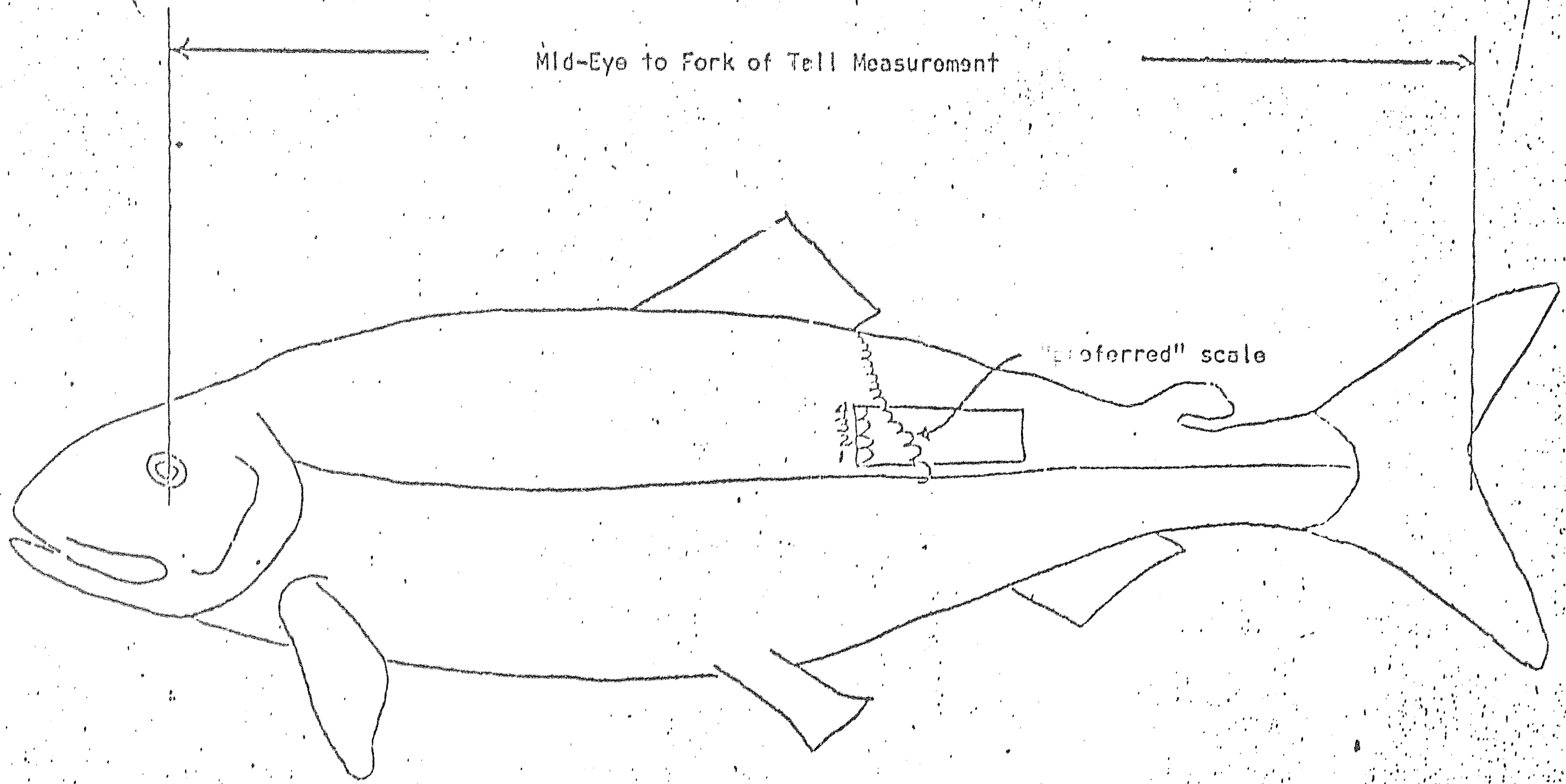
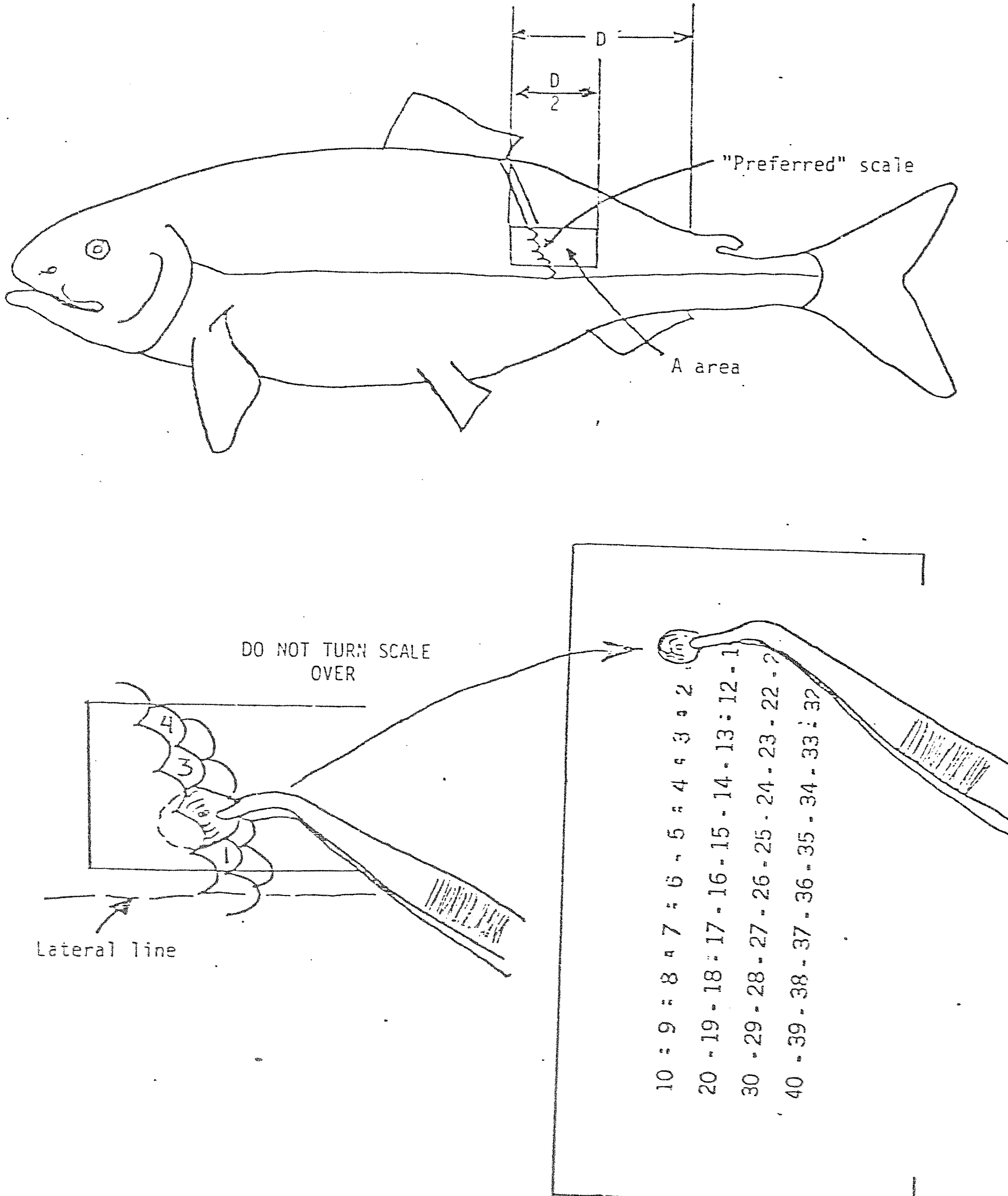



Figure 2. Preferred scale, preferred scale zone, and length measurement

Figure 3 SCALE SELECTION AND MOUNTING ON GUMMED CARD



Labeling Procedures

The functions of proper labeling is to produce a set of sample data which includes a gum card, an acetate impression and an AWL Form (Table 5A and 5B). These have corresponding location, date, species, gear code and subsample number. None ever has more than a single location, date, species, gear code or subsample number.

A. Numbering

Numbering begins with 001 for each species at each escapement sampling location for the 1980 season. Each card, AWL and acetate for a specific group is consecutively numbered throughout the season (i.e., CI Yentna R. 6-29-80 Red 001 to CI Yentna R. 7-29-80 Red 025). It is the responsibility of collectors to check the numbers being used each sampling day to maintain correct sequence and omit duplication.

B. Gum Cards

1. General Guidelines
   (a) Note which number to begin with, for each sample location, for the date in question.
   (b) Prior to sampling, cards may be filled out with species, date, gear, locale, and collector's name. They may also be numbered when the total cards for a given area are known for that date. These must be carefully checked when scales are to be fixed to assure correct information.
   (c) On location before mounting scales, all pertinent information should be completed on that card, in pencil.
2. Information Explanation
   (a) Species: (O. nerka or Reds) Scientific or common name of sample.
   (b) Card No.: Consecutive for this area and species (see A. Numbering).
   (c) Locality: Name of beach, river or area and may include cannery or site name. Use the COOK INLET SAMPLE LOCATION CODES. (Table 6.)
   (d) Scow/Gear: Gear number code is listed on reverse of AWL for appropriate type used.
   (e) Sampling date: mo./day/year that the scales were taken. Omit if the same as period date.
   (f) Period date: mo./day/year fish actually caught.
   (g) Collector: Last name(s) of person(s) collecting scales and data.
   (h) Remarks: Include anything unusual about weather, the sample or anything else considered pertinent by collectors.

| ISTRICT | SECTION OR SUB-DISTRICT | RIVER (STREAM) | SAMPLING LOCATION | PRO-JECT | DATE MONTH | DATE DAY | DATE YEAR | PERIOD | GEAR | MESH SIZE | SAMPLE NUMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | / | |

| NIT OF REMENT | ENGLISH (1) / METRIC (2) | Check | TYPE OF LENGTH MEASUREMENT | | AGE CLASS DESIGNATION | GILBERT/RICH (1) / EUROPEAN (2) | Check |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

| Spec. | SEX M | SEX F | LENGTH | WEIGHT | AGE CLASS | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |

Table 5A. Age, weight and length (AWL) form.

al
ch Sex

Scales Read By: ____________________

Table 5B COMMERCIAL CATCH SAMPLING INFORMATION (AWL CODES)

CATCH DATE ______________________ DELIVERY DATE ______________________
Month Day Month Day

TENDER (Scow, Boat) NAME & ADF&G NO. ______________________

TOTAL FISH DELIVERED

| KINGS | REDS | COHO | PINK | CHUM |
|---|---|---|---|---|
| | | | | |

## CODING

Note: District, Subdistrict, River (stream) and sampling location codes will be provided separately.

PROJECT
1 - Commercial Catch
2 - Subsistence Catch
3 - Escapement (tower, weir, etc.)
4 - Escapement (spawning grounds)
5 - Test Fishing
6 -

GEAR
0 - Trap
1 - Purse Seine
2 - Beach Seine
3 - Drift Gillnet
4 - Set Gillnet
5 - Troll
6 - Long Line - Skates
7 - Otter Trawl
8 - Fish Wheel
9 - Pots
11 - Herring Purse Seine
12 - Handpicked
13 - Dip Net
17 - Beam Trawl
18 - Shovels
19 - Weir
20 -

SPECIES
41 - King
Red, Sockeye
43 - Coho, Silver
44 - Pink
45 - Chum

51 - Smelt
52 - Arctic Char
53 - Dolly Varden
54 - Steelhead
55 - Lake Trout
56 - Northern Pike
57 - Sheefish
58 - Whitefish
59 -

TYPE OF MEASUREMENT
1 - Snout to Fork of Tail
2 - Mid-eye to Fork of Tail
3 - Orbit 1/ to Fork of Tail
4 - Mid-eye to Hypural Plate
5 - Orbit 1/ to Hypural Plate

1/ Orbit refers to posterior edge of eye socket.

BLANK COLUMNS
A -
B -
C -
D -
E -
F -
G -
H -
I -

INJURY
1 - Inshore Net
2 - High Seas Net
3 - Canine-Tooth Predator
4 - Shark
5 - Beluga
6 - Lamprey
7 - Other

AGING DATA
1 - Otolith Sample
2 - Inverted
3 - Regenerate
4 - Illegible
5 - Missing
6 - Reabsorbed

REMARKS
1) If the same code is to be used throughout a column, enter the code for the first fish, then draw an arrow vertically through the column.

2) Length-weight measurement. This form is designed for: a) length measured to the nearest millimeter or tenth of an inch, b) weight measured to the nearest ten grams (i.e. decagram or thousandth of a kilogram) or tenth of a pound.

When recording length-weight data, be sure to enter the digits in their proper columns. For example, a 4.7 lb. fish should be recorded in the 2nd and 3rd colums, not the 1st nd 2nd columns. If for some reason length is measured to inches rather than tenth of inches, a zero should be entered in the third column.

) Blank Columns. These colums are for use as needed. It is anticipated that these uses will vary from area to area, but might include written remarks, tag data, circuli counts, etc

3. Example

Species________________________Card No.__________

Locality________________________________________

Scow/Gear_______________________________________

Sampling Date______________Period Date___________

Collector_______________________________________

Remarks_________________________________________

C. Age Weight Length (AWL) Form

1. General Guidelines
   (a) Information on the back of the gum card should be the same as that on the corresponding AWL form.
   (b) Each finished scale card should be attached to the corresponding AWL form with a paper clip.
   (c) Always use No.2 or softer pencil.
   (d) When filling in length data, place the decimal point in the same column consistantly.
   (e) Put zeros in columns where data not taken - do not leave columns blank.

Table 6. Anadromous Adult Invenstigations - Susitna Hydro Statistical Codes and Code Samples.

| DISTRICT | SUBDISTRICT | RIVER | LOCATION CODE | LOCATION NAME |
|---|---|---|---|---|
| 247 | 41 | 100 | 101 | Yentna Sonar |
| 247 | 41 | 100 | 102 | Sunshine Sonar |
| 247 | 41 | 100 | 103 | Talkeetna Sonar |
| 247 | 41 | 100 | 104 | Curry Tag/Recapture |

2. Information Explanation (See Table 6).
   (a) Heading: At the top of each AWL form, the sample name is written out. The log number will be filled out in Anchorage.
   (b) District, sub-district and river: See Table 6 for proper codes.
   (c) Sampling location: See Table 6.
   (d) Project: Code from reverse side of AWL form.
   (e) Note first date only.
   (f) Period: Not necessary to fill out.
   (g) Gear: Code for type used to catch the fish. Obtained from the reverse side of the AWL form.

(h) Mesh size: Remains blank.
(i) Sample number: Sequential number which matches an appropriate gum card (sée A. Numbering).
(j) Spec.: Code for each species (see reverse of AWL form).
(k) Sex: Check male or female appropriately. Use 1 for male, 2 for female.
(l) Length: Recorded in millimeters from mid-eye to fork of tail.
(m) Weight: Recorded to nearest one-tenth kilogram.
(n) Age class: Completed by biologists after viewing scale impressions.
(o) Column A and I: Used by Stock Identification - do not use.
(p) Column B: River bank designation.
(q) Column C: Injury code (see reverse of AWL form. Table 5b).
(r) Columns D-H: Remarks.

Tag/Recapture Data Collection and Preparation

Daily Procedures

1. Daily fishwheel catch will be reported on the Daily Log/Individual Fishwheel Catch Record form (Table 7). Each fishwheel will have it's own log. Each time a fishwheel is checked, the catch will be recorded along with the corresponding time in military hours. Following, the last daily check, a summation shall be entered in the appropriate space on the form (Table 7).

2. Fish which are tagged will be recorded on the Tag Deployment Record form (Table 8). This form may be used between fishwheels. Appropriate information recorded on each fish tagged shall include: date; tag number; fishwheel location; species; and sex. A sheet summary on the number of fish tagged by species shall be entered in the appropriate location (Table 8).

3. Tagged fish which are recaptured shall be logged on the Tag Recapture Record form (Table 9). Information recorded on each recapture shall include: fishwheel location; tag number; color and type; and species. A sheet summary of recaptures by species shall be entered at the location indicated on the form (Table 9).

DAILY LOG

Table 7.

| DATE |
|---|
| |

# INDIVIDUAL FISHWHEEL CATCH RECORD

PROJECT SITE: FISHWHEEL LOCATION:

| TIME | NUMBER OF FISH CAPTURED | | | | | |
|---|---|---|---|---|---|---|
| | SOCKEYE | PINK | CHUM | COHO | CHINOOK | OTHER 1/ |
| | | | | | | |
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| DAILY TOTAL | | | | | | |

HOURS OPERATED ____

1/ IDENTIFY SPECIE

Table 8.

# TAG DEPLOYMENT RECORD

SITE:

TAG TYPE:

TAG COLOR:

| DATE | TAG NUMBER | FISHWHEEL LOCATION | SPECIES | SEX M | SEX F | |
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SUMMARY

NO. FISH TAGGED

SOCKEYE ______

PINK ______

CHUM ______

COHO ______

TOTAL : [ ]

00054

Table 9.

# TAG RECAPTURE RECORD

| TE | FISHWHEEL LOCATION | TAG DATA NUMBER | COLOR | TYPE 2/ | SPECIES | LEAVE BLANK (OFFICE USE ONLY) |
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SHEET SUMMARY/
NO. RECAPTURES

SOCKEYE ______
PINK ______
CHUM ______
COHO ______
TOTAL : ______

1/ COLOR: INT. ORANGE = O
YELLOW = Y

2/ TYPE: FLOY SPAGHETTI = S
PETERSON DISC = P

# STREAM SURVEY LOG

Table 10.

| STREAM OR SLOUGH | DATE | SURVEY CONDITIONS | SPECIES SURVEYED | NO. OBSERVED | | | NO. TAGGED OBSERVED (LIVE) | | | REMARKS 1/ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LIVE | DEAD | TOTAL | ORANGE DISC | YELLOW FLOY | ORANGE FLOY | |
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1/ GENERAL OBSERVATION INFORMATION INCLUDING: (1) SURVEY DISTANCE (AREA) (2) SURVEY PERSONNEL (3) PREDATOR ACTIVITY (4) CARCASS TAG NUMBER & TYPES & COLOR

Table 10.

Table 11.

| DATE | GEAR TYPE & SPECS[1] | LOCATION | | FISHING TIME (MILITARY) | | | CATCH | | | | | | REMARKS[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GENERAL | LEGAL[2] | BEGIN | END | TOTAL | SOCKEYE | PINK | CHUM | COHO | CHINOOK | OTHER[3] | |
| | | | | | | | | | | | | | |
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1| INCLUDE NET LENGTH, DEPTH, MESH SIZE. (IF APPLICABLE)

2| SECTION, TOWNSHIP, RANGE

3| IDENTIFY SPECIES

4| INCLUDE COLLECTORS NAME(S), RECAPTURES, & MATURATION (ie. PRESPAWNER, SPAWNER, POST SPAWNER).

# EGG DEPOSITION LOG

DATE:

SITE:

GENERAL:

LEGAL[1]:

COLLECTORS:

Table 12.

| PLOT NUMBER (SEQUENTIAL) | NUMBER | | | | REMARKS |
|---|---|---|---|---|---|
| | EGGS | | FRY | | |
| | LIVE | DEAD | LIVE | DEAD | |
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1/ SECTION TOWNSHIP RANGE

### Survey Data Collection and Preparation

Foot surveys on clear water sloughs and stream will be recorded on the Stream Survey Log form (Table 10). Data recorded on each survey will include: stream or slough name; date· survey conditions (Excellent, Good, Fair, Poor); individual species surveyed; live and dead counts on particular species surveyed; and number of live tagged members by tag type/color. The "Remarks" column, in particular, will include information on tagged carcasses (tag type, number and color by species).

Deployment of electro fishing gill, net and other similar sampling gear will be recorded on the Variable Gear Log form (Table 11). Information recorded will include: gear type; survey location (general and legal); date; time (beginning and end); and catch by species.

Egg pumping results will be recorded on the Egg Deposition Log form (Table 12). A separate form will be used for each sampling site. Number of eggs and fry collected will be logged as either dead or alive by individual plot. Sampling location will be identified in legal and general terms.

Development of data forms for the chinook salmon survey is pending review of the survey design by the absent project biometrician.

## B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

Resident and Juvenile Anadromous Fisheries Studies field forms are presented in draft form (Tables 13-15) pending review by the project biometrician. At such time as this review is complete, the final forms and procedures will be released.

General guidelines for collection of biological data on individual fish by species are given under the heading Biological Data. Forms used to record AWL data are the same as those used by the Adult Anadromous Project (Figures 5A and 5B).

### Biological Data

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis.

2. Size sample: The size class sample will consist of the first 50 juvenile chinook captured in each size class and 10% of those captured in each size class thereafter. Measurement will be in mm to total length.

File No. ________ Page ____ of ____

Table 13. SUSITNA HYDRO RESIDENT & JUVENILE ANADROMOUS STUDY
BIOLOGICAL DATA RJ 81-02

Habitat Location __________ Sampling Site __________ River Mile ________ __ __/__ __/__ __/__ __/__

Date(s) Collected ______________ Collector(s) ______________

| | species code | length (mm) | sex | age | scale card # | gear type code | PSN | mesh size | remark on back | | species code | length (mm) | sex | age | scale card # | gear type code | PSN | mesh size | remark on back |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | 26 | | | | | | | | | |
| 2 | | | | | | | | | | 27 | | | | | | | | | |
| 3 | | | | | | | | | | 28 | | | | | | | | | |
| 4 | | | | | | | | | | 29 | | | | | | | | | |
| 5 | | | | | | | | | | 30 | | | | | | | | | |
| 6 | | | | | | | | | | 31 | | | | | | | | | |
| 7 | | | | | | | | | | 32 | | | | | | | | | |
| 8 | | | | | | | | | | 33 | | | | | | | | | |
| 9 | | | | | | | | | | 34 | | | | | | | | | |
| 10 | | | | | | | | | | 35 | | | | | | | | | |
| 11 | | | | | | | | | | 36 | | | | | | | | | |
| 12 | | | | | | | | | | 37 | | | | | | | | | |
| 13 | | | | | | | | | | 38 | | | | | | | | | |
| 14 | | | | | | | | | | 39 | | | | | | | | | |
| 15 | | | | | | | | | | 40 | | | | | | | | | |
| 16 | | | | | | | | | | 41 | | | | | | | | | |
| 17 | | | | | | | | | | 42 | | | | | | | | | |
| 18 | | | | | | | | | | 43 | | | | | | | | | |
| 19 | | | | | | | | | | 44 | | | | | | | | | |
| 20 | | | | | | | | | | 45 | | | | | | | | | |
| 21 | | | | | | | | | | 46 | | | | | | | | | |
| 22 | | | | | | | | | | 47 | | | | | | | | | |
| 23 | | | | | | | | | | 48 | | | | | | | | | |
| 24 | | | | | | | | | | 49 | | | | | | | | | |
| 25 | | | | | | | | | | 50 | | | | | | | | | |

GEAR TYPE CODE

| | |
|---|---|
| beach seine | 3 |
| burbot set | 10a |
| drift gillnet | 1a |
| electroshock | 2 |
| gillnet | 1 |
| hook & line | 9 |
| minnow trap | 5 |
| trot line | 10 |

SPECIES CODE

| | | | |
|---|---|---|---|
| burbot | 590 | humpback whitefish | 582 |
| chinook 0+ | 410 | lake trout | 550 |
| chinook 1+ | 411 | longnose sucker | .920 |
| chum salmon | 450 | pink salmon | 440 |
| coho 0+ | 430 | rainbow trout | 541 |
| coho 1+ | 431 | round whitefish | 586 |
| coho 2+ | 432 | smelt/eulachon | 511 |
| cottid | 910 | sockeye 0+ | 420 |
| dolly varden | 530 | sockeye 1+ | 421 |
| grayling | 610 | stickleback | 660 |

00060

File No. ________ Page ________

Table 14. SUSITNA HYDRO RESIDENT & JUVENILE ANADROMOUS STUDY
TAG AND RECAPTURE DATA RJ 81-03

| TAGGING DATA | | | | | | | | RECAPTURE DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | LOCATION | | | | | | LOCATION | | | |
| tag no. | date | species code | length (mm) | Habitat Location | T | R | S | date | length (mm) | Habitat Location | T | R | S |
| | | | | | | | | | | | | | |
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SPECIES CODE

| | | | | | |
|---|---|---|---|---|---|
| burbot | 590 | humpback whitefish | 582 | rainbow trout | 541 |
| dolly varden | 530 | round whitefish | 586 | | |
| grayling | 610 | lake trout | 550 | | |

File No. ________ 

Table 15. SUSITNA HYDRO RESIDENT & JUVENILE ANADROMOUS STUDY
CATCH DATA RJ 81-01

Habitat Location ________________ Sampling Site ______________ River Mile _________ __ __ __/__ __ __/__ __/__ __ __/__

DATE: Gear Set __________ Gear Pulled ___________ Collector(s) ______________________________

| gear type code | PSN | net length | mesh size | no. hooks | TIME | | | CATCH – SPECIES CODE NO. | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | set | pulled | total* | | | | | | | | | |
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* total time for beach seine haul, electroshock and hook & line

GEAR TYPE CODE

| | |
|---|---|
| beach seine | 3 |
| burbot set | 10a |
| drift gillnet | 1a |
| electroshock | 2 |
| gillnet | 1 |
| hook & line | 9 |
| minnow trap | 5 |
| trot line | 10 |

SPECIES CODE

| | |
|---|---|
| burbot | 590 |
| chinook 0+ | 410 |
| chinook 1+ | 411 |
| chum salmon | 450 |
| coho 0+ | 430 |
| coho 1+ | 431 |
| coho 2+ | 432 |
| cottid | 910 |
| dolly varden | 530 |
| grayling | 610 |
| humpback whitefish | 582 |
| lake trout | 550 |
| longnose sucker | 920 |
| pink salmon | 440 |
| rainbow trout | 541 |
| round whitefish | 586 |
| smelt/eulachon | 511 |
| sockeye 0+ | 420 |
| sockeye 1+ | 421 |
| stickleback | 660 |

3. Scale analysis: Scale samples will be taken monthly from 25 fish captured in the mainstem river and it's major tributaries.

Juvenile chinook, coho and sockeye salmon will be processed to the extent of collecting data on age class, size class and scale analysis. Juvenile pink and chum salmon will be processed only to the extent of collecting size class data.

Rainbow Trout

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis. Scale samples will be taken from all adult rainbow trout captured.

2. Size sample: All rainbow trout captured will be measured for fork length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 10% of fish captured will be killed specifically for these purposes.

Arctic Grayling

1. Data taken same as rainbow trout with the exception that if large numbers of grayling are captured for tagging in the upper study area a 10-20% sample will be taken. Fork length will be recorded in mm.

Round (RWF) and Humpback (HWF) Whitefish

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis. Scale samples will be taken from all adult round (RWF) and humpback (HWF) whitefish.

2. Size sample: All round (RWF) and Humpback (HWF) Whitefish captured will be measured for fork length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 10% of fish captured will be killed specifically for these these purposes.

Dolly Varden/Arctic Char

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis. Scale samples will be taken from all adult Dolly Varden/Arctic Char.

2. Size sample: All Dolly Varden/Arctic Char captured will be measured for fork length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 10% of fish captured will be killed specifically for these purposes.

Lake Trout

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis. Scale samples will be taken from all adult lake trout.

2. Size sample: - All lake trout captured will be measured for fork length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 10% of fish captured will be killed specifically for these purposes.

Long Nose Sucker

1. Age class composition: Age class composition will be accomplished by scale reading and size frequency analysis. Scale samples will be taken from all adult long nose sucker.

2. Size sample: All long nose sucker captured will be measured for fork length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 10% of fish captured will be killed specifically for these purposes.

Burbot

1. Age class composition: Age class composition will be accomplished by reading otoliths of all burbot killed.

2. Size sample: All burbot captured will be measured for total length in mm.

3. Sex composition, maturity, and spawning condition determination: Autopsies will be performed on all sampling mortalities but no more than 20% of fish captured will be killed specifically for these purposes.

Three Spine Stickleback

1. Size sample - If possible a sample of fifty fish or 10% whichever is greater, will be collected and measured for total length in mm on a monthly basis.

## C. AQUATIC HABITAT AND INSTREAM FLOW STUDIES

### Assigning Gear Placement Site Numbers (GPSN)

The GPSN is a two-part code which identifies gear type and sample number, thus providing a sampling location designation for each point specific measurement made within a given sampling site.

The first part of the code indicates gear type employed at the sampling location; the second part indicates sample number. For example, if three minnow traps were set within a sampling site, the GPSN's would be: 5-01, 5-02, 5-03.

Gear code designations are as follows:

| Gear Type | Code |
|---|---|
| Beach Seine | 3 |
| Burbot Set | 10a |
| Drift Gillnet | 1a |
| Electroshock | 2 |
| Gillnet | 1 |
| Hook and Line | 9 |
| Minnow Trap | 5 |
| Trot Line | 10 |
| Observation | 0 |

GPSN's will be included when mapping a sampling site. Resident Juvenile and AA crew members will assign GPSN's and will provide AH personnel with this information to facilitate the correlation of data. AH personnel will assign GPSN's when fishery data are not being collected.

Personal Log Book

A personal log book will be maintained by each AH crew member. Daily entries will include the following:

Date: Year, month, day
Sites visited and activities of that day
Weather: Air temperature, precipitation, cloud cover, wind, etc. Military Time: Twenty-four (24) hour system.
Water Conditions: Turbidity, clarity, color, odor, ice stage, floating debris, etc.
Sampling Problems.
Equipment Problems.
Suggestions for changes or improvements.
Personal Impressions.
Record of Photographs: Establish a separate section in the personal log book for the following data: frame number, roll number, orientation, location, date, and time.
Crew Members: Names of AA, RJ, and AH sampling crew.

Completing Aquatic Habitat Forms

Instructions for completing the AH forms are explained in this section. The numbers introducing each instruction corresponds to a number encircled in the appropriate form. Numbers one (1) through ten (10) apply to all forms with the exception of the Staff Gage form (AH-81-05) while numbers greater than ten (10) apply to the specific form under which they are listed. On the Staff Gage form, numbers one (1) through six (6) refer to the general instructions whereas numbers seven (7) through thirteen (13) refer to specific information.

General Instructions

1. File No.: Indicates file location.

2. Crew: List names or initials of personnel making measurements and entering data on form.

3. Habitat Location: Enter descriptive name of study area (i.e. Slough 8A).

4. Sampling Site: Enter descriptive name of the sampling area within the habitat study location (i.e. head, mouth, etc.).

5. River Mile: Enter the number of miles from the river mouth to the habitat location. River miles are indicated on the Alaska Power Authority's Susitna River hydrographic map set.

6. Geographical Code (GC): Enter the 12 digit code identifying the sampling location.

7. Gage Number (no.) and Height (ht.): Record the established identification number for the gage and the stage reading (i.e., water depth at the gage).

8. Dates: Enter the date or the beginning and ending dates (General Habitat Form AH-81-01) for period which data was collected.

9. Page: Indicate the page number and the total number of pages used (i.e. 1 of 5, 2 of 5, 5 of 5).

10. Description: Enter any information which helps describe the sampling site or the sampling location (i.e. bend in river, riffle 100 yards downstream of small island, river is braided, straight, or meandering, etc. Figure 4).

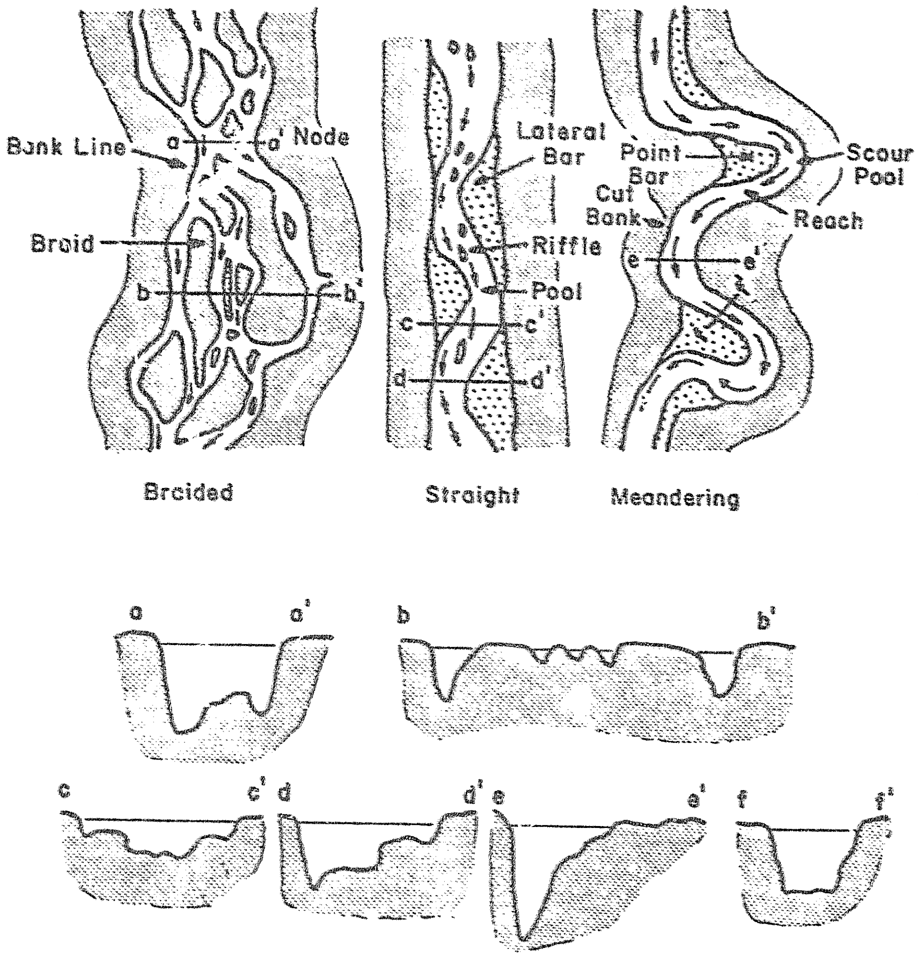


Figure 4. River Channel Patterns (from Richardson et al, 1975).

General Aquatic Habitat Evaluation Form (AH-81-01)

This form to be completed in the field when measuring the general aquatic habitat parameters discussed in the study description.

Instructions:

1-10. Refer to general instructions.

11. Date: Enter date measurement is being taken.

12. Military Time: Enter time using the 24 hour system (i.e. for 1:00 p.m., enter 1300).

13. Temperature (Temp) °C: Enter air and water temperature.

14. Specific Conductance (Cond, $\mu$ mhos/cm): Enter specific conductance value as measured by the procedure described in the methods section.

15. pH: Enter value as measured using the procedure described in the methods section.

16. Dissolved Oxygen (D.O., mg/l): Enter value as measured following the procedure in the methods section.

17. Turbidity (FTU): Indicate with a check (✓) on left side of blank that a turbidity sample was taken, enter turbidity value after analysis.

18. Discharge (cfs): Indicate with a check on left side of blank when measurement is made, enter value after calculated from the discharge data form.

19. Related Data: Record number of any data forms that you know were filled out at the same time and place, film roll number and number of photos taken and identification of photographer or other data that will relate (i.e., USGS, R&M etc.)

20. Date: Enter date data collected.

21. Aquatic Vegetation: Estimate the percent of the area within the sampling site covered by aquatic vegetation, specify if algae or macrophyte.

22. Substrate Classification (0-9): Estimate the three major substrate types within the sampling site and enter their respective percentages, also note if other identifiable size classes are present in minor amounts by entering a P for present.

23. Embeddedness: Enter the code of the size class(es) that are embedded, percent embedded and the size class(es) of the embedding material.

<u>Point Specific Aquatic Habitat Evaluation Form</u> (AH-81-02)

This form to be completed in the field when measuring the point specific habitat parameters discussed in the study description.

Instructions:

1-10. Refer to general instructions.

11. GPSN: Enter the two-part gear placement site number (GPSN) which identifies the type of fish sampling gear indicated in the gear code and the sample number (i.e. trot line sample #3 would be 10-3).

12. Depth: Enter water depth at the gear placement site.

13. Velocity: Enter the point velocity at the depth of the sampling gear and the mean column velocity.

14. Substrate: Enter the percent and the class number of each sediment size class (up to three) identified within a two (2) foot radius of each velocity/depth measurement point.

15. Embeddedness: Enter the class number for the size of substrate Class Five (5) and larger embedded in surrounding materials, the percent (%) of embeddedness and the class number for the size of the embedding material, within the same area as the substrate evaluation.

16. Aquatic Vegetation: Enter the percent (%) cover of algae or vascular plants within a two (2) foot radius of the gear placement site.

17. Related Data: Record the data form number of any data collected at the same time and site. Also note any observation which may be pertinent to the sample (i.e. minnow trap placed under cut bank, number of fish at three (3) foot intervals along gill net, etc.).

13. Notes: Include any information which may help in interpreting data. For example: document <u>any</u> deviation from the methods described in the Procedures Manual and the conditions which prevented use of conventional methods, unusual weather or other circumstances.

Aerial View Map Form (AH-81-03)

A map describing the study habitat site is drawn on this form in the field.

Instructions:

1-10. Refer to general instructions.

11. Draft map to include the following:

Substrate
Cover
Bankfull top width and top width
Pools and riffles
Channel dimensions
Location of staff gages and transect
Location of sampling gear (use GPSN)
Compass orientation

Discharge Form (AH-81-04)

This form to be completed in the field to record total discharge measurements and calculations.

Instructions:

1-10. Refer to general instructions.

11. Type Meter and Number: Record the type of meter (i.e., Price AA, Pygmy or Marsh McBirney meter) and the serial number.

12. Distance From Head Pin or Water's Edge: The horizontal measurement from the head pin or waters edge to each vertical along the transect.

13. Angle Coefficient: A correction factor for the angle of flow as it intersects the transect line. Values fall between 0.00 and 1.00 and are determined by use of an angle coefficient chart.

14. Velocity Depth: This is the vertical distance from the water surface to the channel bottom at each vertical measured to the nearest 0.1 foot if possible.

15. Streambed Elevation: Computed at each vertical by subtracting the velocity depth from the average of the right bank (RB) and left bank (LB) water surface elevations for that transect at that particular flow. Left and Right banks are determined by looking upstream. These data are collected only where surveyed head pins are established.

16. Observation Depth: Indicate at what depth the point velocity was measured. Velocity will be measured at .6 of the depth from the surface for a depth less than three (3) feet and .2 and .8 for depth greater than three (3) feet.

17. Revolutions: Recorded number of revolutions when using a Price AA or Pygmy flow meter. When using a Marsh McBirney meter draw a line through this column.

18. Time: Recorded in seconds by use of a stopwatch, when using a Price AA or Pygmy flow meter. When using a Marsh McBirney meter draw a line through this column.

19. Point Velocity: This is the velocity obtained from the rating table using revolution and time information or the velocity reading from a direct readout meter.

20. Mean Vertical Velocity: The average of the 0.2 and 0.8 point velocity readings for the vertical. If the velocity was measured only at 0.6 the depth this is the same as the point velocity.

21. Mean Cell Velocity: The average of the two adjacent mean vertical velocities are normally grouped beginning from the LB to the RB water's edges.

22. Mean Cell Depth: The average of the depths of two adjacent verticals.

23. Cell Width: The horizontal distance between adjacent verticals.

24. Cell Area: Computed by multiplying each mean cell depth with the cell width.

25. Flow (Discharge): Computed by multiplying each cell area by its respective mean cell velocity, and when applicable, the angle coefficient and totalling the resultant values.

Staff Gage Form (AH-81-05)

Used to keep a complete record of all readings made on a specific staff gage.

Instructions:

1-6. Refer to general instructions.

7. Page: Indicate the page number and the total number of pages used.

8. Staff Gage No.: Enter the established identification number.

9. Calibration Factor: Distance from channel bottom to zero mark on gage.

10. Date: Enter date of reading.

11. Time: Record military time of reading.

12. Height: Record stage reading to the nearest 0.01 foot.

13. Initial: Initials of person who records staff gage data.

File No. ___(1)___ GENERAL AQUATIC HABITAT EVALUATION AH-81-01 Page (9) of ____

Crew ___(2)___ Dates ___(8)___ to ______

Habitat Location ___(3)___ Sampling Site ___(4)___ River Mile ___(5)___ GC ___(6)___ / ____ / ___ / ____ / __

Description ___(10)___

| Date | Military Time | Temp. C° Air | Temp. C° $H_2O$ | Gage no. | Gage ht. | DO (mg/l) | pH | Turbid. (FTU) | Conductivity (μmhos/cm) | Discharge (cfs) | Related Data |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (11) | (12) | (13) | | (7) | | (16) | (15) | (17) | (14) | (18) | (19) |
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| Date | Aquat. Vegeta | 0 Organ. Detr. | 1 Silt/Clay | 2 Sand | 3 1/16-1/4 | 4 1/4-1 | 5 1-3 | 6 3-5 | 7 5-10 | 8 10 + | 9 Bed-rock | EMBEDDEDNESS Embedded material | % | Embedded material |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (20) | (21) | ← | | | | | (22) | | | | → | ← | (23) | → |
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File No. ___(1)___

Crew ___(2)___

# POINT SPECIFIC AQUATIC HABITAT EVALUATION
AH-81-02

Page (9) of ___

Gage Number (7) Height ___ Date (8)

Habitat Location ___(3)___ Sampling Site ___(4)___ River Mile ___(5)___ GC ___(6)___ / ____ / ___ / ____ / __

Description ___(10)___

| GPSN | DEPTH (ft) | VELOCITY POINT | VELOCITY MEAN | SUBSTRATE % CLASS | SUBSTRATE % CLASS | SUBSTRATE % CLASS | EMBEDDEDNESS % | | | AQUATIC VEGETA. % | RELATED DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (11) | (12) | (13) | | ← | (14) | → | ← | (15) | → | (16) | (17) |
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NOTES: (18)

(ADF&G/Su Hydro, Habitat 5/81)

File No. (1)

# AERIAL VIEW MAP
AH-81-03



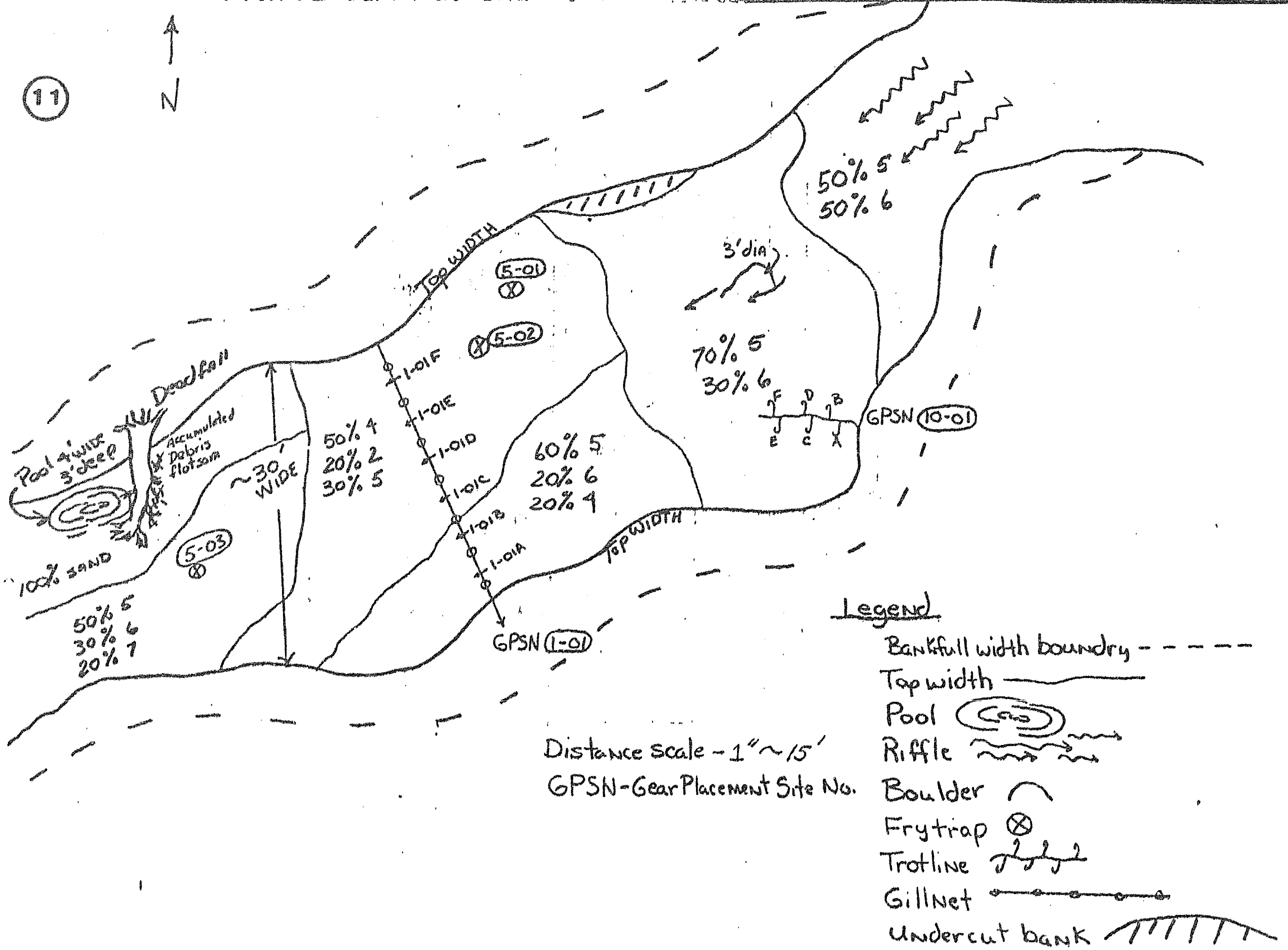
Date (8)

Gage # (7) Height ____

Crew (2)

Habitat Location (3) Sampling Site (4) River Mile (5) GC (6) ___/____/___/____/__

Description (10)




(ADF&G/Su Hydro 5/81)

File No. (1)　　　　DISCHARGE AH-81-04　　　　Page (9) of ____

Crew (2)　　　　Date (8)

Habitat Location (3)　Sampling Site (4)　River Mile (5)　Meter Type (11) No. ____

GC (6) __ / ___ / ___ / ____ / __　　Gage Number (7) Height ____

Description (10)

| Distance from Head Pin (ft) LB RB | Angle Coef. | Vel. Depth (ft.) | *Stream-bed Elev.* | Obs. Depth % | Revo-lutions # | Time (sec) | *Velocity fps* Point | *Velocity fps* Mean Vertical | *Velocity fps* Mean Cell | *Mean Cell Depth (ft.)* | *Cell Width (ft.)* | *Cell Area (ft.$^2$)* | *Flow (ft$^3$/s)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |

(ADF&G/Su Hydro, Habitat 5/81)

STAFF GAGE NO. (8)
AH-81-05

File No. (1)

Page (7) of ____

Crew (2)

GC (6) __/__ __/__ __/__ __/__

Habitat Location (3)

Sampling Site (4)

River Mile (5)

Calibration Factor (9)

| DATE | TIME | HEIGHT | INITIAL |
|---|---|---|---|
| | | | |
| | | | |
| (10) | (11) | (12) | (13) |
| | | | |
| | | | |

| DATE | TIME | HEIGHT | INITIAL |
|---|---|---|---|
| | | | |
| | | | |

000077

(ADF&G/Su Hydro, Habitat 5/81)

## IV. QUALITY CONTROL

### A. ADULT ANADROMOUS FISHERIES STUDIES

Field sampling techniques and data recording procedures will be monitored of each crew weekly by the Adult Anadromous Project Leader or his appointed designee. This will insure consistency, accuracy and conformance with standard sampling and data collection and recording methods.

Sampling gear and support equipment will be maintained in good working order. It will be the responsibility of each crew leader to insure that preventive maintenance is conducted on all equipment. Minor equipment breakdowns will be repaired in the field. Major equipment breakdowns and/or losses will be reported immediately to Anchorage headquarters. Replacement equipment or parts will be provided at first available opportunity.

### B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

Fishing techniques utilized in the various sampling schemes have been proven for effectiveness in earlier biological studies (Lagler, 1956; Sundstrom, 1957; and McClane, 1965). Personnel will be instructed to use proven lures. Natural baits, where used, will be changed regularly to insure "freshness" and ensure maximum scent transfer to the water.

Gillnets and seines will be kept mended or will be replaced if badly damaged in operations. Equipment such as tagging guns, fishing tackle, firearms, and other tools used in day-to-day operations will be cleaned and oiled after each use to prevent rust.

Data forms will be filled out in a neat and legible manner and will be subject to periodic review by the project leader or his assistant.

### C. AQUATIC HABITAT AND INSTREAM FLOW STUDIES

A systematic approach for maintaining desired standards for the measurement of field parameters has been established for the instruments used in this study. Thermometers are periodically compared to a National Bureau of Standards (NBS) standard thermometer for the range of temperatures to be encountered. If present, variations are noted and correction factors are calculated and taped onto each thermometer.

Thermographs are calibrated following the above procedures. Timing mechanisms are also evaluated for accuracy. Operational thermographs are periodically inspected comparing the temperature and time on the chart with the known time and temperature data. A mark is made on the chart at that point.

Dissolved oxygen probes (Hydrolabs and YSI) are checked over the range of use against the Winkler determination (Standard Methods, 1975). Other instruments (i.e., pH meters and conductivity meters) are periodically evaluated by the USGS. Whenever a question arises concerning quality control, the USGS, EPA, and manufacturer of the data collection device will be consulted.

Literature is periodically reviewed to insure that state-of-the-art data collection and analysis techniques are being observed. A hydraulic engineer will be consulted to evaluate the accuracy of data collection and analysis techniques. The USFWS is periodically consulted to evaluate the accuracy of instream flow data collection and analysis techniques.

The project biometrician is consulted to evaluate the accuracy and statistical merit for collecting data.

State-of-the-art habitat data collection and analysis courses are attended when it is determined attendance will improve the quality of the program.

The field data are reviewed periodically by the field biologist responsible for its collection. A brief narrative is prepared summarizing the habitat characteristics described by the data set. Any abnormal or intervening field conditions or sampling problems which might have biased the data set are also to be discussed in the narrative.

<u>Data Routing</u>

Raw data from the respective project sections will be forwarded to the Anchorage Su Hydro office for copying and filing. Actual routing will follow the path in figure 1.

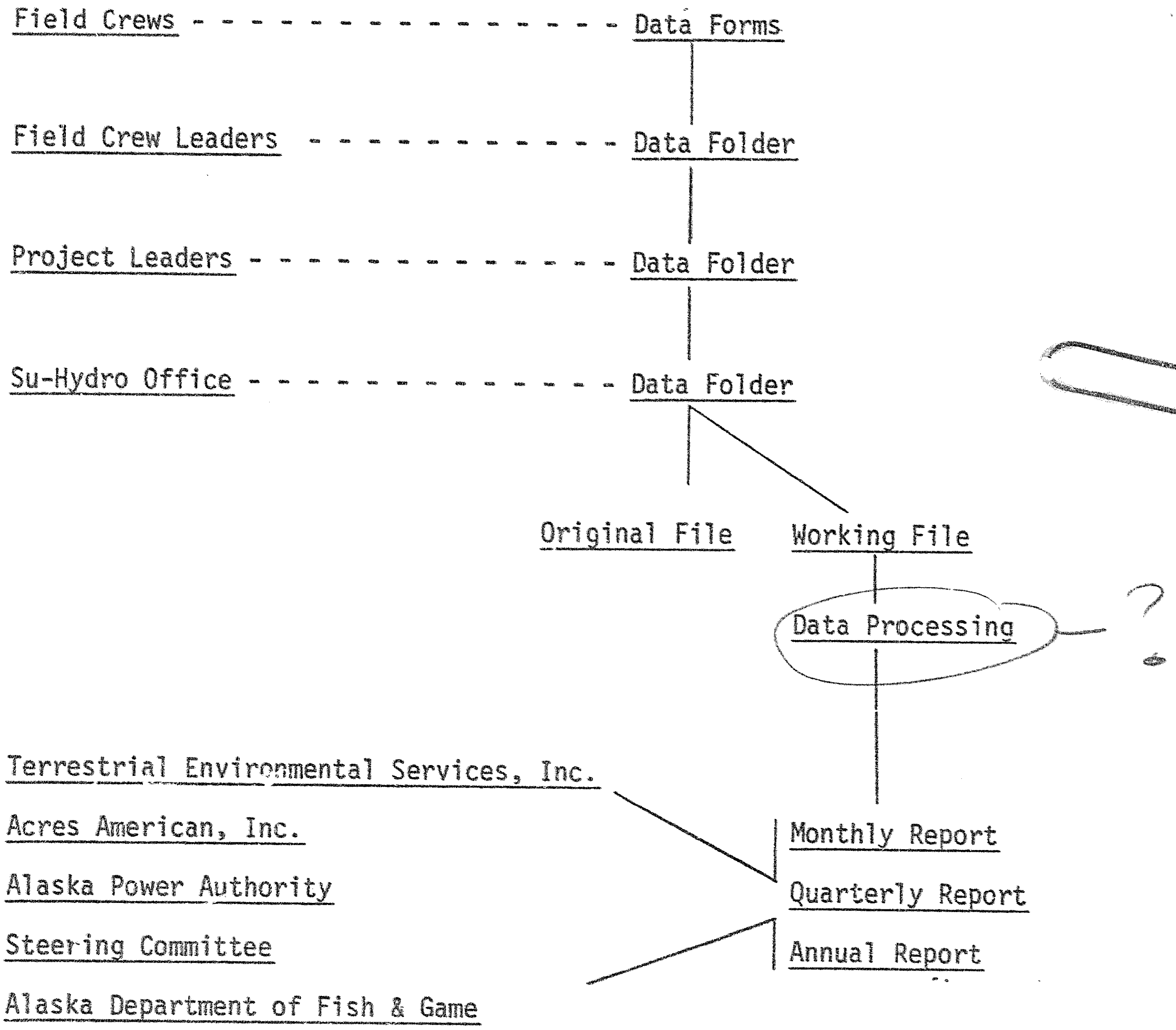



Figure 1. Data Routing, Phase I, 1981.

## V. SCHEDULE

Project scheduling is as outlined in Figures 1, 2 and 3. By inspecting the figures, it becomes evident that the Adult Anadromous Fisheries Project will conduct it's field program between June 15 and October 17 at the sites indicated on Figure 1. The Resident and Juvenile Anadromous Fisheries Project will integrate it's field program with the Aquatic Habitat and Instream Flow Project along those river reaches indicated in Figure 2. These projects will operate year round from the estuary to Devil Canyon and from March 15 through October 15 upstream from Devil Canyon.

Reporting dates for all projects are depicted in Figure 3.

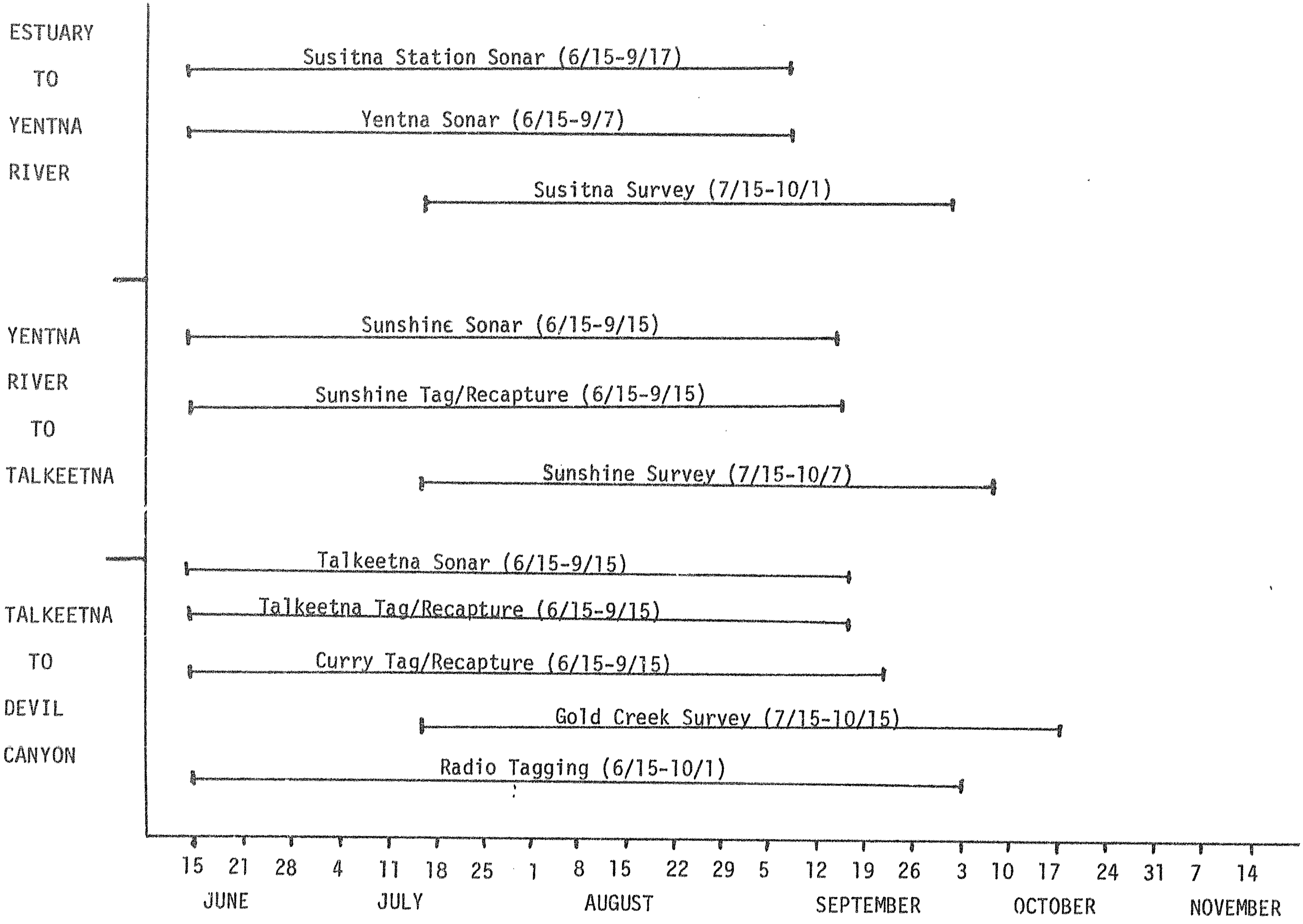



Figure 1. Adult Anadromous Project Schedule, 1981.

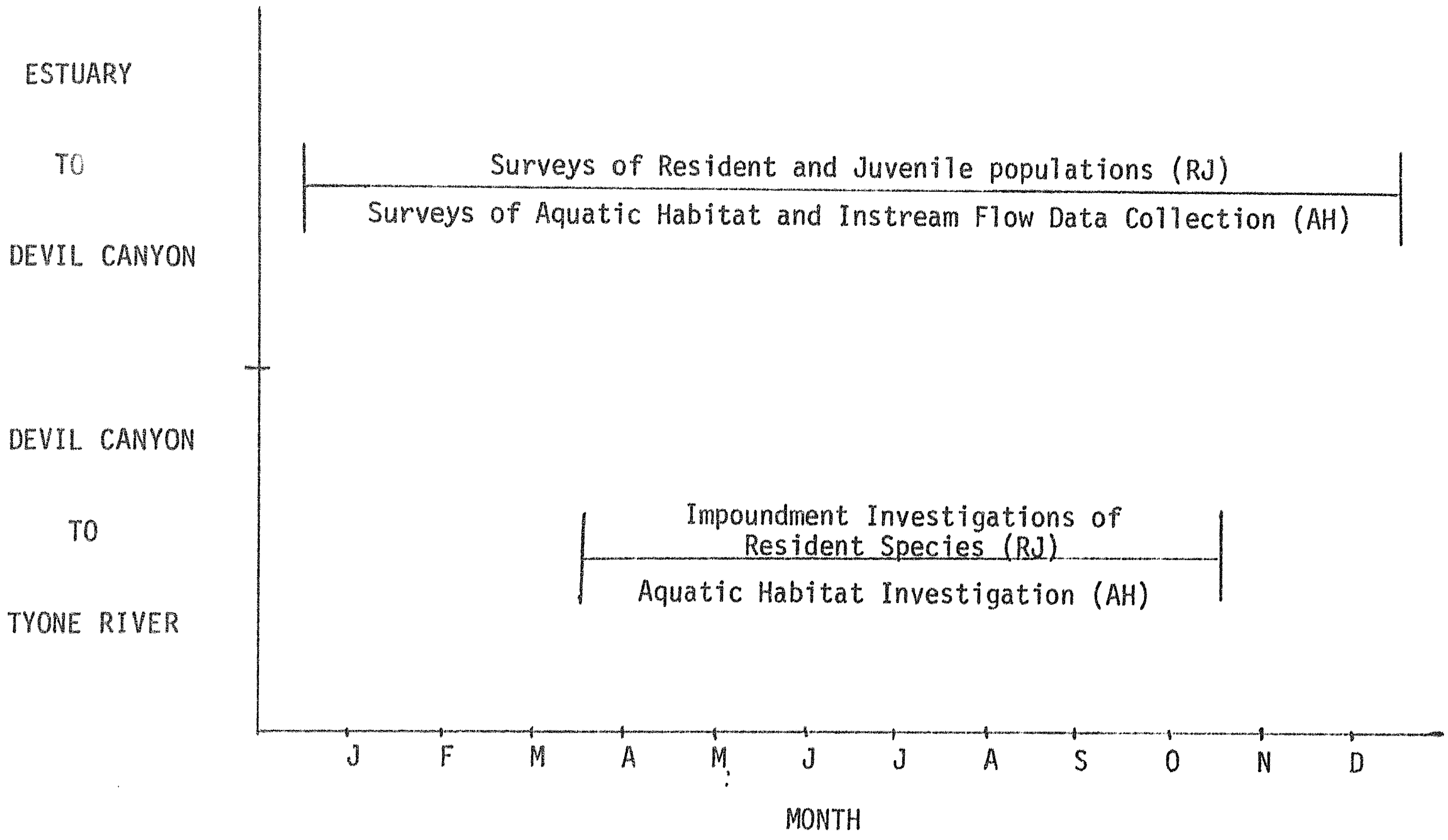



Figure 2. Activity schedule, 1981. Integrated Resident and Juvenile Anadromous Fisheries and Aquatic Habitat and Instream Flow Projects.

January -
10 - Monthly Report

February -
10 - Monthly Report

March -
10 - Monthly Report

April -
10 - Monthly Report

May - Quarterly Report
10 - Monthly Report

need copy

June -
10 - Monthly Report

July -
10 - Monthly Report

August - Quarterly Report
10 - Monthly Report

September -
10 - Monthly Report

October -
10 - Monthly Report

November - Quarterly Report
10 - Monthly Report

December -
10 - Monthly Report
15 - Anadromous Phase I Draft Report

Figure 3. Reporting Schedule, 1981.

## VI. PERSONNEL

Mr. Thomas W. Trent will supervise coordination of the Su Hydro Aquatic Studies. Tom is a 1965 graduate of the University of North Dakota with a degree in biological and physical sciences. After graduation, he undertook extensive post-baccalaureate and graduate studies at Oregon State University in fisheries and water resources.

Tom acquired professional experience in fisheries science and water pollution biology as a trainee for the Federal Water Quality Administration and with the Oregon Game Commission Research Division before he joined the Alaska Department of Fish and Game in 1971. Since joining ADF&G, Tom has held positions with the Sport Fish Division in the Anchorage area and West Side Susitna river sport fisheries management programs, and with the Habitat Protection Section dealing with development activities and environmental impact evaluation. In 1974, the Commissioner of Fish and Game delegated Tom the responsibility of developing and coordinating the Departments positions and policies on the proposed Susitna River hydroelectric project.

Tom resigned from the Department of Fish and Game in early 1975 to accept a position with the U.S. Bureau of Land Management as the State Fisheries Biologist. He subsequently rejoined the Alaska Department of Fish and Game in 1976 as supervisor of the Region II Habitat Protection Section. In this capacity, Tom was responsible for coordination of fish and wildlife resource planning and policy input to the DNR State Land Disposal program, management of the Title 16 regulatory program for Southcentral Alaska, and coordination of ADF&G Susitna River Hydro Project matters.

Mr. Bruce M. Barrett will supervise the Adult Anadromous Project. Bruce holds a Bachelor of Science degree in fisheries from the University of Alaska in Fairbanks and completed one year of graduate study in fisheries before joining the Alaska Department of Fish and Game in 1972.

Bruce has held several key positions with the Department of Fish and Game involving anadromous fish investigations in Cook Inlet and the Susitna River system. In 1974 he conducted the first ADF&G anadromous fish study on the Susitna River between Devil Canyon and the village of Talkeetna.

Mr. Kevin Delaney will head the Resident and Juvenile Anadromous Fisheries Study. Kevin holds a Bachelor of Science degree from St. Cloud State University in St. Cloud, Minnesota. In 1974 he joined the Alaska Department of Fish and Game in Kodiak, Alaska as a shellfish research biologist. Kevin transferred to Anchorage in 1976 where he co-authored the Alaskan Fisheries Atlas Volumes I and II.

Kevin has been involved with Susitna River studies since 1977. He conducted research on Susitna River juvenile chinook and coho salmon and held the assistant area Sport Fish biologist position for the western Susitna drainage before joining the Su Hydro feasibilities study.

Mr. Christopher Estes will lead the Aquatic Habitat and Instream Flow Studies. Christopher holds a B.A. in Environmental Science from Prescott College, Prescott, Arizona. Graduate course work at Washington State University was directed toward instream flow and aquatic habitat evaluation procedures. Upon approval of his thesis, he will receive a MS degree in the fall of 1981.

Christopher conducted his first instream flow and aquatic habitat evaluation study for the Montana Department of Fish, Wildlife, and Parks in 1975. He joined the ADF&G as a fishery research biologist in 1977 and has been associated with the Su Hydro feasibility studies since that time. In 1979, he initiated the ADF&G Instream Flow Program. During the same year, he was appointed Co-chairman of the Western Division of the American Fisheries Society Water Development and Streamflow Committee, a position he continues to fill.

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# APPENDIX I

## A. ADULT ANADROMOUS FISHERIES STUDIES

## Sonar Installation and Operation Manual

THE
BENDIX
CORPORATION

Electrodynamics
Division
North Hollywood
California

# INSTALLATION

# AND

# OPERATION

# MANUAL

# SIDE SCAN

# SALMON COUNTER

(1980 Model)

Report No.
SP-78-017
10 March 1980)

Prepared For:
The State of Alaska
Department of Fish
And Game
Anchorage
Alaska

TABLE OF CONTENTS





1 03

# INDEX

INTRODUCTION

Before attempting to operate or install the Side Scanner, thoroughly read this manual to become familiar with the system operation.

Section I will familiarize you with all the controls and their purpose. It is probably the most important section of this manual.

Section II will show you how to initially set up the unit and test it to determine that it is operating properly. Read this section before applying power to the unit.

Section III will aid you in pinpointing any source of problems and in making any necessary field repairs by replacing printed circuit cards.

Section IV will show you how to install the artificial substrate in the river.

1 06

I. FUNCTION OF FRONT PANEL CONTROLS

A. PRINTER

1. Printout

The printer prints out 12 lines of data.1/ The number at left designates the river sector, the next column is a letter identifying various conditions such as normal, command print, or auto test. These letters are explained on the front panel. If normal, the letter "A" will be printed.2/ The following 4 digits are the number of fish counts that have been accumulated in each sector. Each sector represents a length of river, perpendicular to the shore that is equal in length to 1/12 of the "COUNTING RANGE" control setting, with sector 1 being closest to shore. E.G., if the "COUNTING RANGE" control is set to 60 feet, then each sector represents 5 feet in distance. A + in the 3rd column indicates debris has been detected in the corresponding sector. Anytime PRINTOUT TIME OR AUTOTEST TIME is changed, the time must be reset.

2. Set Time (Printer)

The purpose of this pushbutton is to initially set the printout time and auto test time at any point. The "SAFETY SWITCH" must be "OFF" to do this.3/

3. Print Command

The printer may be commanded to print its contents at any time without affecting the timing. The letter "C" is printed when this pushbutton is depressed to permit you to know that this is a command print and not in the normal time sequence. The printout timing is not affected but the counts are erased after printout.4/

4. Printer On-Off Switch

This switch does not affect the timing or data in any way and is merely used to shut off the printer. The sounder will sound to alert you to put the printer ON-OFF switch back on. It normally takes only a minute to change paper so try to plan your paper change between prints.5/ models using the "DATEL" printer, be sure to shut off printer switch when changing printer paper.

5: Replacing Printer Paper - See next page.

B. Data Clear Time

Data is cleared (erased from memory) after each print out. Set for AT Print position on 1978 and 1979 models.

C. Clear Pushbutton

The red CLEAR pushbutton located on the left side of the panel will clear the data in the memories controlling the printer and 4 digit

5. Replacing Printer Paper

A blue line on the paper alerts you about 1 day in advance of p depletion. To change paper, shut off the printer switch and un screw the 2 small silver knurled screws on the printer face. L a new pad of paper in the rear tray with the blue lines toward tray bottom. Feed the paper over the silver roller in front an between the plastic face and rubber roller. Start the paper by revolving the rubber roller with your finger. When replacing th printer, push it in while making sure the paper is not pinched b tween the printer and panel by manually pulling some paper out c the slot. Make sure the printer seats completely flush with the panel since an electrical connector must make contact. Retighte the two knurled screws as tightly as possible with your fingers If the ink becomes dim after 2 to 4 years operation, loosen the two black screws on the printer face and pull out the ink pad. new pad may then be screwed in. Spare pads have been supplied t Alaska and spare printers have been included. Any printers may interchanged between systems, as they are identical.

1/ Set to print out on the hour. During operation place a binder c on the end of the tape as it comes out of the counter. Hanging clip over the edge of the counter stand will allow tape to move smoothly out of the counter, eliminating printer malfunction.
2/ 1978 model this may appear as a dot.
3/ On the hour.
4/ Erasure of data on '78 and '79 models can be avoided by setting DATA CLEAR TIME switch in NEVER position until printout is over.
5/ Or a complete printout could be missed without your knowledge.
6/ Screws on printers must be tightened daily as vibrations can cause them to loosen.

C. Clear Pushbutton Contd.

liquid crystal display. It does not affect the cumulative counter at right. To clear the data, the "SAFETY" switch must be "OFF". The sounder alerts you when this switch is left off.

D. 4-Digit Display and Manual Sector Selector

The liquid crystal display shows you the number of counts accumulated in any of the 12 sectors that is selected by the black thumbwheel switch above it. It is always on since it uses only 1 microamp of current. Being liquid crystal, it is a reflective display and requires some ambient light to be seen. At night a flashlight or match may be necessary to see it.

E. Meter, Meter Switch and Battery

When in the "BATT" position, the meter reads the condition of the GEL-CELL battery. When in the "SOLAR CHARGE" position, the meter reads the output of the solar panel. In full, unobscured sunlight the meter will read at the extreme right indicating the solar panel is supplying 12 times the current that the Side Scanner is using with the excess going to charge the supplied GEL-CELL battery. When the meter is at the point where the red and green meet (such as cloudy weather) the solar panel is supplying twice as much current as the Side Scanner is consuming with the excess going to charge the GEL-CELL battery. This would be enough to indefinitely carry it through the night hours. Although a 12V, 16 amp hour rechargeable GEL-CELL battery is supplied with each system, any 12V battery of equal or greater capacity may be used. The supplied battery, when fully charged, will operate the Side Scanner for approximately 300 hours, or about 2 weeks, day and night, with no solar charging. Internal protection is provided against battery overcharging in the event of constant full sun.

F. Fish Velocity Control

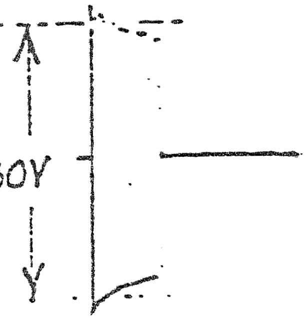
This thumbwheel switch controls the transmit repetition rate of the system. It has been observed that salmon migrate upstream at about 1.75 feet per second (ground speed). Since the switch is labeled in seconds per foot, the reciprocal of 1.75 feet per second is 0.571 seconds per foot so until new fish speed information is obtained, set the control to 0.571. (33T on Susitna west bank).

G. Sensitivity Control

This controls the amount of power transmitted to the transducer and is essentially a system sensitivity control.

To adjust it initially requires a fine bladed screwdriver or knife blade and an oscilloscope. It is adjusted as follows:

(1) Connect the oscilloscope input to the red test point on the panel marked XM2°. Set the vertical sensitivity of the scope to 5V per division and the scope trigger to internal. Set the horizontal scope sweep speed to 50 µsec per division. Make sure the transducer is properly connected and in the water.




(2) Set the beamwidth switch to 2°. Adjust the front panel sensitivity control for an average peak to peak (top to bottom) signal of 30V. It will look something like the Waveform at left so adjust for an average as shown.

(3) In very muddy rivers such as the Susitna, set this level to 35V.

H. Dead Range Control

This controls the distance from the face of the transducer that the system is "blanked out." That is, any echos received within this preset range will not be accepted for processing. The control may be set from 0 to 10 feet. This control is necessary to blank out transducer "ringing" which occurs for about 2½ feet and would result in false counts. Sometimes a source of air bubbles near shore exists which could cause false counts. In this case, increase the DEAD RANGE control until the count stops in sector 1 (as evidenced by the #1 fish light blinking). The fish would then have to be weired out to beyond the dead range. See "weirs" under Misc.

I. Counting Range Control

This controls the total perpendicular distance to which fish counts will be accepted. This preset distance starts immediately after the DEAD RANGE ceases, thus the total range from the face of the transducer is the total of both the "DEAD RANGE" and "COUNTING RANGE" settings.

J. Transducer Aiming

The end of the artificial substrate contains a target, approximately 60 feet from the transducer face. This is necessary for proper

J. Transducer Aiming (Contd.)

initial aiming of the transducer beam.1/ To do so, merely set the range controls for a total somewhat over 60 feet and manipulate the transducer until the sector #12 fish light consistently blinks. The $2^{o}$ beam should be used for this although the $4^{o}$ beam may be used to initially locate the beam. When in position, tighten the transducer mounting knurled handles.

The beam should be as low as possible without actually reflecting back from irregularities on the pipe so the best way to set the beam is to start high and lower the beam until it hits the target, then lower it further until echos begin returning from some point before the target, then raise it just enough to miss the early target.

To facilitate transducer aiming, the knurled handles should be partially tightened and the 3 foot rod supplied with the system alternately inserted in the vertical and horizontal holes in the transducer plate to move the transducer. Make sure that the final tightening does not upset the aiming.

An oscilloscope should be used in lieu of the #12 FISH LIGHT for more precise aiming. To do so, trigger the oscilloscope from the XM $2^{o}$ panel test point, connect the scope ground to the GND, test point and the scope input to the RCVR test point. Set the scope vertical control to 1 V/CM and the horizontal control to 5 milliseconds per CM.2/ The target will be observed on the scope 24 milliseconds from the start of the trace and the transducer may be manipulated for a maximum "spike" at that point. If the transducer is aimed too low, early echos coming from rough surfaces on the pipe will be seen before 24 msec.3/

The new (1978) artificial substrates have an improved method of transducer adjustment and have transducers modified for the new substrates. (See Figure 4 on the last sheet.) The transducer plate should be installed in the shroud on the shore end member. The 3 studs attached to the plate will be secured to the plate with the 3/8-16 locknuts.4/ About 1½ inch away there will be a 1/2-20 nut followed by a flat washer, a spring and flat washer in that order. The three studs should be pushed through the three corresponding holes in the shroud with the last flat washer against the inside of the shroud. A hand wheel should then be screwed onto the outside of the shroud on each of the protruding studs.5/ The transducer cables should be fed over the top of the transducer and back to shore, securing them with tape to prevent chafing and to

1/ Prior to submersion, transducer plate should be flushed on all sides with transducer housing. This can be accomplished by "feel" or using a straight edge.

2/ See section titled Oscilloscope Operation for the Side Scanner.



3/ See section titled Typical Side Scanner Oscilloscope Waveforms for various transducer aiming conditions.

4/ Use lockwashers and tighten with channel lock pliers.

5/ Extreme care should be taken when installing or removing transdu[illegible] as spring mechanisms [illegible]

J. Transducer Aiming (Contd.)

provide a little service loop to prevent their being torn off the transducer. The three hand wheels should be tightened with an equal amount of stud protruding through the wheel. The transducer will now be approximately aimed at the target end 60 feet away. (The remaining three hand wheels should be used after final transducer adjustment by running them up the stud and tightening them against the first wheel to lock them in place.)

The transducer should be accurately aimed at the target by the oscilloscope method discussed in the previous section with the following new exception. To raise the beam, screw the upper wheel clockwise (to the right) one turn for each 3/4 foot beam movement 60 feet away (or counterclockwise to lower it). To move the beam to the right, turn the lower right wheel clockwise and the lower left wheel the same amount counterclockwise at the same time. To move the beam to the left, reverse the procedure.1/ Each full turn of both wheels together will move the beam horizontally 1-1/2 feet. By turning them together, the vertical aiming remains unchanged and the upper wheel does not affect horizontal beam movement. The $2^{o}$ beam is 2 feet wide at 60 feet away. See attached section on Transducer aiming.

K. Cumulative Counter

This counter maintains a running total of all counts. It is an 8-digit counter and being of the L.E.D. type, consumes a fair amount of power when lit. For this reason a "READ" pushbutton is provided below it to read the total when desired. To clear the cumulative counter, shut OFF the SAFETY switch and depress the "CLEAR" pushbutton located below the counter. The alarm will alert you that the "SAFETY" switch is OFF.

L. Safety Switch

This switch is an interlock provided to prevent accidental clearing of the data or accidental resetting of PRINTER time or AUTOMATIC TEST time. Whenever it is left in the "OFF" position the sounder will sound, alerting you of this fact.

M. Sounder

The sounder will alert you whenever any of the following three switches are left in the "wrong" position to prevent walking away from the unit in that condition: (The sounder will "click" whenever fish is counted.2/

1/ Horizontal movements should involve exactly the same amount of turning on each wheel to avoid "skewing" the beam out and up or down.

2/ Speaker may be covered when working to lessen obnoxious noise. However, the speaker is not a gum repository.

M. Sounder (continued)

a. Sounds when "DATA" switch is left "OFF".

b. Sounds when "PRINTER" switch is left "OFF".

c. Sounds when "SAFETY" switch is left "OFF".

N. Test Pushbutton and Data Switch

The purpose of this test is to verify proper functioning of almost the entire system (except the transmitter). This button, when depressed, electronically simulates fish in the first 11 sectors. When the system is operating properly, the first 11 fish lights will blink, the sounder will sound, the cumulative counter and the 4-digit counter at left will record these counts. If only a partial system test is desired, without interfering with data already present in the memories or the cumulative counter, the "DATA" switch should be left "OFF". This will prevent these "false counts" from being recorded but will permit the FISH lights to blink. When a full system test is desired at the cost of losing the data already present, the "DATA" switch may be left "ON".

O. Fish and Sector Lights

The two red SECTOR L.E.D.'s indicate that the electronics logic card is probably functioning properly. The sector lights must always blink. If a light(s) does not blink, the cause may be merely a burned out light. This can be verified by dialing the large thumbwheel switch to the sector in question and simulating fish by depressing the "TEST" pushbutton with the "DATA" switch "ON". If data is recorded in that sector, it merely means that either the light is bad or the L.E.D. card in the system is bad, which will not affect proper operation.

To check sector 12, merely increase the "RANGE" control setting a few feet to "count" the target at the end of the substrate. The FISH lights will blink whenever fish are detected in the corresponding sector and the sounder will sound.

P. Automatic Test

This feature permits automatic self testing of the entire system including the transducer and its proper aiming. It functions automatically each 22 hours as follows:

Note: 1978 and 1979 models can be set at 6, 12, or 24 hours.
Set at 24 hours.

P. Automatic Test Cont'd.

To start the 12 hour timing sequence at any point in time, press the "SET TIMES" red pushbutton. This initiates both the printer and auto test times. Precisely 2 seconds after the normal printout 12 hours later, the system will go into an automatic test mode. It will automatically electronically simulate between 2 to 7 fish in each of the first 11 sectors and it will automatically extend its range by 3 feet, thus counting the artifical target 60 feet away and recording these counts in sector 12. It will then print out all these counts and the letter E in the second column to indicate a self start.1/ None of these counts will enter the cumulative counter at right, and will be erased right after the print.

Q. Test Points on Panel

The test points have the following purposes:

1. XMALT. This test point is connected to the 4$^{\circ}$ section of the transducer which shows the transmitted voltage when the unit is transmitting at 4$^{\circ}$.

2. The XM2$^{\circ}$ test point is directly connected to the transducer sector that is selected by the beamwidth switch and permits oscilloscope reading of the transmitted voltage, thus checking the transmitter card in the system. The 4$^{\circ}$ transmit will always be considerably higher than the 2$^{\circ}$ transmitted voltage except when the beamwidth switch is set to 2$^{\circ}$. When the "BEAM WIDTH" switch is in the "ALT" position, the transmitted voltage can be seen to alternately go high and low as the 2$^{\circ}$ and 4$^{\circ}$ sectors are automatically selected.

3. RCVR Test Point. This test point is the receiver output and gives a true "analog picture" on an oscilloscope of what is happening in the water. Any echos received are amplified and presented at this test point. Any time the echo exceeds 3 volts at this point for the proper pre-programmed number of "hits" it will result in a count. To use this feature, the scope input is connected to the "RCVR" test point, the scope ground connected to the "GND" test point and the scope may be

1/ 1978 and 1979 models will have letter I in the second column.

Q. Test Points on Panel Contd.

triggered from either the "XM" test point which permits observation of the entire 60 feet or from any one of the "SCOPE - TRIG" test points which starts the scope trace at the beginning of any of the 12 sector "listening times." The scope trigger must be set to - . By doing this and properly expanding the scope sweep speed, any one or more of the 12 sectors may be individually observed.

R. Beamwidth Switch

This switch electronically controls the transducer beamwidth by connecting only the center section of the transducer for a $4^{o}$ beamwidth or paralleling both the center and outer transducer sections for a $2^{o}$ beamwidth. Any of the three modes may be selected, but for optimum coverage, the "ALT" position should be used since this tends to make the lateral coverage more uniform. When in the "ALT" position, the system alternately transmits on the $2^{o}$ sector then on the $4^{o}$ sector and back to the $2^{o}$ sector, etc. After transmitting on the $4^{o}$ sector, only those echos received during the first half of the active range are accepted (sectors 1 thru 6). When transmitting on the $2^{o}$ sector, only those echos received during the last half of the active range are accepted (sectors 7 thru 12). The system electronically gives more weight to sectors closer to the transducer face since the fish will be in the beam a shorter period of time because of the fact that the closer to the transducer, the narrower the beamwidth. A number of samples of each fish are taken, permitting different "aspects" of the fish to be sampled as it crosses the beam. A varying number of valid "hits" are required before the system "decides" the target is a fish and enters it into permanent memory. The number of valid hits required for detection is a function of which of the 12 sectors the fish was detected. For example, although a fish travelling at 1.75 feet/sec is sampled 9 times, if it is detected in sector 9, only 5 valid "hits" are required to count, so if 5, 6, 7, 8 or 9 hits are made during the passage of the fish, only 1 count will result.

This feature essentially eliminates downstream passing debris which typically is travelling at the river velocity which is usually much faster than 1.75 ft/sec and which would not be in the "beam" long enough to count. To prevent single debris counts occurring over a period of time from adding up to the number required for a valid fish count, the temporary fish decision memories are automatically cleared 4 transmissions after receipt of any single echo.

5. Debris Alerting

Any time 24 counts are made in any one of the 12 sectors in a 35 second period (starting from the first count), the system assumes that this cannot be fish and is probably a piece of debris hung up on the artificial substrate. When the next printout occurs, the corresponding sector column will contain the symbol "+" in the 3rd column next to the sector identification number.1/ After printout, the debris detector is cleared and starts out "fresh" again. If the debris is still present, the system will again accept up to 24 counts in 35 seconds and indicate "+" again. If the debris has washed away, it will resume normal operation.

NOTE: Some of the front panel switches are of the "PULL TO CHANGE" types. This is to prevent inadvertent changing of the switch positions. The switch handle must be pulled away from the panel and then changed. Make sure that the switch is firmly seated in the desired position.

T. Tape Recorder Operation

The salmon counter is designed with the provision to tape the following two outputs on a JVC-1636 cassette stereo tape recorder:

a. RECEIVER - This output is the raw but amplified echos received by the transducer.

b. FISH - This output provides a 65 microsecond pulse every time the system decides that the echos received were that of a fish and not passing debris (unless the debris becomes hung up on the pipe and counts continuously.

c. TAPE PWR - This output provides a regulated 8.7 volts to power the tape recorder automatically for 3.6 minutes after each printout.

The purpose of the tape feature is to permit calibration of the system, after the fact, at some later date. It has been found that visual oscilloscope observation of the receiver output is an excellent indicator of fish passage, even in glacially silty water. Test conducted in Wood River have shown that, with a little practice, an oscilloscope observer can count the fish passage with a better than 95 percent correlation with an observer on the fish counting tower since passing debris echos are of a fleeting nature while fish can be seen entering and leaving the beam with a gradual build-up and decay of its echos.

Thus, by recording the receiver echos and the actual simultaneous fish counts that the salmon counter has electronically decided upon, the two may be compared and system accuracy determined for any given site. The fish velocity control may then be changed to permanently calibrate system.

To record, merely plug the dc power cord of the tape recorder into the side scan TAPE PWR plug, plug the RECEIVER output into the right channel line input of the tape recorder. Plug the FISH output into the left channel line in of the tape recorder.1/ Set the tape recorder controls as follows: SUPER ANRS, CRO2, line, (use only TDK SA-C90 tape).2/ Set the recorder level controls to maximum, press the RECORD and PLAY buttons. Be sure the tape is inserted and at its beginning. When the TAPE PWR switch is in the AUTO position, the tape recorder will automatically come on for 3.6 minutes after each print, thus recording a 3.6 minute sample of the echos and counts each hour at the usual printout setting of 1 hour. Since each side of the cassette has 45 minutes recording time and there are twelve 3.6 minute periods in 45 minutes this means that the recorder can operate unattended for a 12 hour period before turning over the tape.

NOTE: Never leave the TAPE PWR switch in the "ON" position, since this position is only used to set up the tape recorder or to record for greater time periods. Even if no tape recorder is plugged into the side scanner, this would cause the system to consume 20 percent more power needlessly.

## II. INITIAL SET UP AND SYSTEM TEST

To verify proper system operation when first turned on or anytime desired, do the following:

| |
|---|
| Before the battery is plugged in, which turns on the system, place the following switches in the noted positions: |

(1) PRINTER OFF.

(2) TRANSDUCER NOT PLUGGED IN.

(3) SAFETY SWITCH OFF.

(4) METER SWITCH in BATT position.

(5) FISH VELOC to 0.571.

(6) DATA ON.

(7) ACTIVE RANGE to about 50 feet.

The remainder of the controls may be left in any position.

Next, plug in the battery and then press the ~~SET TIMES push~~button. (This synchronizes the system.) Some of the FISH lights may remain on. To clear the system, press and hold the red TEST pushbutton noting that each of the FISH lights blink in sectors 1 thru 11. The system is now cleared and ready for operation. At this time, the SECTOR lights should be blinking and the BATTERY CONDITION METER should be in the green.

1/ FISH output is left or white cord.
2/ Tapes should be run through fast forward and reverse once to lessen wow and flutter effects.

Press the two red CLEAR pushbuttons to erase any counts from the memories.

Press and hold the red TEST pushbutton. This will simulate counts on sectors 1 thru 11. Hold it in until a few hundred counts appear on the CUMUL counter. (You have to press the black READ pushbutton to see this.)

The next step will be to verify that counts have been registered on each section of the 4-digit liquid crystal display and that the printer is functioning, and that all counts agree. To do this, turn on the PRINTER switch and momentarily press the black PRINT COMM pushbutton. The printer should now print out 12 lines of data. The left will be the sector identification number and should sequentially read 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2. The next column should have printed the letter "C" Dial the large black thumbwheel switch through its 12 positions and compare the numbers in the 4-digit numerical display with the corresponding blue printed columns. They should agree.

Next, add up the column of figures. The total should agree with the total CUMUL count within one or two digits.

Solar Panel

The purpose of the solar panel is to charge the 16AH GEL-CELL battery supplied with the system.

Mount the solar panel such that it will receive a maximum average amount of light throughout the day. Plug it into the side connector marked SOLAR PANEL (observing polarity).1/ Put the METER switch in the SOLAR CHARGE position. If full sunlight is falling directly on the solar panel, the meter will be at the extreme right. In very cloudy weather the meter will probably be in the red. When it is at the red/green crossover point, the solar panel is supplying twice as much current as the system is consuming, with the excess going to the battery. This condition will be adequate to indefinitely carry the system through the night hours. Make sure no part of the solar panel is shaded because shading one cell is the same as shading the entire panel.

If the solar panel is connected backward, no damage will result, but the meter will read no solar charge when exposed to light.

III. TROUBLESHOOTING

Many complete sets of printed circuit card spares have been supplied to Alaska Department of Fish and Game. They contain pre-tested cards of every type used in the Side Scanner System.

They are identified by a function name etched on the component side of the cards at the upper left corner of the card. The following table lists the P.C. card names and their functions to aid in troubleshooting.

1/ This means red to red and black to black.

| Printed Circuit Card Name & Location in P.C. Card File | Card Function |
|---|---|
| MEMORIES<br><br>(Slot 1 & Slot 2) (These 2 cards are identical) | The memory cards store valid fish counts after the electronic decision has been made if debris or fish. They drive the 4 digit liquid crystal display and the printer. They have nothing to do with the cumulative counter display. The 2 cards are identical and interchangeable. The memory card in slot 1 controls the two most significant digits of the display and printer fish counts, i.e., the two digits on the left. The memory card in slot 3 controls the 2 least significant digits of the display and printer fish counts, i.e., the two digits on the right. |
| LOGIC<br><br>(Slot 5) | The logic card controls the system repetition rate (or "ping" rate). It controls the duration of the transmit signal, the 11 simulated fish counts for test, the automatic range extension during auto test, the counting range, the dead range, the smolt vs. fish function, the power to the receiver, all the L.E.D. functions, the 12 sector scan, the cumulative counter, the sounder duration when fish are detected and the temporary memories which decide whether the echo detected is fish or debris. If debris, it is erased; if fish, it is routed to the previously mentioned permanent memories cards for storage and then erased from this card. This card also controls the $2^{o}$, $4^{o}$ and ALT beam routing in conjunction with the beamwidth switch. |
| PRINTER<br><br>(Slot 7) | The printer card controls the printer time clock, the printer command, the 12 print sequencing, the printer sector I.D. number printed on the left of the printed paper, the letters printed next to the left on the printed paper, the automatic self test timing, the erasure or automatic clearing of the data after print, the tape recorder automatic power turn-on for 3.6 minutes after each print, and makes the decision whether a very high rate of counts is fish or debris and if debris it tells the printer to print the symbol "+". |

| Printed Circuit Card Name & Location in P.C. Card File | Card Function |
|---|---|
| RECEIVER<br><br>(Slot 11)<br><br>CAUTION:<br>If this card is changed, it will be necessary to readjust the sensitivity screwdriver control on the front panel as discussed earlier in this manual. | The receiver card contains the receiver which takes the minute fish echos, amplifies them 23,000 times and if the echo exceeds a predetermined threshold it triggers a device which sends a signal to the temporary memory card for subsequent decision as to whether it was fish or debris. This card also contains a 9V regulator to power the entire system. It also controls the battery and solar charge meter and provides T.V.G. which means time variable gain which causes fish echos detected far away to be amplified at a greater factor than fish close by since the echo decreases with distance in a log manner. This card also contains the transmitter which transmits a 515 kHz signal to the transducer. The card also contains part of the circuitry to electronically simulate fish in the first 11 sectors for automatic and manual test. The tape recorder power regulator is located on this card also. |
| LIQUID CRYSTAL DISPLAY CARD.<br><br>Located on front panel. | This card contains a 4-digit liquid crystal display on the front panel. If it becomes defective it may be removed from the <u>inside</u> by removing the two retaining 6-32 nuts and replacing it with a spare display card. If this done, be sure the two flat plugs that are inserted in its connector are <u>firmly</u> inserted in the new card in identical orientation. The display has an average life of about 7 years. It will be noticed that in cold weather the display takes longer to change its numbers. This is a <u>normal</u> characteristic of liquid crystal displays. |

Most of the card functions are self-explanatory so that in the event of trouble, a card may be replaced. Since many of the card functions are inter-related, a problem may sometimes not be definitely localized to a specific card and more than one card may have to be interchanged to cure the problem (one at a time).

To change a printed circuit card, <u>disconnect</u> the <u>battery</u> and <u>solar panel.</u> Remove the 6 screws holding the front panel and carefully lift the front panel <u>straight</u> up. It may then be turned and laid down next to the electronics.

<u>CAUTION:</u> The electronic components on the cards are suceptible to immediate destruction by static electricity. They should never be handled in an office where carpets generate static electricity.

Replace the suspect card with a new one and retest. The system can be operated in the open position so it will not be necessary to close the system to test it, but be very careful not to short anything.

To remove a card, pull up on the two card ejectors. To replace a card, press the card firmly down and hook the combination black card ejector/inserter under the ridge of the card file and push the two black interters down. These will force the card into its sockets and may have to alternately be "rocked" until the card i- firmly seated in its socket.

CAUTION: NEVER remove or replace a card with power from the battery or solar panel connected.

To replace the panel, reverse the removal procedure being careful not to pinch any cables between the panel and the case. The 6 nuts are on sliding plates and may have to be repositioned with a knife blade if they were moved.

## IV. SIDE SCAN ARTIFICAL SUBSTRATE

General Description

The array (Figure 1, 2 and 3) is made up of three 18½ foot long sections of tubes that plug together with an 18 inch overlap forming a single tube.

Off shore and on shore sections terminate the assembly ends. A 1/4 inch diameter wire rope runs through the assembly and is pinned to the off shore cap. The on shore cap has a threaded shaft and handwheel which is used to provide tension holding the array sections together by tensioning the cable.1/ Alignment of the vortex shedding fins on each section is required in order to prevent oscillation or vibration of the array in fast currents. Install and tighten the 1/4" bolts on the welded brackets. These will squeeze the slots together thus securing the pipes together.2/

NOTE: The bolts should be tightened with the pipe upside down from the way it will lie on the river bottom. This will help straighten the pipe.

The off shore cap provides the wire rope termination, has a water check valve used for blowing out and floating the array, mounts the off shore cable attachment point and has a target attached for acoustic signal alignment.

The on shore cap has a 2 inch diameter hole in the end which is used to stake the array in position on the shore. A second 2 inch hole may be used

1/ Cable should be threaded on downstream side of bolts which hold sections together.

2/ 1978 and 1979 arrays: tighten 1/2 inch diameter bolts to 45 ft/lbs (second bolt from target end - tighten to 20 ft/lbs only). If too loose, the array will bend excessively, allowing fish to escape under the beam. If tightened to greater than 60 ft/lbs, the bolts will break or the tube deform.

to tie off the array for safety. A mount for the transducer is provided on this cap. Both verical and horizontal adjustment of the transducer is possible. A 1/2 inch diameter x 2 feet long bar is provided to use as a lever for aligning the transducer on the 1976 systems. The new systems have adjustment hand wheels. Mount the transducer in the upper 3 holes of it's housing.

A traveler, attached to the cable swivel, rides on a bar preventing rotation of the cable when tightening.

NOTE: The cable must be as tight as possible to prevent array breakup in fast rivers. Hand tighten only.

A 1/2 inch threaded plug is provided for an air hose to blow out and float the array prior to removal from the river bed. Netting is tied to the lower vortex fin. 1/8 inch diameter holes spaced at 1-1/2 inch intervals provide net tie points. Holes are provided on both top and bottom fins as installation on the opposite shore requires turning the array end for end and rotating $180^{\circ}$.

NOTE: It has been found by A.D.F.&G. that if no air is available, the array may be raised by allowing the pipe to tilt down in the direction of the water flow. The fairings act as ailerons and will raise the pipe to the surface. Conversely, when sinking the array, the stake on the shore end should be attached via a "come-along" to a tree and should be tilted upstream a few degrees to help sink the array and hold it firmly on the river bottom.

Assembly Procedure for 60 Foot Array

1. Layout the following parts on a reasonably level surface parallel to the river bed in the order listed. Leave 1 foot space between parts.

   1 each Off Shore Cap.

   2 each 18-1/2 foot section with couplers attached.

   1 each 18-1/2 foot section without coupler.

   1 each On Shore Cap (screw in tension screw handwheel all the way).

2. Attach swivel end of 1/4 inch cable (36-1/2 foot long) to eye on threaded tension screw.

3. Feed opposite end of cable (with eye) through the 18-1/2 foot tube sections. Cable must pass through center hole in bulkheads (2 places), and on downstream side of 3/8" bolts.

4. With the on shore cap transducer housing straight up, slip the first 18-1/2 foot section onto the shore cap (male), reduced diameter, align the bolt holes and install 1/4 inch diameter bolts. Be sure 18-1/2 foot section is facing in right direction. Fins go downstream. 1/

5. Install second and third sections in similar manner. 1/

NOTE: If couplings hang up and do not seat the cable and tension secrew can be used to pull the couplings together. However, care must be taken to align the fins during coupling insertion as turning the sections after complete assembly may be difficult.

6. Insert cable eye through the off shore cap and install cap on last section. Insert bolt. Target (curved projection) should be up.

7. Install end plate (with slot for pin) onto off shore cap. Cable should project through cap center hole and extend out about 12 inches if all couplings are seated.

8. Start to tighten handwheel inside on shore cap until cable eye is aligned with slot in end plate.

9. Install pin through eye and seat in slot of end plate.

10. Tighten cable hand tight, using handwheel. All couplings should now be fully seated.

11. Install coupling bolts and cap nuts not previously installed. Tighten to 20 ft/lbs only; apply silicone.

12. Install end cap onto end plate covering cable and pin using two 3/8 inch bolts.

2/

13. The array is now ready for placing into the river.

Array Installation Procedure

Installation of the array into the river will vary from one location to another dependent on local terrain and river conditions. Primarily, current speed will determine whether the array can be floated and swung into place from a parallel to the river position, see Figure 2A (slow currents 2-3 feet per second) or pushed into the river at right angles to the current with the off shore end controlled by a cable, see Figure 2B, current of 4 to 7 feet per second.

1/ Coat outside of reduced diameter portions with clear silicone to prevent air leaks. Also coat both ends of bolts.

2/ To prevent air leaks (when raising):
1) Wrap all seams tightly with grey 2" pvc tape (this may require cutting fins back 2-3" on each side of seam).
2) Place 2 connected 8" hose clamps on each side of seam and over tape.
3) Tighten clamps being careful to keep clamp nuts to downstream side of array and out of beam path.

A judgement as to the best procedure must be made at each site based on the results of past experience. The following steps will apply to both methods.

1. Attach an appropriate shore cable 1/4 inch minimum diameter to upstream end of clamp provided on off shore cap.1/

2. Attach opposite end of shore cable to stake, tree or other available attachment point. CAUTION NOTE: In 7 foot per second currents cable tension of floating array will be as high as 850 pounds.

3. Push the array into the river with transducer housing in a vertical position. (Vortex fins parallel to water flow.) Array must be positioned with reasonable speed as water will leak into the numerous unsealed joints allowing the array to sink in 5 to 10 minutes. The array will have an initial positive buoyancy of about 900 pounds when floating.2/

4. A 1-1/2 inch diameter steel stake should be ready to drive through the on shore cap into the river bed during deployment of the array. This stake must be long enough to be driven securely into the river bed as well as extend out of the water. See following page for new inshore end instructions.

5. Remove the 1/2 inch plug on top and the plastic plug on the side to permit the pipe to sink quickly.

6. The array when installed should have at least 1/2 foot of water over the transducer.

7. Alignment of the transducer beam with the target mounted on the off shore cap is accomplished by separate horizontal and vertical adjustment procedures, see Figures 1B and 1C.

Horizontal

Loosen Knob "A" and the two horizontal adjustment plate bolts. Install adjustment bar into horizontal adjustment hole (do not loosen opposing side knobs B and D). Adjust beam by moving bar forward or aft as required. When correctly positioned tighten the horizontal adjustment plate bolts.

NOTE: This adjustment is a one-time adjustment and should not require readjustment until the transducer is replaced.

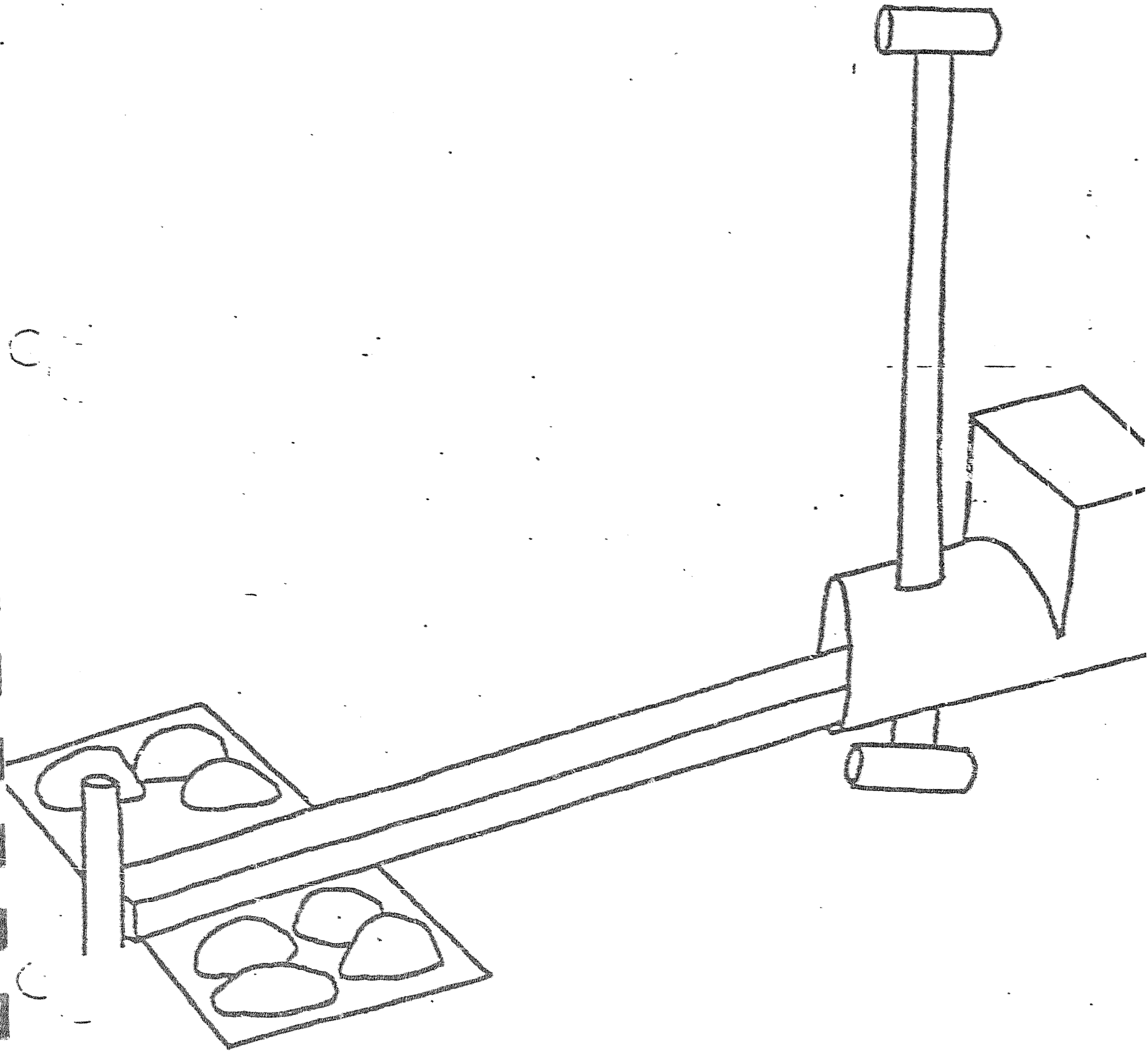
Vertical

Loosen knobs A, B, C, and D. Install adjustment bar into vertical adjustment hole. Adjust by moving bar forward and aft in slotted hole. When adjusted tighten knobs A, B, C, and D.

1/ Easier in and out movement of array while in water can be accomplished by using an inshore cable also. REMEMBER the longer the cable, the easier it will be to move the array in and out.

2/ If correct sealing procedures are followed, the tube will not sink rapidly.

4) The 1 1/2" diameter stake should be replaced with a 2" O.D. x 4' long steel pipe thread on both ends which acts as a "pivot point". Pipe "T"'s are attached to both ends after it is pushed through the holes provided on the inshore end. Movement of the array inshore from current pressure is prevented by placing a 4 x 4 or pole in the opening below the transducer housing and butting it up against the pivot pole. Weights or stakes can then be used to hold the 4 x 4 or pole in place (see drawing).



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5. Install second and third sections in similar manner. 1/

NOTE: If couplings hang up and do not seat the cable and tension secrew can be used to pull the couplings together. However, care must be taken to align the fins during coupling insertion as turning the sections after complete assembly may be difficult.

6. Insert cable eye through the off shore cap and install cap on last section. Insert bolt. Target (curved projection) should be up.

7. Install end plate (with slot for pin) onto off shore cap. Cable should project through cap center hole and extend out about 12 inches if all couplings are seated.

8. Start to tighten handwheel inside on shore cap until cable eye is aligned with slot in end plate.

9. Install pin through eye and seat in slot of end plate.

10. Tighten cable hand tight, using handwheel. All couplings should now be fully seated.

11. Install coupling bolts and cap nuts not previously installed. Tighten to 20 ft/lbs only; apply silicone.

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13. The array is now ready for placing into the river.

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Installation of the array into the river will vary from one location to another dependent on local terrain and river conditions. Primarily, current speed will determine whether the array can be floated and swung into place from a parallel to the river position, see Figure 2A (slow currents 2-3 feet per second) or pushed into the river at right angles to the current with the off shore end controlled by a cable, see Figure 2B, current of 4 to 7 feet per second.

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1) Wrap all seams tightly with grey 2" pvc tape (this may require cutting fins back 2-3" on each side of seam).
2) Place 2 connected 8" hose clamps on each side of seam and over tape.
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A judgement as to the best procedure must be made at each site based on the results of past experience. The following steps will apply to both methods.

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2. Attach opposite end of shore cable to stake, tree or other available attachment point. CAUTION NOTE: In 7 foot per second currents cable tension of floating array will be as high as 850 pounds.

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5. Remove the 1/2 inch plug on top and the plastic plug on the side to permit the pipe to sink quickly.

6. The array when installed should have at least 1/2 foot of water over the transducer.

7. Alignment of the transducer beam with the target mounted on the off shore cap is accomplished by separate horizontal and vertical adjustment procedures, see Figures 1B and 1C.

Horizontal

Loosen Knob "A" and the two horizontal adjustment plate bolts. Install adjustment bar into horizontal adjustment hole (do not loosen opposing side knobs B and D). Adjust beam by moving bar forward or aft as required. When correctly positioned tighten the horizontal adjustment plate bolts.

> NOTE: This adjustment is a one-time adjustment and should not require readjustment until the transducer is replaced.

Vertical

Loosen knobs A, B, C, and D. Install adjustment bar into vertical adjustment hole. Adjust by moving bar forward and aft in slotted hole. When adjusted tighten knobs A, B, C, and D.

1/ Easier in and out movement of array while in water can be accomplished by using an inshore cable also. REMEMBER the longer the cable, the easier it will be to move the array in and out.

2/ If correct sealing procedures are followed, the tube will not sink rapidly.

## Array Removal Procedure

1. Blow out water in the array through the check valve located in the shore cap. This is done by removing the 1/2 inch pipe plug located in the shore cap and replacing with an air hose. Air pressure applied here (as from a diver's tank) will force water out the check valve floating the array assembly.

   If no air is available, the alternate raising method described earlier may be used, i.e., allow the shore end stake to tilt forward (downstream) which will raise the array by the aileron action of the fins.

2. The floating array can now be hauled ashore either by pulling straight out or by pulling in the off shore cable.

## Array Disassembly Procedure, See Figure 1A, 1B and Figure 3

1. With the array on a reasonably level area remove the end cap by unscrewing the two 3/8 inch bolts.

2. Untighten (screw in) the handwheel inside the on shore cap. This will loosen the tension cable and allow removal of the pin on the off shore end plate.

3. Remove the end plate.

4. Drive a stake through the 2 inch on shore cap hole into the ground. Also drive a second stake into the ground about 10 feet from the opposite end of the array.

5. Attach the "Y" cable to the off shore cap, see Figure 3. Install come-along between stake and "Y" cable.

6. Remove through bolt of first section to be disassembled (any order is OK).

7. Pull apart with come-along.

8. Install 2 eye short cable between sections pulled apart. See Figure 3.

9. Remove next through bolt and pull apart next section.

10. Continue process until all sections are pulled apart.

## General Caution Notes

1. Before placing array in water inspect check valve operation.

2. Cable must be tensioned before array deployment.

3. Do not turn array votex fins into current in currents over 4 feet per second. Excessive load may damage array.

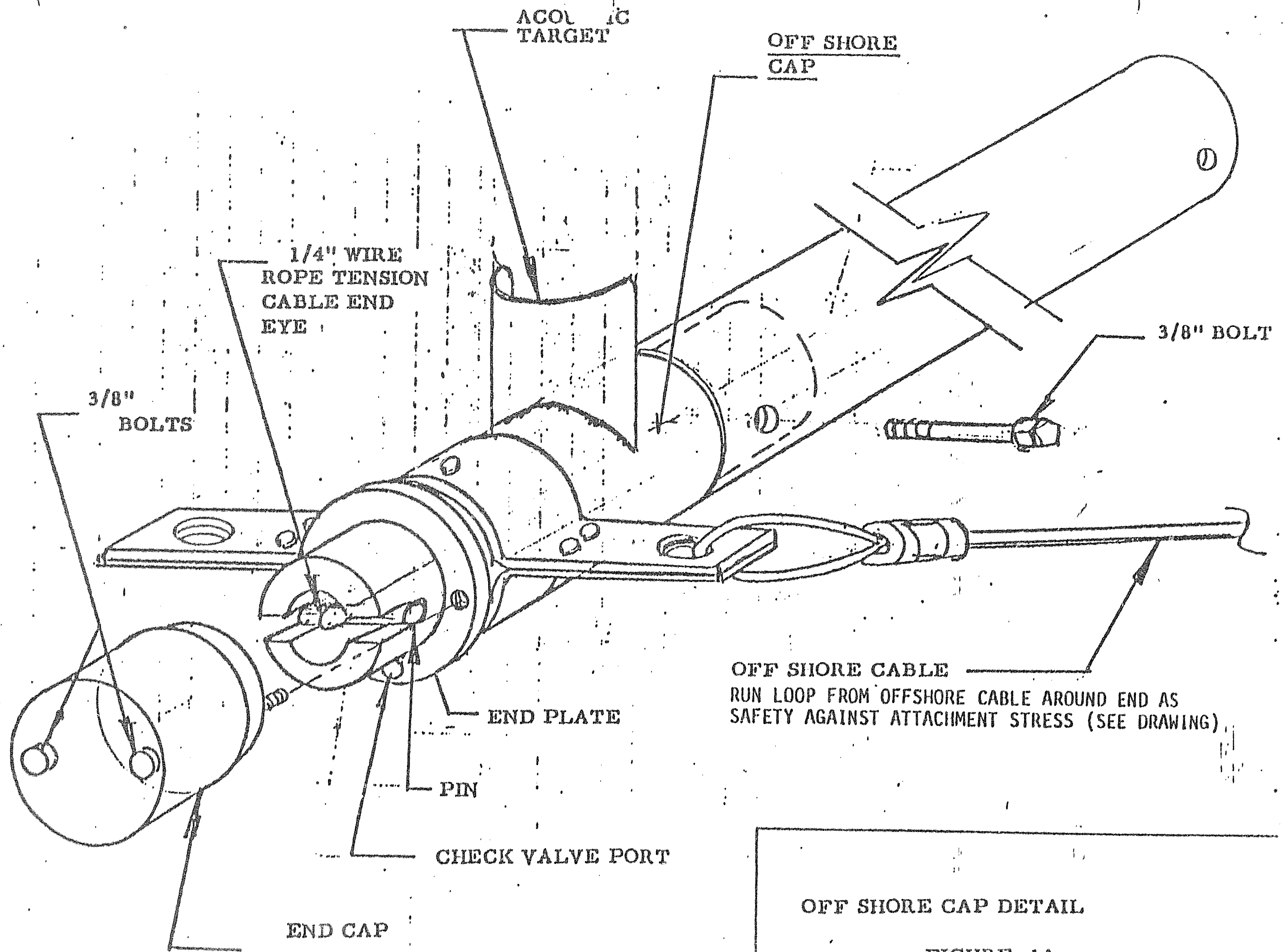
4. Installation of a cable around the <u>on shore cap</u> to a stake upstream on shore may be useful in a fast current river.

5. If corrosion prevents loosening of cable tension wheel on assembled array, the off shore cap pin may be driven out, after removal of the cap, thus releasing cable tension.

6. Handle exposed section ends with reasonable care to avoid nicks or tube distortion.

7. Be sure 1/2 inch diameter carrage bolt in coupling sections are tightened to 45 ft. lbs. in order to eliminate coupling to tube clearance thus preventing array sag. <u>Never</u> exceed 50 ft. lbs.

8. Transducer. The transducer, although reasonably rugged would be destroyed if dropped on a rock. Before use, the radiating polyurethane face should be washed with a detergent, preferably liquid detergent with the liquid left on the face. This cleans off finger oils. Any oil or grease will completely block the high frequency output and make the transducer inoperative. In some rivers, a buildup of various forms of "crud" may develop on the transducer face after a week or two, so a quantity of liquid detergent should be placed in the hand and the hand quickly put under water to rub the face of the transducer. This should be done whenever too much buildup of "junk" is felt or seen on the transducer face. A moderate amount of detritus will not affect normal operation.




OFF SHORE CAP DETAIL

FIGURE 1A

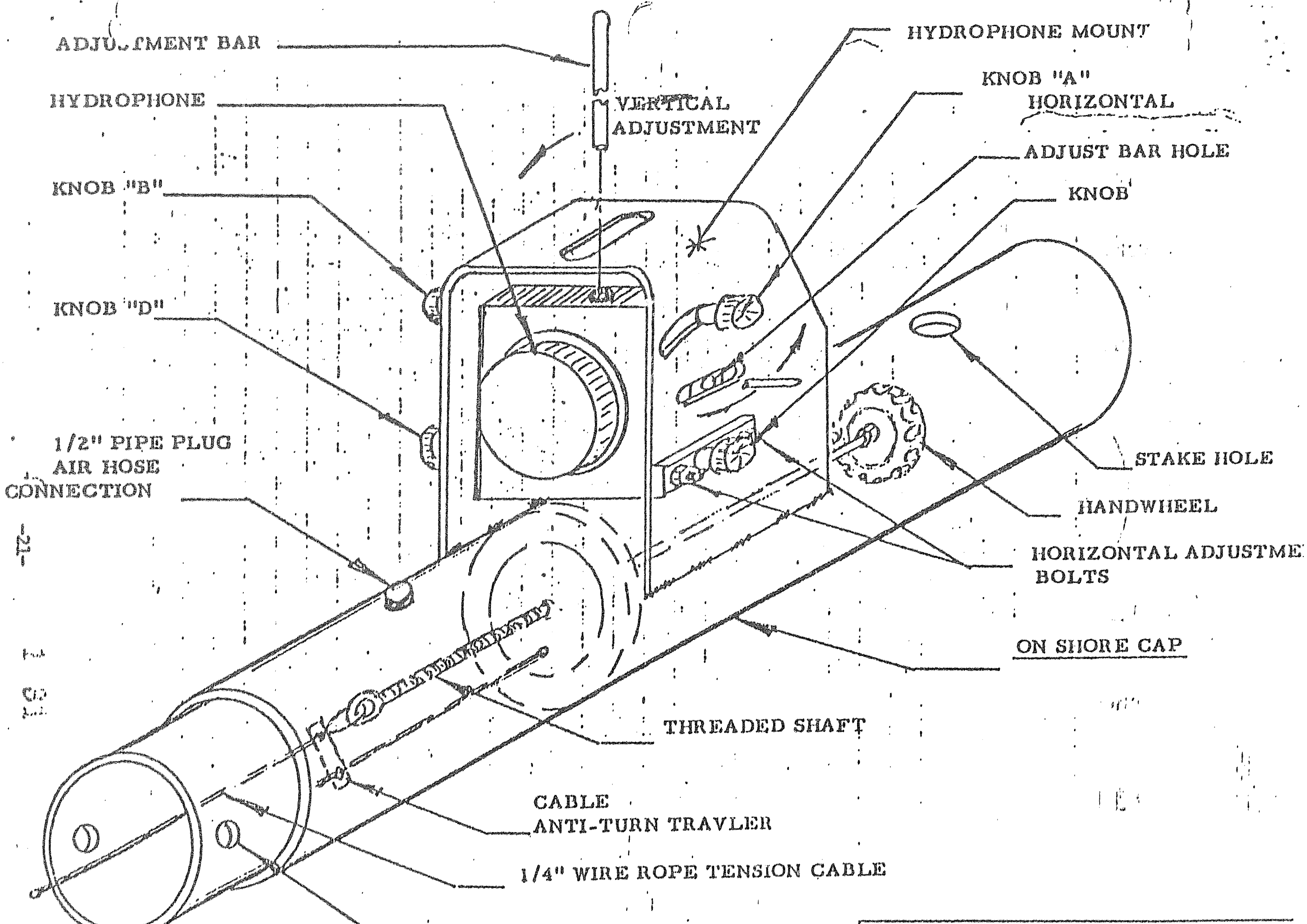
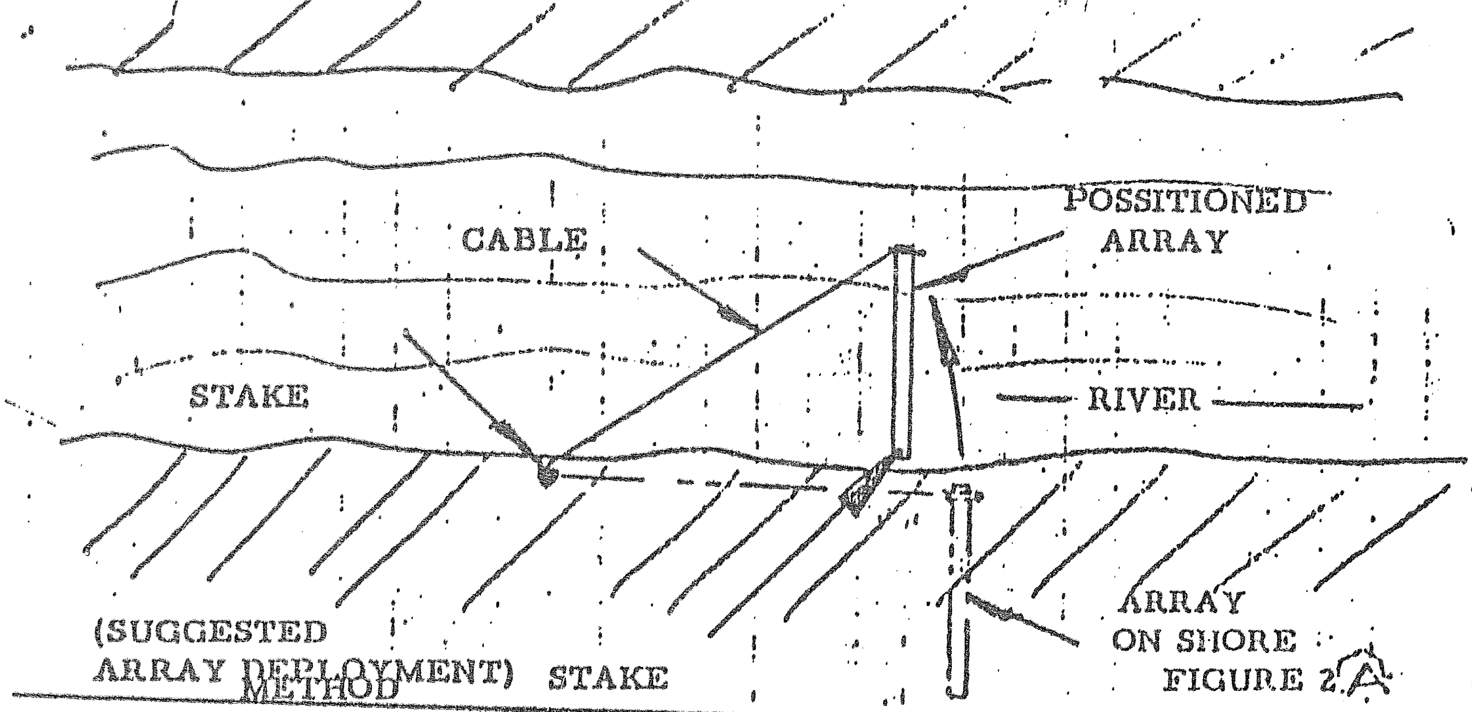
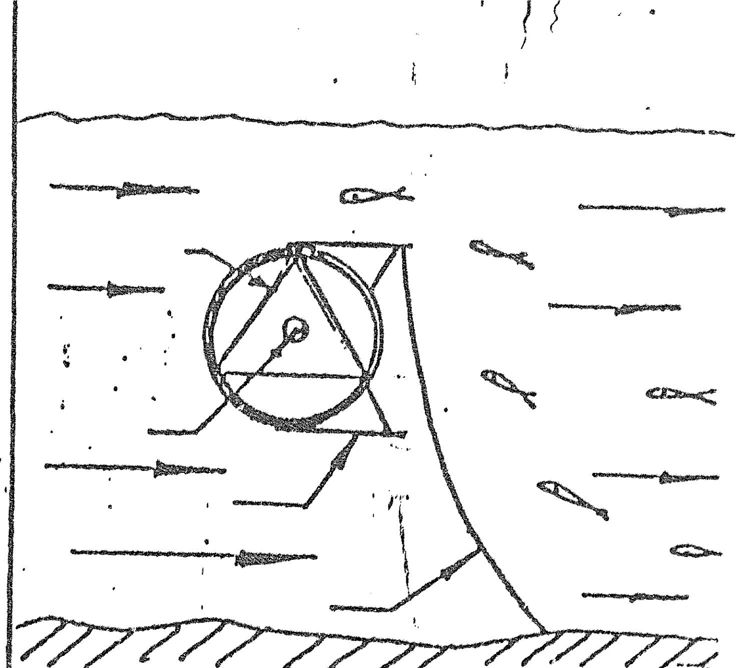

ADJUSTMENT BAR
HYDROPHONE
VERTICAL
ADJUSTMENT
KNOB "B"
KNOB "D"
1/2" PIPE PLUG
AIR HOSE
CONNECTION
HYDROPHONE MOUNT
KNOB "A"
HORIZONTAL
ADJUST BAR HOLE
KNOB
STAKE HOLE
HANDWHEEL
HORIZONTAL ADJUSTME
BOLTS
ON SHORE CAP
THREADED SHAFT
CABLE
ANTI-TURN TRAVLER
1/4" WIRE ROPE TENSION CABLE
THRU BOLT HOLE

Figure 1B

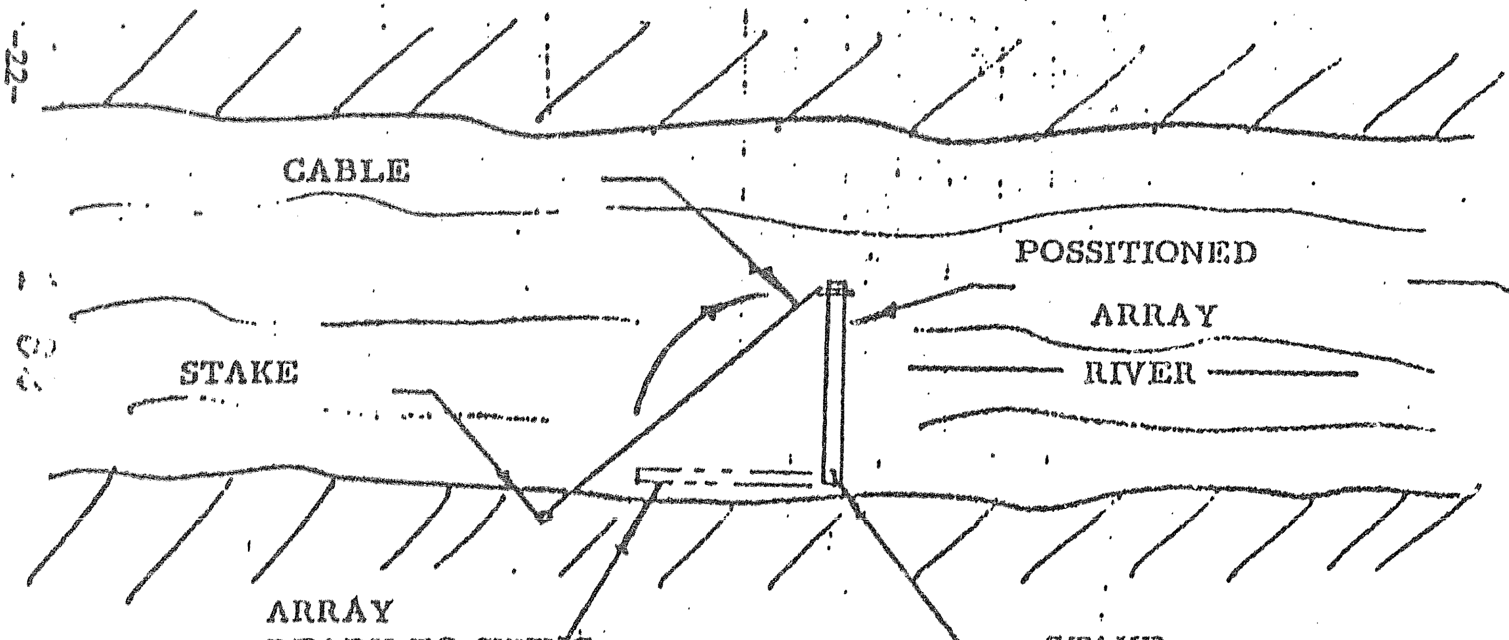



(SUGGESTED ARRAY DEPLOYMENT METHOD)

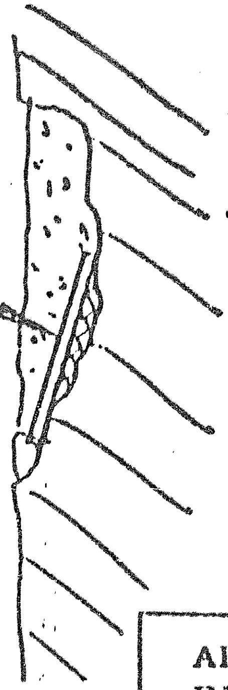
FIGURE 2A



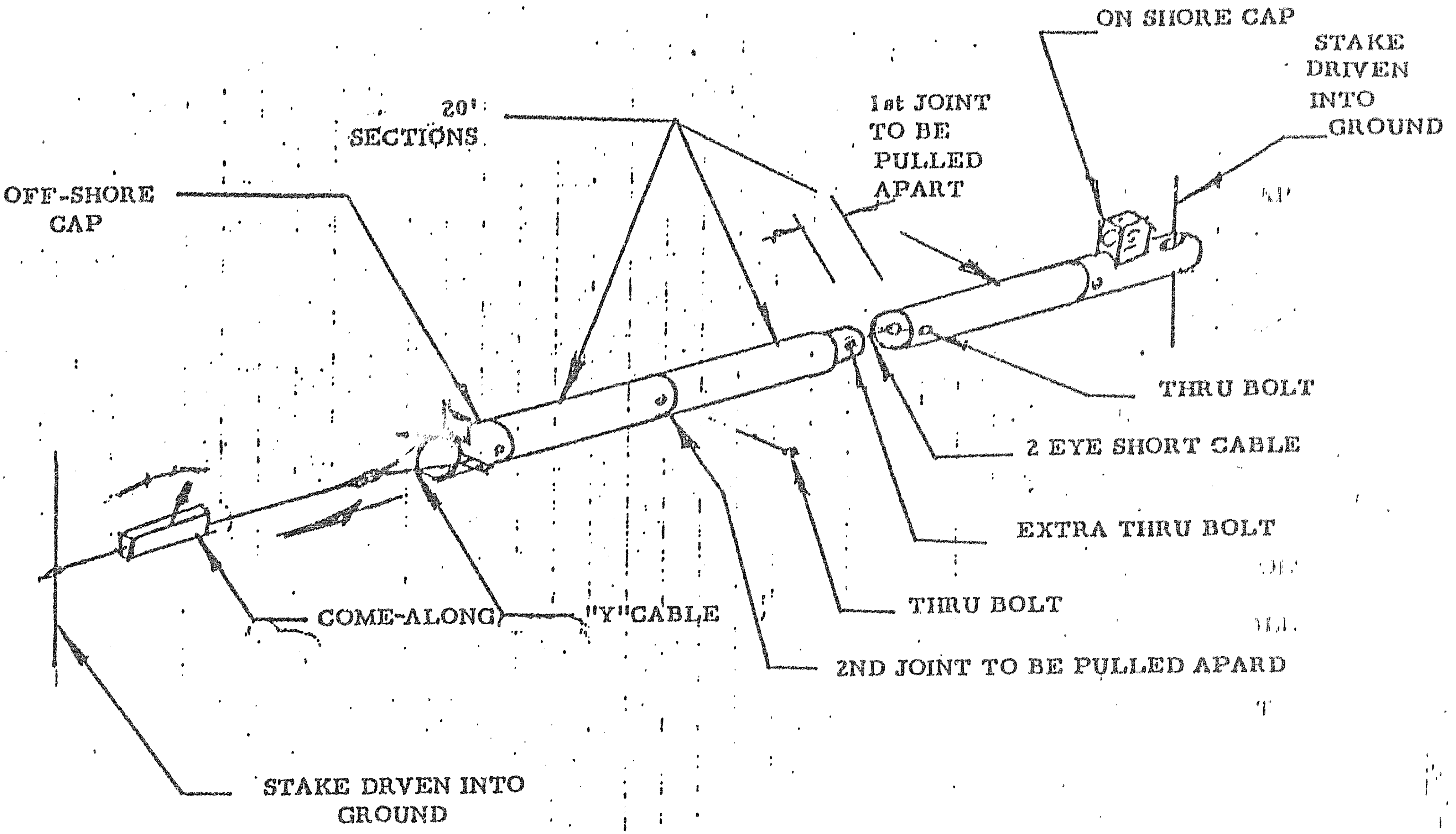
CROSS SECTION OF INSTALLED ARRAY




ALTERNATE ARRAY DEPLOYMENT METHOD
(SLOW CURRENT STREAMS)

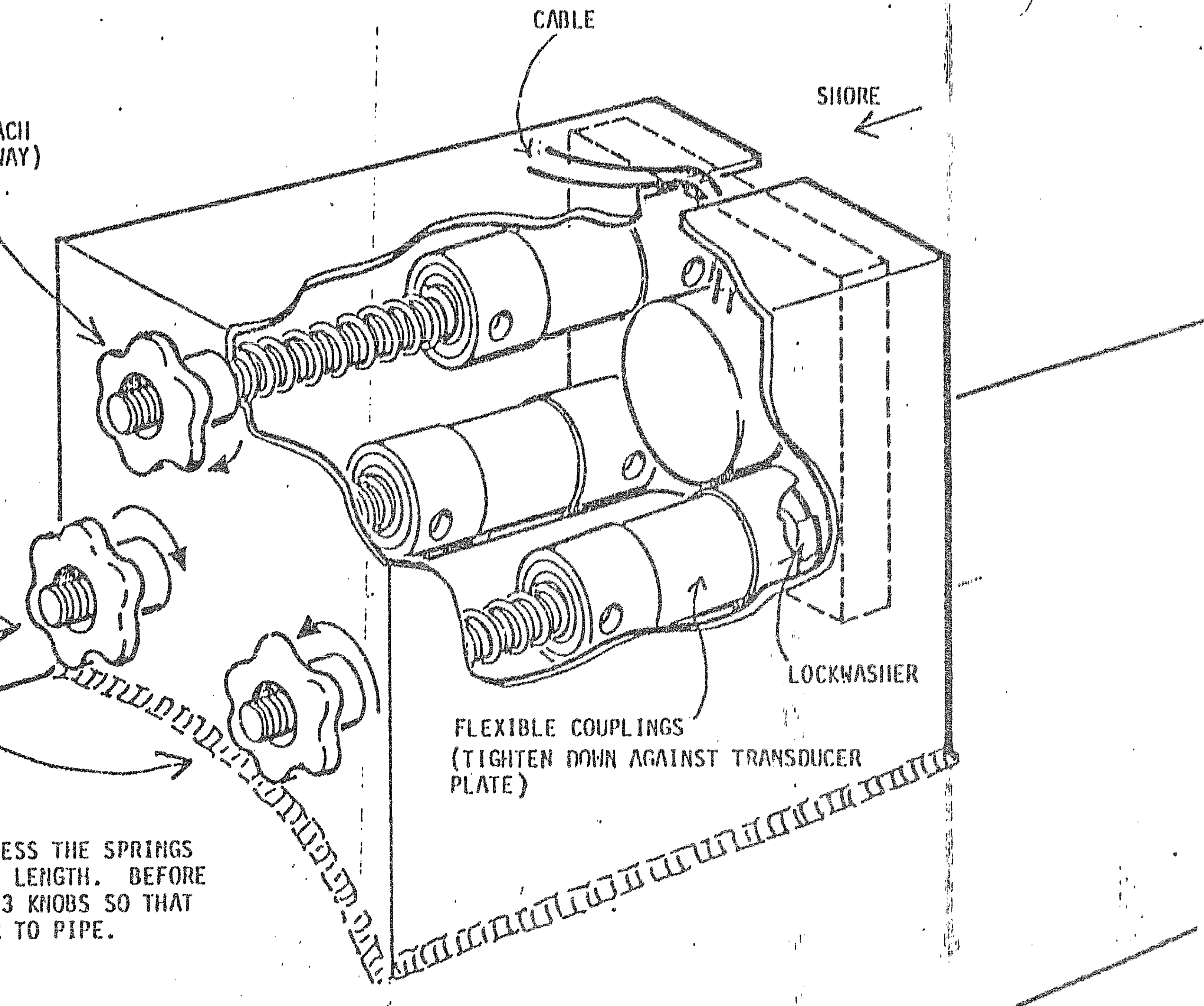


ARRAY
INSTALLED IN
RIVER
Figure 2




ARRAY DISASSEMBLY

FIGURE 3




INITIALLY TIGHTEN KNOBS TO COMPRESS THE SPRINGS TO ABOUT 2/3 OF THEIR NO-TENSION LENGTH. BEFORE INSTALLING IN WATER, ADJUST THE 3 KNOBS SO THAT TRANSDUCER FACE IS PERPENDICULAR TO PIPE.

NOTE: Use upper three holes.

September 6, 1978
[redacted] VERS[redacted] OF [redacted]

# APPENDIX II

## A. ADULT ANADROMOUS FISHERIES STUDIES

### Oscilloscope Operation

July 16, 1979

A. Menin

# OSCILLOSCOPE OPERATION

for the

SIDE SCANNER

This manual describes how to use the oscilloscope in conjunction with the side scanner. Although it is specificially written around the Tektronix model 323 "scope", the same basic rules apply to virtually any model scope except for the location of controls.

## THEORY OF SCOPE OPERATION

The scope is basically a time variable voltmeter. A bright dot moves across the screen at a constant rate from left to right. The speed at which it moves is determined by the TIME/DIV control setting on the scope. At most settings, the dot moves so quickly that it looks like a continuous horizontal line to the human eye.

The VERTICAL INPUT of the scope (on the left side of scope) is the same as the + & - input leads on a voltmeter except that a voltage connected to VERTICAL INPUT scope connector will cause an upward vertical deflection of the moving dot of light proportional to the amount of voltage at the input at the point in time that the moving dot happens to be when that voltage is connected. For example, if there is no voltage on the scope input for the first half of the trace, you will see a straight line. If a + voltage is then applied during the middle of the trace (or sweep as it is usually called), the bright dot will go vertically up to the corresponding place on the scope's face as determined by the VOLTS/DIV setting of the scope. Example: With a 2V/DIV setting, the dot would rise three divisions at the precise instant in time that you connected the + of a 6V battery to the scope's VERTICAL INPUT with the - of the battery connected to the scope ground.

## TRIGGERING

The bright dot on the screen requires an electrical voltage on the TRIGGER INPUT of the scope (on the left side of scope) to start the dot moving at the rate (or speed) set by the TIME/DIV control on the scope's front panel. This trigger is required for each "sweep" of the dot. At the instant in time that a voltage is applied to the TRIGGER INPUT of the scope, the dot will start moving from left to right. This provides synchronization of what you see on the screen with the side scanner. In the case of the side scanner, the TRIGGER INPUT will be connected to either XM2°, XM4° (or XM ALT. in the latest version of the side scanner). Each time the side scanner transmits a "burst of sound", the transmitted voltage momentarily appears on the XM pin connector of the side scanner. At this instant in time, this voltage causes the dot to start moving from left to right. Since you will have the TIME/DIV set to 2 ms (MILLISECONDS) for proper operation with the side scanner, this dot is now moving across the screen at the rate of 2 milliseconds (2 thousanths of a second) per division. This of course is too fast for the human eye to follow so it looks like a straight line to the eye. Since sound travels (in water) at about 5000 feet per second which equals 5 feet per milliseconds (1 thousanth of a second), when the scope's VERTICAL INPUT is connected to the RCVR (receiver) pin connector of the side scanner, an echo (a vertical line) from a fish (or other object) 25 feet away from the transducer would be seen as a vertical line at 5 divisions from the left of the start of the sweep of the bright dot. This is because it took 5 milliseconds for the sound to travel the 25 feet to the "fish" and another 5 milliseconds for the "echo" from the fish to return to the transducer for a total of 10 milliseconds round trip travel time. Since the scope is set to 2 milliseconds per division, 10 milliseconds would be 5 divisions.

To see the metal target at the end of the pipe which is about 59 feet away from the transducer, you should expect to see this target 23.6 milliseconds from the face of the transducer (the start of the sweep) because at 5 feet per millisecond travel time, it will take 11.8 milliseconds for the sound to hit the metal target and another 11.8 milliseconds for the "echo" to return to the transducer or a round trip travel time of 11.8 + 11.8 = 23.6 milliseconds. Since the TIME/DIVISION of the scope is set to 2 Msec/DIVISION, that would be just beyond the 10 divisions on the scope screen and would not be seen, so a fine variable adjustment knob located in the center of the TIME/DIV coarse control should be rotated a little counter clockwise so that the echo from the metal target can be seen on the scope's face. Rotating this small control counterclockwise increases the time per division to some amount greater than the 2 milliseconds per division that the coarse control was set to.

SCOPE CONTROLS AND THEIR FUNCTIONS

1. POWER SWITCH-ON (see fig. 1) - CAUTION: Be sure to shut off power when scope is not being used since it draws much more power than the side scanner and would rapidly discharge the battery.

2. POWER SOURCE SELECT SWITCH (see fig. 2) - This is a small slide switch on the rear of the scope and should be pushed down to the EXT DC position which means that the scope is being powered by an external 12V from the side scanner.

3. VOLTS/DIV. ROTARY CONTROL (see fig. 1) - This switch may be set as desired for viewing the side scanner RCVR output. It should be set to either 1V or 2V. If it is set to 1V per division you may want to rotate the small "fine control" center knob inside the coarse control VOLTS/DIV to reduce the height of the vertical lines or fish echos to about 1 inch.

4. POSITION CONTROLS (see fig. 1) - These 2 controls merely affect the horizontal and vertical position of the scope display. You may want to set the vertical position control so that the horizontal trace of the scope is a little above the bottom of the screen and the first vertical line on the left

is about 1/4 inch inside of the screen. (This corresponds to the transmitted burst of sound or the transducer position).

5. INPUT LEVER SWITCH (see fig. 1) - This should be down (in the DC position).

6. TRIGGER LEVER SWITCH (see fig. 1) - This important switch should be in one of the 2 bottom external trigger positions, either AC or DC. This switch is located on the right side of the model 323 scope.

7. TRIGGER KNOB (see fig. 1) - This is probably the most important (and most often mis-set control). Its function is to assure that the start of the sweep of the scope picture exactly coincides with the instant the side scanner transmits its burst of sound. This will cause the transmit burst vertical line to be at the start of the sweep (the extreme left side of the trace). If this knob is rotated completely clockwise or completely counterclockwise, the scope trace will "free run", that is to say, it will never be synchronized with the transmit burst and therefore the transmit burst vertical line on the scope's face may occur anywhere along the scope sweep.

8. TIME/DIV. ROTARY CONTROL (see fig. 1) - This controls the speed at which the bright dot crosses the screen. For use with the side scanner, it should be set to the 2 Ms (MILLISECONDS) position.

9. ATTEN. SLIDE SWITCH (see fig. 1) - This switch is located on the left side of the scope. Although it can be operated in either position, stable triggering is a little easier to adjust if this slide switch is in the 10X position.

10. FOCUS AND INTENSITY (see fig. 1) - These two controls are located on top of the scope.

The intensity control should be rotated fully clockwise for maximum brightness of the trace. After adjusting the brightness, rotate the focus control for the sharpest vertical lines.

At night you may want to decrease the brightness. If you do, refocus the FOCUS control.

## OSCILLOSCOPE CONNECTIONS TO SIDE SCANNER

1. EXT. D.C. POWER (see fig. 2) - This twin connection is located on the right side of scope. This should be connected to the mating connector labeled "SCOPE" on the right side of the side scanner. CAUTION: This is the 12 volt power connection to the scope and does not have reverse polarity protection. If these leads are reversed, the scope will burn out instantly.

2. EXT TRIG. (see fig. 1) - This connector is located on the left side of scope. It should be connected to either the 2° or 4° (or ALT. in 1980 model side scanner). This is to provide triggering of the scope from the side scanner. Use either one of the supplied connector cables. The black pin on the connector cable is ground and may be connected to the gnd. pin of the side scanner or left disconnected if you like, since the scope will be grounded anyway through the power connector.

3. VERT. INPUT (see fig. 1) - This connector is also located on the left side of the scope. It should be connected to the RCVR connector on the face of the side scanner using the supplied connector cord which is identical to the ext. trig. cord. The black pin is ground and need not be connected to the side scanner ground since the scope is already grounded through the 12V power cord.

This is the vertical input to the scope and causes the bright moving dot of the scope to go up vertically when a voltage is present on the RCVR output of the side scanner as it would be when a fish echo is present.

## OSCILLOSCOPE ADJUSTMENTS

1. After all three connectors are in place (trigger, vertical input and external 12V power) turn on the scope power.

2. Turn the brightness control fully clockwise.

3. Place the rear slide switch in the down (ext DC) position (Fig. 2).

4. Place the ext. trig. switch on the left side of scope to the 10X position.

5. Place the input lever switch on the scope face to the DC position (down).

6. Place the trigger lever switch (on the right side of scope face) down, to the EXT TRIG DC position.

7. Set the TIME/DIV rotary switch to 2 ms.

8. Rotate the small center knob inside the TIME/DIV switch about 1/3 of a revolution counterclockwise from its fully clockwise (detent) position.

9. Set the VOLTS/DIV rotary switch to 1 volt.

10. Rotate the small center knob inside the VOLTS/DIV switch about 1/3 of a revolution counterclockwise from its fully clockwise (detent) position.

11. Push in the 2 POSITION controls located on the bottom center of the scope face. These 2 rotary controls are also push-pull switches and should always be pushed in.

12. Rotate the trigger knob on the lower right side of scope face fully counterclockwise to its detent position. This will cause the scope to operate even without an external trigger so that you can adjust the two position controls.

13. Rotate the vertical position knob on the bottom center of the scope until the trace on the screen is about 1 division from the bottom of the screen.

14. Rotate the horizontal position control on the lower center of the scope face until the trace starts about one division from the left side of the scope screen.

The scope is now ready for final trigger adjustments.

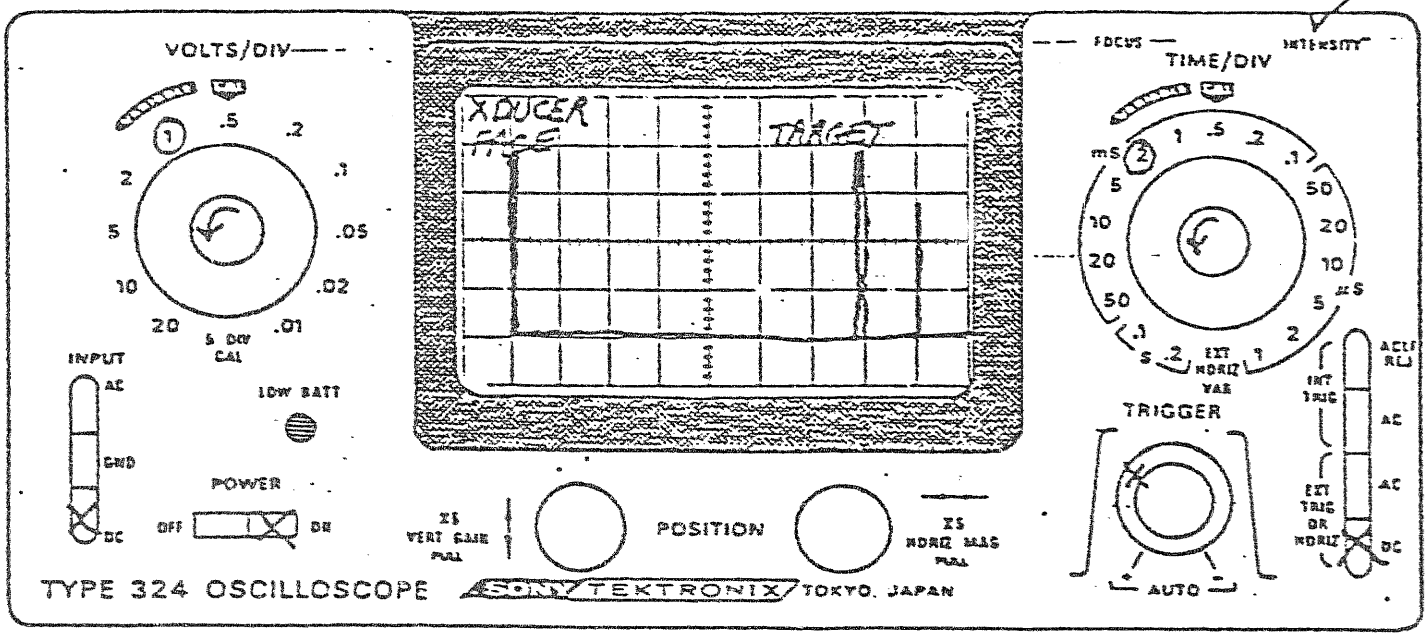
15. Put the side scanner beamwidth switch in the 2° position and connect the <u>EXT TRIG</u>. cable to the XM2° pin connector on the face of the scope.

Rotate the TRIGGER knob on the right side of scope face to about the 10 o'clock position. Somewhere near this point, the scope should be triggering properly as evidenced by a stable vertical "spike" being seen on the extreme left (the beginning) of the scope trace. Now place the beamwidth switch on the side scanner to the Alternate position. The scope trace should look the same as it did in the 2° position meaning that you are still triggering only on 2°. If it looks different or seems to speed up or get brighter that means you are slightly misadjusted. If so, rotate the TRIGGER knob a bit until the scope picture <u>does not</u> change as you switch between the 2° to the ALT positions on the side scanners beamwidth switch.

Now put the EXT TRIG connector cord in the XM4° connector (or the XM ALT. on the 1980 model). When the side scanner beamwidth switch is in the ALT position the trace on the scope should now be triggering twice as fast (brighter) as in the 2° position since now you are alternately triggering the scope twice as fast as you were. You are causing the scope to alternately trigger on 2°, 4°, 2°, 4° etc. If you now move the EXT TRIG. cable connector back to the XM2° connector you will see a change in the trace since it will only be triggering on the 2° beam (half as often).

You should now see a stable vertical spike, about 1 inch high on the left side of the trace and you should see the metal target echo (about 1 inch high) near the right side of the trace if you increase the COUNTING RANGE control on the side scanner to beyond 60 feet. To operate the side scanner normally, you should now reduce the COUNTING RANGE control slowly until it <u>just ceases</u> to count the target (on sector 12) and then reduce it about one foot more for safety.

FACE OF SCOPE




LOCATED ON LEFT SIDE OF SCOPE →

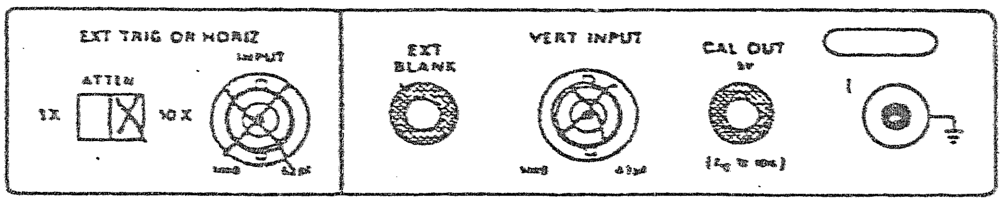
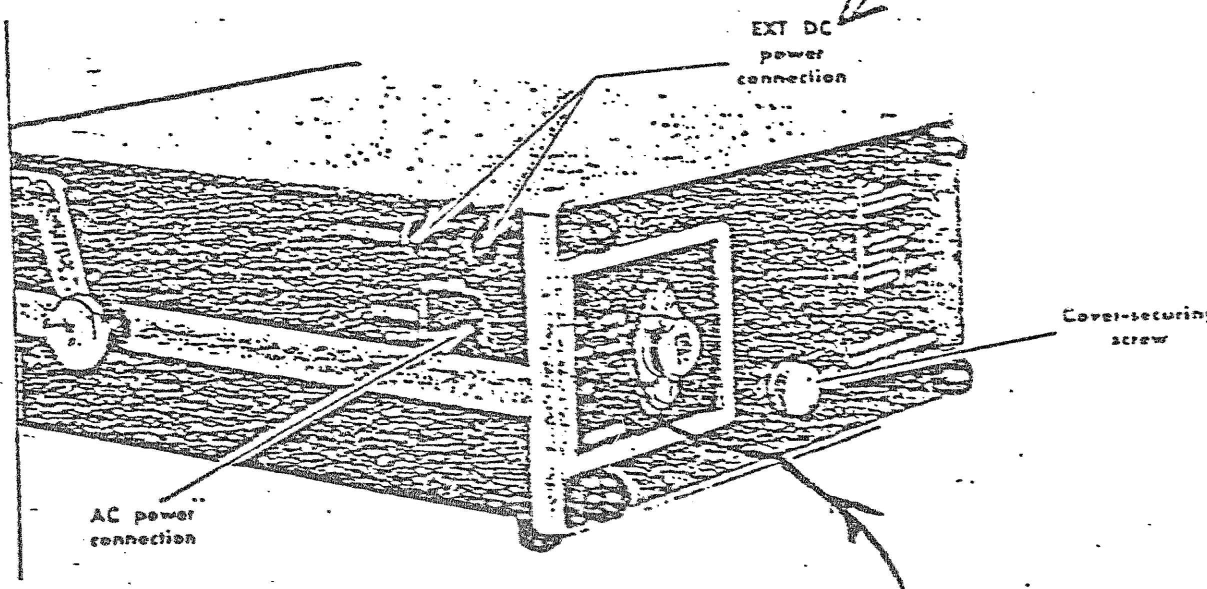



Figure II-1. Oscilloscope controls. Sony Tektronix type 324 oscilloscope.

FIG. 1 2 10

CONNECT THIS TO SCOPE
POWER CONNECTOR ON SIDE SCAN




PUT THIS SLIDE SWITCH
IN DOWN (EXT. DC) POSITION

Figure II-2. Oscilloscope adjustments. Sony Tektronix type 324 oscilloscope.

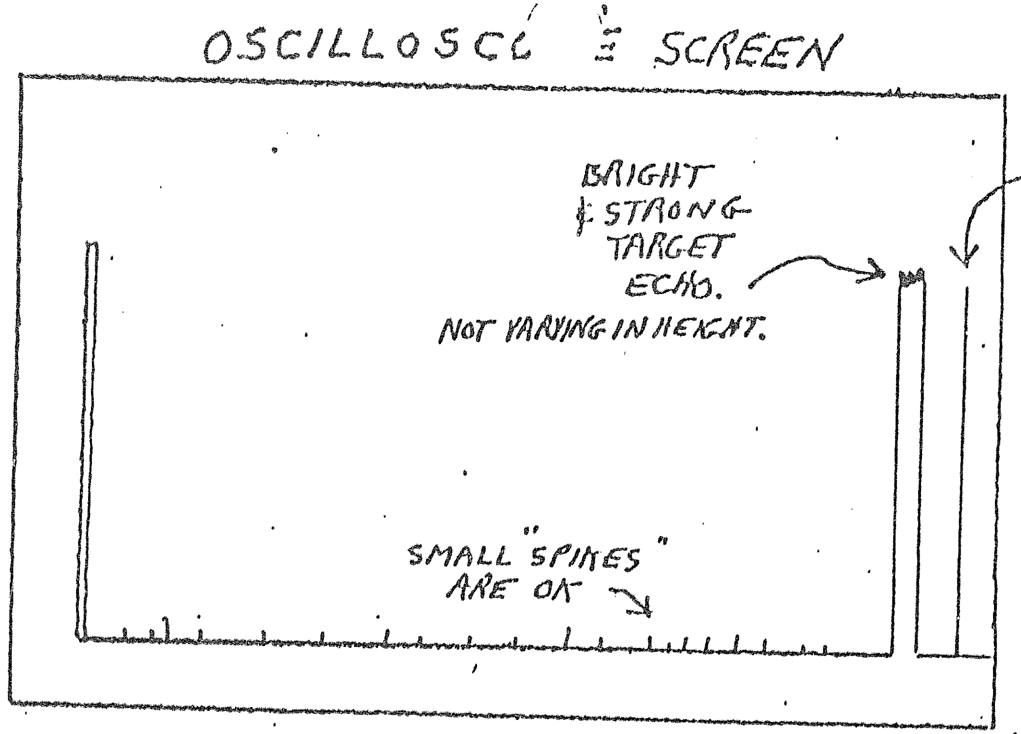
FIG 2.

A. Menin - T. Namtvedt, 6-18-79

Table II-1. TYPICAL SIDE SCANNER OSCILLOSCOPE WAVEFORMS FOR VARIOUS TRANSDUCER AIMING CONDITIONS

| FIGURE # | CONDITION |
|---|---|
| II-3. | PROPER VERTICAL AIMING. 2° |
| II-4. | PROPER VERTICAL AIMING. ALT. BUT SCOPE TRIG. ON 4° |
| II-5. | PROPER VERTICAL AIMING. ALT. BUT SCOPE TRIG. ON 2° |
| II-6. | IMPROPER VERTICAL AIMING. (AIMED TOO LOW) |
| II-7. | IMPROPER VERTICAL AIMING. (AIMED TOO HIGH). 2° |
| II-8. | IMPROPER VERTICAL AIMING. (AIMED TOO HIGH). 4° |
| II-9. | IMPROPER HORIZONTAL AIMING. (AIMED TOO FAR DOWNSTREAM) |
| II-10. | PROPER HORIZONTAL AIMING. |
| II-11. | IMPROPER VERTICAL AIMING. (TOO LOW AND BOUNCING OFF SUBSTR |
| II-12. | ECHOS FROM BOAT WAKE |
| II-13. | IMPROPER VERTICAL AIMING IN SHALLOW WATER |

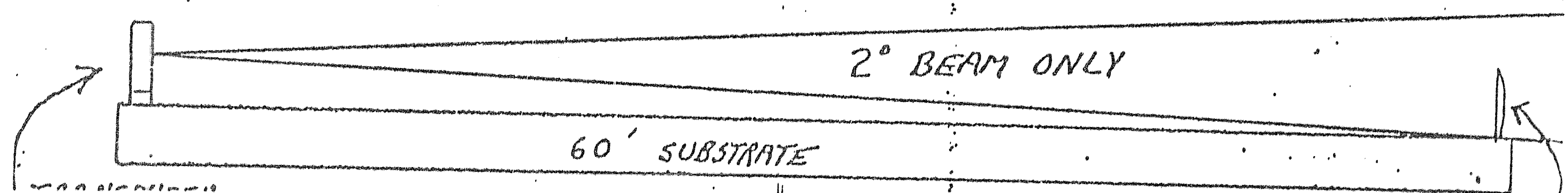
FIG. 5




RANGE CONTROL ON SIDE SCANNER SET TO JUST BEYONI TARGET. (SECT 12 WILL COUN:

Figure II-3. PROPERLY AIMED TRANSDUCER

WHEN BEAMWIDTH SWITCH IS SET TO 2° AND SCOPE TRIGGERRED FROM XM 2°



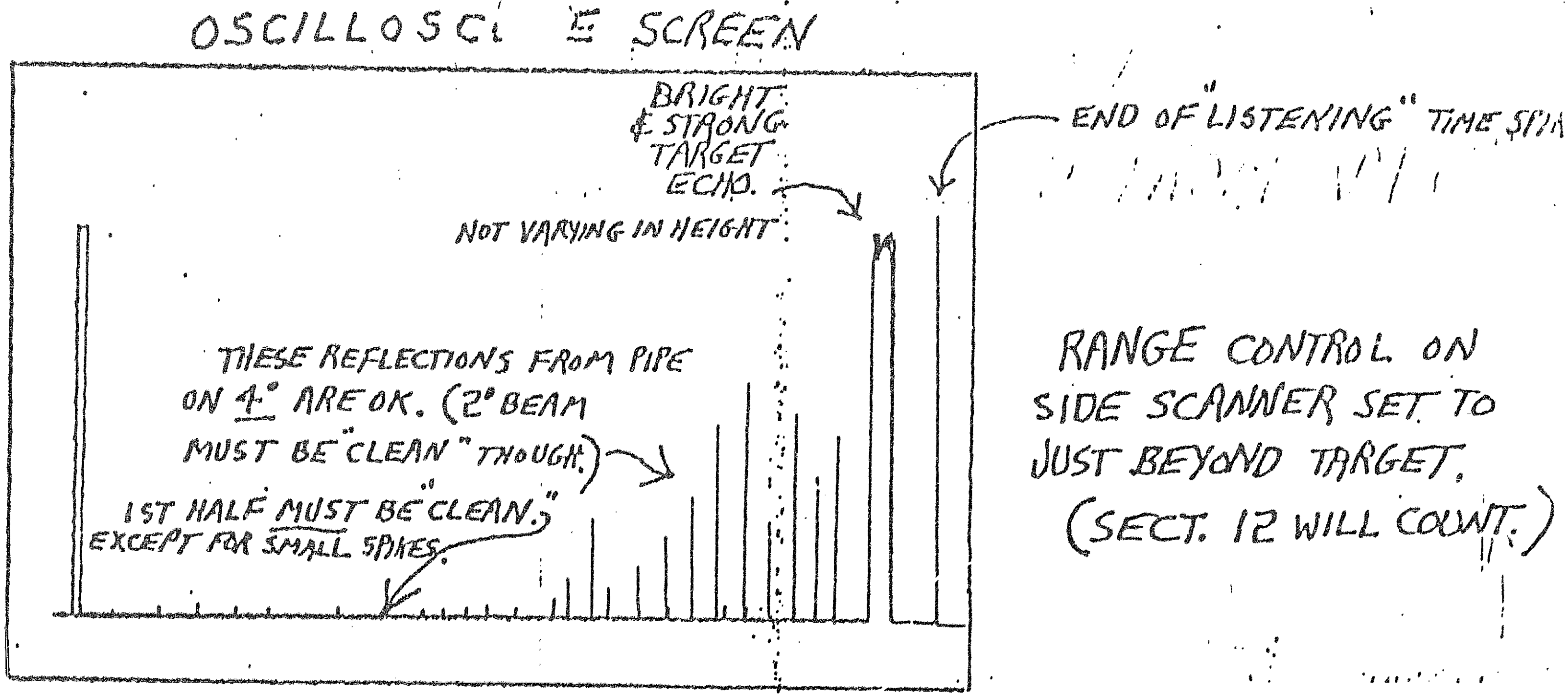



Figure III-4. PROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO ALTERNATE & SCOPE IS TRIGGERRED FROM XM 4°. NOTE 4° BEAM IS SKIMMING SURFACE OF SUBSTRATE BEYOND THE 50% POINT ON SUBSTRATE THUS CAUSING REFLECTIONS FROM IMPERFECTION ON SUBSTRATE SURFACE. THIS IS OK, SINCE THE 4° BEAM WILL NOT COUNT ANY ECHOS BEYOND THE 50% POINT.

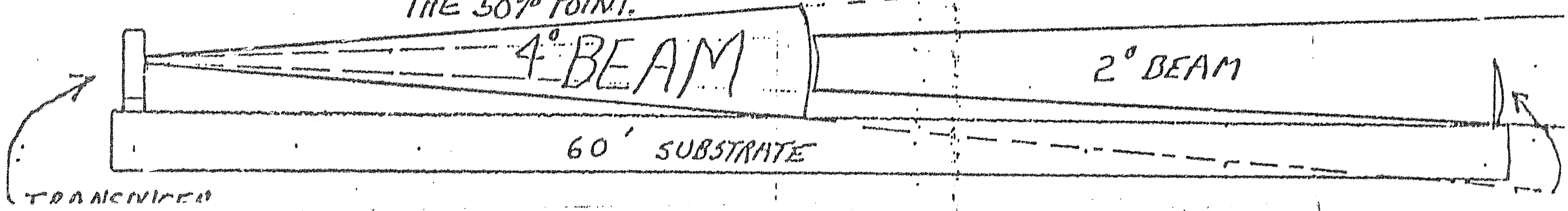


FIG 3

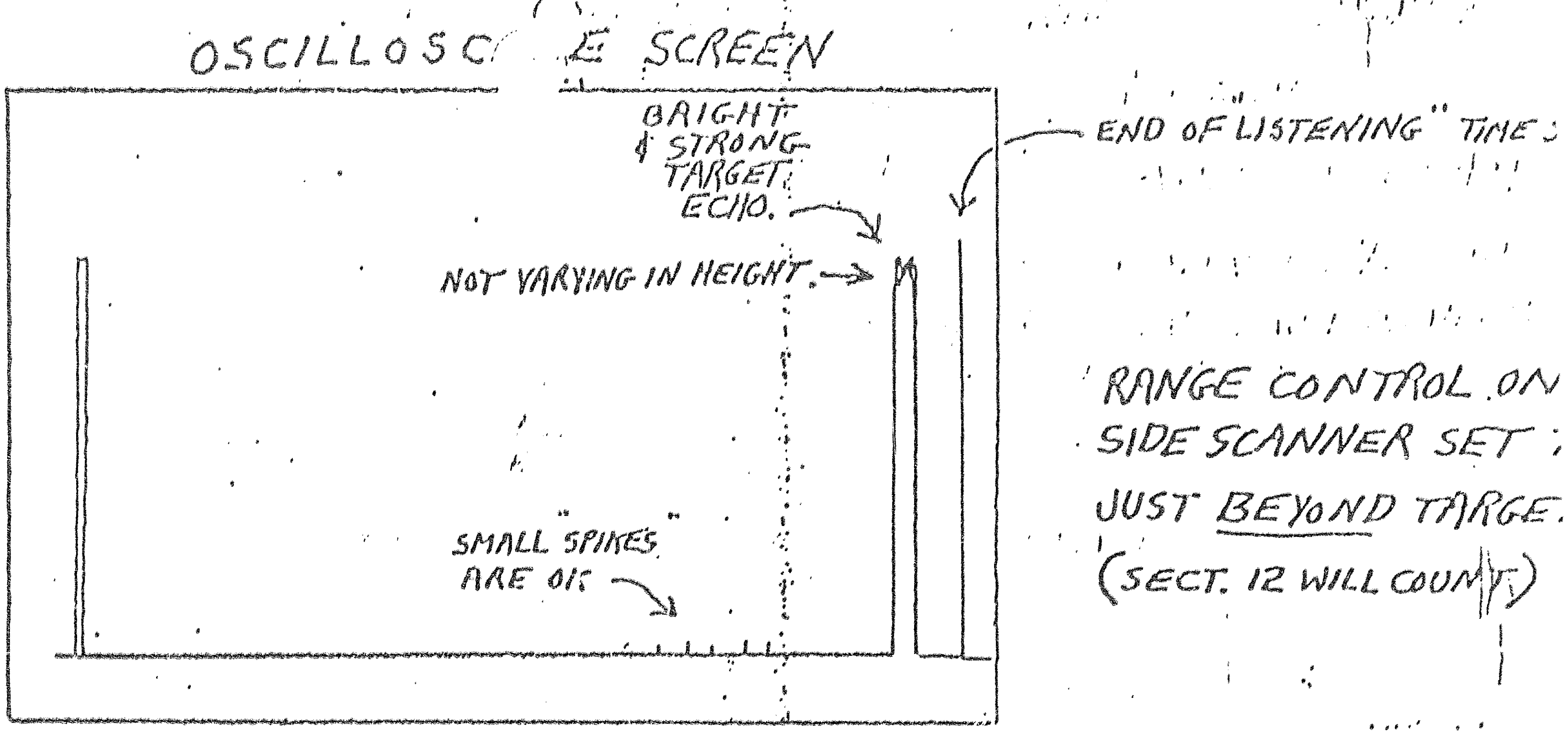
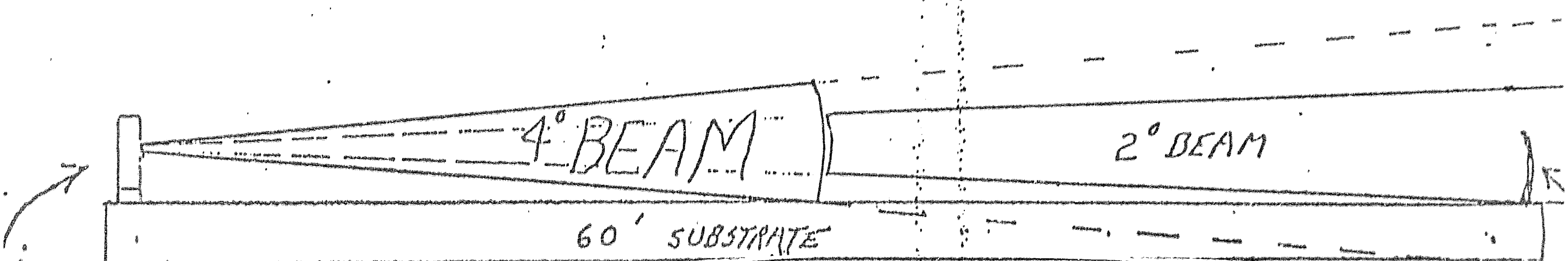



Figure II-5. PROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO ALTERNATE BUT SCOPE TRIGGERRED FROM XM 2°



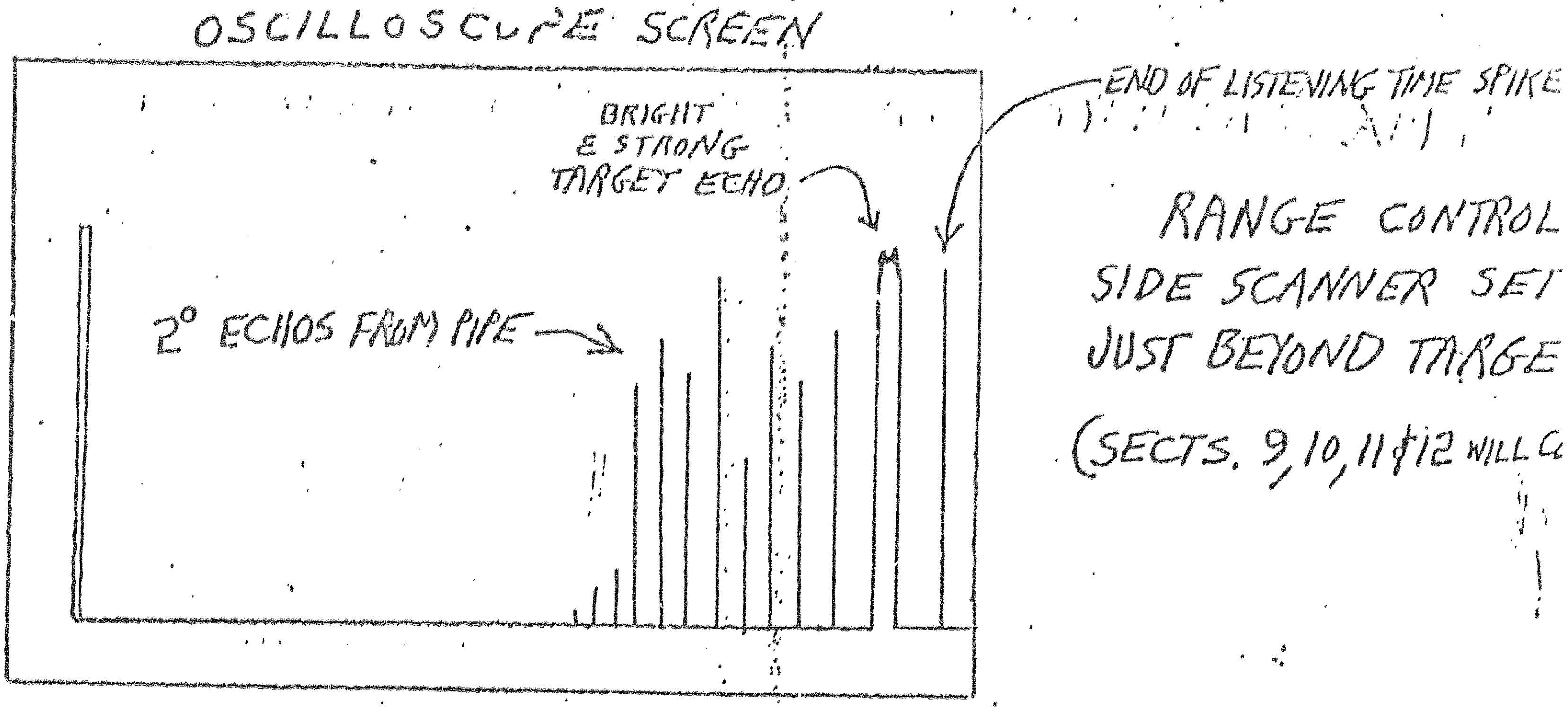



Figure II-6. IMPROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO 2° & SCOPE IS TRIGGERRED FROM XM 2°. NOTE THAT BEAM IS AIMED TOO LOW, CAUSING ECHOS TO BE RETURNED FROM LAST 1/3 OF SUBSTRATE IMPERFECTIONS EVEN THOUGH TARGET ECHO IS STRONG & DOESN'T VARY IN HEIGHT.

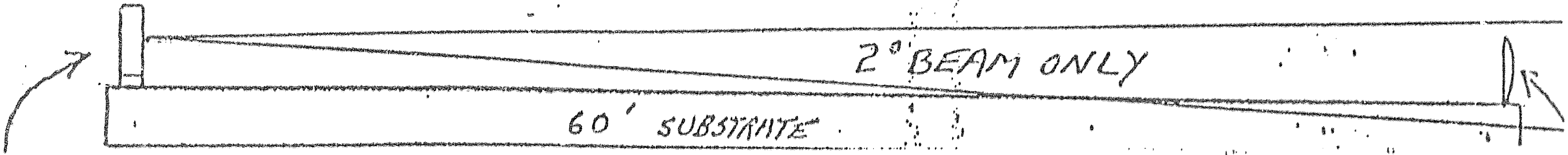


FIG.

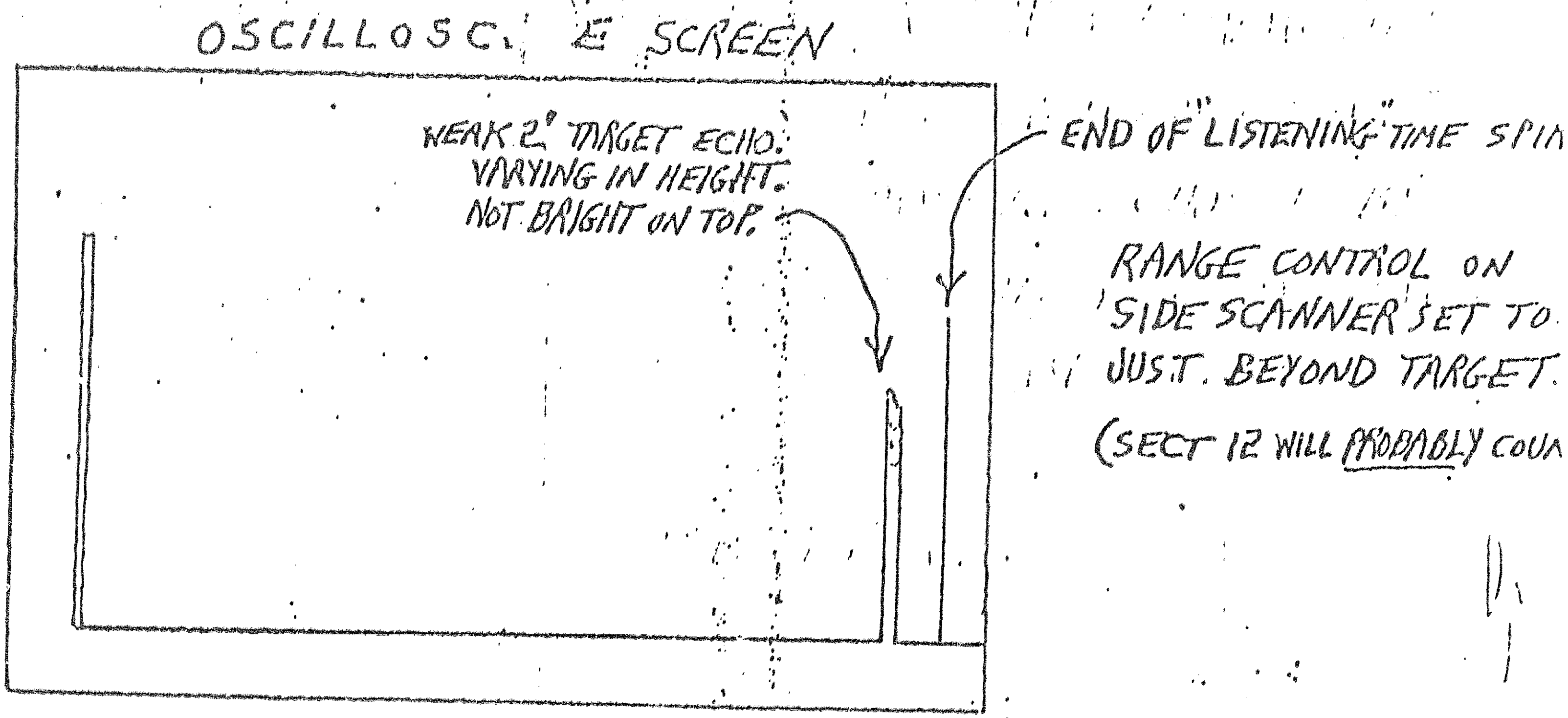
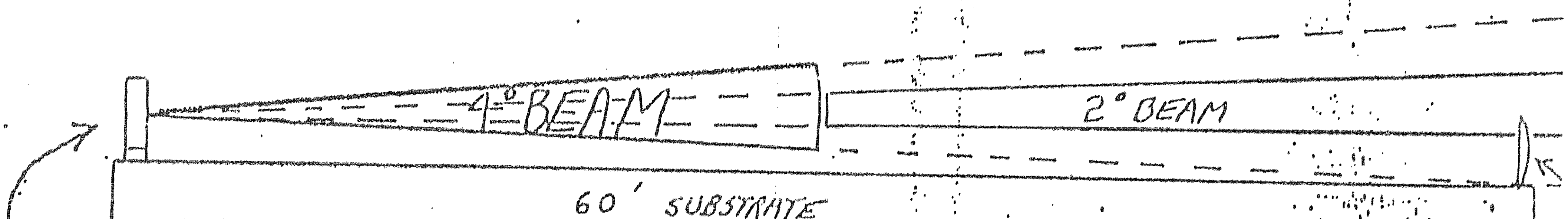



Figure II-7.

IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO AL & SCOPE IS TRIGGERRED FROM XM 2°. NOTE THAT BEAM IS AIMED TOO HIGH, JUST BARELY CATCHING TARGET IN 2° BEAM ALTHOUGH 4° BEAM DOES HIT TARGET. (SEE FIG. 6.) LOW PASSING FISH MAY BE MISSED.



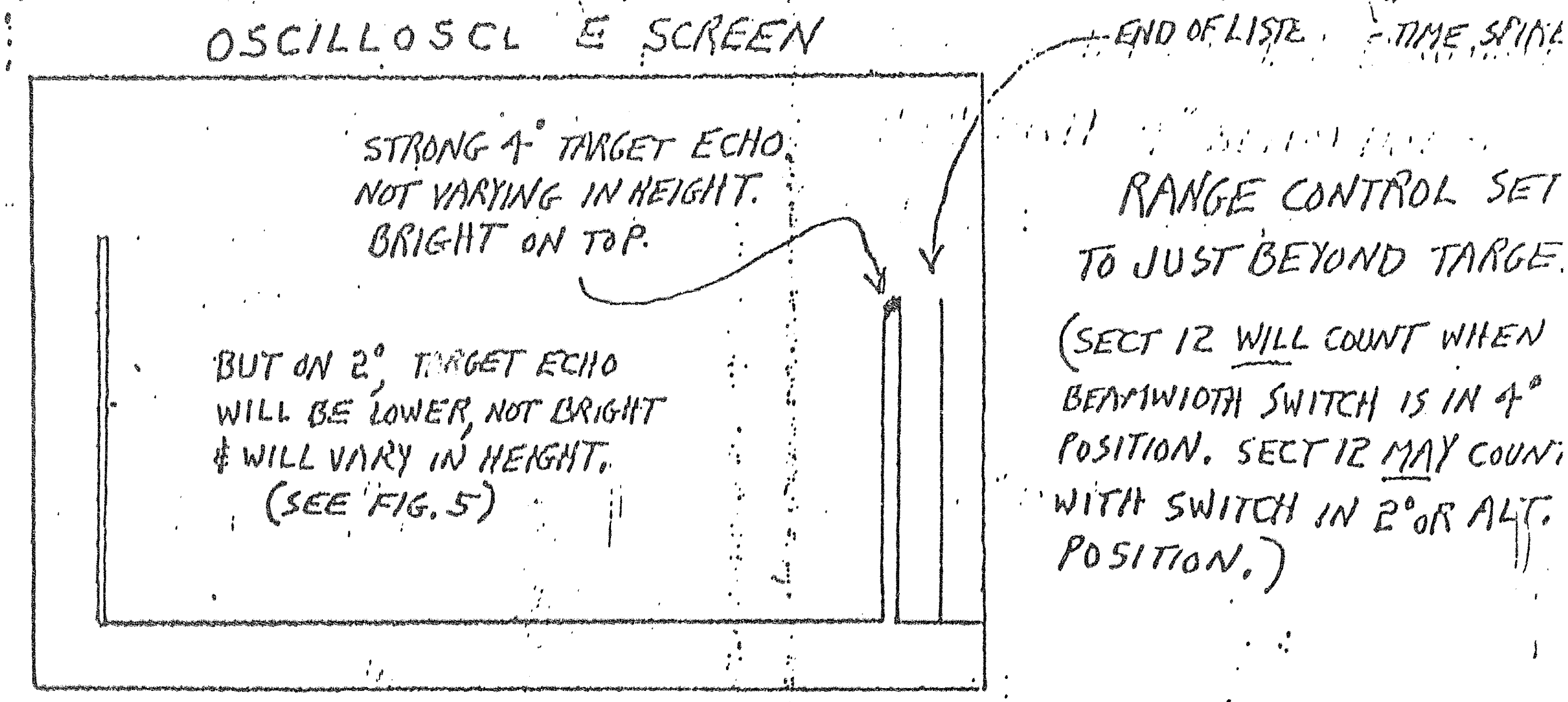



Figure II-8. IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO ALT. (OR 4°). SCOPE IS TRIGGERRED FROM XM 4°. NOTE THAT BEAM IS AIMED TOO HIGH, ALTHOUGH THE 4° BEAM SOLIDLY HITS THE TARGET, THE 2° BEAM JUST BAREL HITS TARGET (SEE FIG. 5 FOR 2° SCOPE WAVEFORM). FISH MAY BE MISSED.

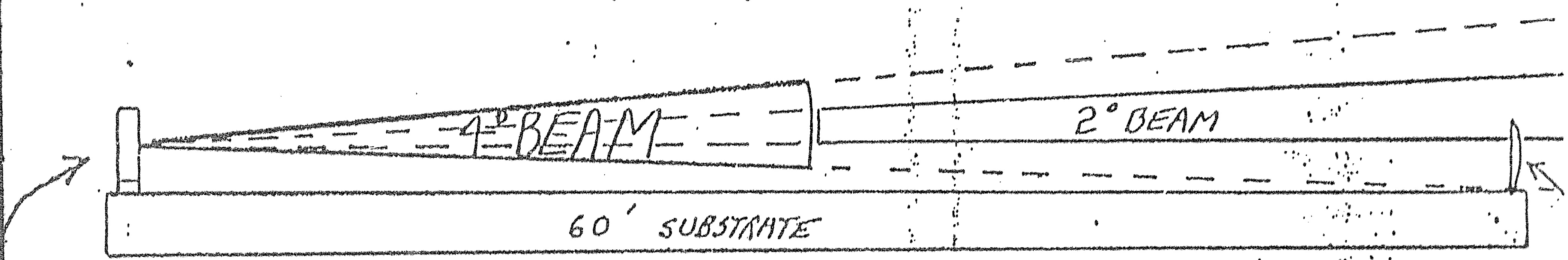


FIG 7

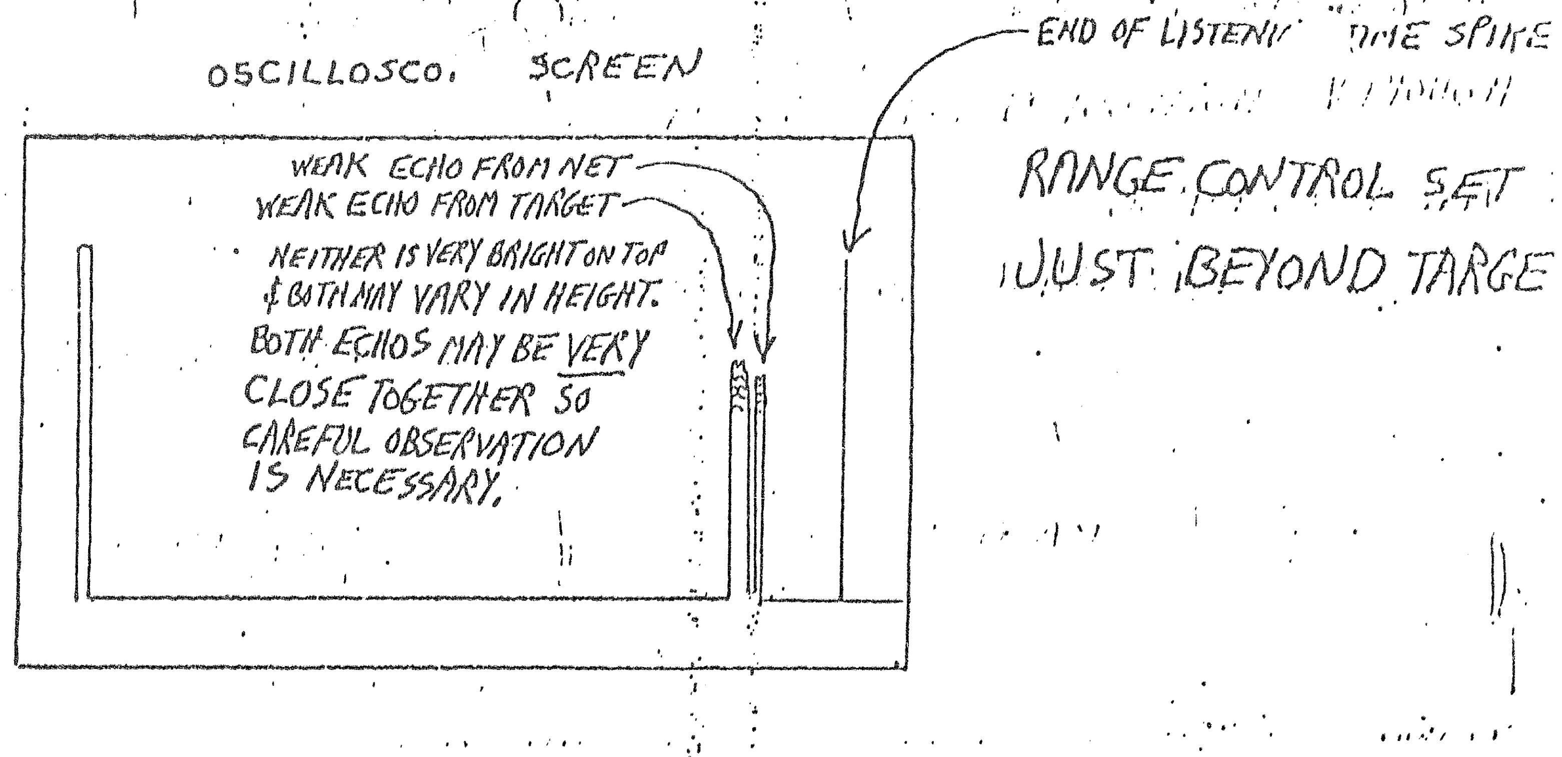
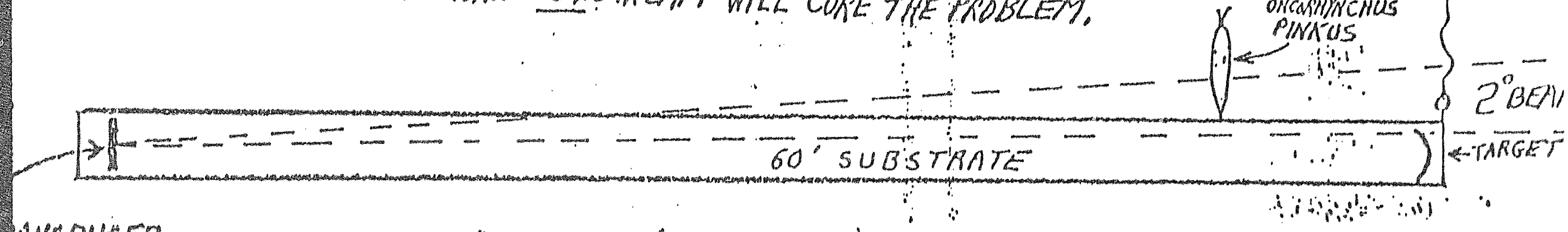



Figure II-9. IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO 2° & SCOPE IS TRIGGERRED FROM 2°. TRANSDUCER IS AIMED TOO FAR DOWNSTREAM, JUST BARELY HITTING TARGET. THIS WILL CAUSE AN OVERCOUNT ON SALMON IN THE LAST HALF OF SUBSTRATE BECAUSE SALMON TEND TO LINGER DOWNSTREAM OF PIPE BEFORE CROSSING. IF SALMON TEND TO OVERCOUNT NEAR END OF SUBSTRATE, THIS MAY BE THE PROBLEM. REAIMING THE TRANSDUCER MORE UPSTREAM WILL CURE THE PROBLEM.



FIG

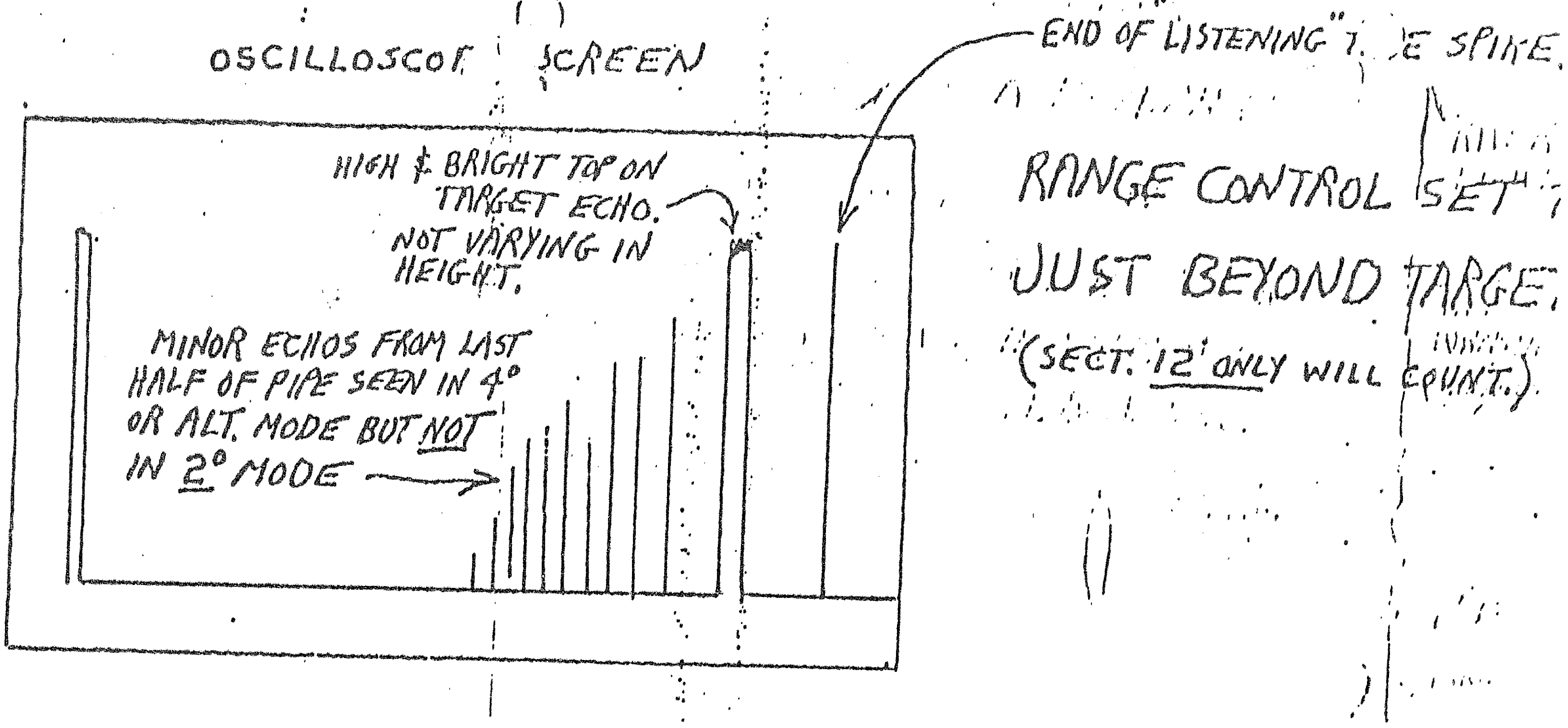
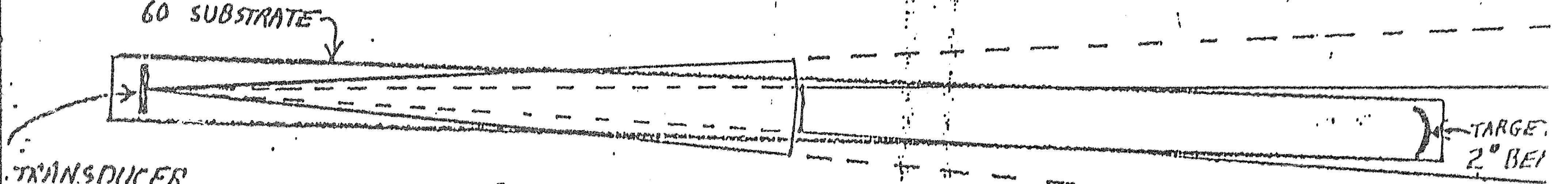



Figure II-10. PROPERLY AIMED TRANSDUCER.

TRANSDUCER BEAMWIDTH SWITCH IS SET TO ALT.
SCOPE IS TRIGGERRED FROM XM 4°

(ASSUMING VERTICAL AIMING OF TRANSDUCER IS CORRECT.)



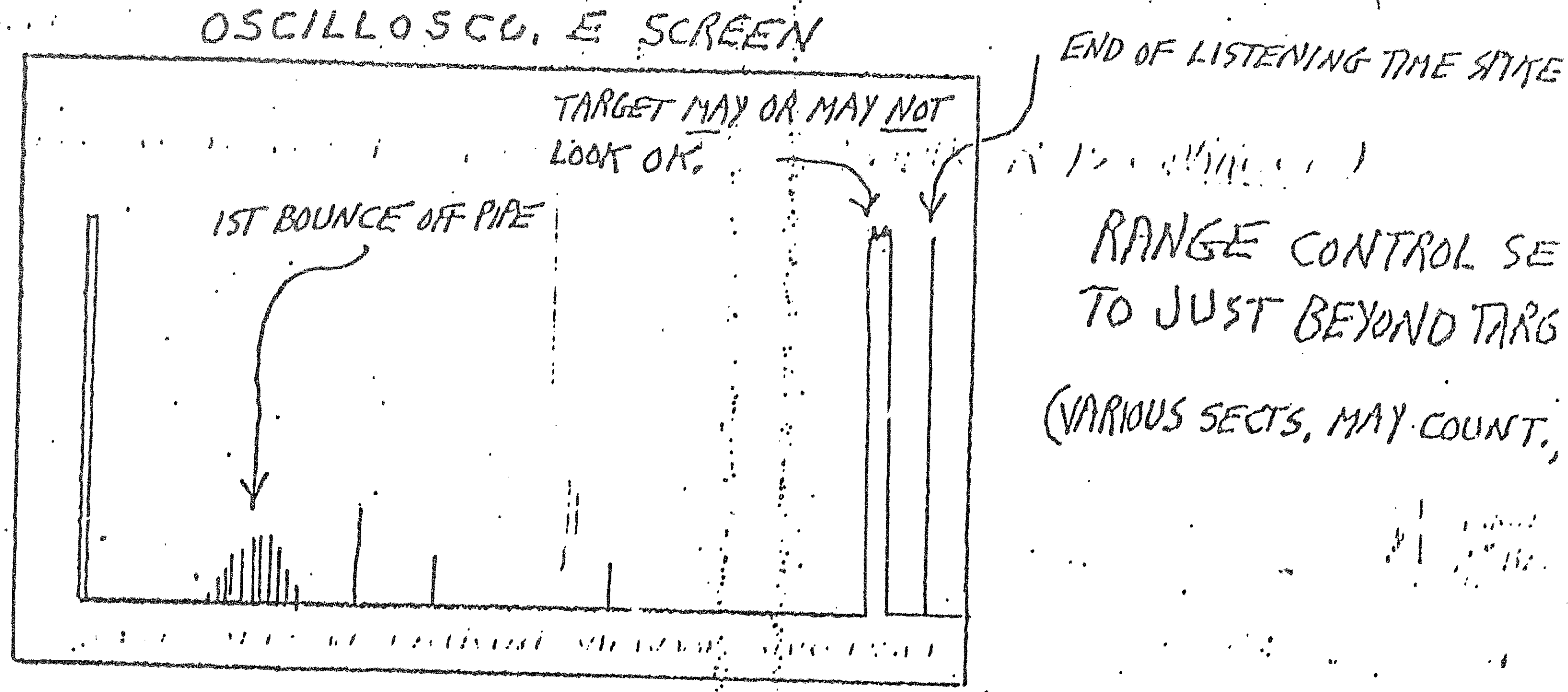



Figure II-11. IMPROPER TRANSDUCER AIMING.

BEAMWIDTH SWITCH SET TO 2° & SCOPE TRIGGER TO XM 2°. TRANSDUCER IS AIMED MUCH TOO LOW & BEAM IS BOUNCING OFF PIPE NEAR TRANSDUCER, THEN HITS TARGET & RETURNS BY SAME PATH.

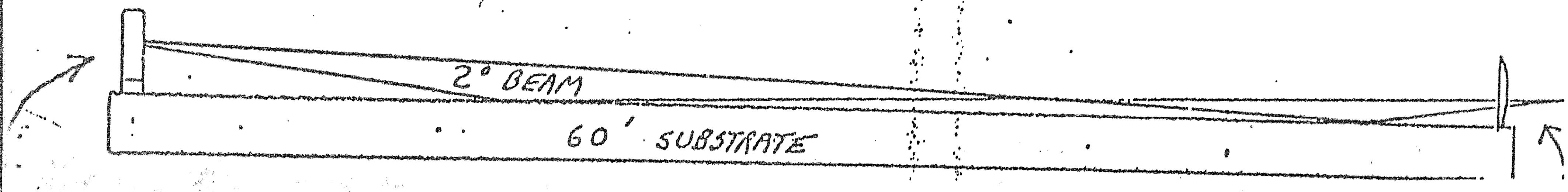


FIG. 19

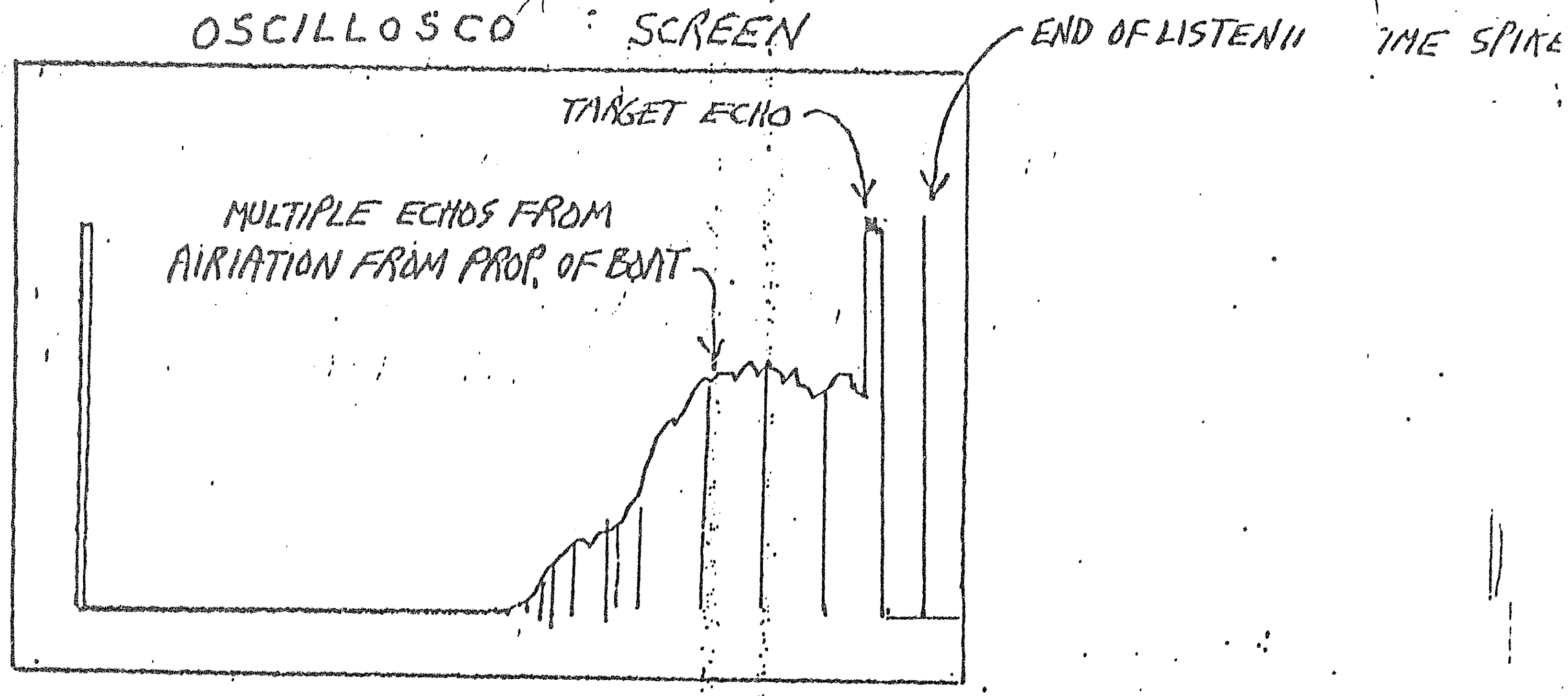
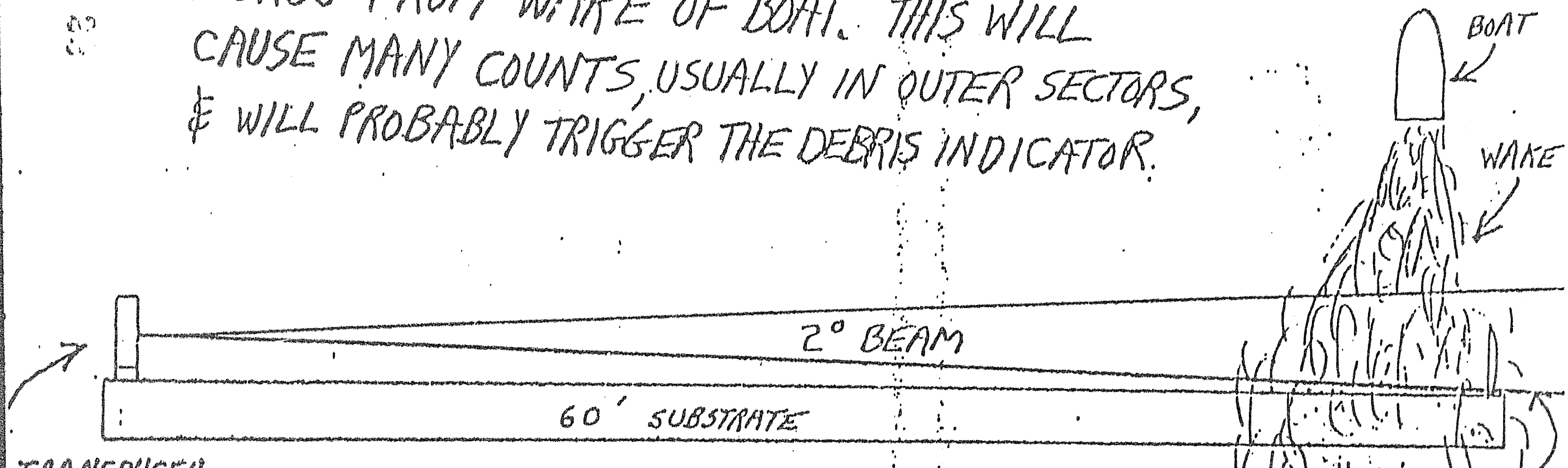



Figure II-12.

PROPERLY AIMED TRANSDUCER BUT MULTIPLE ECHOS FROM WAKE OF BOAT. THIS WILL CAUSE MANY COUNTS, USUALLY IN OUTER SECTORS, & WILL PROBABLY TRIGGER THE DEBRIS INDICATOR.



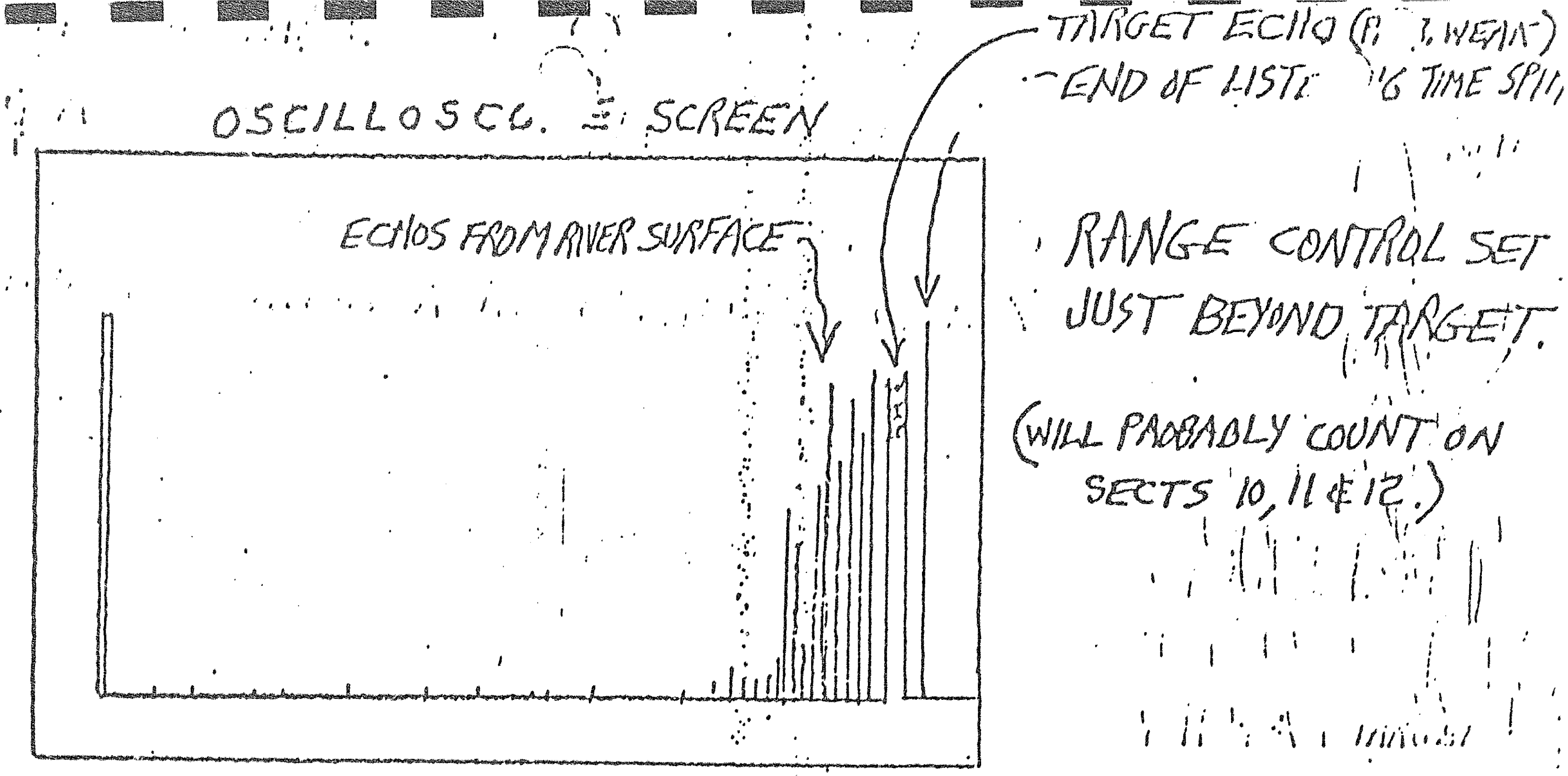
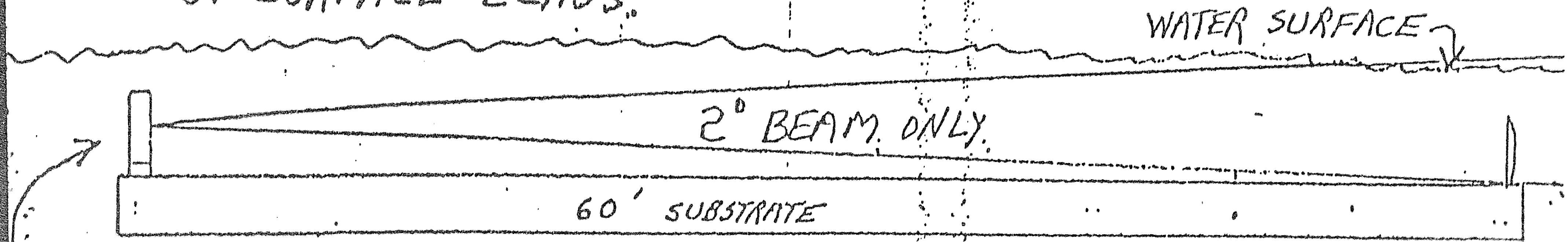



Figure II-13.

IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH SET TO 2 AND SCOPE TRIGGERRED FROM 2°. NOTE WATER IS TOO SHALLOW EVEN FOR 2° BEAM WHICH IS "BOXED IN". COUNTING RANGE ON SIDE SCANNER WOULD HAVE TO BE REDUCED TO ABOUT 50' TO PREVENT SURFACE ECHOS FROM COUNTING. TARGET WILL BE OBSCURED BY SURFACE ECHOS.



APPENDIX III

## A. ADULT ANADROMOUS FISHERIES STUDIES

### Fishwheel Operation

#### Design

A schematic of the type of fishwheel to be deployed on the Su/Hydro program is shown in Figure III-1. The axle is adjustable to accomodate water depths ranging from seven (7) to four (4) feet: the axle turns on nylon pillow blocks. The pillow blocks are designed to allow friction adjustments therein providing a breaking mechanism. Native spruce poles form the baskets and paddles. Basket web or netting is rubber coated fencing material. Floatation is provided by styrofoam logs shielded by plywood. The wheel is equipped with a plywood livebox which is collared between the two (2) offshore floatation logs. A fish sampling platform spans the two (2) outside floats on the downstream side of the livebox. The fishwheel is anchored by a cable or rope bridle anchored to a deadman upstream of the fishwheel. The wheel is kept offshore by a boom log arrangement as shown in Figure III-2.

#### Lead Weir

The purpose of positioning the livebox on the offshore side of the fishwheel is to allow placement of a weir on the inshore side between the bank and the near shore float. A sketch of the weir is presented in Figure III-3. The weir is comprised of several willow or alder pannels contoured to the stream bed. The pannels are held in place by the downstream boom log and on the bottom, by the stream bed. The latter is accomplished by sliding the weir pannels into the water at an upstream angle to the riverbed. The weir is a critical component of the fishwheel. An improperly installed or incomplete weir will allow bank migrant fish to pass inshore of the wheel thus reducing catch.

#### Debris Deflection

At a few fishwheel sites it will be necessary to install a debris lead. A deflector which is reasonably efficient in channeling debris past a fishwheel is illustrated in Figure III-4.

#### Operation

The fishwheels are designed to operate at 2.5 revolutions per minute (rpm). Under no circumstances should a fishwheel be operated at a speed greater than 3.5 rpm. The preferred speed is 2.5 rpm with a range between 2.0 and 3.0 rpm. For maximum catch efficiency, fishwheel baskets should be adjusted to scoop within six (6) inches of the bottom. Anything more than six (6) inches will reduce catch efficiency.

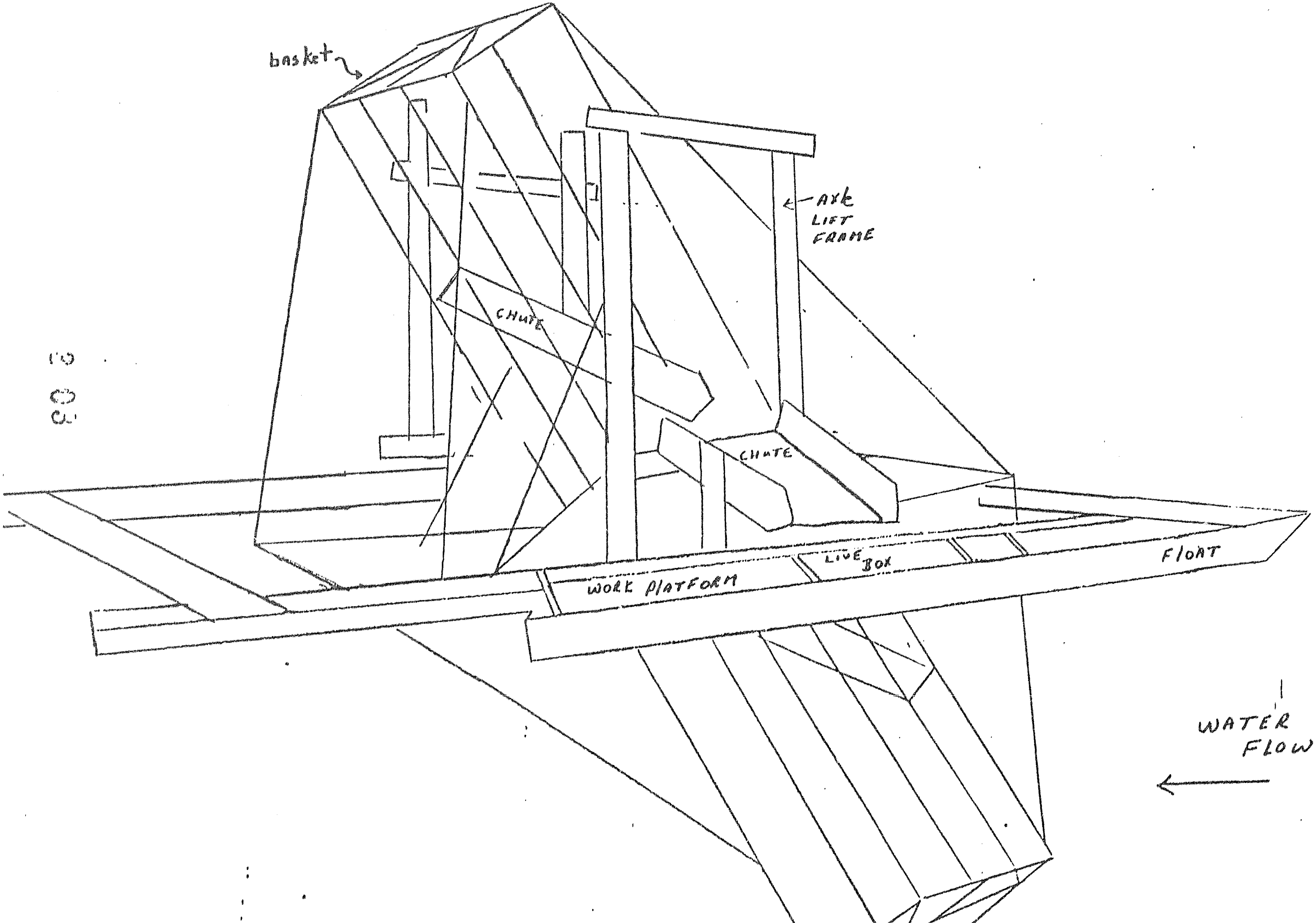
Maintenance

Lead weirs should be inspected to insure they are functioning once every (3) days. Debris cleaning should be performed as often as necessary but at least once every day. Inspection must be made twice daily for wear, broken components and loose riggings. Appropriate repairs are to be effected at first indication of a problem. Fishwheel basket depth should be monitored twice daily and appropriately adjusted.

FISH WHEEL

Figure III-1.

(SIDE VIEW)



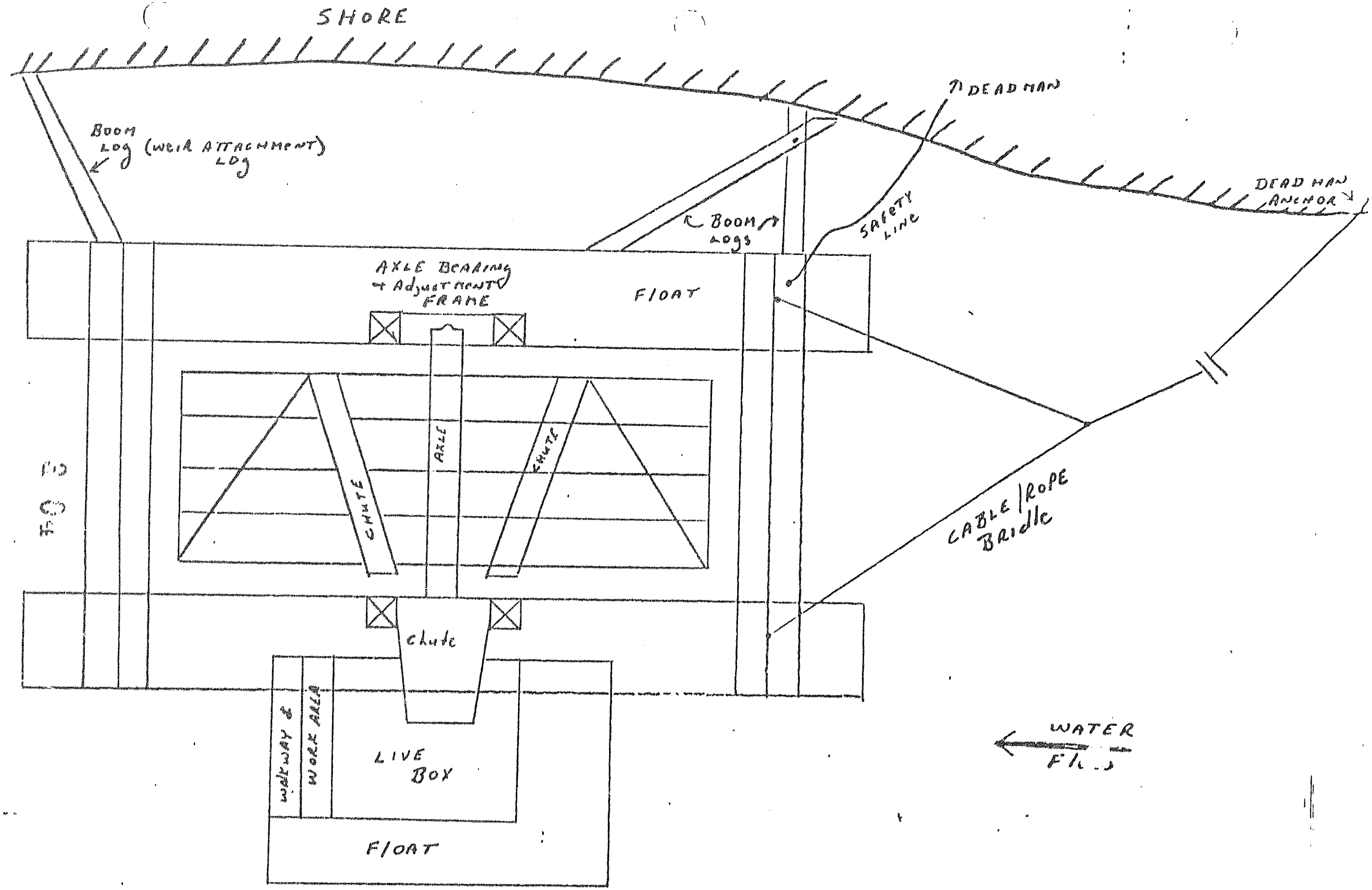
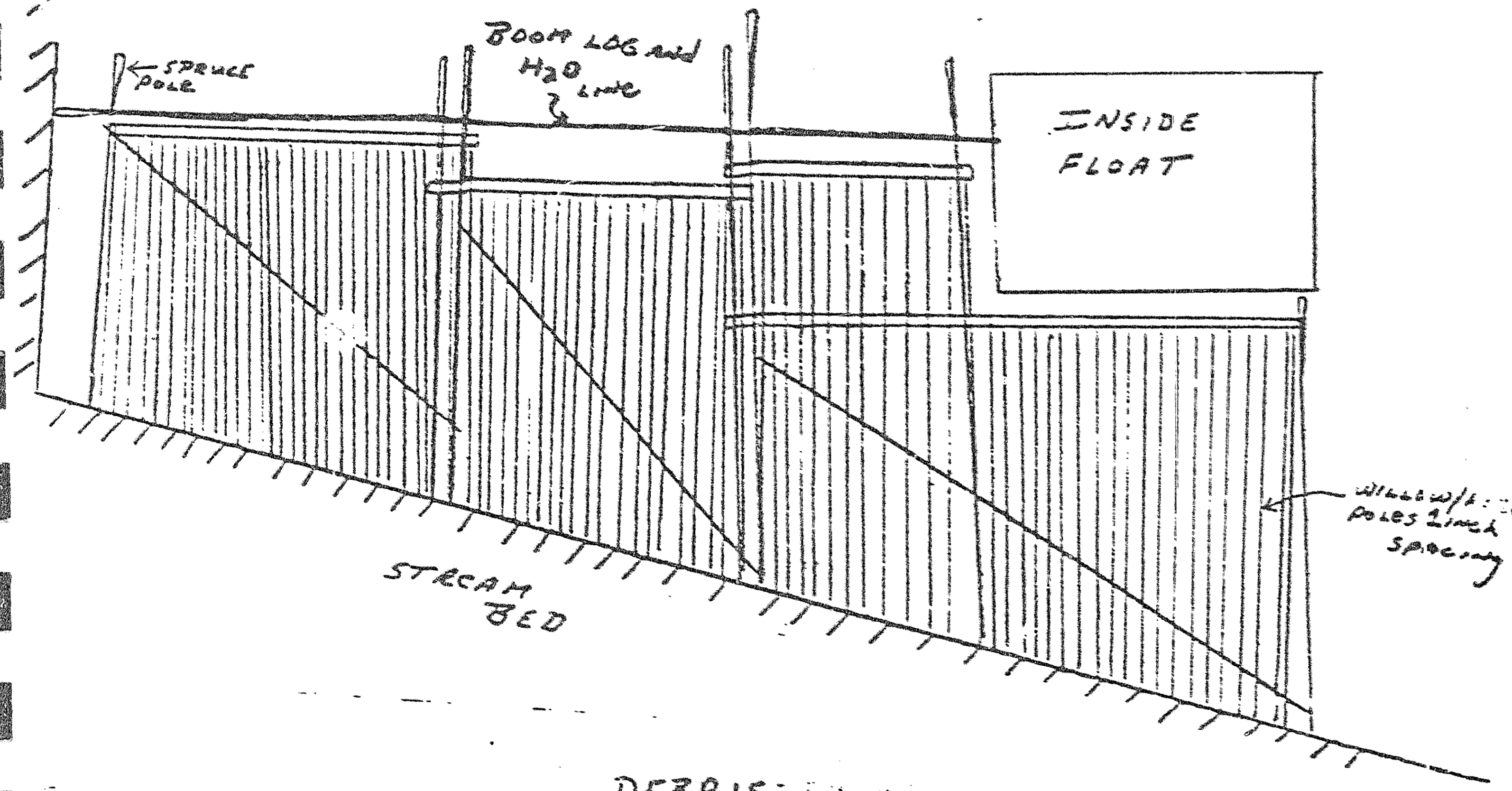


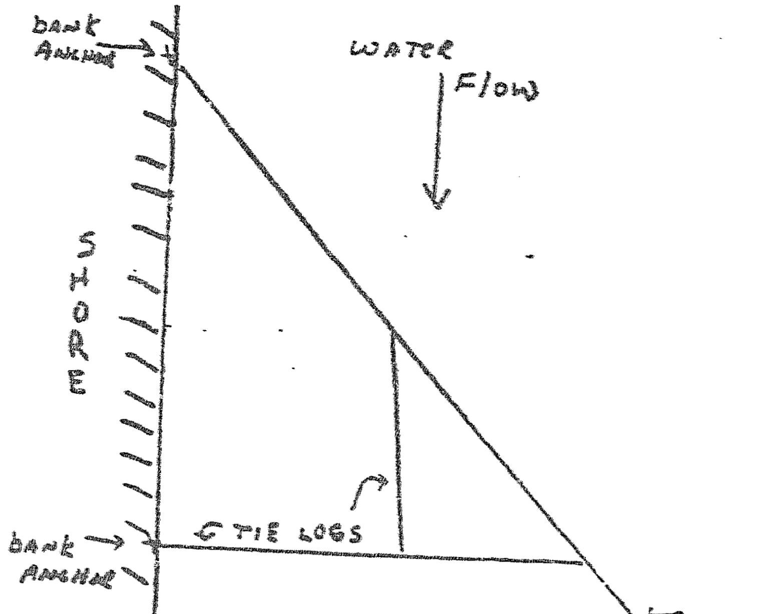

Figure III-2. FISHWHEEL (TOP VIEW)

FISHWHEEL LEAD WEIR (UPSTREAM VIEW) Figure III-3.




DEBRIS DEFLECTOR

Figure III-4. (TOP VIEW)



(SIDE VIEW)

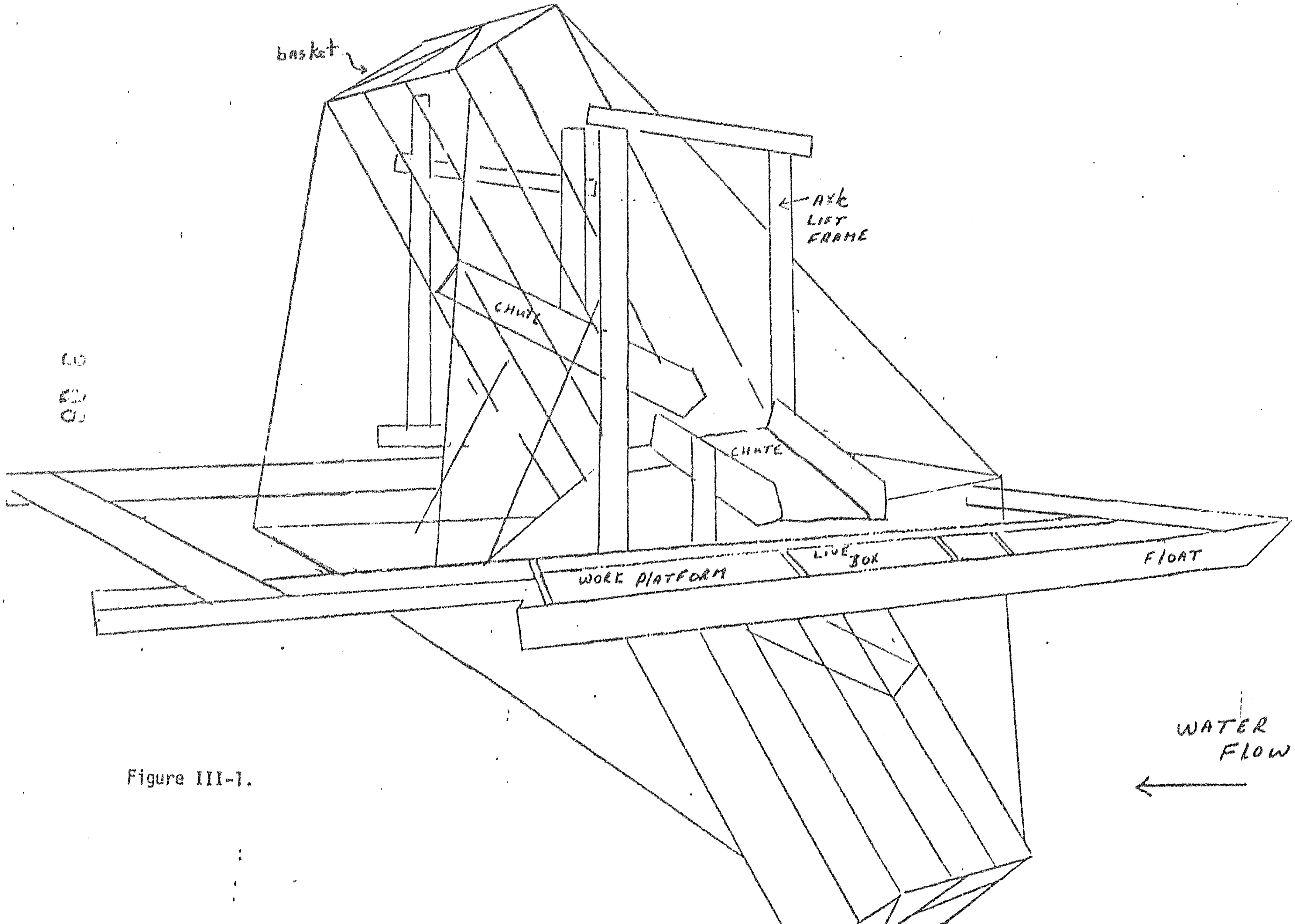



Figure III-1.

APPENDIX III

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### Fishwheel Operation

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# APPENDIX IV

## A. ADULT ANADROMOUS FISHERIES STUDIES

### Fish Tagging (ADF&G, 1976)

#### Development of Marking of Fish

A mark can be defined as a brand, label, seal or tag which identifies an object to show the maker or owner. Early tagging of fish was begun by land owners along streams who were interested in conserving salmon and trout runs. Charles Atking tagged Atlantic salmon in 1873 in Maine's Penobscot River and several recoveries were noted in following years. T.W. Fulton of Scotland (1893) and C.G.J. Petersen of Denmark (1894) both used numbered buttons or disks on plaice (flatfish) and other fish species in the Atlantic Ocean. The Petersen disk has been one of the most successful types of tags and most widely used over the years.

Exact figures on the rate of development of tagging are hard to accumulate, but there are estimates that by 1910 about 100,000 fish had been marked with tags. By 1936, the total was around 600,000 marked fish. Presently many millions of fish (also molluscs, crustacea and sea mammals) are being tagged every year for the purpose of studying population dynamics and migrations.

#### Ideal Fish Marks

Information on what constitutes an ideal fish mark, the types of marks, purposes of tagging and methods of tagging and recovery are spread through the fisheries literature.

Arnold (1966) suggested the following criteria for an ideal fish mark.

1. It should be retained essentially unaltered for life of fish regardless of the age at which applied.
2. It should have absolutely no effect of fish's behavior, reproductions, life-span, growth, feeding, movement, vulnerability to predation, angling or other external factors.
3. It should not tangle in vegetation or nets of any kind.
4. It should be inexpensive and easily manufactured.
5. It should be usable on any size fish without significant alteration.

6. It should not be found in nature nor should it be possible to confuse it with any other mark, nátural or artificial.

7. It should be easily applied to fish in the field without the need for an anesthetic.

8. It should be easily detected in the field by untrained personnel or the public.

9. If the marked fish is preserved as a scientific specimen, or for later examination, the mark should not be affected by the preservation.

10. There should be enough possible variations of the mark so that many individuals or many small groups can be identified separately.

11. The marking substance should not present any health or safety hazard to the biologist, fish, or the public.

12. The mark should not cause adverse public relations by spoiling edible parts of the fish.

Obviously, no one mark satisfies all the above listed requirements and it generally only satisfies a few of them. One of the critical problems of a research project is to decide on the best mark for the particular circumstances.

Both Floy and Peterson disc tags have been utilized in the Susitna River drainage in the past and will be used to tag fish at the Sunshine, Talkeetna and Curry tag recapture sites.

Peterson Disc Tags

One (1) inch diameter, sequentially numbered Peterson disc tags will be utilized at the Curry site. The color code will be international orange.

Tagging procedures will be reviewed in the field as it is difficult to explain without having tags and a fish in hand. Generally, the following steps are followed:

1. Hold prepared tag (pin, disc, and numbered tag) with pliers and insert through the cartilage immediately under the dorsal fin.

2. Place a blank tag on the pin and cut off all but 3/8 inch of the pin with a cutting pliers.

3. Twist remaining pin in an inward and rolling motion so that the pin lies flat against the disc and forms a loop.

Here are a couple suggestions that will help:

1. Use a sharpening stone to make a sharp point on the tagging pins. This can be done ahead of time and will make penetration easier.

2. Prepare tags prior to making fishwheel checks. Assemble tags in sequential order and stick them in a piece of styrofoam: pin, clear buffer disc, tag.

Floy Tags

Sequentially numbered FT-4 Floy tags will be utilized at the Sunshine and Talkeetna sites. Color code for the Sunshine site will be international orange and yellow for the Talkeetna site.

Tagging procedures will be demonstrated in the field; generally the following steps are followed:

1. Slide tag over barbed end of tagging needle. Run the needle completely through the fish in the anterior cartilage immediately below the dorsal fin.

2. Disconnect tube from the needle and tie-off with overhand knot.

Several suggestions are:

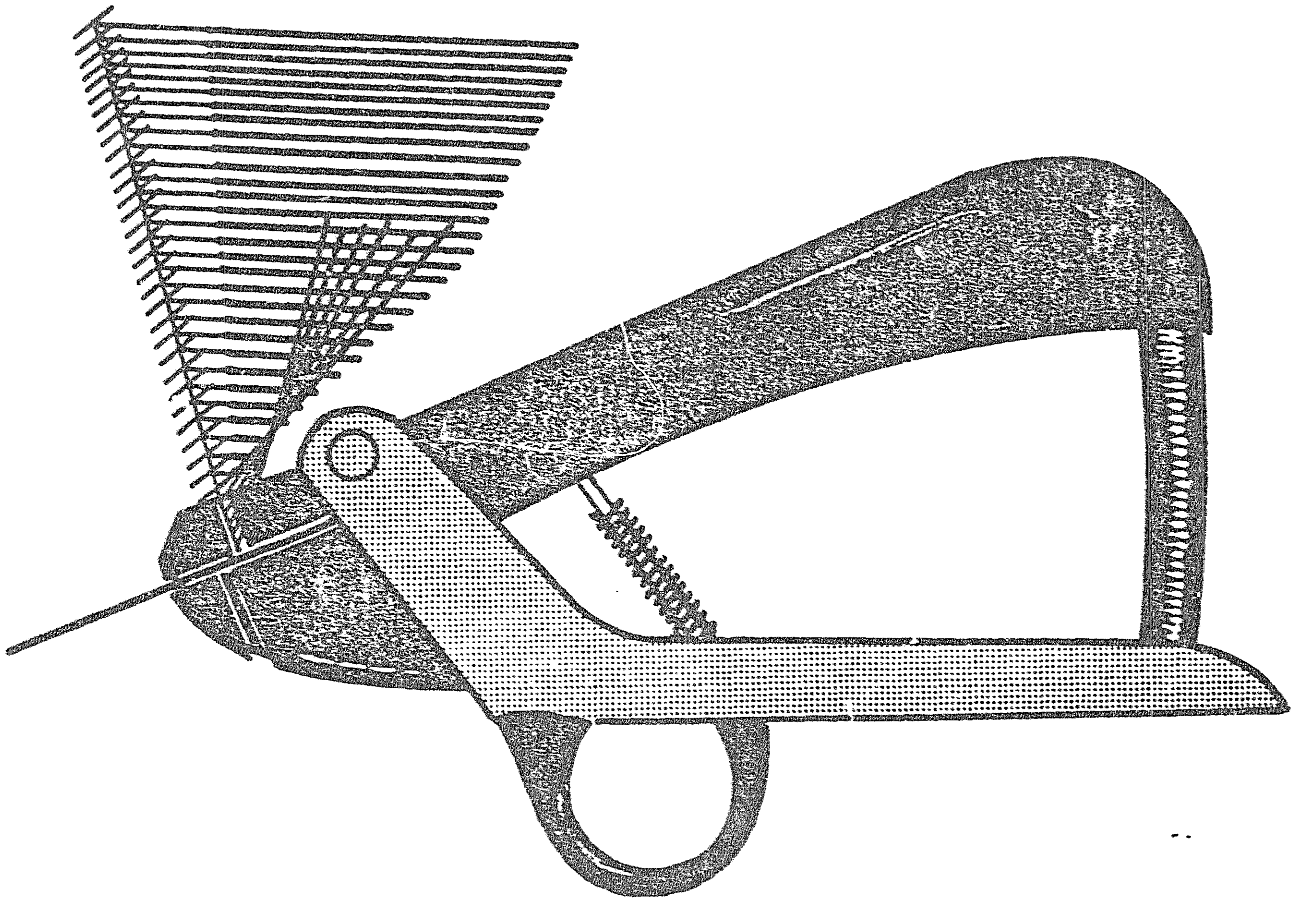
1. Keep two (2) or three (3) tagging needles available in the event of a loss.

2. Use a sharpening stone to maintain a sharp point on the tagging needle. This can be done ahead of time, making tagging easier.

3. Prepare tags prior to making fishwheel checks. Assemble tags in sequential order on a board and tape them in place, thus allowing them to be withdrawn easily.

## B. RESIDENT AND ANADROMOUS FISHERIES STUDIES

Figure IV-1. FDM-68 TAGGING GUNS AND ANCHOR TAGS



*(actual size)*

MODIFIED GUN INSERTS TAG UP TO 1-1/8 INCH

THE FDM-68 MODIFIED GUN HAS PROVED TO BE VERY EFFICIENT IN TAGGING VERY SMALL FISH AS WELL AS LARGE FISH. THE LONGER NEEDLE MAKES IT POSSIBLE TO INSERT A TAG INTO A SMALL BODIED FISH AT THE DESIRED ANGLE. THIS ALLOWS THE TUBING BEARING LEGEND AND NUMBER TO "FLOW" ALONGSIDE THE FISH"S BODY AS IT SWIMS. THIS PLACEMENT OF THE TAG IS NOT AS POSSIBLE WITH A SHORT GUN. THE REGULAR NEEDLE IS .085 OD. THE HEAVY DUTY NEEDLE (RECOMMENDED FOR FISH 10 POUNDS AND UP) IS .096 OD. THE LIGHT NEEDLE IS .073 OD.

## FDM-68 Tagging Guns and Anchor Tags

### Operating Instructions

#### Loading Gun

1. Place gun in left hand with forefinger through the trigger ring.
2. Hold tag clip between the thumb and index finger of the right hand with the extension of the "runner" (the bar holding the tags) toward the gun.
3. Insert the runner into the feed slot of the gun. Press the runer down until the first tag engages the feed mechanism.

#### Suggested Tagging Procedure

1. A clip of blank tags is provided for practice tagging.
2. Make certain the fish is held FIRMLY or anesthetized when being tagged. A squirming fish may bend the needle.
3. Insert needle on the left side of the fish forcing it forward through the dorsal rays and toward the anterior of the dorsal. This placement will lock the "T-bar" firmly behind the interneural rays.
4. Once the needle has been inserted, hold the gun FIRMLY against the fish's body while compressing the handle. Do not release the compressed handle until the needle has been withdrawn.

#### Unloading Gun

1. Pull the release lever (the black metal lever in front of the trigger ring.) Withdraw clip.

#### If Gun Jams

1. DO NOT attempt to clear the jam by forcing the tags through the mechanism. This will cause damage.
2. Remove clip from gun.
3. Turn the plastic lock lever (right side near needle) 180 degrees so lever points forward and remove needle.
4. Remove jammed tag from from needle or gun. Inspect needle and ram.
5. The tag (if not damaged) can be re-used by inserting the T-bar into the needle two thirds back from the point of the needle. This can be accomplished only if the tag clip has been removed from the gun. BE CERTAIN TO LINE UP THE SLOT IN THE NEEDLE WITH THE SLOT IN THE GUN.

#### Care of Gun and Needle

1. Operate gun without tags in warm soapy water to remove dirt, slime and scales.
2. Rinse carefully in warm (not hot) water. Shake and wipe dry.
3. Store in warm area to remove moisture from inside gun.
4. Lubricate with "WD-40" which prevents rust, penetrates and displaces moisture.
5. WHEN TAGGING UNDER SALINE CONDITIONS, THE GUN SHOULD NOT BE EXPOSED TO AIR ANY LONGER THAN ABSOLUTELY NECESSARY. A PAN OF FRESH WATER SHOULD BE KEPT AT HAND TO "SLOSH" OFF THE GUN CONTINLALLY. IF TAGGING IS INTERRUPTED, THE GUN (INCLUDING TAGS) SHOULD BE KEPT IMMERSED IN FRESH WATER.

## Disk-Dangler Type Tag

The disk-dangler type tag is attached to the body of the fish beneath the dorsal spine with two strands of wire. A small, viselike clamp holding two hypodermic needles of size number 18 is used to pass the wires through the fish's body. The needles are put in place and pushed through the body in one motion. The tag wires are then inserted into the hollow needles and the clamp pulled outward. Tags are attached with one wire anterior and one posterior to the origin of the dorsal fin. The needles are spaced so that their points are approximately one-half inch apart. A spacing strap may be placed between the wires to keep them from pulling together and tearing flesh when the wires are twisted together. If a single person is tagging, however, such a strap may be impossible to hold in place. If care is used in twisting the wires, excess injury to the fish may be avoided without the use of such a spacer. Excess wire is cut off the twisting end, and the exposed wire and tag are bent back.

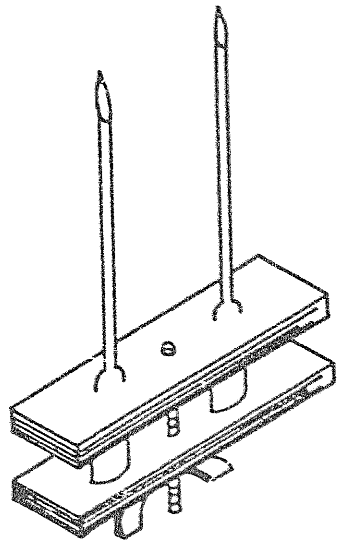


Figure IV-2. Tag clamp holding two hypodermic needles (from Pelgen, 1954)

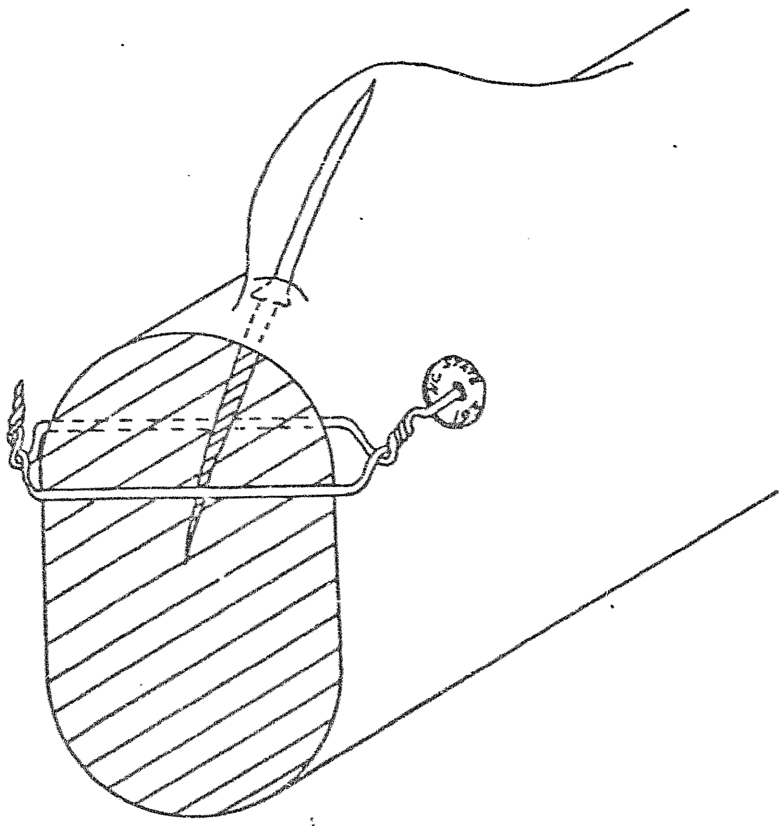


Figure IV-3. Disk-dangler tag in place (after Pelgen, 1954)

## APPENDIX V

## A. ADULT ANADROMOUS FISHERIES STUDIES

### Electro-Shocking Boat Operations

#### Safety Precautions

These procedures must be adhered to for the safety of all operators of this equipment.

1. A minimum of two (2) persons is required to safely and efficiently operate the unit, provided the control box can be easily monitored by the boat operator. For two (2) man operations, the boat operator should be capable of adjusting voltage and amperage, activating the power switches on the control box, and shuting down the generator without having to leave his station as outboard operator.

   Should these conditions not be met, then a minimum crew would be three (3). One (1) person should monitor the control box at all times.

2. All personnel should be thoroughly familiar with the equipment and its operation. Personnel should be briefed as to emergency procedures should the situation arise.

3. All equipment, connections and wiring should be checked before each day's operation. Particular attention should be payed to the platform railing and safety foot switch. The railing should be strong and secure enough to support a man's weight. The safety switch must be free of rust and corrosion. It would be advisable to have the metal railing insulated with foam pipe insulation or plastic electrical tape. Wiring should be left exposed to facilitate inspection of the insulation.

4. Only dip nets with fully insulated handles will be used.

5. Personnel will wear only hip boots or chest waders that are completely leak proof. The platform surface should be of a non-skid type. Rubber gloves are advisable as an added safety measure.

6. All personnel will wear life jackets or other adequate floatation devices. Should anyone fall overboard, it is unlikely that he will have enough muscle control to swim.

7. Never start the generator until all connections for the particular mode of operation are complete. While traveling between points of operation, the electrodes should be disconnected from the electrical source if the generator is to be left running, i.e., for night operations.

8. Never change the position of the boom or handle the electrodes unless the leads are disconnected and all switches on the control box are in the "off" position.

9. When disconnections are made or lines left disconnected, all switches on the control box should remain in the "off" position to preclude ary load on the wiring.

10. All personnel should be familiar with first aid treatment for shock victims and be trained in artificial respiration. At least one (1) member of the crew should have completed a recognized first aid course (hopefully he will not be the one injured).

11. The equipment shall not be operated in such a manner so as to endanger the public. The current shall be turned off anytime the public is in the immediate proximity of the aparatus, be it on shore, in the water, or in a boat.

In an emergency, the electrical current into the water may be broken in three ways:

1. By releasing the foot pedal switch which is located on the platform and controlled by the dip net operator.

2. By turning off all switches on the control box. One (1) man must be operating the control box at all times.

3. By actuating the grounding switch effectively killing the generator. If possible, switches should be located both on the dipping platform and near the motor operator and wired so that activation of either switch will kill the generator.

First Aid for Victims of Electrical Shock

Should anyone fall overboard or receive an electrical shock, the unit will be immediately shut off. Rescue the victim from the water or free him from the electrical circuit as quickly as possible. Act quickly, as any delay in removing the person from the electrical field or circuit will lessen the chance of resuscitating him. Do not endanger yourself attempting to rescue someone with the power on.

If the victim is not breathing, begin artificial respiration at once. Mouth-to-mouth resuscitation is recommended. Continue resuscitation until you are certain breathing is restored. Frequently, after a temporary recovery, a victim will stop breathing again. If natural breathing stops, resume artificial respiration at once.

Physical shock is a serious complication that is likely to occur after electrical shock. Shock can interfere with the normal action of the heart, respiration and circulation, so every precaution should be taken to prevent this condition from further weakening the victim. The victim should be lying flat and it is most important that he be kept as warm as possible, even during artificial respiration.

The following procedure is recommended in cases where it appears the victim's heart has stopped:

1. Place the victim on his back.
2. Position yourself on your knees beside his chest.
3. Find the lower end of his breast bone.
4. Place the heel of your hand one inch above that end.
5. Place your other hand on top of the first hand.
6. Press down firmly with about sixty (60) pounds of weight.
7. Repeat every second until heart starts.
8. If necessary, apply mouth-to-mouth resuscitation as follows: one (1) operator - 15 compressions, two breaths or two (2) operators - one breath every fifth compression.

The above procedure would be life sustaining should the victim go into ventricular fibrillation.

Admittedly, the above first aid procedures are brief, but due to lack of more competent means to deal with electrical accidents, this should serve as a guide for emergency treatment until the patient can be taken to medical facilities.

NOTE: A COPY OF THIS PROCEDURE MUST BE ONBOARD THE SHOCKING BOAT AT ALL TIMES!!!!

B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

Model XV-BPG Self-Contained Gas Powered Electrofisher
(Backpack Mounted)

Since the introduction of the lightweight, quiet and reliable TAS-300 alternator, Smith-Root, Inc. now offers the type XV-BPG, a gasoline powered backpack electrofisher. Designed for very low to medium conductivity waters, the Type SV-BPG delivers a high 1100 volt peak DC for the very low conductivity waters and as much as 2.5 amps for the higher conductivity waters.

Both the electrofisher and alternator are mounted on a comfortable, reinforced plastic pack frame. The new pack frame not only outlasts aluminum packs, it provides an extra margin of safety from electric shock providing an insulation between the operator and the electrical apparatus. The pack frame harness has been designed to provide instant release should it become necessary to quickly drop away the complete pack frame from the operator.

SPECIFICATIONS:

| | |
|---|---|
| Power Source | TAS Model QEG-300 Watt gas-powered generator |
| Recommended Conductivity Range | Approximately 10 to 200 micro-mhos/cm2 max. Useable to 400 micromhos |
| Input Power | 300 watts, 450 watts intermittent (all voltage ranges) |
| Output Modes: | |
| AC | 130-390 VRMS in 130 volt steps |
| Pulsed DC | 180-550 VDC peak fast rise, slow decay |
| Pulsed DC (x 2) | 360-1100 V |
| Metering | Output current 0 - 2.5 amp |
| Voltage Selection | Rotary Switch |
| Circut Protection | Electronic circuit breaker with reset |
| Safety Protection | Tilt switch kills engine if shocker is tilted beyone 45 degrees |
| Engine Kill | Push-button switch mounted on pack frame |

| | |
|---|---|
| Backpack Frame | Lightweight, comfortable frame with padded shoulder straps, padded hip belt and emergency quick release |
| Weight | 36 lbs. |

Standard Equipment: TAS-300 Generator, Anode Pole with Pull-Behind Cathode: optional Cathode pole available.

Specifications Subject to Change Without Notice

1/81

# APPENDIX VI

## A. ADULT ANADROMOUS FISHERIES STUDIES

Habitat Site Locations

## B. INTEGRATED RESIDENT AND JUVENILE ANADROMOUS FISHERIES AQUATIC HABITAT AND INSTREAM FLOW STUDIES

Habitat Site Locations

System of Specifying Geographic Locations

For conciseness and for use in the computer processing, it is convenient to use a modification of the General Land Office method of specifying locations as developed by federal and state agencies in Montana (MDFWP, 1979).

In this report, locations of features such as sampling points are specified by using 12 characters. The first three characters of the location give the township, the next three characters the range. The next two give the section number within the township, and the next tract, the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section in the northeast quadrant. If there is more than one feature in a 10-acre tract, consecutive digits beginning with 2 are added to the number. For example, if a sample was collected in Section 21, Township 9 North, Range 20 West, it would be numbered 09N20E21DAA2. The letters DAA indicate that the site is in the N1/4 of the N1/4 of the SE1/4, and the number 2 following the letters DAA indicates there are at least two sampling locations in this 10-acre tract.

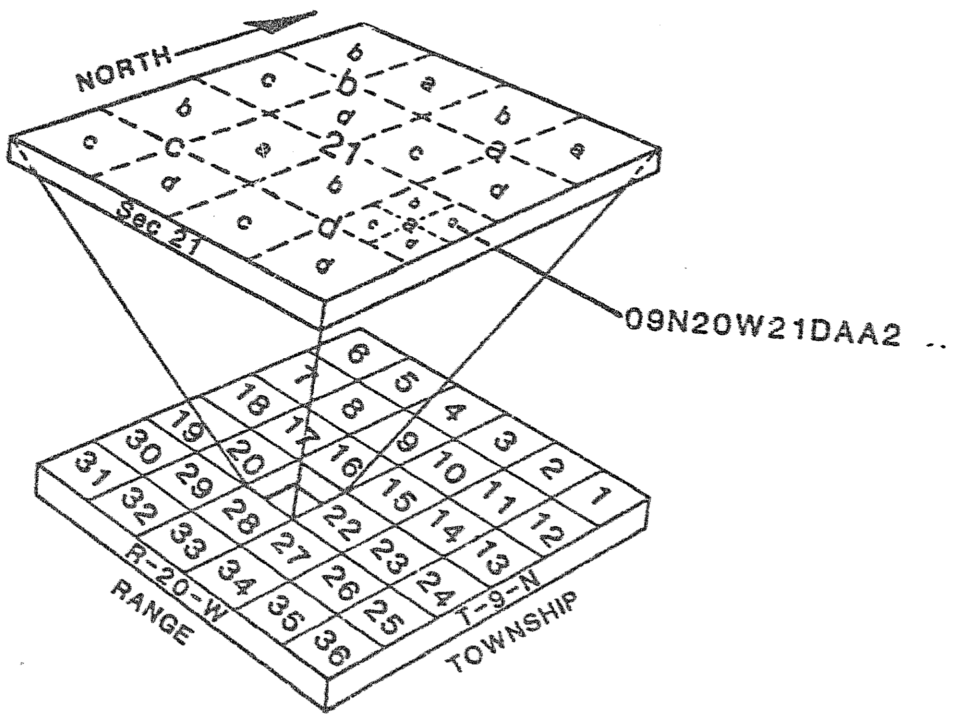



Figure VI-1. System used by ADF&G in this study to specify geographic locations.

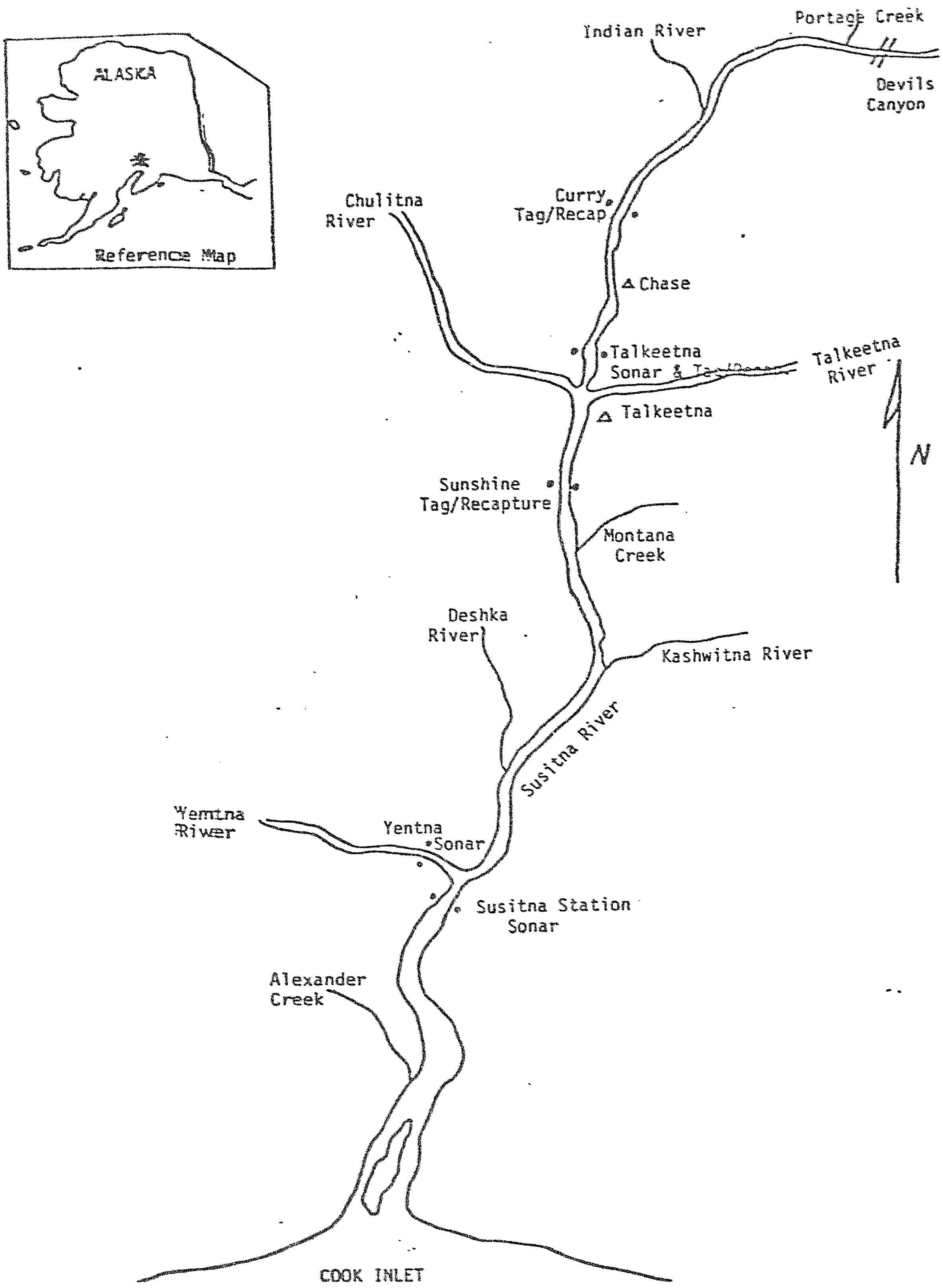



Figure VI - 2. Anadromous Adult Project study locations, 1981.

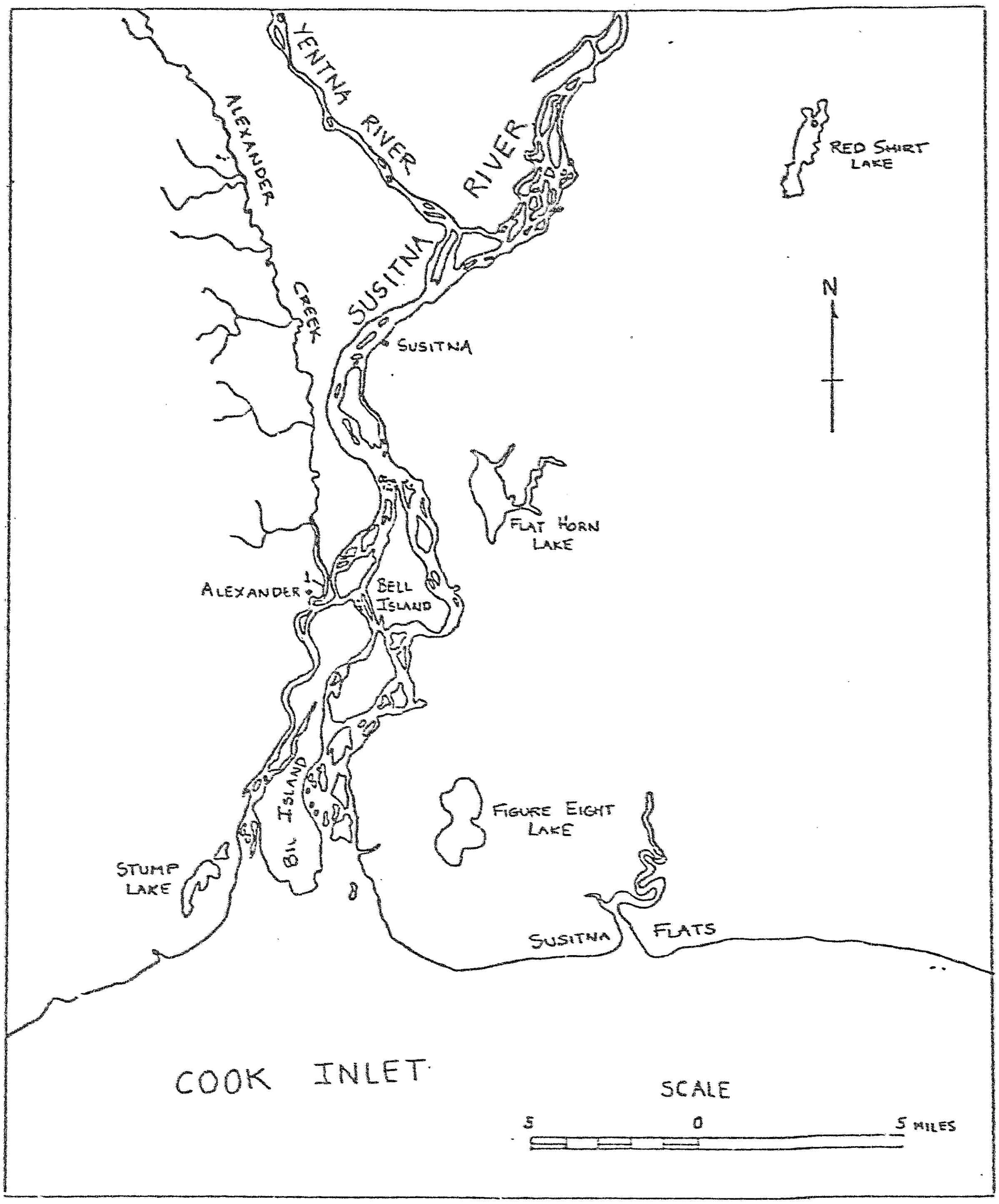



Figure VI - 3. RJ and AH sampling locations, 1981.

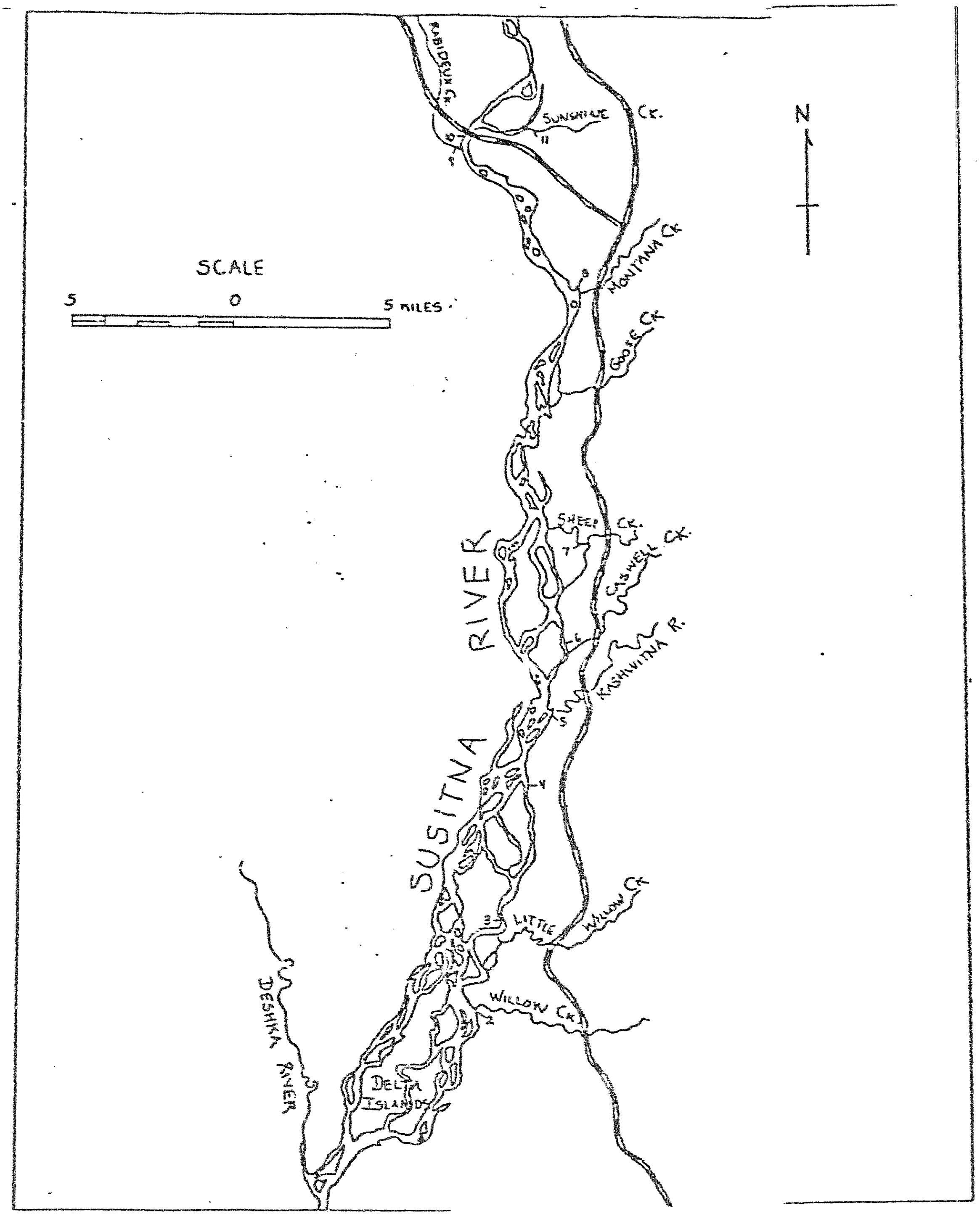



Figure VI - 4. RJ and AH sampling locations, 1981.

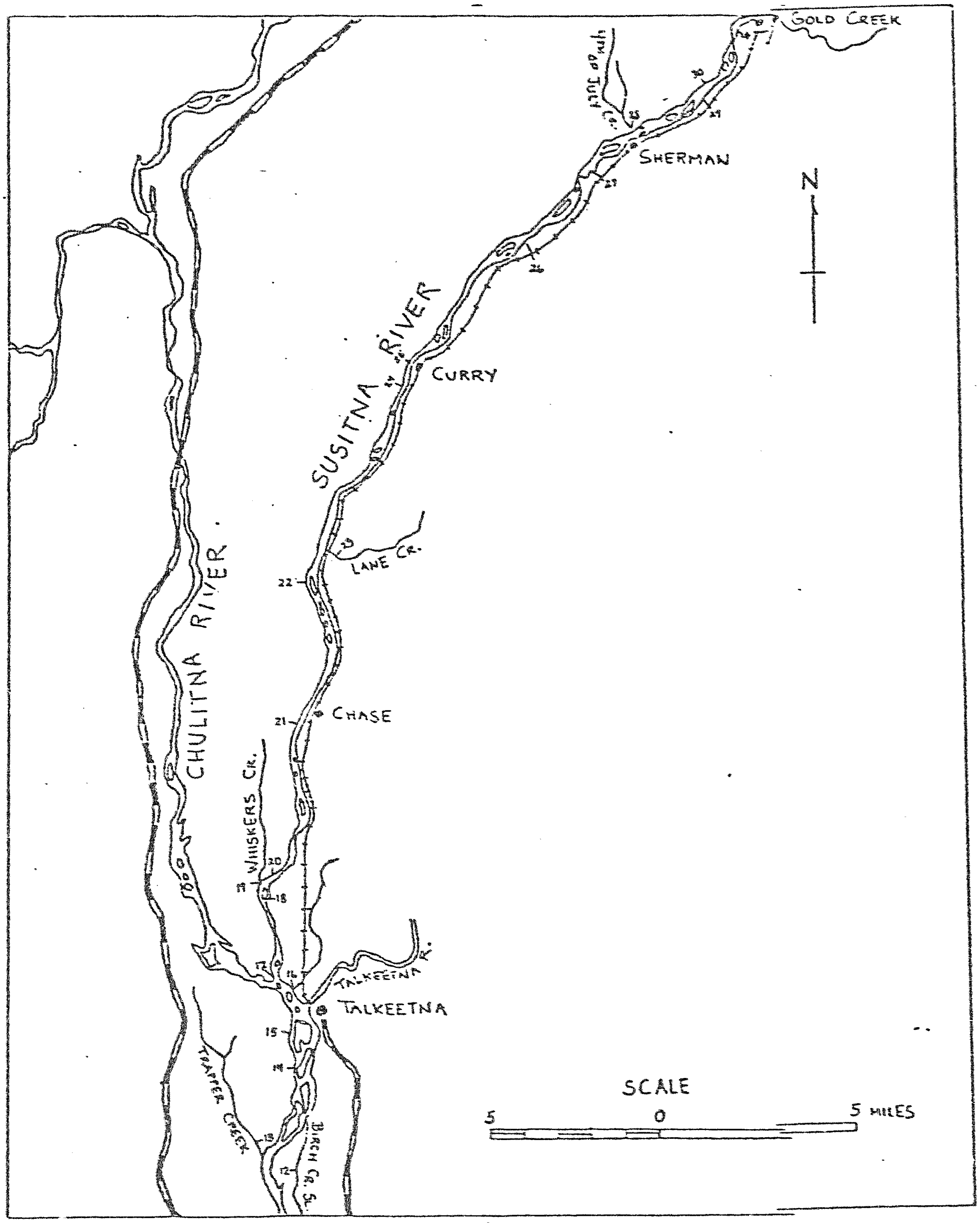



Figure VI - 5. RJ and AH sampling locations, 1981.

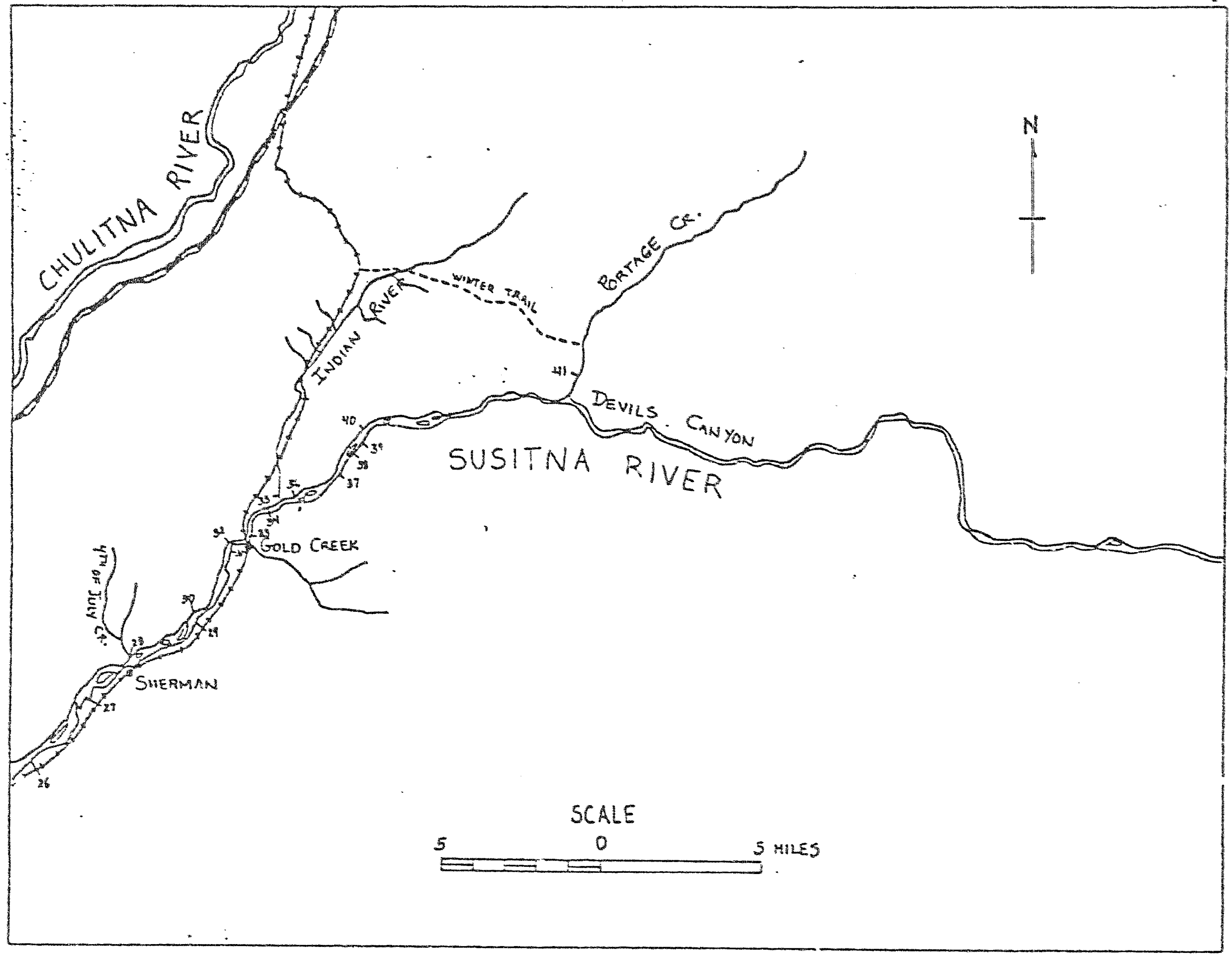



Figure VI - 6. RJ and AH sampling locations, 1981.

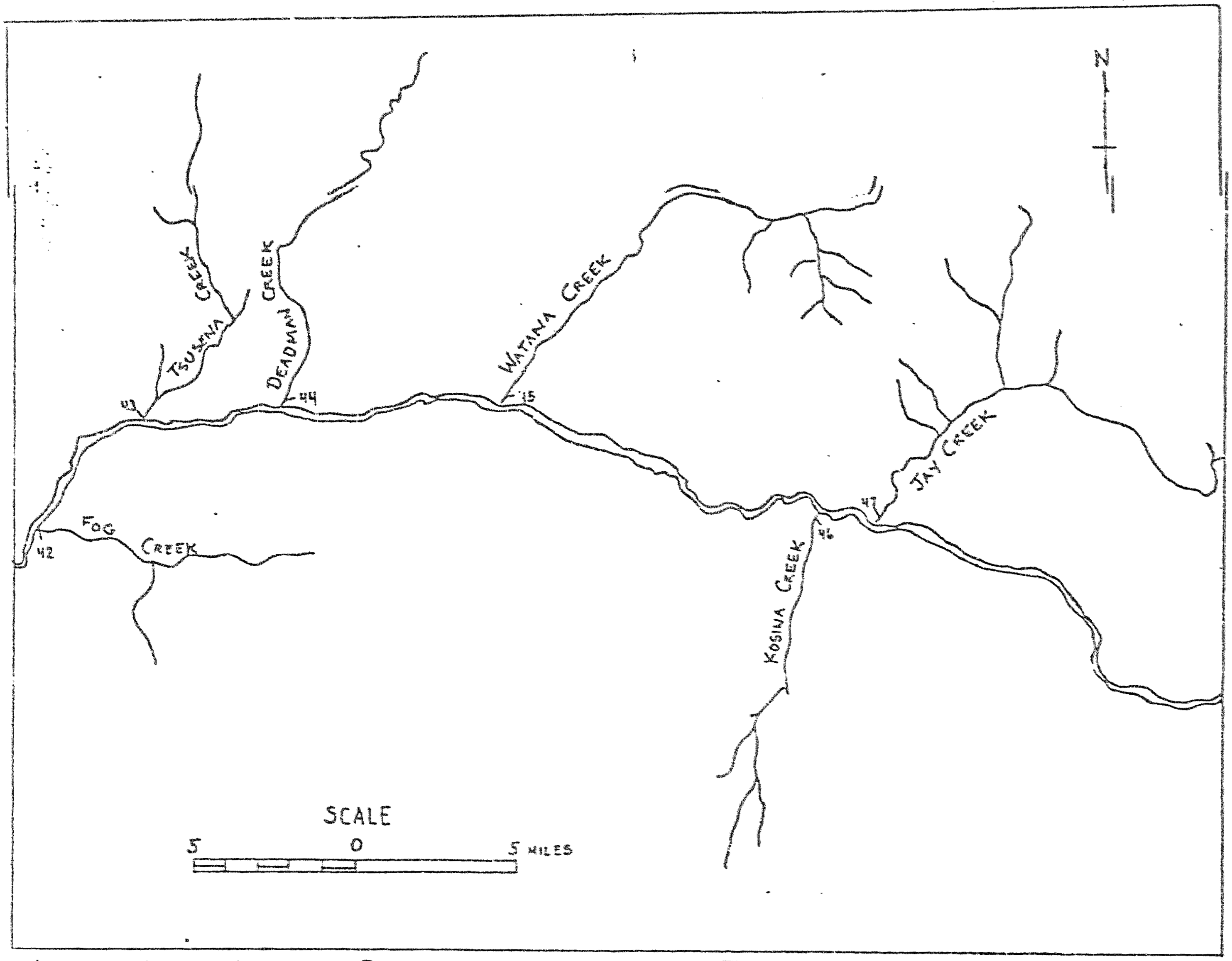



Figure VI - 7. RJ and AH sampling locations, 1981.

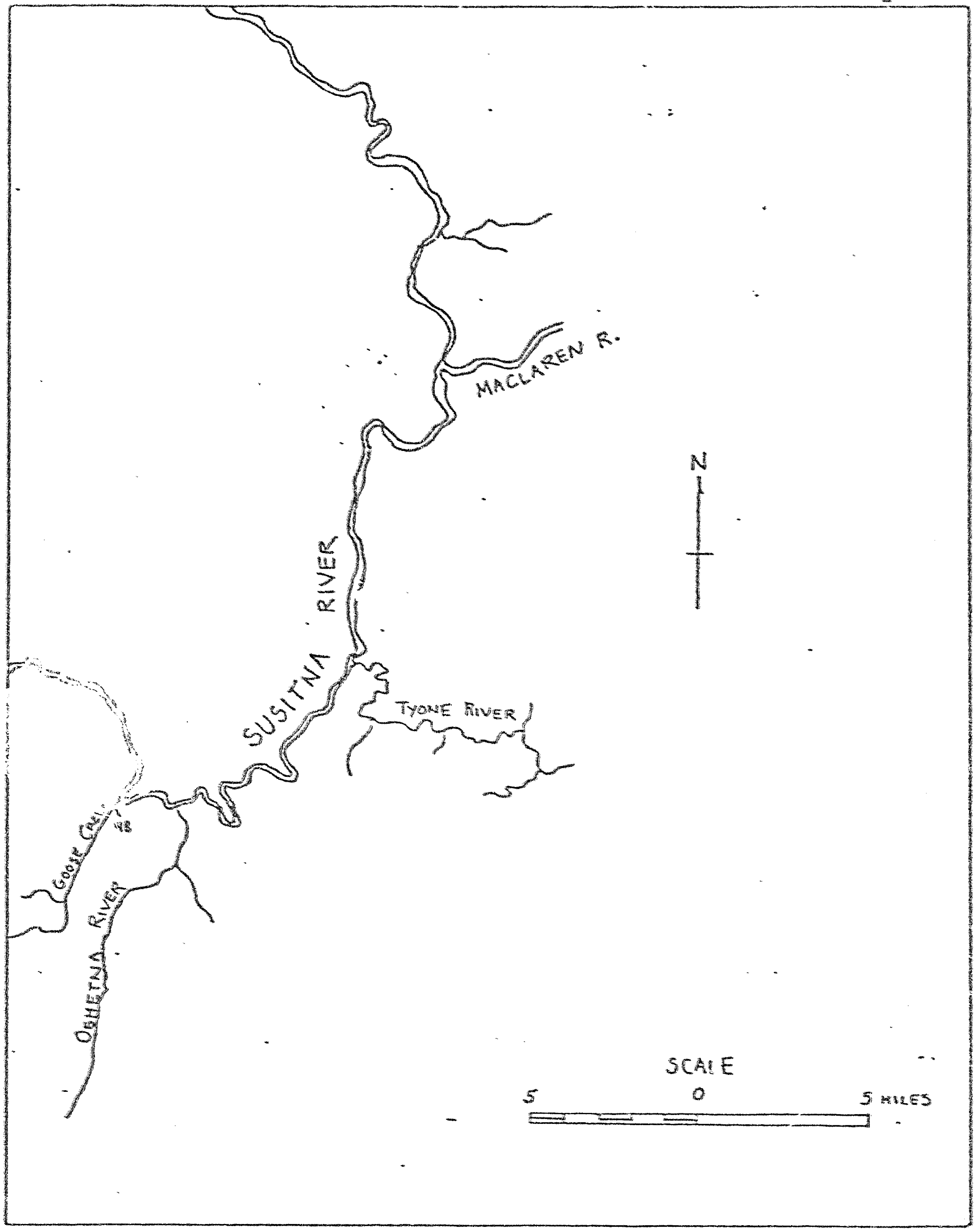



Figure VI - 8. RJ and AH sampling locations, 1981.

Table 1. Susitna River Resident and Juvenile Anadromous Fish Sampling Locations, 1981.

| MAP CODE | SAMPLING LOCATIO[illegible] | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| | Estuary to Talkeetna: | | | | |
| 1 | A. Mainstem Susitna (.75 mile south of | | | | |
| | Alexander River Mouth) | 15 N | 07 W | 07 | |
| | B. Alexander River | | | | |
| | (Mouth) | 15 N | 07 W | 07 | AB |
| | (.75 Mile Upstream) | 15 N | 07 W | 05 | |
| | (1.5 Mile Upstream) | 16 N | 07 W | 31 | |
| | C. Mainstem Susitna | | | | |
| | (Side-Channel Opposite Alexander R. Mouth) | 15 N | 07 W | 07 | |
| | D. Mainstem Susitna (1.0 mile North of | | | | |
| | Alexander River Mouth) | 15 N | 07 W | 05 | |
| 2 | A. Mainstem Susitna (Willow Creek Mouth) | 20 N | 05 W | 34 | CA |
| | B. Willow Creek (Mouth) | 20 N | 05 W | 34 | |
| | (Parks Highway) | 19 N | 04 W | 06 | AC |
| 3 | A. Mainstem Susitna (100 yards Above Little | | | | |
| | Willow Creek) | 20 N | 05 W | 27 | BA |
| 4 | A. Slough A (Rustic Wilderness Subdivision) | 21 N | 05 W | 25 | CB |
| | B. Mainstem Susitna (East Bank, 700 yards | | | | |
| | above Slough A) | 21 N | 05 W | 23 | DD |
| | C. Mainstem Susitna (West Bank, Opposit Sl.A) | 21 N | 05 W | 23 | DA |
| | D. Mainstem Susitna (East Bank, below Slough | | | | |
| | E Head) | 21 N | 05 W | 24 | BA |
| | E. Slough E (.25 mile above Rustic Wilderness | | | | |
| | Subdivision) | 21 N | 05 W | 25 | BC |
| | | | | | |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 5 | A. Mainstem Susitna (West bank, adjacent to | | | | |
| | Susitna Landing) (C) | 21 N | 05 W | 13 | BC |
| | (West bank, Slough Mouth) (A) | 21 N | 05 W | 12 | CC |
| | B. Mainstem Susitna (.25 mile, West of | | | | |
| | Kashwitna River Mouth) | 21 N | 05 W | 13 | AB |
| | C. Mainstem Susitna (100 feet below | | | | |
| | Kashwitna River Mouth) | 21 N | 05 W | 13 | AC |
| | D. Kashwitna River (Mouth) | 21 N | 05 W | 13 | AAC |
| 6 | A. Caswell Creek (Mouth) | 21 N | 04 W | 06 | BA |
| 7 | A. Mainstem Susitna (Site A, below Sheep | | | | |
| | Creek Slough Mouth) | | | | |
| | (Site B, below Sheep Creek Slouth Mouth) | | | | |
| | B. Sheep Creek Slouth (Mouth) | 22 N | 05 W | 25 | DD |
| | C. Mainstem Susitna (East channel, .5 mile | | | | |
| | above Sheep Creek Slough Mouth) (D) | 22 N | 05 W | 24 | DD |
| | (East channel, .6 mile above Sheep Creek | | | | |
| | Slough Mouth) (E) | 22 N | 05 W | 24 | DA |
| | D. Slough ( .50 mile NW of Sheep Creek | | | | |
| | Slough Mouth) (F) | 22 N | 05 W | 24 | DB |
| | ( .75 mile NW of Sheep Creek Slough | | | | |
| | Mouth) (H) | | | | |
| | E. Mainstem Susitna (Center Channel, .9 mile | | | | |
| | across from Sheep Creek Slough Mouth) (I) | 22 N | 05 W | 23 | DB |
| | (Center Channel, .9 mile above Sheep | | | | |
| | Creek Slough Mouth) (G) | 22 N | 05 W | 24 | BC |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 7 | E. Mainstem Susitna (Cont'd.) | | | | |
| | (Center Channel, 1.0 mile above Sheep | | | | |
| | Creek Slough Mouth) (J) | 22 N | 05 W | 23 | AB |
| | F. Slough L (West Center Channel, below | | | | |
| | Echo Island) (L) | 22 N | 05 W | 14 | CD |
| | G. Mainstem Susitna (Below Echo Island) (M) | 22 N | 05 W | 14 | CD |
| | (Adjacent to Echo Island) (K) | 22 N | 05 W | 14 | DC |
| 8 | A. Mainstem Susitna (Below Montana Creek | | | | |
| | Mouth) (B) | 23 N | 04 W | 07 | AB |
| | B. Mainstem Susitna (West Channel, Slough | | | | |
| | Mouth, 1.25 mile above Montana Creek) (F) | 23 N | 05 W | 13 | DC |
| | C. Side-Slough (West Channel, small slough | | | | |
| | 1.0 mile below Montana Creek) (G) | 23 N | 05 W | 13 | AD |
| | D. Side-Slough (West Channel, slough .25 mile | | | | |
| | below Montana Creek) (E) | 23 N | 05 W | 12 | DB |
| | E. Montana Creek (Mouth) (A) | 23 N | 05 W | 07 | AB |
| | F. Mainstem Susitna (East Channel, .25 mile | | | | |
| | above Montana Creek) (C) | 23 N | 04 W | 06 | CD |
| | (East Channel, .50 mile above Montana | | | | |
| | Creek) (D) | 23 N | 04 W | 06 | CD |
| | G. Beaver Pond (West Bank, 1.0 mile above | | | | |
| | Montana Creek Mouth) | | | | |
| | H. Mainstem Susitna (West bank, slough | | | | |
| | Mouth above Montana Creek) | | | | |
| | (East Bank, 1.0 mile above Montana Creek) | | | | |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 8 | H. Mainstem Susitna (Cont'd.) | | | | |
| | (Center Channel, 1.25 mile above | | | | |
| | Montana Creek) | | | | |
| | I. Slough (West bank, 2 miles above Montana | | | | |
| | Creek) | | | | |
| 9 | A. Rabideux Creek | 24 N | 05 W | 16 | AAB |
| | (Mouth) | | | | |
| | (500 feet Upstream) | | | | |
| 10 | A. Mainstem Susitna ( .25 mile below | | | | |
| | Parks Highway Bridge) | 24 N | 05 W | 15 | BA |
| | B. Mainstem Susitna (Parks Highway Bridge) | 24 N | 05 W | 15 | BA |
| 11 | A. Mainstem Susitna (1.0 mile South of | | | | |
| | Sunshine Creek Mouth) | 24 N | 05 W | 10 | |
| | B. Mainstem Susitna ( .75 mile South of | | | | |
| | Sunshine Creek Mouth) | 24 N | 05 W | 14 | |
| | C. Mainstem Susitna (At Sunshine Creek) | 24 N | 05 W | 14 | AA |
| | D. Sunshine Creek | 24 N | 05 W | 14 | AA |
| | (Mouth) | | | | |
| 12 | A. Birch Creek Slough (Mouth) | 25 N | 05 W | 25 | |
| | (.25 mile below Birch Creek Mouth) | 25 N | 05 W | 25 | |
| | (Birch Creek Mouth) | 25 N | 05 W | 25 | |
| | (Head) | 25 N | 05 W | 12 | |
| 13 | A. Trapper Creek (Mouth) | 25 N | 05 W | 15 | |
| 14 | A. Slough Fed by Cache Creek (Mouth), 1.5 mi. | | | | |
| | South West of Birch Creek Slough Head | 25 N | 05 W | 14 | |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION: TOWNSHIP | RANGE | SECTION | GRID |
|---|---|---|---|---|---|
| 14 | B. Slough-Susitna (1.0 mile South West of | | | | |
| | Birch Creek Slough Head | 25 N | 05 W | 11 | |
| | C. Mainstem Susitna (.25 mile below head of | | | | |
| | Birch Creek Slough) | 25 N | 05 W | 12 | |
| | D. Mainstem Susitna (South West side of | | | | |
| | Island, 1.5 mile South of Cache Creek Mouth) | 25 N | 05 W | 01 | |
| | E. Mainstem Susitna (South West side of island | | | | |
| | 1.0 mile South of Cache Creek Mouth) | 25 N | 05 W | 01 | |
| | F. Mainstem Susitna (West channel, .75 mile | | | | |
| | South of Cache Creek Mouth) | 26 N | 05 W | 35 | |
| | G. Mainstem Susitna (Below Mouth of Cache | | | | |
| | Creek Slough) | 26 N | 05 W | 36 | CB |
| | (Mouth of Cache Creek Slough) | 26 N | 05 W | 35 | DA |
| 15 | A. Cache Creek (Mouth) | 26 N | 05 W | 36 | CB |
| | (Inside Mouth) | 26 N | 05 W | 35 | ABC |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| | Talkeetna to Devil's Canyon: | | | | |
| 16 | A. Mainstem Susitna (Billian Slough Mouth) | 26 N | 05 W | 23 | AAD2 |
| | B. Billian Slouth (Mouth) | 26 N | 05 W | 23 | AAD3 |
| | (Open Lead Below Railroad Trestle) | 26N | 05 W | 13 | CCD |
| 17 | A. Mainstem Susitna (West side of Island, | | | | |
| | Chulitna River Confluence) | 26 N | 05 W | 14 | |
| | B. Mainstem Susitna (East side of Island, .25 | | | | |
| | mile North of Chulitna River Confluence) | 26 N | 05 W | 14 | |
| | C. Mainstem Susitna (.75 mile North of | | | | |
| | Chulitna River Confluence) | 26 N | 05 W | 14 | |
| | (1.0 mile North of Chulitna R. Confluence) | 26 N | 05 W | 11 | |
| | (1.25 mile North of Chulitna R. Confluence) | 26 N | 05 W | 11 | |
| 18 | A. Mainstem Susitna (Side-Channel Below | | | | |
| | Slough 2 Mouth) | 26 N | 05 W | 02 | CBD |
| | B. Mainstem Susitna (Side-Channel above | | | | |
| | Slough 2) | 26 N | 05 W | 02 | BCD |
| 19 | A. Mainstem Susitna (Below Mouth of Whiskers | | | | |
| | Creek Slough) | 26 N | 05 W | 03 | ADC |
| | (Adjacent to Mouth of Whiskers | | | | |
| | Creek Slough) | 26 N | 05 W | 03 | ABC3 |
| | B. Whiskers Creek Slough (200 yards | | | | |
| | above Mouth) | 26 N | 05 W | 03 | ADB |
| | C. Whiskers Creek (Mouth) | 26 N | 05 W | 03 | |
| | D. Mainstem Susitna (Side-channel, 1.0 mile | | | | |
| | east of Whiskers Creek) | 26 N | 05 W | 02 | |

Table 1 - Cont'd.

| MAP CODE | SAMPLING SITES | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 20 | A. Mainstem Susitna (.25 mile NW of Whiskers | | | | |
| | Creek Mouth) | 26 N | 05 W | 02 | |
| | B. Slough 3 (Above Whiskers Creek Slough) | 27 N | 05 W | 35 | CCC2 |
| | C. Slough 3B (Mouth) | 27 N | 05 W | 35 | CCB |
| | D. Mainstem Susitna (Side Channel Adjacent | | | | |
| | to Slough 3) | 27 N | 05 W | 35 | CCA |
| 21 | A. Mainsetm Susitna (Adjacent to Slough 5) | 27 N | 05 W | 01 | CCA |
| 22 | A. Slough 6A | 28 N | 05 W | 13 | CAB3 |
| 23 | A. Lane Creek (Mouth) | 28 N | 05 W | 12 | ADD2 |
| 24 | A. Oxbow II-(Mouth) | 29 N | 04 W | 16 | CAD4 |
| 25 | A. Mainstem Susitna (Curry) | 29 N | 04 W | 10 | CBB2 |
| 26 | A. Side Channel Below Slough 8A (Above Mouth) | 30 N | 04 W | 25 | DBA |
| | (Below Mouth of Slough 8A) | 30 N | 04 W | 25 | DAB |
| | B. Slough 8A (Mouth) | 30 N | 03 W | 30 | CBB |
| | (Above Mouth) | 30 N | 03 W | 30 | BCD |
| | (Beaver Pond) | 30 N | 03 W | 30 | AAA |
| | C. Mainstem Susitna (Above Slough 8A) | 30 N | 03 W | 20 | ACB |
| 27 | A. Slough 9 (Mouth) | 30 N | 03 W | 16 | CBB |
| | (Above Mouth) | 30 N | 03 W | 16 | CBAB |
| | (Below Bend) | 30 N | 03 W | 16 | CBAA |
| 28 | A. Mainstem Susitna (300 yards below 4th of | | | | |
| | July Creek) | 30 N | 03 W | 03 | DCAB |
| | (200 yards below 4th of July Creek) | 30 N | 03 W | 03 | DCAA |
| | B. Mainstem Susitna (Side channel, adjacent | | | | |
| | to 4th of July Creek) | 30 N | 03 W | 03 | DAD |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 28 | C. Side Channel (Beaver pond outlet, above | | | | |
| | 4th of July Creek) | 30 N | 03 W | 03 | ADD |
| 29 | A. Slough 9A (Above Mouth) | 31 N | 03 W | 36 | DCB |
| | (First Pool) | 31 N | 03 W | 36 | DCA |
| | (Open Lead) | 31 N | 03 W | 36 | DBDC |
| | (Second Pool) | 31 N | 03 W | 36 | DBD |
| | B. Mainstem Susitna-Between 9A & 10 | | | | |
| | (Lower, Lead) | 31 N | 03 W | 36 | DBC |
| | (Middle, Lead) | 31 N | 03 W | 36 | ACD |
| | (Upper, Lead) | 31 N | 03 W | 36 | ADC |
| 30 | A. Mainstem Susitna-Below Slough 10 | 31 N | 03 W | 36 | AAC4 |
| | B. Slough 10 (Lower, Pool) | 31 N | 03 W | 36 | AABD2 |
| | (Middle, Pool) | 31 N | 03 W | 36 | AABA |
| | (Tributary Stream) | 31 N | 03 W | 25 | DDC |
| 31 | A. Slough 11 (Lower Reach) | 31 N | 02 W | 19 | DDD |
| | (Middle, Reach) | 31 N | 02 W | 20 | CBA |
| | B. Mainstem Susitna (Above Slough 13) | 31 N | 02 W | 19 | ADB3 |
| | C. Side-Channel (Above Slough 13) | 31 N | 02 W | 19 | ADA |
| 32 | A. Slough 14 (Lower Bend) | 31 N | 02 W | 19 | ACA |
| | (Beaver Pond) | 31 N | 02 W | 19 | ABD |
| 33 | A. Mainstem Susitna (Beneath Gold Creek | | | | |
| | Railroad Bridge) | 31 N | 02 W | 20 | BAC2 |
| | B. Mainstem Susitna (Tributary Creek | | | | |
| | Above Gold Creek) | 31 N | 02 W | 20 | BAA |
| | C. Mainstem Susitna (North Bank above Gold Creek Railroad Brodge) | 31 N | 02 W | 17 | CDD |

Table 1 - Cont'd.

| MAP CODE | SAMPLING SITES | LOCATION | | | |
|---|---|---|---|---|---|
| | | TOWNSHIP | RANGE | SECTION | GRID |
| 34 | A. Slough 16 (Mouth) | 31 N | 02 W | 17 | ABD |
| | (First Lead) | 31 N | 02 W | 17 | ABD |
| | (Second Lead) | 31 N | 02 W | 17 | ABD |
| 35 | A. Indian River (Mouth) | 31 N | 02 W | 09 | DD2 |
| | B. Indian River (Approx. 3 miles Upstream) | 32 N | 02 W | 33 | ABD5 |
| | C. Indian River-Beaver Pond (Approx. 7 miles | | | | |
| | Upstream) | 32 N | 02 W | 11 | ADC2 |
| | D. Mainstem Susitna (Above Indian River) | 31 N | 02 W | 09 | DCB2 |
| 36 | A. Slough 17 (Mouth) | 31 N | 02 W | 09 | DCA |
| | (Above Mouth) | 31 N | 02 W | 09 | DBD |
| | B. Mainstem Susitna (Above Slouth 18) | 31 N | 02 W | 10 | CBD |
| 37 | A. Slough 20 (Mouth) | 31 N | 02 W | 10 | ADA |
| | (Middle Reaches) | 31 N | 02 W | 11 | BBD |
| | (Upper Tributary) | 31 N | 02 W | 11 | BBA |
| 38 | A. Side Channel Below Slough 21 (Lower) | 31 N | 02 W | 02 | CAC |
| | (Middle) | 31 N | 02 W | 02 | CAA |
| | (Upper) | 31 N | 02 W | 02 | ABD |
| 39 | A. Slough 21 (Mouth) | 31 N | 02 W | 02 | AAB |
| | (Middle) | 31 N | 02 W | 02 | AAA |
| | (Upper) | 32 N | 02 W | 36 | CCC |
| 40 | A. Mainstem Susitna (Above Slough 21) | 32 N | 02 W | 36 | ACD |
| 41 | A. Portage Creek (Mouth) | 32 N | 01 W | 25 | CDB4 |
| | B. (8 miles Upstream-Below Thoroughfare Creek) | 33 N<br>33 N | 01 E<br>01 E | 25<br>25 | DBA4<br>ACD2 |
| | C. (11 miles Upstream-Mouth of Thoroughfare | | | | |
| | Creek) | 33 N | 02 E | 17 | CCB3 |

Table 1 - Cont'd.

| MAP CODE | SAMPLING LOCATION | LOCATION | | | |
| --- | --- | --- | --- | --- | --- |
| | | TOWNSHIP | RANGE | SECTION | GRID |
| | Devil's Canyon to Tyone River: | | | | |
| 42 | A. Fog Creek (Mouth) | 31 N | 04 E | 16 | DBB |
| 43 | A. Tsusena Creek (Mouth) | 32 N | 04 E | 36 | ADB |
| 44 | A. Deadman Creek (Mouth) | 32 N | 05 E | 26 | CDB |
| 45 | A. Watana Creek (Mouth) | 32 N | 06 E | 25 | CCA |
| 46 | A. Kosina Creek (Mouth) | 31 N | 08 E | 15 | BAB |
| 47 | A. Jay Creek (Mouth) | 31 N | 08 E | 13 | BCC |
| 48 | A. Goose Creek (Mouth) | 30 N | 11 E | 32 | DBC |
| 49 | A. Oshetna River (Mouth) | 30 N | 11 E | 34 | CCD |

APPENDIX VII

## B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

### Under Ice Sampling Techniques

Minnow Traps:

Assemble as depicted in Figure 1

Materials:

One each-Minnow trap (17 1/2" long, 9" diameter, 1/4" square mesh
One each-Minnow trap clip
One each-(4 oz.) pint, screw-top plastic sampling bottle
15.0'-nylon seine twine, #72

1) Drill 1/4" holes through the plastic sampling bottle at 90° intervals around the circumference of the bottle 1" and 2" above its bottom.
2) Drill a 1/8" hole through the center of the bottle's screw cap.
3) Thread a 6" piece of stout nylon line through the hole in the cap. Tie several overhead knots at the end of the line inside the cap so that the cap can be suspended from the line. Tie the other end of this line to the mesh on the minnow trap near the metal clip which secures the trap shut. Screw the cap onto the perforated plastic bottle and the bait container is complete. (Note-steps 1-3 should be completed prior to going into the field).
4) Tie one end of the 15' nylon twine to the metal clip which is used to fasten the two halves of the minnow trap together.

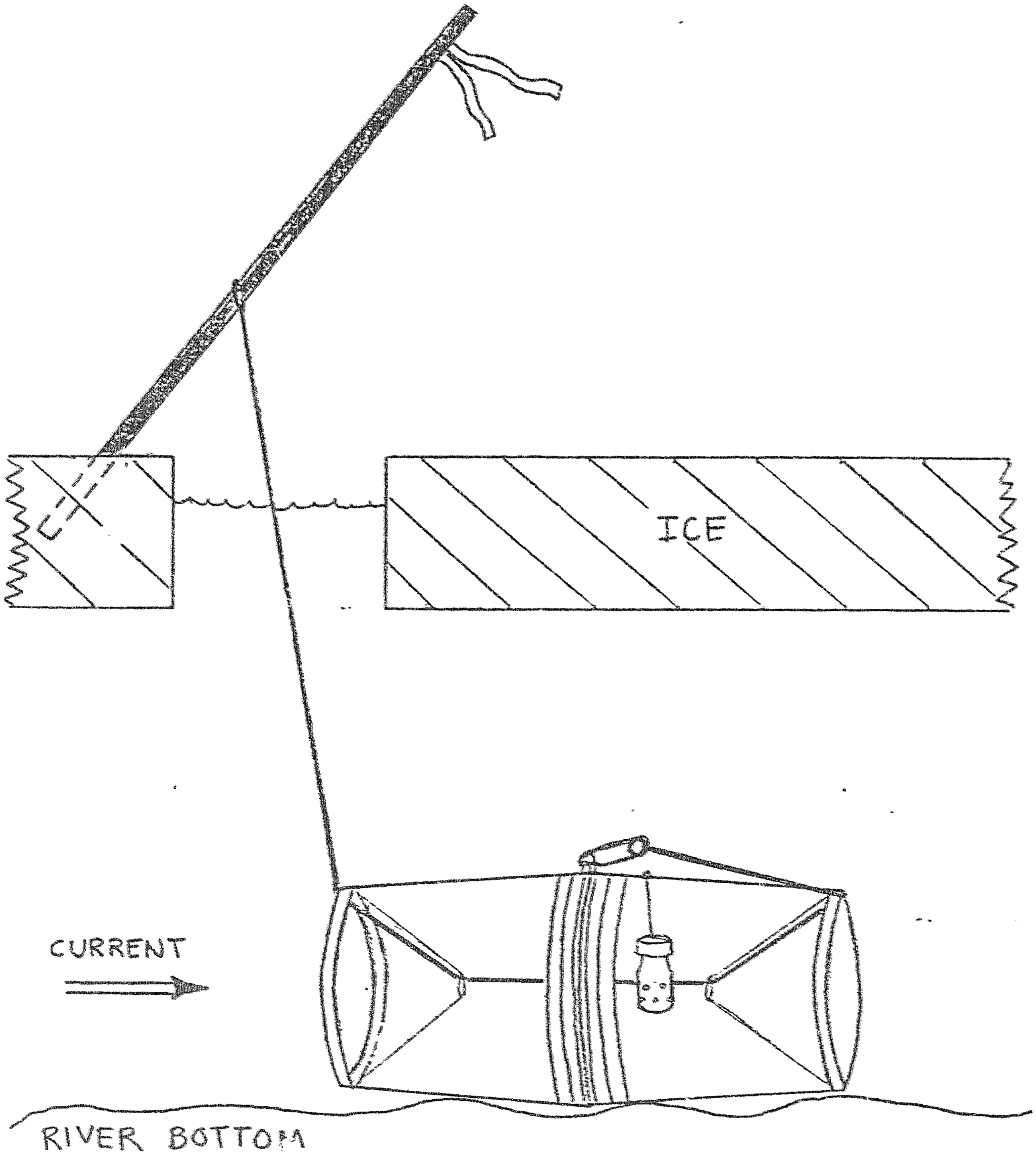
Setting (Figure 2):

Materials:

One each-ice auger with 10" diameter bit and an extension
One each-spud bar
One each-shovel
One each-ice scoop
One each-tablespoon, salmon eggs for bait
One each-5' wooden marker stick
One each-5' orange surveyors flagging tape

1) Placement of gear. Minnow traps can be set in open leads or under the ice in areas that are generally 10 inches to 4 feet deep with slow to moderate currents. Traps are set at 5 yard intervals with 10 traps per sampling site.
2) In order to set a trap underneath the ice, shovel all snow off the spot selected and auger one 10 inch diameter hole in the ice.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Measure and record the depth of the ice and the water beneath the ice.

Figure 1. Minnow trap set under the ice.



5) Probe the river bottom with the spud bar to determine the type of bottom which exists at the trap (silt, sand, gravel stone, etc.).

6) Place approximately 1 tablespoon of salmon eggs in the bait jar and screw the top on securely. Thread the clip and the attached seine twine through both ends of the minnow trap as shown in the illustration.

7) Insert the pair of metal hooks on the bottom inside edge of each half of the minnow trap. Once attached these hooks act like a hinge and the trap can be closed and fastened together at the top with the metal clip.

8) Lower the trap through the hole in the ice and orient the trap length wise with the current. Feed out enough line so that the trap sits on the bottom. (Note-in areas with strong currents, additional weight such as a rock can be placed inside the trap to anchor the trap in place.)

9) Anchor the 5 foot wooden marker stick in the snow or ice next to the hole as shown in Figure 1. Tie the remaining end of the seine twine from the minnow trap to the marker stick. Attach approximately 1.5 feet of orange surveyors tape to the top of the stick to help identify the spot. (Note-when temperatures are below freezing, cover the hole with a piece of slit cardboard. The slit in the cardboard will allow you to align the seine twine in the center of the hole so that it won't freeze to the edges. Then cover the cardboard with snow to retard ice formation in the hole.)

10) The same general procedure is used to set minnow trap sets in open leads.

Checking:

1) Minnow traps are rebaited after 24 hours and pulled after 48 hours.

Trot Lines:

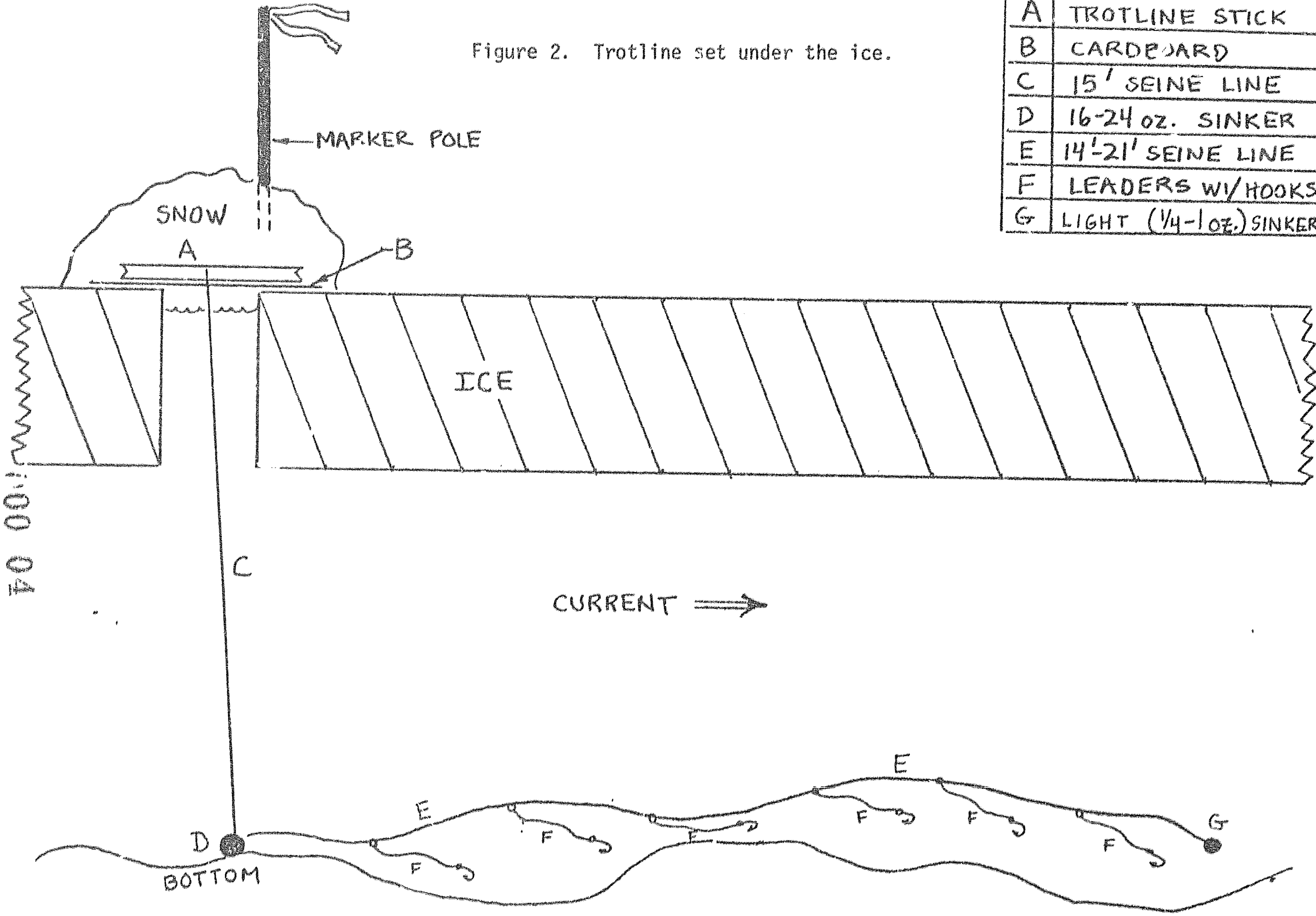
Materials:

One each-1" X 2" x 18" board w/V-notched end
One each-30'-36'-#72 nylon seine twine
Two each-large (2/0) snap swivels
One each-16-24 oz. sinker
One each-1/4-1 oz. sinker
Six each-leaders or ganging w/baited hooks (Sizes of hooks dependent on species: #4-6 for burbot, #8 for trout

Assembly (Figure 2):

1) Cut a length of seine twine to 36 feet and tie a 2/0 snap swivel to one end; attach a 1 oz. Bell sinker to swivel.

Figure 2. Trotline set under the ice.




| | |
|---|---|
| A | TROTLINE STICK |
| B | CARDBOARD |
| C | 15' SEINE LINE |
| D | 16-24 oz. SINKER |
| E | 14'-21' SEINE LINE |
| F | LEADERS W/ HOOKS |
| G | LIGHT (1/4-1 oz.) SINKER |

2) Attach a second 2/0 snap swivel 15 feet from the other end of the twine. Fasten the 16-24 oz. sinker to this swivel.
3) Tie a total of 6 overhand loops into the line at three foot invervals between the two weights. (Note-the loops should be at least 1 inch in diameter.)
4) Tie the end of the line, w/o the snap swivel to the 1" X 2" X 18" board. Wrap the entire length of line around the board lengthwise, from notch to notch. (Note-by not attaching the hooks until you're actually setting the line, tangling and loss of time is avoided.

Setting the line (Figure 2):

1) To use this trotline method, a reasonable amount of current and a minimum water depth of 2 feet is needed. A larger hole (10") is usually used for ease in recovery and landing fish.
2) Unwind the trotline beside the hole and attach the small bell sinker to the end snap swivel.
3) Hooks are baited variously depending upon species sought. In general cut fish, such as herring or whitefish are the preferred bait for burbot. Salmon eggs singly or in clusters are preferred for trout.
4) Lower the sinker into the hole until you come to the first loop, where you attach a prebaited leader line. Continue lowering the line and attaching leaders until all 6 loops are hooked up.
5) After the 6th loop, attach the larger (16-24 oz.) sinker to the snap swivel. Lower this sinker down until it rests on the bottom.
6) Tie a half hitch around the board with the line and center the line and board over the hole. The set is complete.
7) Set two trot lines per sampling site at 10 yard minimum intervals.
8) Trot lines are checked and rebaited after 24 hours and pulled after 48 hours.

Pulling a set:

1) Reverse the setting procedures. As the line is pulled in, remove the hooks and sinkers and rewind the line on the board.

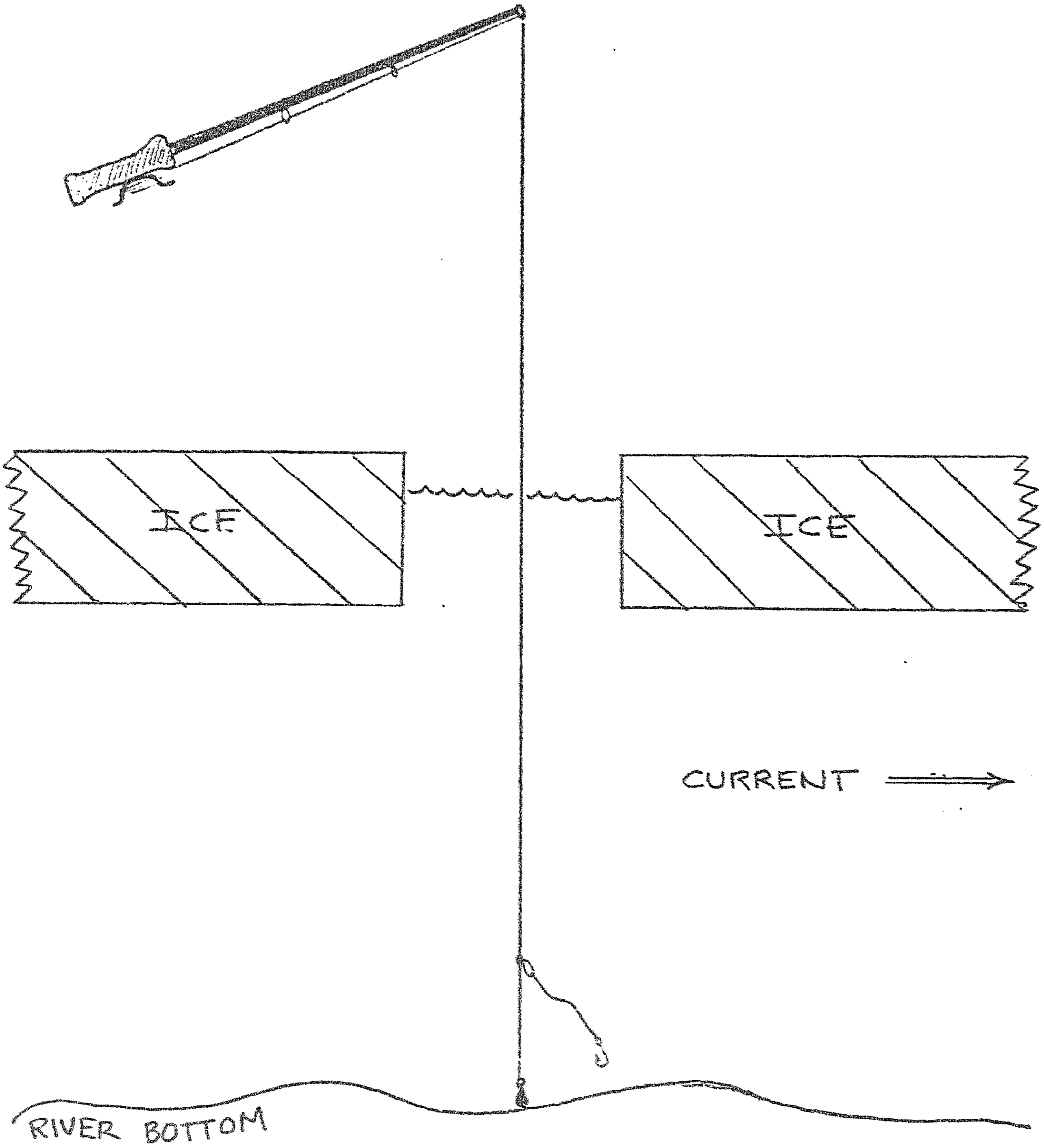
Hook & Line (Jigging):

Assembly (Figure 3):

Materials:

One each-Fiberglass jigging pole (Approx. length-2.5')
30'-20 lb. test, monofilament line

Figure 3. Hook and line jigging under the ice.



One each-pack, assorted weights
One each-pack, assorted single shank fish hooks (size-10 to 5/0)

Setting (Figure 3):

Materials:

One each-ice auger with 6" to 10" diameter bit, plus an extension
One each-spud bar
One each-shovel
One each-ice scoop
Bait-salmon eggs, salmon roe, whitefish, herring, etc.

1) Placement of gear. The hook and line technique or jigging can be used in almost any area of the river that has stable ice conditions with at least 2 feet of water beneath the ice. However, it is generally reserved for use in deeper sections of the river such as pools, eddys, and tributary mouths.
2) When fishing through the ice, shovel all snow off the sampling site and auger one 6" to 10" diameter hole in the ice for each jigging site. Jigging holes should be drilled no closer than 5 yards apart and 2 units of gear fished per sampling site.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Select the hook and bait of your choice, (Table 1).
5) Affix the hook and bait of your choice to the 20 lb. test monofilament line which has previously been wound on the jigging pole handle and threaded through the eyes of the pole.
6) A sinker can also be attached above or below the baited hook if the current at the sampling site warrants one.
7) Lower the hook, line, and sinker through the hole in the ice into the water until the sinker rests on the bottom or at a satisfactory depth.
8) Note the time and begin bobbing the jigging pole up and down gently. At this point the procedure can be continued until a fish is caught, the bait is lost, or until the sampler decides to change bait, tackle, or move to a more productive site.
9) Standard effort forms should be filled out completely regarding sets and habitat fished. The unit of effort consists of man hours spent fishing per baited hook.

Burbot Sets (Under Ice Application Only):

Assemble as depicted in Figure 4

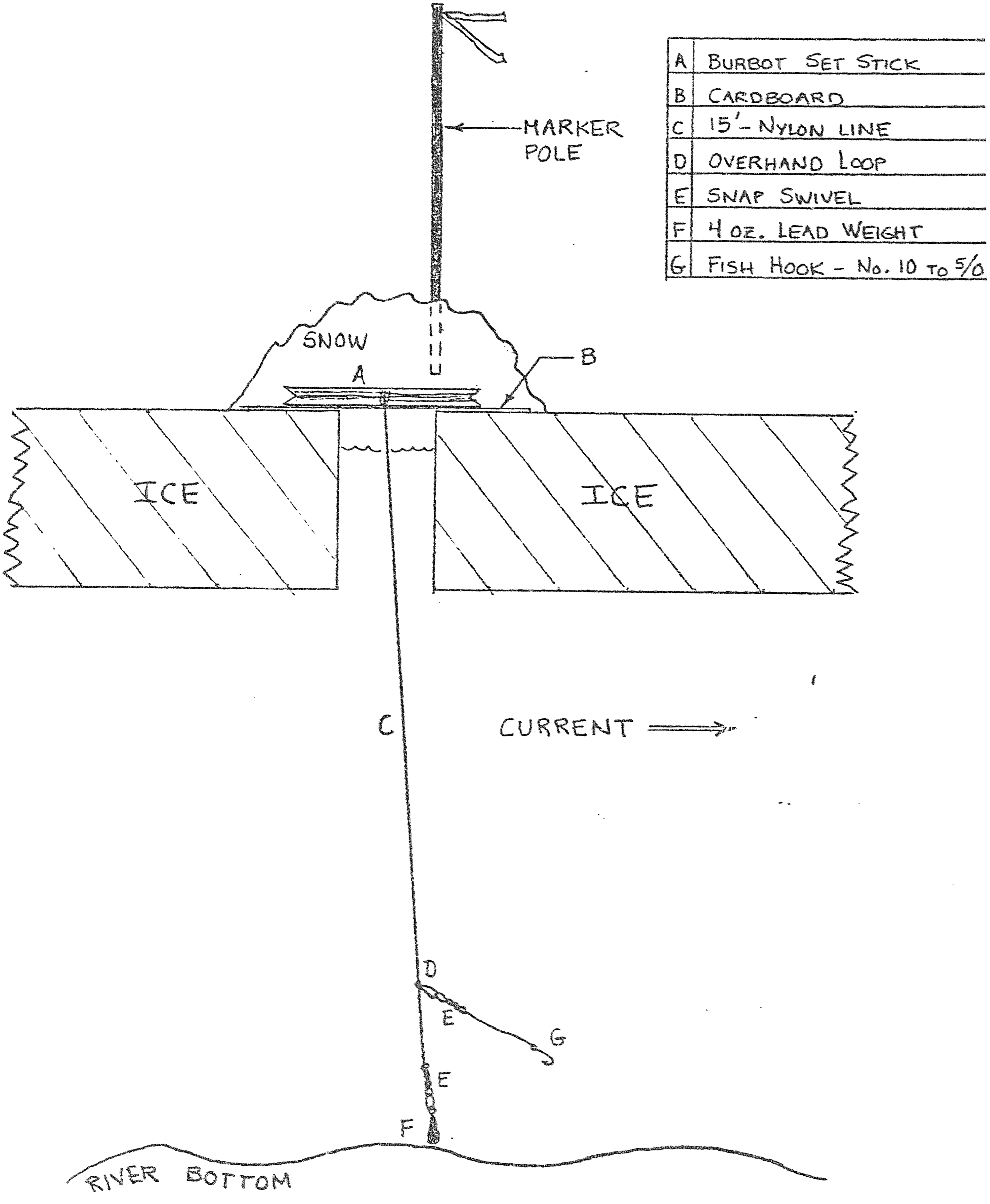
Materials:

One each-1" X 2" X 18" board w/V-notched ends
15'-80 lb. test nylon line, yellow

Table 1. Preferred hook size and bait type by fish species.

| Resident Susitna Fish Species | HOOKS SIZES No. 10 | No. 6 | No. 2/0 | No. 5/0 | BAITS Insect Larva | Salmon Eggs | Salmon Roe | Herring | Whitefish | Shrimp | Artificial Lure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Burbot | | | X | X | | | X | X | X | | |
| Dolly Varden | | X | | | | X | X | | | | |
| Grayling | | X | | | X | X | | | | | |
| Rainbow Trout | | X | | | | X | X | | | | |
| Whitefish/sp. | | | | | | | | | | | |
| Humpback | X | | | | X | X | | | | | |
| Round | X | | | | X | X | | | | | |

Figure 4. Burbot set under the ice.



Two each-No. 2/0 brass snap swivels or No. 1500 trot line clip
One each-4 oz. lead weight
Two each-wide rubber bands
One each-single shank fish hook (size-No. 10 to No. 5/0)
One each-9" leader line (nylon or monofilament)

1) Wrap a rubber band around each end of the notched 1" X 2" X 18" board, about 3 1/2" from the ends.
2) Tie one end of the 15' piece of 18 lb. test nylon line to the center of the notched board with a half hitch.
3) Wind the remainder of the nylon line around the 1" X 2" X 18" board between its notches.
4) Tie a 2/0 snap swivel to the free end of the nylon line with a clinch knot and attach a 4 oz. lead weight to the swivel. Secure the sinker to the board with a rubber band.
5) Use another clinch knot to attach the 9" leader line to the single shank fish hook of your choice. The other end of the leader should be tied to a 2/0 snap swivel or a No. 1500 trot line clip. (Note-this hook and leader assembly can be attached to the burbot set when you are ready to make your set. Hooks and leaders can be made up in groups of 8 to 12 and inserted in sheets of cardboard which are labeled according to hook size. Use of this method provides a safe and efficient way of transporting and storing hooks which are easily accessible when needed.
6) Tie an overhand knot with a 1" loop in the 80 lb. nylon line approximately 12" above the lead weight assembly.

Setting (Figure 4):

Materials:

One each-ice auger
One each-spud bar
One each-shovel
One each-ice scoop
One each-5' stick with orange surveyors tape attached
Bait-herring, salmon eggs, cheese, etc.

1) Placement of gear. Usually an area 2' to 7' deep with slow to moderate current and stable conditions.
2) Shovel all snow off the spot selected and auger one 6" to 10" diameter hole in the ice for each burbot set to be put out. Holes should be spaced at 5 yard intervals with 5 sets fished per sampling site.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Select the hook and bait of your choice.
5) Affix the baited hook and leader to the snap swivel by the 4 oz. lead weight or to the 1" loop above it.
6) Lower the hook, line, and sinker through the hole in the ice into the water until the sinker rests on the bottom or a satisfactory depth.

7) Using the remaining line, tie a half hitch around the middle of the notched board. Center the line in the middle of the hole and lay the board across the hole. (Note-in below freezing weather, place a slit piece of cardboard under the board so that it covers the hole. Then cover the set with snow. This will retard ice formation in the hole.
8) Erect a 5' stick near the site and tie orange surveyors tape to its top to mark the location of the burbot set.

Checking:

1) Burbot sets are checked and rebaited after 24 hours and pulled after 48 hours.

Gill Net:

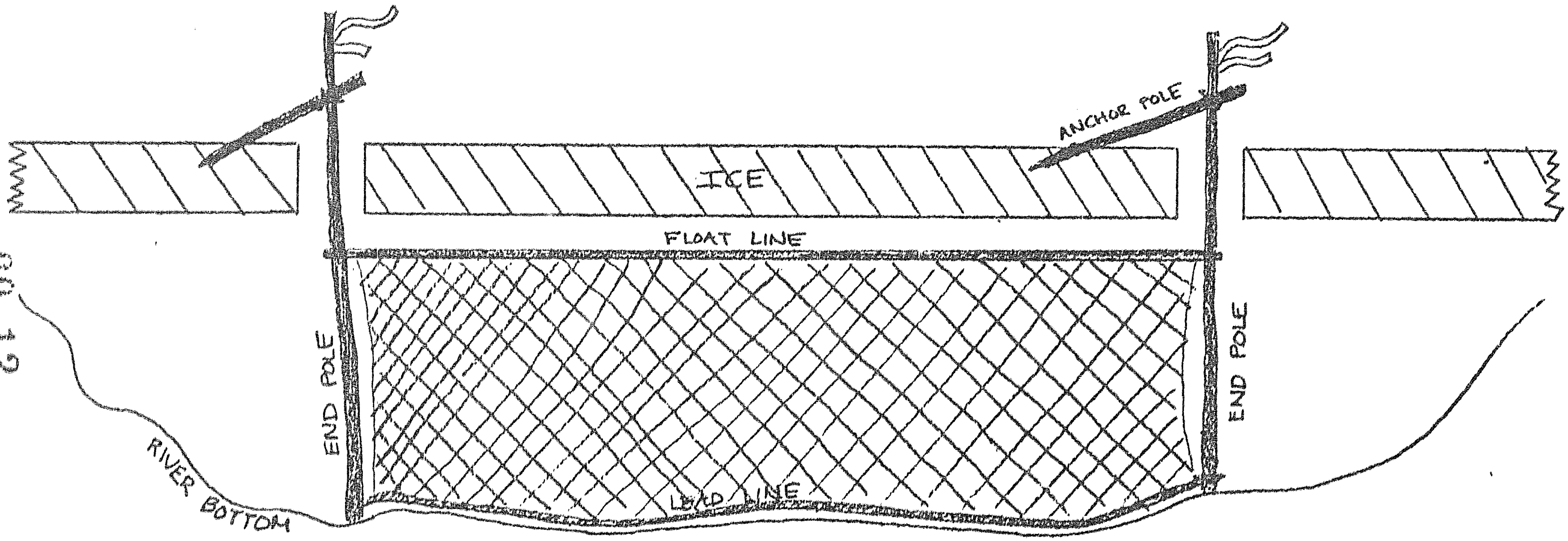
Setting (Figure 5):

Materials:

One each-Gill net (length, depth & mesh size vary depending on species and size of anticipated catch. Enter on data dorms specifications and quantity.
One each-ice auger with a 10" diameter bit and an extension
One each-murphy stick
One each-spud bar
One each-hooked pole (approx. 6' to 8' long)
One each-shovel
One each-ice scoop
60'-1/4" nylon line
Two each-stout wooden end poles (approx. height 10' to 15')
3.0'-orange surveyors flagging tape

1) Placement of gear. Under-ice gillnets are generally utilized in the wider and deeper stretches of the river with slow to moderate currents. However, by rolling up the length and width of the net, they can be set in tributaries and side-sloughs that are as small as 3' deep and 10' wide. Set only 1 gillnet per sampling site.
2) Bore holes with the ice auger along the general line of set to determine the depth of the water under the ice.
3) Shovel the snow from the ice along a transect where the net will be set. The length of this transect should be equal to the length of the net.
4) Measure off the hole centers to be drilled along the transect so that they correspond with the length of the Murphy Stick. Mark these auger points by starting them with the spud bar.
5) Using a 10" auger, drill a cluster of three or four holes through the ice at the end points of th net and a single hole at each auger point in between. If the ice is thick, bore all the holes one-half way, add the entension to the bit, and then finish drilling the holes.

Figure 5. Gillnet set under the ice.



6) Tie the 1/4" set line to the loop in the float line attached at the lead end of the Murphy Stick. Push the Murphy Stick under the ice and maneuver it in a direction that is slightly upstream of the next hole.
7) Partner holds a hooked pole straight down the second hole to catch the Murphy Stick as it swings downstream in the current or torque on the butt end until the lead end appears in the hole.
8) Use the hooked pole to catch the loop in the float line which is attached to the set line. Untie the set line and secure it at the hole with the spud bar. Withdraw the Murphy Stick from the initial hole and repeat the process listed above until the set line is strung through the final hole.
9) Roll the net to the proper height so that the float line will not contact the ice and freeze in.
10) Tie the set line to one end of the gillnet and pull the other end of the set line to string the net under the ice.
11) Before the net is pulled completely through, an end pole is attached to the end still on the ice. This pole must be stout and long enough to reach the river bottom and protrude two to three feet above the ice.
12) The end pole should be secured either by anchoring or driving the lower end into the river bottom or by lashing the top end to a cross pole frozen into the ice at the surface.
13) Attach the final end pole to the other end of the net after pulling it the remainder of the way through. Be careful not to pull too hard and lose the far end. Secure the final end pole.
14) Cover the holes at each end of the net with snow to retard their freezing.
15) Attach orange surveyors tape to each end pole to mark the set. An illustration of the final set it enclosed.

Checking:

1) Under-ice gillnets are picked after 24 hours and pulled after 48 hours.

Open Water Sampling Techniques

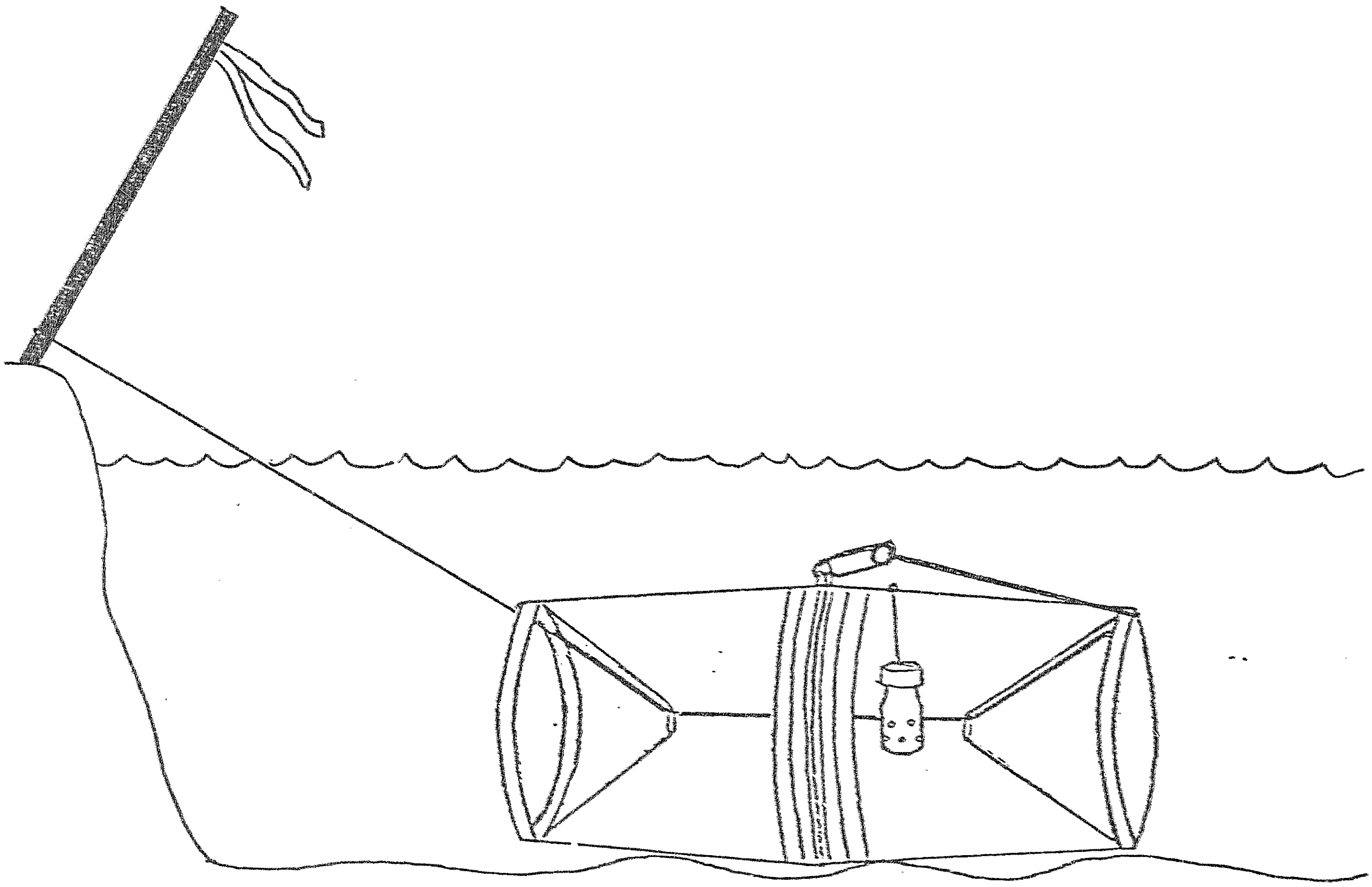
Minnow Traps (Open Water Application):

Assemble as depicted in Figure 6:

Materials:

One each-Minnow trap (17 1/2" long, 9" diameter, 1/4" square mesh)
One each-Minnow trap clip

Figure 6. Minnow trap set in open water.



One each-(4 oz.) pint, screw top plastic sampling bottle
15.0'-nylon seine twine, #72

1) Drill 1/4"holes through the plastic sampling bottle at 90° intervals around the circumference of the bottle 1" and 2" above its bottom.
2) Drill a 1/8" hole through the center of the bottle's screw cap.
3) Thread a 6" piece of stout nylon line through the hole in the cap. Tie several overhead knots at the end of the line inside the cap so that the cap can be suspended from the line. Tie the other end of this line to the mesh on the minnow trap near the metal clip which secures the trap shut. Screw the cap onto the perforated plastic bottle and the bait container is complete. (Note-steps 1-3 should be completed prior to going into the field).
4) Tie one end of the 15' nylon twine to the metal clip which is used to fasten the two halves of the minnow trap together.

Setting (Figure 6):

Materials:

One each-5' wooden marker stick
One each-1.5' orange surveyors flagging tape

1) Placement of gear. Minnow traps can be set in areas that are generally 10" to 4' deep with slow to moderate currents. Traps are set at 5 yard intervals with 10 traps per sampling site.
2) Measure and record the depth of the water.
3) Using sight, pole, or a lead weight tied to a heavy nylon seine twine probe the river bottom to determine the type of bottom that exists at the sampling site (silt, sand, gravel, stone, etc.) and record on habitat form.
4) Place approximately 1 tablespoon of salmon eggs in the bait jar and screw the top on securely. Thread the clip and the attached seine twine through both ends of the minnow trap as shown in the illustration.
5) Insert the pair of metal hooks on the bottom inside edge of each half of the minnow trap. Once attached these hooks act like a hinge and the trap can be closed and fastened together at the top with the metal clip. Refer to illustration.
6) Toss the trap out into the water so that it becomes oriented length wise with the current. Feed out enough line so that the trap sits on the bottom. (Note-in areas with strong currents, additional weight such as a rock can be placed inside the trap to anchor the trap in place.)
7) Anchor the 5' wooden marker stick in the ground along the river bank as shown in the illustration. Tie the remaining end of the seine twine from the minnow trap to the marker stick. Attach

approximately 1.5 feet of orange surveyors tape to the top of the stick to help identify the spot.

Checking:

1) Minnow traps are rebaited after 24 hours and pulled after 48 hours.

Beach Seine:

Assembly (Figure 7):

Materials:

Two each-8' poles (aluminum or willow)
One each-25' to 100' beach seine, 6' deep, desired mesh size, weighted bottom line and trailing center trap (length, mesh size, depth of seine used to vary with sampling situation. Specs will be entered on data form). Amount of water actually fished will be highly variable in upper sampling areas, i.e., samples not quantitatively comparable.
30'-#36 tarred nylon seine twine

1) Tie each end of the seine net to an 8' pole using the tarred nylon seine twine, aligning the weighted bottom line with the base of each pole.

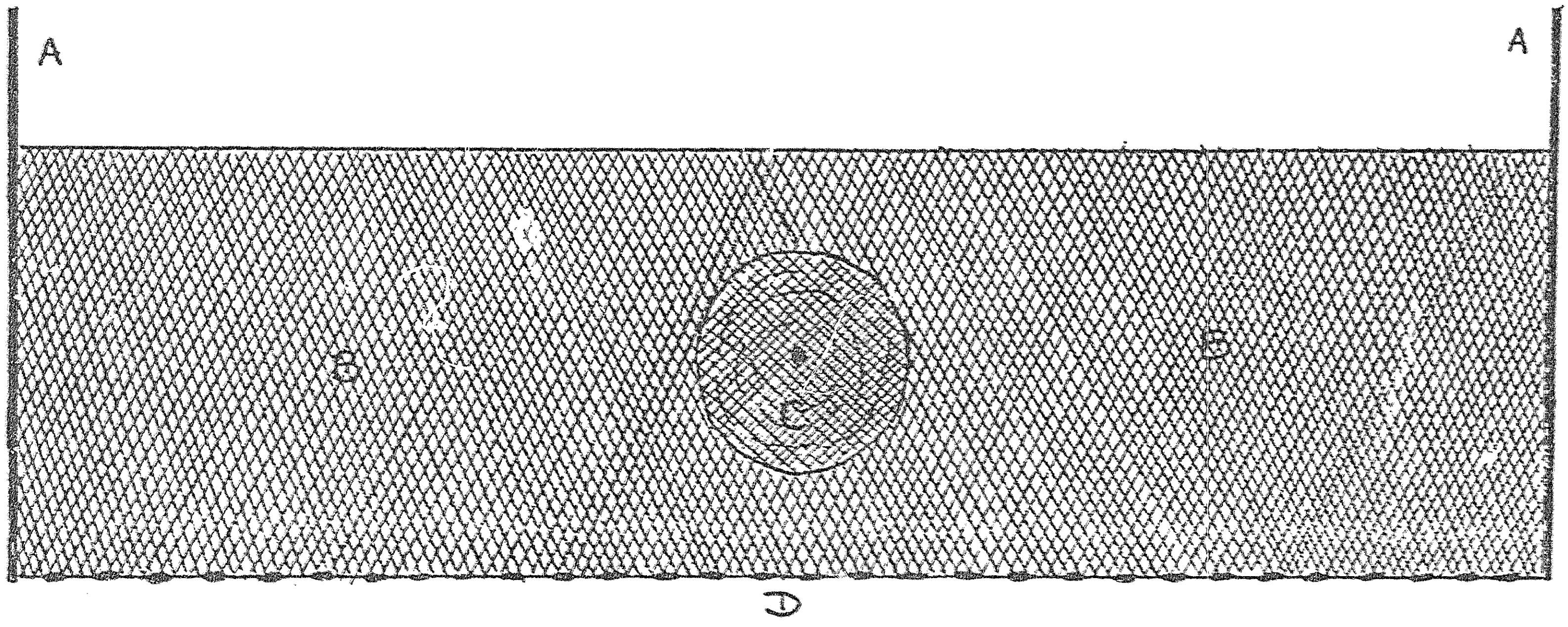
Beach Seine Haul:

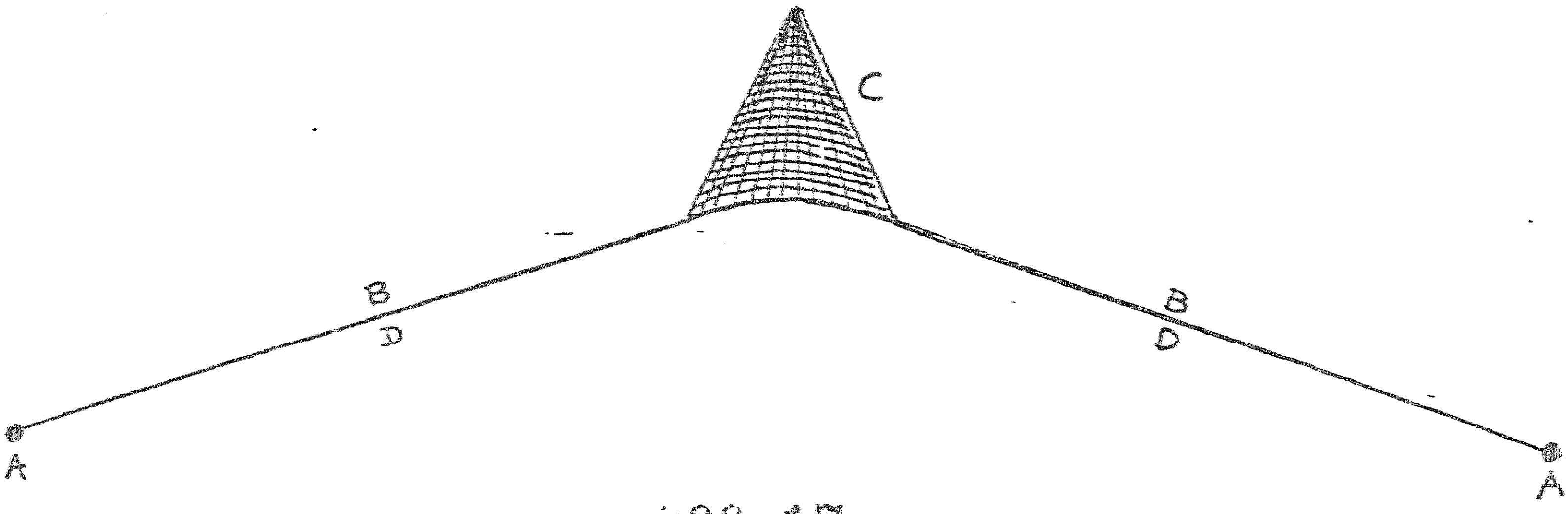
Materials:

Two each-crew members equipped with hip boots or chest waders
Two each- 2 1/2 gallon sample buckets
Anesthetic (MS-222 or equivalent)

1) Select a suitable seining area at the sampling site. (Note-the site should be free of debris and snags, and allow safe walking conditions.)
2) One crew member (A) remains next to shore handling one pole of the seine.
3) The second crew member (B) enters the water channel handling the remaining pole. The seine is stretched between A and B so that the center trap is trailing upstream, (Figure 13b). (Note-the seine may be rolled onto the poles to decrease the seine length to the desired distance. Roll even quantities of seine net onto both poles to maintain the center trap 1/2 way between each pole.)
4) Both crew members walk at an even pace downstream. (Note-care must be taken to keep the weighted bottom line of the seine in contact with the substrate to prevent fish escapement under the net.)

Figure 7. Beach Seine



5) When the desired distance is sampled, A stays stationary while B walks downstream and toward shore.
6) When 1/2 of the seine length remains between B and shore, B walks towards A.
7) Both poles are held together and the seine is brought to shore by grasping the weighted bottom lines and pulling the seine so that the center trap trails the net. (Note-the weighted bottom line must continually remain in contact with the substrate until the seine retrieve is complete.)
8) Place all captured fish into the sampling bucket containing water and anesthetic.
9) Complete desired analysis on fish, return fish to bucket containing clean water, and release fish after anesthetic recovery is complete.
10) Roll net onto poles when sampling is completed and allow beach seine to dry before storing.

Hook and Line:

Assembly:

Materials:

One each-7' casting rod or 8.5' fly rod
One each-medium size casting reel or fly reel
Use 6-30 lb. test for line in casting rod with a lighter test for leader. For fly fishing using floating fly line with 10 inches or lighter test for leader.
One each-tackle box with assorted lures, flies, single hooks, weights, snap swivels, extra line, bail springs, etc.

Setting:

Materials:

Bait-single salmon eggs, salmon eggs in clusters, corn, or artificial lure, etc.

1) Placement of gear. Begin fishing by using a standard method of casting and reeling in. For fly fishing, your technique may vary but your final goal is to catch fish.
2) Select an appropriate hook size and bait or proven artificial lure.
3) Affix the hook and bait or lure to your snap swivel.
4) A sinker may be used when using hook and bait.
5) Note the time and begin fishing until you are ~~successful~~ or change bait, lure, or hook size, or move to a more productive site.

Checking:

1) Record fishing time in 0.25 hour increments.
2) Record hook sizes and bait types or lure sizes and types for each sampling site.

Electroshocker:

Materials and procedures will be provided upon receipt of operating instructions from the manufacturer, Smith-Root, Inc. Information available is attached. (Appendix V, Section B.)

Open Water Gill Net (Drift and Set):

Setting:

Materials:

One each-floating gill net (length, depth, and mesh size vary, gear specifics to be recorded on data sheets).
One each-orange float, 24" in diameter
One each-outboard motor
One each-riverboat
One each-Anchor

1) DRIFT gill nets will be fished by pulling the net out, as nearly perpendicular to the river channel as possible, with the outside end of the float line attached to a buoy and the other end held in the boat. Operate the boat under just enough power to keep the net reasonably straight and perpendicular to the current. Mainstem areas fished by the method should be substantially free of surfact and subsurface debris and sufficiently shallow enough to allow the net to reach within a foot or less of the bottom. Gill nets will be drifted once a maximum of 100 yards at each sampling site.
2) SET gill nets will be deployed by all crews in slack water areas and eddies on Susitna River mainstem.
3) Deploying a gill net is achieved by tying one (1) end of the float line to the shore and "playing out" the net from the side or bow of the boat and then releasing the end of the lead line and float line respectively. Properly positioned, the net should extend offshore in a straight line or with a slight downstream arc.
4) Pulling a set gill net is achieved by taking the anchored end first into the boat and going ashore as you restack the net. Stacking the net is accomplished by coiling the lead line and floating line in two separate piles leaving the net in between.

Checking:

1) DRIFT gill nets are monitored and picked after each drift through the sampling site.
2) SET nets are picked after 24 hours and pulled after 48 hours.

# APPENDIX VIII

## C. AQUATIC HABITAT AND INSTREAM FLOW STUDIES

### Instruction Manual

OPERATION AND MAINTENANCE INSTRUCTIONS

HYDROLAB DIGITAL 4041

October 1980

TABLE OF CONTENTS

DIGITAL 4041 USER'S GUIDE

## How The 4041 Works

When the 4041 is in operation, the four parameters are being measured simultaneously at the sonde unit (underwater unit). The resulting signals are transmitted in parallel up the cable to the indicator unit. In the indicator unit, the signals may be amplified or shifted. After this processing, the signals are ready to be selected by the user (via the panel switch) for digital conversion and immediate read-out.

Calibration control(s) for each parameter are provided on the front panel of the indicator unit for user access. These controls are used to adjust the instrument before going to the field. This pre-field calibration adjusts for changes due to new pH fluid, a fresh D.O. membrane, re-polished conductivity electrodes, and so on.

Zero-adjust controls are not provided because the 4041 circuits automatically null any zero-offsets that may appear in the system.

## Some Details

Twelve wires connect the sonde unit to the indicator unit: (4) for Conductivity, (1) each for pH, D.O., and Common; (3) for Temperature; and (2) for Power.

Temperature is measured by a high accuracy thermistor, whose resistance goes down as its temperature increases. The thermistor is in the slim stainless steel tube in the bottom of the sonde unit. This single temperature signal is used to generate the automatic temperature compensation for the other three parameters.

Dissolved Oxygen is measured by the popular Clark polarographic cell. It is the plastic device with a gold ring in its end and a dull silver pellet in its center cavity. As oxygen diffuses through the Teflon membrane (according to its partial pressure), it is reduced by a polarizing voltage established between the gold and silver electrodes. This produces a measurable current proportional to the partial pressure. A constant polarizing voltage is maintained by the small, 2.7 volt, mercury battery located in the sonde unit. This battery should be changed approximately every three months. See the maintenance section for directions.

The pH of the sample is measured using a pH-sensitive glass electrode, which due to the sample pH, reaches a certain potential with respect to a reference electrode. This potential is amplified and buffered by the circuits in the sonde unit, and the resulting signal is sent to the indicator unit. The pH electrode is the glass tube with the small bulb on the end. The reference electrode is covered by a larger white plastic cover.

Conductivity is measured using the four-electrode technique. A large enough current is forced between two electrodes, through the resistive sample, to create a certain potential between two other electrodes. The current required to maintain this potential is proportional to the conductivity, and this current is measured for display. The conductivity probe is easily recognizable by its gray epoxy body with four electrodes protruding from it into a white plastic cell.

The display is read in the following manner: temperature, pH and dissolved oxygen are read out directly. For example, a temperature of 21.8$^{o}$C. will be displayed as 21.8. A D.O. or pH reading of 8.1 will be displayed as 08.1. Conductivity is read out directly on the 2K scale. If the 20K scale is being used the number that is displayed will need to be multiplied by 10. In the 200K scale the reading will be multiplied by 100. For example, suppose the sample being measured has a conductivity of 1527 uS/cm. Using the 2K scale the display will show 1527 (direct read-out). Using the 20K scale the display will show 153 (153 x 10 = 1530 uS/cm.). Using the 200K scale the display will show 015 (015 x 100 = 1500 uS/cm.).

INITIAL PREPARATION

Your system has undergone a thorough calibration and testing procedure immediately prior to shipment. There are a few precautions that should be taken, however, before you attempt to connect the system components for operation:

BATTERY CHARGE: The battery should be fully charged when you receive it. It is advisable however to charge the battery for a period of 24 hours to avoid an unexpected loss of power during operation.

UNDERWATER CONNECTORS: In order to prevent unnecessary abrasion of the sealing surfaces of any underwater connector pair, a very light coating of the underwater connector lubricant should be applied to both sealing surfaces before you attempt to mate them.

CONNECTING THE SYSTEM COMPONENTS

SONDE UNIT TO UNDERWATER CABLE: This paragraph applies only to those units that were ordered with Marine Connectors. Connect the Sonde Unit to the Underwater Cable by carefully aligning and mating the two halves of the 12-pin connector pair. This operation often requires considerable force and care should be taken to expel any air that may be trapped within the connector cavity.

CIRCULATOR MOTOR TO SONDE UNIT: This paragraph applies only to those units that were ordered with a Circulator. Connect the (2-pin) connector that breaks out from the top cap connector to the 2-pin motor lead by aligning the large pin on the male half with the raised nub on the female half. Expel any air that may be trapped within the connector cavity.

BATTERY PACK TO INDICATOR UNIT: Attach the battery cable to the Indicator Unit connector marked "12 VOLTS DC INPUT".

CALIBRATION

The procedures for calibrating the 4041 are simple and easy to perform. However, in order to expect good results in the field, all calibration checks which are pertinent to the measuring systems must be performed. TAKE NO SHORTCUTS. This is important since calibration errors will be reflected in the accuracy of all subsequent measurements.

FREQUENCY OF CALIBRATION: A complete calibration check should be accomplished before going to, and after returning from the field. This dual calibration procedure will afford judgment as to drift due to sensor fouling and to the frequency and type of sensor maintenance required between field operations. Because of a multitude of variables encountered under differing field conditions, there is no rule-of-thumb in establishing: 1) the length of time that a system may be deployed without recalibration or 2) the extent of cleaning and maintenance required between field operations. These judgments are made on a case-by-case basis and should be expected to change in time.

CONDITIONS: The calibration procedures should be carried out in a place where ambient conditions are under control and where there is a readily available supply of distilled or de-ionized water, reliable calibration standard solutions and maintenance items. Generally, the laboratory is best suited but a field office or closed-in shelter will suffice.

REQUIRED MATERIALS: In order to properly calibrate the 4041 the following items will be needed:

1) Calibration Cup
2) Two reliable KCl standard solutions (known conductivity)
3) Two freshly prepared pH buffer solutions. Generally pH 7.0 and either pH 4.0 or 9.18 are used, depending upon the measuring assignment.
4) Distilled Water or De-ionized Water (approx. two liters)
5) Absorbent tissue
6) Two screwdrivers (supplied in Accessory Kit)

CALIBRATION PROCEDURE: At least one hour prior to calibrating the system (preferably the night before), take the following preparatory steps.

1) Remove the "Storage-Cup" from the Sonde Unit.

2) Remove the protective guard from the dissolved oxygen sensor.

3) Install the "Calibration-Cup" on the Sonde Unit and fill to the brim with tap water.

4) Seal the Calibration Cup with the soft plastic cap and store the sonde unit, calibration standards, and the distilled water at constant room temperature for at least one hour in order to bring the various sensors, temperature compensating elements, and the calibration solutions into thermal equilibrium (within a few degrees)

All of the calibration controls are located on the front panel of the Indicator Unit. Adjustments, if necessary, should be made in the following manner:

1) Remove the appropriate seal-screw for the parameter being adjusted.

2) Insert the small screwdriver through the access hole and adjust the calibration control in the direction which brings the reading into agreement with the value of the standard solution being employed.

3) Replace the seal-screw.

A RINSE STEP will be used several times during the calibration procedure. It is to be performed in the following manner: Fill the calibration cup halfway with de-ionized water (or distilled). Snap on the soft plastic cap; shake the sonde unit for ten seconds and then pour out the water. Repeat twice more using fresh de-ionized water. Remove the cup and shake as much of the rinse water as possible from the electrodes.

DISSOLVED OXYGEN CALIBRATION: The Dissolved Oxygen system is the first to be calibrated since the water that has been stored in the calibration cup is used to maintain control of the temperature inside the cup. The calibration standard is "water-saturated air at the temperature of the D.O. cell".

Invert the Sonde Unit and remove the soft plastic cap. Pour off enough water to bring the level to just below the D.O. membrane-retaining O-ring. With a clean paper towel or tissue blot any moisture from the D.O. membrane. Cover the calibration cup mouth with one of the hard plastic caps provided in the Accessory Kit. This will keep drafts from blowing on the membrane. Do not seal the cup with the soft plastic cap, because that could cause a partial-pressure change in the cup. Wait approximately 5 minutes, or until the reading is stable, then switch to the TEMPERATURE position and record the temperature reading. Refer to the solubility table for the correct oxygen concentration at this temperature. Since the table values refer to concentrations at Standard Pressure it will be necessary to correct the value for local barometric pressure. This should be done in the following manner:

Correct D.O. Setting = (Pressure/760mm) x (Table value at Cup Temperature)

EXAMPLE: If T = 28.7°C and Pressure = 800mm.

Correct D.O. Setting = (800mm/760mm) x (7.67mg/l) = 8.07mg/l

If you don't have a barometer, the equivalent pressure may be estimated from your altitude by recalling that atmospheric pressure drops from standard sea-level pressure (760mm Hg) at the approximate rate of 2.5mm for every 100 feet of elevation. Therefore, the approximate atmospheric pressure at an altitude of 1240 feet, for example, would be: Local Atmospheric Pressure = 760mm - (2.5 x 12.4) = 729mm Hg.

Adjust the Dissolved Oxygen calibration control until the proper value (rounded to nearest tenth) is displayed. Pour out the water; and then follow with the RINSE STEP.

pH CALIBRATION: Calibrating the pH system requires the use of two pH buffer solutions. Depending upon the application, either pH 4.0 or pH 9.18 is used in addition to pH 7.0. Invert the Sonde Unit and fill the calibration cup with fresh pH 7.0 buffer solution. Switch to "pH", and wait approximately 5 minutes for thermal equilibrium. Then adjust the pH Calibration control until 7.0 is displayed on the read-out.

Pour out the 7.0 buffer and repeat the RINSE STEP. Invert the Sonde Unit and screw on the calibration cup; fill with 9.18 or 4.0 buffer. After approximately 5 minutes, adjust the pH "Slope" control until either 9.2 or 4.0 is displayed on the read-out. Pour out the buffer and repeat the RINSE STEP Two Times.

CONDUCTIVITY CALIBRATION: After the second RINSE STEP, take a clean paper towel or tissue, and blot most of the moisture in the electrode area so that the standard will not suffer dilution.

Install a clean calibration cup and invert the Sonde Unit. The Conductivity system is calibrated using at least two prepared KCl standard solutions with a known conductivity at 25°C. From the table select two standard solutions with values of approximately one third and two thirds of the range you are most likely to encounter in the field. For example, if you are going to be working in fresh water (0-2K scale) you would want to use a 0.01M standard and a 0.005M standard. Select the more concentrated of the two standards and pour it slowly down the side of the calibration cup until full. If there are any bubbles in the bores of the conductivity cell block, fill the calibration cup again. When the reading is stable, adjust the Conductivity calibration control until the display matches the value listed in the table. Empty the calibration cup and repeat the RINSE STEP Two times. Pour in the second standard. Check the reading on the Display. It should be correct within ± 1% of the range being used. For example, if the 0-2K scale is used the reading for the second standard should be correct ± 20uS/cm. Pour out the standard solution.

TEMPERATURE CALIBRATION: The Temperature system is factory calibrated and is accurate to ± 0.2°C. No calibration adjustment is provided. A periodic check of the temperature system against a customer-owned ASTM thermometer could be helpful in detecting a system malfunction. Twenty minutes in a large, vigorously-stirred bath is necessary.

## FINAL PREPARATION

Turn the system off and disconnect the system components. Replace all rubber dust caps. Remove the Calibration Cup from the Sonde Unit and replace the protective guard on the dissolved oxygen electrode. Install the Storage Cup, filled with tap water, onto the Sonde Unit. The system is now calibrated and ready for transport to the field.

## FIELD OPERATION

Remove the Storage Cup from the calibrated Sonde Unit and install the guard or the optional sample circulator. Connect the system components. Lower the Sonde Unit into the water (sideways, if possible) and shake it to dislodge air bubbles trapped in the conductivity cell block. Release the Sonde

Unit and lower it to sample depth. Wait until the readings stabilize (D.O. is the best indicator), then record the value for each parameter. Repeat at new depths or locations.

Fig. 1 provides the user with a way to determine sea water salinity from the Conductivity readings obtained via the 4041. Fig. 2 allows the user to correct Dissolved Oxygen readings for the "salting-out" effect of ionic solutions. The Dissolved Oxygen correction factor is temperature-dependent, so use the appropriate curve. The 25°C curve should always be used in Fig. 1, however.

Check the battery voltage occasionally; charge or change batteries if the level drops below 10.5 volts. DO NOT charge the battery routinely after each day's use. Doing so may shorten the life of the battery. Use the battery until the voltage level drops to between 10.5 and 11.0 volts. At this point put the battery on charge for 24 hours.

The instrument case is hermetically sealed against moisture and dust. As long as the case seals are intact, the 4041 may be operated without harm in heavy rain or spray. The liquid crystal display is protected during cold weather by a built-in heater circuit which is automatically energized when temperatures drop below freezing. As long as the external battery is connected to the instrument the liquid crystal display is protected against freezing, down to a temperature of -20°C.

## STANDARD MAINTENANCE

As long as the 4041 is functioning properly there is no need to perform the following maintenance procedures. However, in the event of biological or chemical fouling these steps are necessary to restore the measuring elements to like-new condition.

Servicing the Probes:

1) Remove the conductivity cell block by unscrewing the two screws that hold it to the gray epoxy electrode mount. Carefully remove the O-rings from the electrodes. Polish the electrodes with a strip of fine emery cloth, being careful not to scratch the nearby pH bulb. Polish the entire surface of each electrode, including the ends. Now, rinse any sanding residue away from the Conductivity electrodes, and push the O-rings onto the electrodes. Carefully re-install the cell block and tighten it until the O-rings are about 2/3 as thick as they were when not compressed.

2) Remove the reference electrode sleeve by pointing it toward the floor (it's full of buffer solution) and twisting it while pulling downward (it's held on by a single O-ring). Discard the old buffer. Fill the reference electrode sleeve to the brim with fresh pH 7.00 buffer solution. Without tilting it, push it back on until it seals on the O-ring. Invert the assembly (sleeve pointing up now). Push and twist the sleeve down until it butts against the bottom cap. The 7.00 buffer solution should have bubbled through the porous tip of the sleeve; if not, repeat the procedure. For illustration, please refer to Figure 4.

3) Remove the Dissolved Oxygen cell guard. Remove the D.O. cell membrane-retaining O-ring. Discard the old membrane and shake out the old electrolyte solution. With the gold electrode facing up, hold a membrane against the side of the D.O.

cell with a thumb. Using the other hand, fill the cell cavity with fresh D.O. electrolyte. If a bubble is visible in the cell beneath the silver pellet electrode, shake out the cell and refill the cavity slowly. Overfill the cavity, creating a high meniscus, then (still holding the membrane with a thumb) grasp the free end of the membrane and pull it quickly and tightly over the meniscus. Please refer to Figure 3.

A quick firm pull is necessary to prevent wrinkling and additional bubble entrapment. If bubbles are visible beneath the membrane, or if tiny wrinkles are visible just outside the gold ring, start over with a new membrane. Otherwise, secure the membrane by rolling the membrane O-ring over the membrane, into its groove. Check the membrane again for wrinkles, then trim the excess membrane. Replace the D.O. guard.

4) Screw on the calibration cup and fill it about half full of water. Add some detergent. Install the soft plastic cap and shake the sonde unit for 20-30 seconds. Pour out the soapy water. Fill the calibration cup half full of clean water; install the soft plastic cap and shake it for 10 seconds. Pour out the water and repeat twice using clean water each time. Remove the calibration cup. Fill the storage cup three-quarters full of clean water and screw it onto the sonde unit.

<u>NOTE</u>: If the sonde unit is to be stored for several days or more, add some Alconox or similar detergent to the water in the storage cup. This will help retard biological growth.

SERVICING THE D.O. POLARIZING BATTERY:

1) Remove the two allen-head screws from the top of the sonde tube.

2) Pull off the top cap by grasping the exposed plastic portion. (It might be helpful to insert the tip of a small screw-driver between the tube and top cap to start the process) DO NOT pull on the connector.

3) Remove the battery retaining clip and install the new battery. Replace the retaining clip.

4) Make sure the sealing O-rings on the top cap are clean. Clean off any residue that may be present inside the tube.

5) Take a small amount of the white O-ring grease and smear a light coating on the O-rings and on the sealing surface of the tube.

6) Install the top cap and screws.

7) Hold the sonde unit up to the light, in a horizontal position, and check to see that all of the O-rings have made a good seal. If not repeat steps 1, 2, 6, and 7.

COMMON PROBLEMS AND SOLUTIONS

| SYMPTON | CAUSE | SOLUTION |
|---|---|---|
| (1) D.O. Reads Low | Low Battery in Sonde Unit. | Confirm battery voltage is 2.7v |
| | Insufficient Stirring. | Check to see that Circulator is working properly i.e. No shorts in the motor lead |
| | Contaminated Cell or Membrane. | Replace the membrane |
| (2) D.O. Reads "00.0" | Mercury Battery in Sonde Loose | Open sonde and check connection and voltage on mercury battery, replace battery or secure connection |
| | No Power to Sonde Board. | For power problems, consult factory |
| (3) D.O. Too High to Calibrate | Wrong Membrane (Too Thin), Membrane Stretched Too Tight, Hole in Membrane, Wrinkle in Membrane. | Replace membrane making sure the membrane is from a packet marked "standard" |
| (4) D.O. Reads abnormally high or low (EX: 55.0mg/l) | Dead Battery in Sonde Unit | Replace mercury battery |
| | No Power to Sonde Board. | For power problems, consult factory |
| (5) D.O. Reading Drifts or is unstable during Calibration | Contaminated Membrane. | Replace Membrane |
| (6) D.O. Reading Drifts or is unstable In-Situ | Air Bubble on Outside of Membrane. | "Jig the sonde unit up and down in the water to dislodge any trapped bubbles |
| | Contaminated Membrane. | Replace Membrane |
| | Erratic Circulation. | Check circulator operation, or if no circulator, maintain circulation of at least 1 FPM. |

| | SYMPTOM | CAUSE | SOLUTION |
|---|---|---|---|
| 1) | pH Slope Will Not Adjust to 9.2 or 4.0 | Bad Buffer . . . . . . . . . . . . . . . | .Mix up new Buffer and repeat |
| | | Clogged Reference Junction or Buffer Solution inside Reference is bad . | .Refill reference probe with fresh pH 7.0 Buffer |
| | | Cracked or Scratched pH Bulb . . . . . | .Check pH Probe for scratches, cracks, or internal bubbles. If pH Probe is bad consult factory for replacement. |
| 2) | pH Response very slow | Clogged Reference Junction, Cracked or Scratched pH Bulb . . . . . | .Please refer to #1 above. |
| 3) | pH Won't Respond | Cracked Bulb; No Power to Sonde Board | .Consult factory for replacement of broken Probe or power problems |
| | | Reference Filling Solution Low . . . . | .Refill Reference Probe with fresh pH 7.0 Buffer. |
| 4) | pH Unstable | Bubble in pH Bulb; Cracked or Scratched pH Bulb . . . . | .Consult factory for pH Probe replacement |
| | | Clogged Reference Junction . . . . . . | .Refill Reference with fresh pH 7.0 Buffer |
| | | Loose Reference Sleeve . . . . . . . . . | .Make sure the Reference Sleeve is seated tightly over the O-Ring |
| 5) | pH Negative or Over 14 | No power to Sonde Board; Electrode(s) Disconnected . . . . . . . | .Consult factory for repair checks |
| | | Electrode(s) Not in Solution . . . . . | .Make sure Probes are in solution |

| SYMPTOM | CAUSE | SOLUTION |
| --- | --- | --- |
| 1) Conductivity Reads Low In-Situ or during Calibration | Bubble in Cell Bore or in Probe Area of Sonde Unit | "Jig" the Sonde Unit up and down in the water to dislodge any trapped bubbles |
| | Dirty Electrodes | Clean the Electrodes |
| | Bad Calibration | Recheck Calibration with fresh standards |
| 2) Conductivity Unstable In-Situ or during Calibration | Bubble in Cell Bore; Bubble in Probe Area of Sonde Unit | Dislodge any Bubbles as described in #1 above |
| | Cell Block Loose | Check Cell Block to see that it is secure |
| | Dirty Electrodes | Clean the Electrodes and recalibrate |
| 3) Conductivity Does Not Fall Into Specs (±1.0% of Range) During Calibration | Bubble in Cell Bore | Check for Bubbles and dislodge any that are present |
| | Dirty Electrodes | Clean the Electrodes |
| | Bad Standard | Mix new standards and recalibrate |

* From Truesdale, Downing and Lowden (1955).

TABLE OF OXYGEN SOLUBILITY @ 0 o/oo CHLORINITY, 760mm Hg

| TEMP. | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 14.16 | 14.12 | 14.08 | 14.04 | 14.00 | 13.97 | 13.93 | 13.89 | 13.85 | 13.81 |
| 1 | 13.77 | 13.74 | 13.70 | 13.66 | 13.63 | 13.59 | 13.55 | 13.51 | 13.48 | 13.44 |
| 2 | 13.40 | 13.37 | 13.33 | 13.30 | 13.26 | 13.22 | 13.19 | 13.15 | 13.12 | 13.08 |
| 3 | 13.05 | 13.01 | 12.98 | 12.94 | 12.91 | 12.87 | 12.84 | 12.31 | 12.77 | 12.74 |
| 4 | 12.70 | 12.67 | 12.64 | 12.60 | 12.57 | 12.54 | 12.51 | 12.47 | 12.44 | 12.41 |
| 5 | 12.37 | 12.34 | 12.31 | 12.28 | 12.25 | 12.22 | 12.18 | 12.15 | 12.12 | 12.09 |
| 6 | 12.06 | 12.03 | 12.00 | 11.97 | 11.94 | 11.91 | 11.88 | 11.85 | 11.82 | 11.79 |
| 7 | 11.76 | 11.73 | 11.70 | 11.67 | 11.64 | 11.61 | 11.58 | 11.55 | 11.52 | 11.50 |
| 8 | 11.47 | 11.44 | 11.41 | 11.38 | 11.36 | 11.33 | 11.30 | 11.27 | 11.25 | 11.22 |
| 9 | 11.19 | 11.16 | 11.14 | 11.11 | 11.08 | 11.06 | 11.03 | 11.00 | 10.98 | 10.95 |
| 10 | 10.92 | 10.90 | 10.87 | 10.85 | 10.82 | 10.80 | 10.77 | 10.75 | 10.72 | 10.70 |
| 11 | 10.67 | 10.65 | 10.62 | 10.60 | 10.57 | 10.55 | 10.53 | 10.50 | 10.48 | 10.45 |
| 12 | 10.43 | 10.40 | 10.38 | 10.36 | 10.34 | 10.31 | 10.29 | 10.27 | 10.24 | 10.22 |
| 13 | 10.20 | 10.17 | 10.15 | 10.13 | 10.11 | 10.09 | 10.06 | 10.04 | 10.02 | 10.00 |
| 14 | 9.98 | 9.95 | 9.93 | 9.91 | 9.89 | 9.87 | 9.85 | 9.83 | 9.81 | 9.78 |
| 15 | 9.76 | 9.74 | 9.72 | 9.70 | 9.68 | 9.66 | 9.64 | 9.62 | 9.60 | 9.58 |
| 16 | 9.56 | 9.54 | 9.52 | 9.50 | 9.48 | 9.46 | 9.45 | 9.43 | 9.41 | 9.39 |
| 17 | 9.37 | 9.35 | 9.33 | 9.31 | 9.30 | 9.28 | 9.26 | 9.24 | 9.22 | 9.20 |
| 18 | 9.18 | 9.17 | 9.15 | 9.13 | 9.12 | 9.10 | 9.08 | 9.06 | 9.04 | 9.03 |
| 19 | 9.01 | 8.99 | 8.98 | 8.96 | 8.94 | 8.93 | 8.91 | 8.89 | 8.88 | 8.86 |
| 20 | 8.84 | 8.83 | 8.81 | 8.79 | 8.78 | 8.76 | 8.75 | 8.73 | 8.71 | 8.70 |
| 21 | 8.68 | 8.67 | 8.65 | 8.64 | 8.62 | 8.61 | 8.59 | 8.58 | 8.56 | 8.55 |
| 22 | 8.53 | 8.52 | 8.50 | 8.49 | 8.47 | 8.46 | 8.44 | 8.43 | 8.41 | 8.40 |
| 23 | 8.38 | 8.37 | 8.36 | 8.34 | 8.33 | 8.32 | 8.30 | 8.29 | 8.27 | 8.26 |
| 24 | 8.25 | 8.23 | 8.22 | 8.21 | 8.19 | 8.18 | 8.17 | 8.15 | 8.14 | 8.13 |
| 25 | 8.11 | 8.10 | 8.09 | 8.07 | 8.06 | 8.05 | 8.04 | 8.02 | 8.01 | 8.00 |
| 26 | 7.99 | 7.97 | 7.96 | 7.95 | 7.94 | 7.92 | 7.91 | 7.90 | 7.89 | 7.88 |
| 27 | 7.86 | 7.85 | 7.84 | 7.83 | 7.82 | 7.81 | 7.79 | 7.78 | 7.77 | 7.76 |
| 28 | 7.75 | 7.74 | 7.72 | 7.71 | 7.70 | 7.69 | 7.68 | 7.67 | 7.66 | 7.65 |
| 29 | 7.64 | 7.62 | 7.61 | 7.60 | 7.59 | 7.58 | 7.57 | 7.56 | 7.55 | 7.54 |
| 30 | 7.53 | 7.52 | 7.5 | 7.50 | 7.48 | 7.47 | 7.46 | 7.45 | 7.44 | 7.43 |
| 31 | 7.42 | 7.41 | 7.40 | 7.39 | 7.38 | 7.37 | 7.36 | 7.35 | 7.34 | 7.33 |
| 32 | 7.32 | 7.31 | 7.30 | 7.29 | 7.28 | 7.27 | 7.26 | 7.25 | 7.24 | 7.23 |
| 33 | 7.22 | 7.21 | 7.20 | 7.20 | 7.19 | 7.18 | 7.17 | 7.16 | 7.15 | 7.14 |
| 34 | 7.13 | 7.12 | 7.11 | 7.10 | 7.09 | 7.08 | 7.07 | 7.06 | 7.05 | 7.05 |
| 35 | 7.04 | 7.03 | 7.02 | 7.01 | 7.00 | 6.99 | 6.98 | 6.97 | 6.96 | 6.95 |

TABLE OF CONDUCTIVITY CALIBRATION STANDARDS

CONDUCTIVITIES OF POTASSIUM CHLORIDE SOLUTIONS AT 25°C
M.W. = 74.555

CONDUCTIVITY READING ON 4041 DISPLAY FOR GIVEN RANGE SETTING (uS/cm)

| CONC. M | | GRAMS/L KCl | | uS/cm | (0-2K) | (0-20K) | (0-200K) |
|---|---|---|---|---|---|---|---|
| 0.0005 | | 0.03728 | | 73.9 | | | |
| 0.001 | | 0.07456 | | 147.0 | 147 | | |
| 0.002 | | 0.1491 | | 292.0 | 292 | | |
| 0.005 | | 0.3728 | | 717.8 | 718 | | |
| 0.01 | | 0.7456 | | 1.413K | 1413 | 141 | |
| 0.02 | | 1.491 | | 2.767K | --- | 277 | |
| 0.05 | | 3.728 | | 6.668K | --- | 667 | |
| 0.1 | | 7.456 | | 12.90K | --- | 1290 | 129 |
| 0.2 | | 14.911 | | 24.82K | --- | --- | 248 |
| 0.5 | | 37.278 | | 58.64K | --- | --- | 586 |
| 1.0 | | 74.555 | | 111.9K | --- | --- | 1119 |

NOTES: (1) Two conductivity standards are recommended for each range setting (boxed-in values). Make calibration adjustments with the higher concentration and check with the lower concentration.

(2) Shaded areas are not recommended for calibration checks.

CUSTOMER SERVICE

In the event of instrument malfunction, please notify HYDROLAB immediately by telephone (512) 255-8841. If telephone assistance will not suffice, authorization for the return of any part or all of the system will be given with instructions for shipping under a Returned Goods Authorization Number. (RGA No.________).

Upon authorization, goods should be shipped by:

1) UPS, AIR FREIGHT, FEDERAL EXPRESS, OR MOTOR FREIGHT TO:

HYDROLAB CORPORATION
12921 BURNET ROAD
AUSTIN, TEXAS 78759

ATTN: SERVICE DEPARTMENT
RGA No.__________

2) Shipment of goods by US Mail is NOT AUTHORIZED.

3) All shipments must be shipped PREPAID and INSURED unless otherwise agreed in advance.

4) For Technical or Applications Assistance please contact HYDROLAB by Telephone (512) 255-8841.

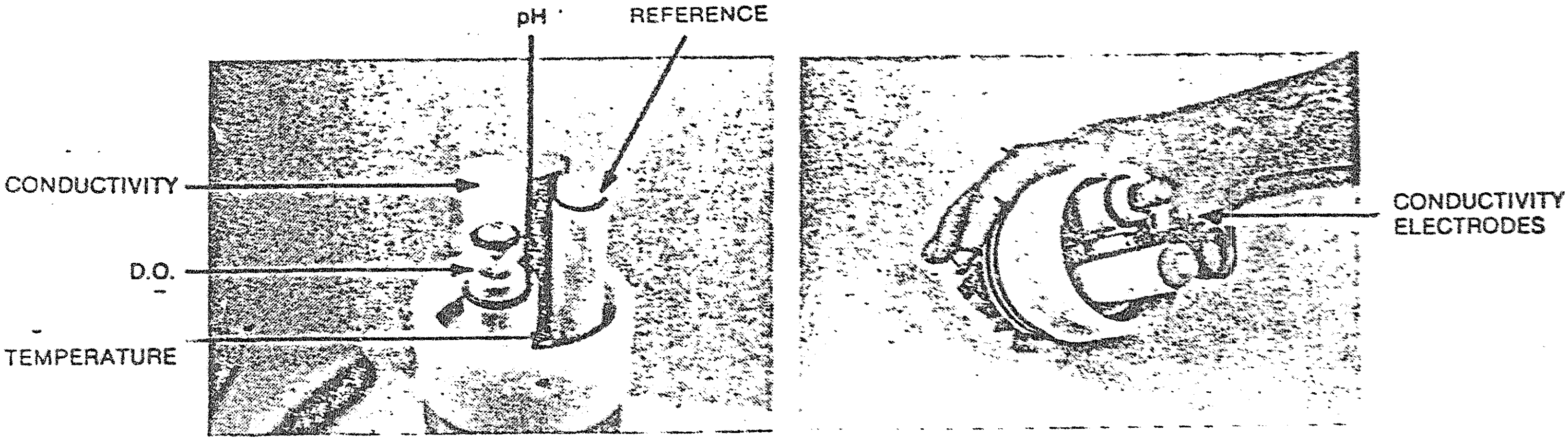
APPLICATION NOTE: (4000 SERIES INSTRUMENTS) January, 1980

USING CABLES LONGER THAN 100 METERS

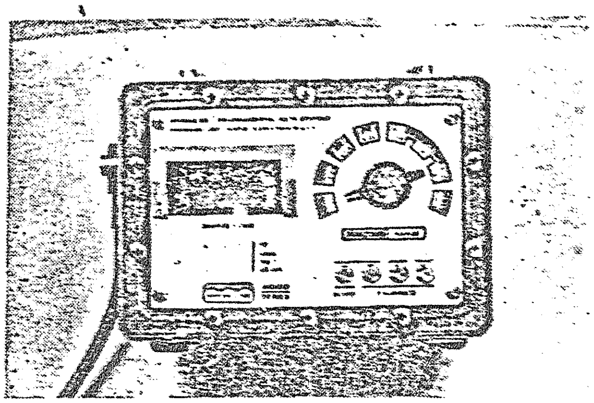
Due to cable capacitance, cable combinations that exceed 100 meters in length will slightly decrease the accuracy of measurements in the 0-2K conductivity range. The 0-20K and 0-200K ranges will not be affected.

For best results on the 0-2K range:

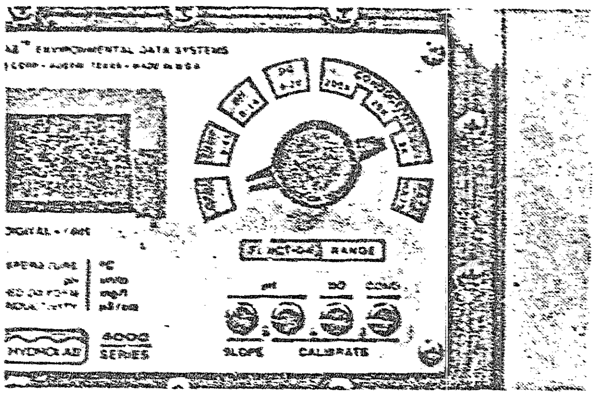
1) Re-calibrate the conductivity circuit when changing from a short cable to a long cable, or vice-versa.
2) When using the long cable, note the conductivity reading with the conductivity cell dry. Subtract this reading from subsequent measurements.



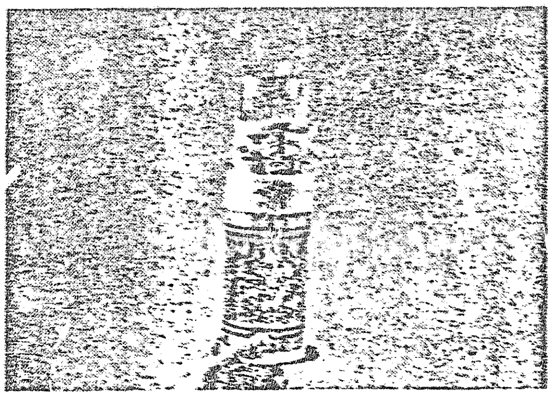

..4041 PROBE ASSEMBLY



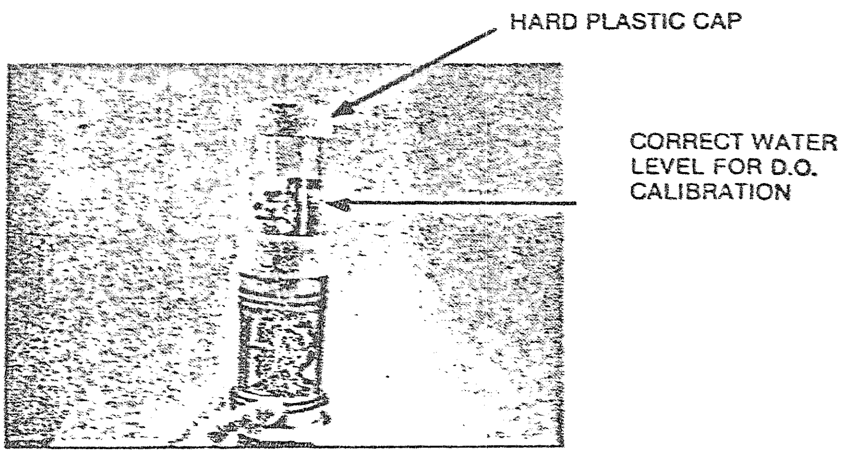
..4041 INDICATOR UNIT




CALIBRATION CONTROL
SEAL SCREWS

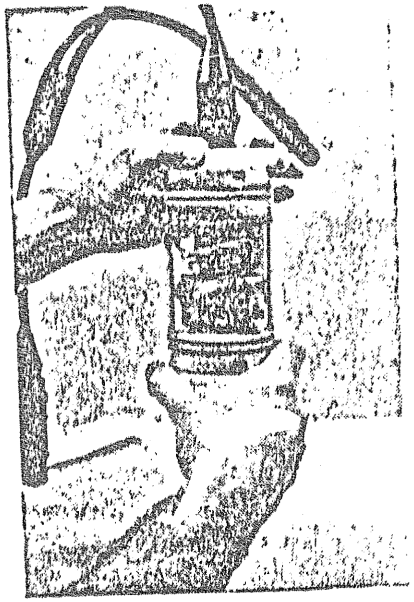


SONDE UNIT IN THE
INVERTED POSITION.

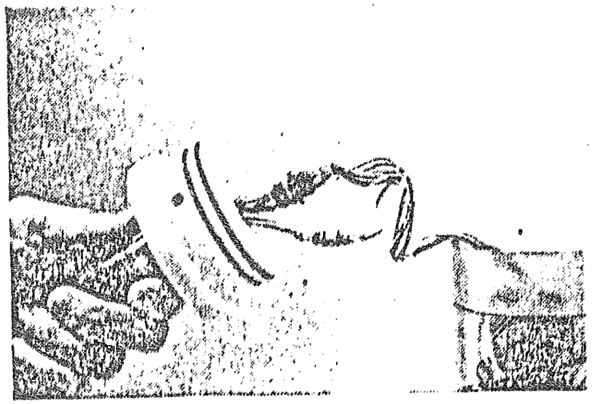



SONDE UNIT INVERTED
FOR D.O. CALIBRATION.

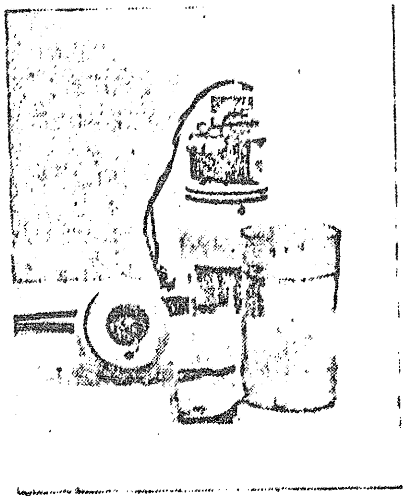
# REPLACING THE D.O. POLARIZING BATTERY



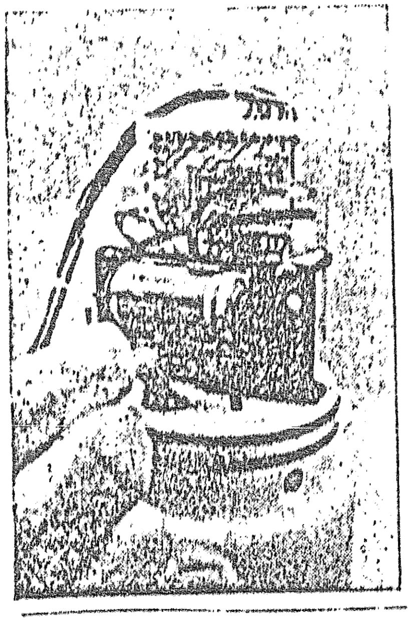
REMOVE TOP CAP.
STEP 1



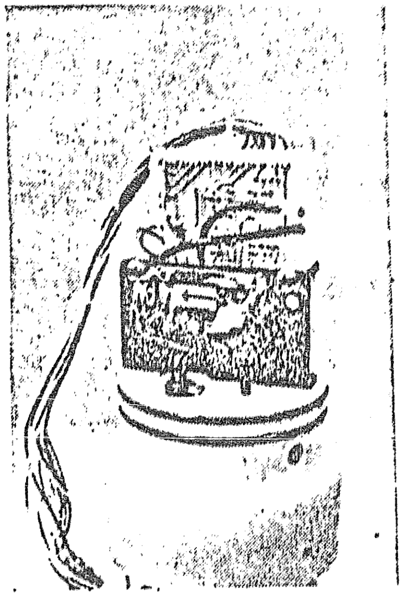
10 PIN & 2 PIN CONNECTORS
(DISCONNECT THESE)
STEP 2



SONDE WITH TUBE AND
DESICCANT REMOVED
STEP 3



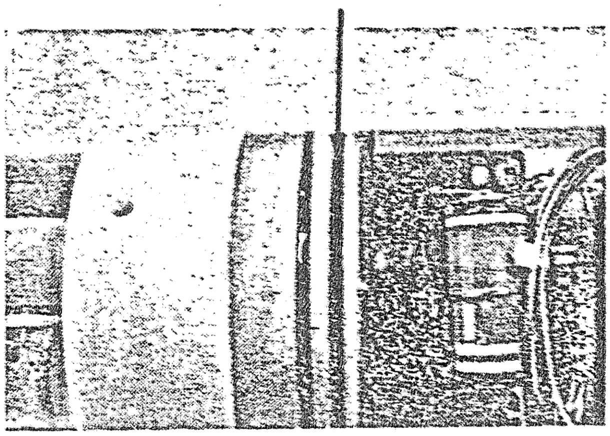
REMOVE BATTERY RETAINER
CLIP.
STEP 4



BATTERY REMOVED.
NOTE: POLARITY MARKERS
STEP 5

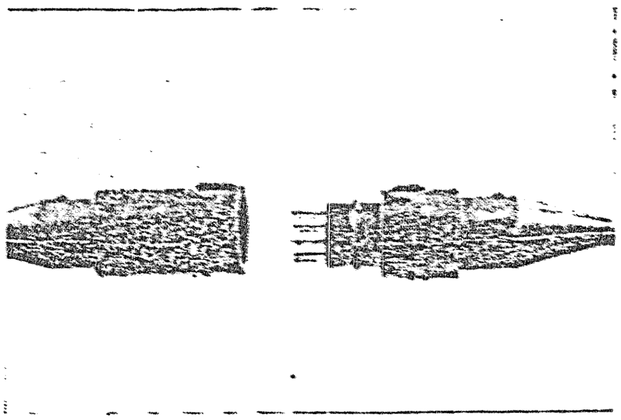
INSTALL NEW
BATTERY
STEP 6

NOTE: SEAL

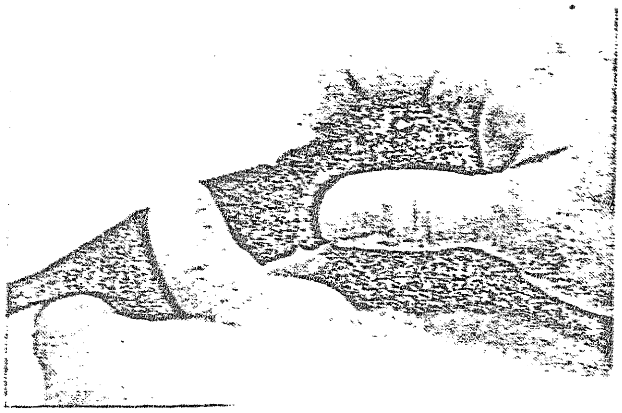


CHECK O-RING SEAL AFTER
SONDE IS RE-ASSEMBLED.

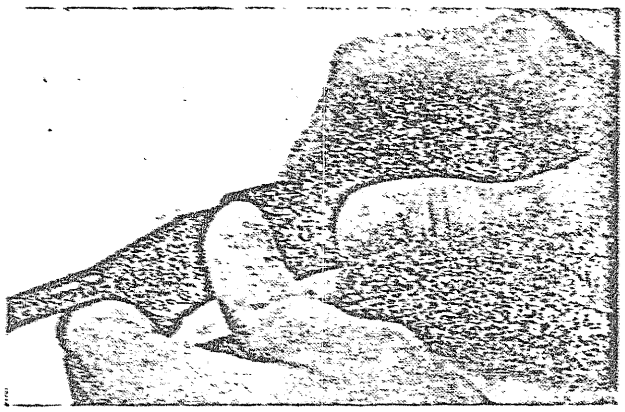
## INSTALLING MARINE CONNECTORS



ALIGN THE RAISED NUBS AND
PUSH STRAIGHT TOGETHER.
DO-NOT-BEND
STEP 1

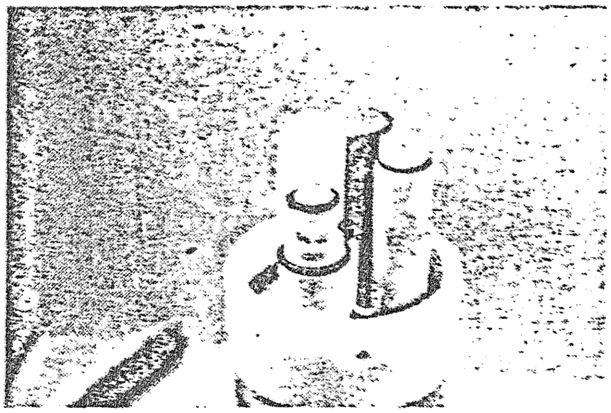


EXPEL TRAPPED AIR WHILE
PUSHING THE CONNECTORS TOGETHER.
STEP 2

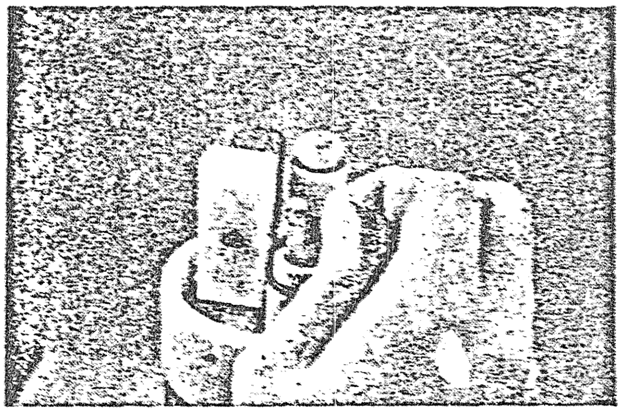


EXPEL TRAPPED AIR AGAIN
AFTER CONNECTION IS COMPLETE.
STEP 3

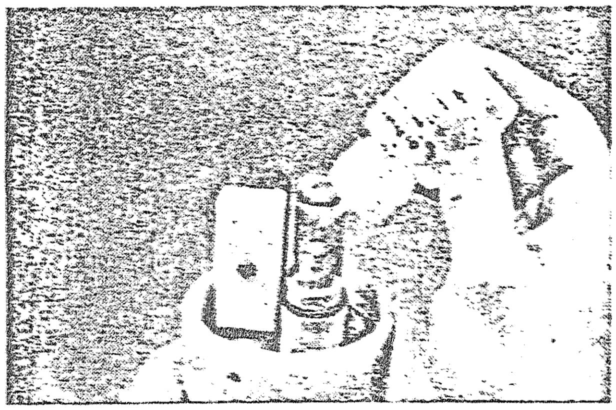
CHANGING THE D.O. MEMBRANE



D.O. PROBE READY FOR
MEMBRANE REMOVAL
STEP 1

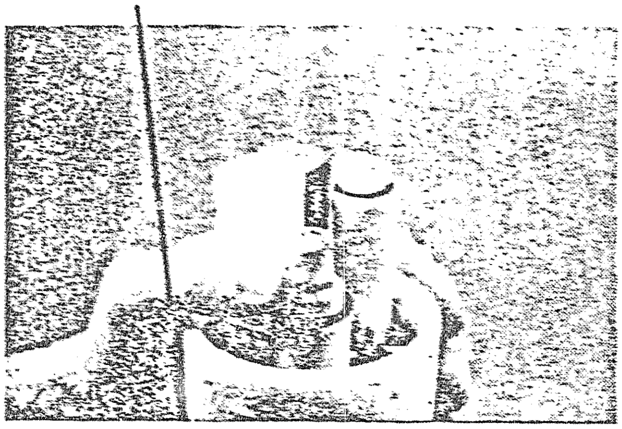


REMOVE OLD MEMBRANE
STEP 2

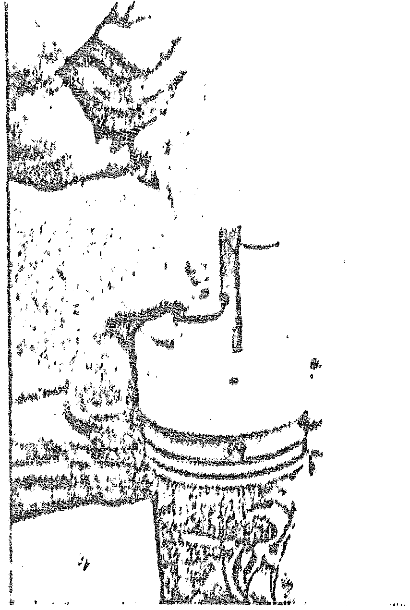


REFILL THE D.O. CELL
WITH FRESH ELECTROLYTE
STEP 3

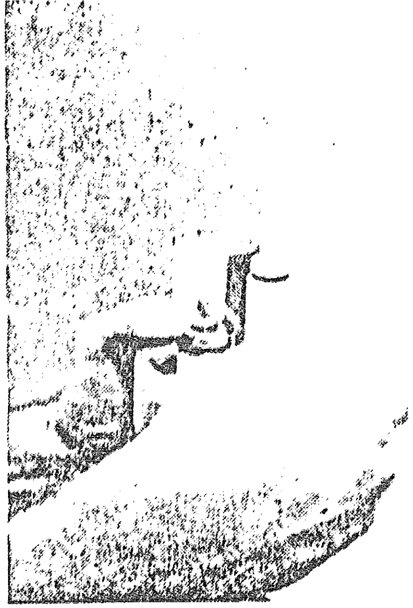
NOTE: MEMBRANE



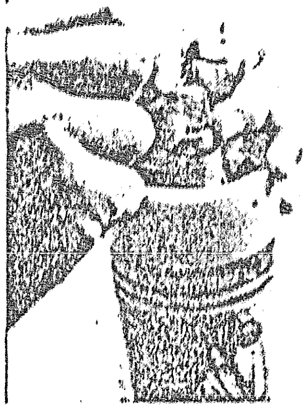
READY TO INSTALL
NEW MEMBRANE
STEP 4



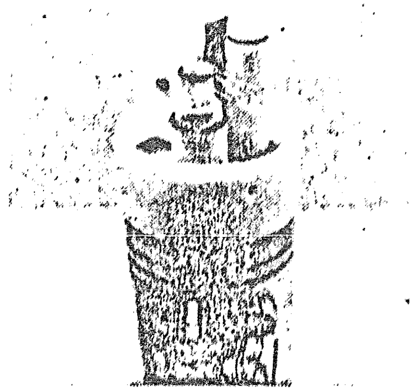
MEMBRANE READY TO BE
STRETCHED INTO PLACE
STEP 5



WITH QUICK OVER-AND DOWN
MOTION, STRETCH
MEMBRANE OVER CELL.
STEP 6

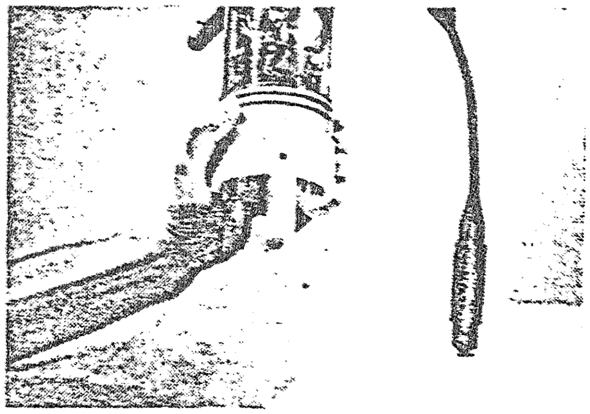


HOLD MEMBRANE TIGHTLY ON
BOTH SIDES OF THE PROBE.
INSTALL RETAINING O-RING.
STEP 7

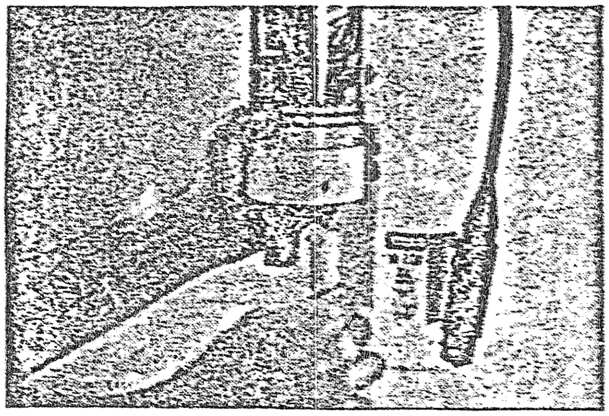


NEW MEMBRANE INSTALLED.
TRIM OFF EXCESS.
STEP 8

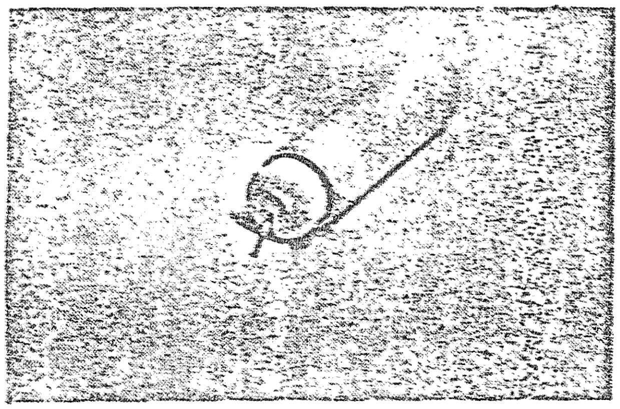
# SERVICING THE pH REFERENCE PROBE



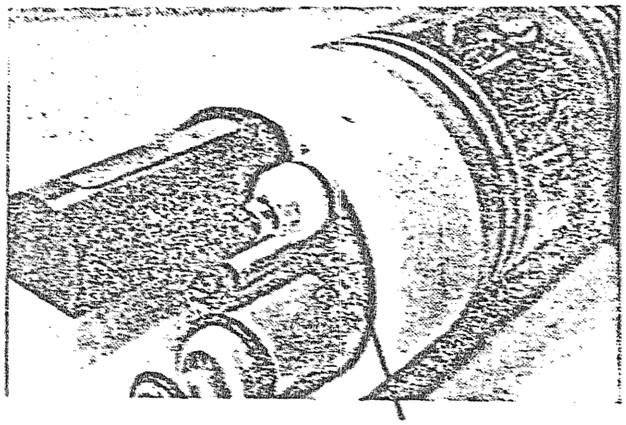
REMOVE THE REFERENCE SLEEVE.
STEP 1



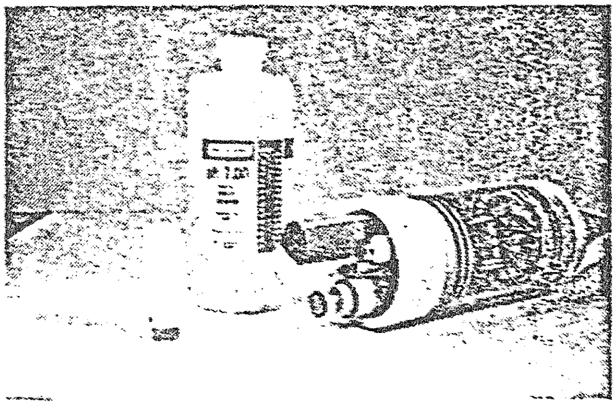
REFERENCE PROBE WITH SLEEVE REMOVED.
STEP 2



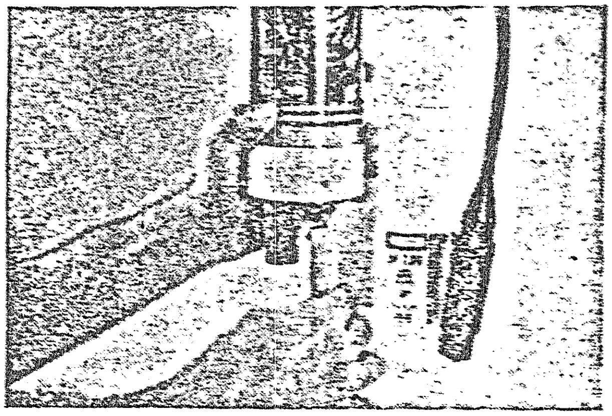
REFERENCE SLEEVE.
(NOTE: TEFLON JUNCTION)
STEP 3



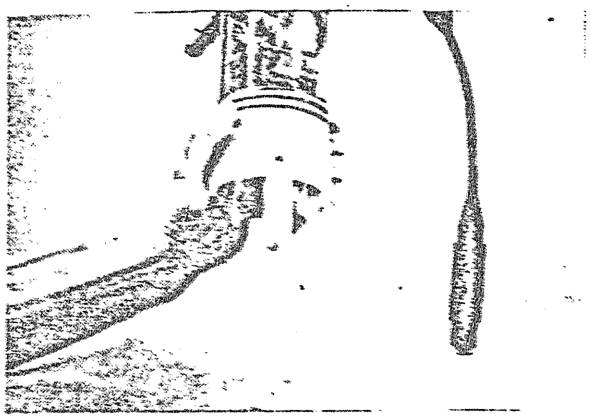
REFERENCE PROBE O-RING
THE OUTER SLEEVE SEALS
ON THIS O-RING.
STEP 4



REFILL SLEEVE WITH FRESH pH 7.0
BUFFER (CREATE A MENISCUS).
STEP 5



BEGIN REPLACING THE REFERENCE SLEEVE.
STEP 6



PUSH THE REFERENCE SLEEVE ON
UNTIL IT SEALS ON THE O-RING.
STEP 7

INVERT SONDE UNIT AND PUSH
REFERENCE SLEEVE BACK INTO PLACE.
STEP 8

Techniques of Water-Resources Investigations of the United States Geological Survey

Chapter B2

# CALIBRATION AND MAINTENANCE OF VERTICAL-AXIS TYPE CURRENT METERS

By George F. Smoot and Charles E. Novak

Book 8

INSTRUMENTATION

## CONTENTS



## FIGURES



## TABLE

# SYMBOLS AND UNITS

| Symbol | Definition | Unit |
|---|---|---|
| C | Constant. | |
| $K$ | Proportionality constant. | |
| $N$ | Angular velocity of meter rotor. | revolutions/sec |
| $V$ | Velocity. | ft/sec |

# CALIBRATION AND MAINTENANCE OF VERTICAL-AXIS TYPE CURRENT METERS

By George F. Smoot and Charles E. Novak

## Abstract

The purpose of this chapter is to describe the procedures used in the manufacture and calibration of current meters and to present in detail information pertinent to their proper maintenance and repair. Recent intensive studies on the calibration of current meters and the effects of wear of the component parts on the performance of the meters have led to the adoption of new procedures for the manufacture, calibration, maintenance, and repair of meters. This chapter, therefore, updates the provisional manual "Care and Rating of Current Meters" (1957) by including these new procedures.

## Introduction

Precision instruments and their proper use and maintenance are prerequisites for the collection of accurate data. Current meters are precision instruments and their proper use and maintenance are doubly important because of the hard usage often received by them in measuring stream velocities. The following quotation from an earlier provisional manual emphasizes the importance the Water Resources Division attaches to this aspect of streamflow measurements:

> The operation of a current meter, as of any scientific instrument, will be largely affected by the way in which it is used. While the design, material, and construction of the meter may be large factors in its successful operation, these factors may not prevent errors due to improper care and use of the instrument. In this connection each fieldman is urged to use the greatest possible care to see that his meter is kept in proper condition.

The condition of the fieldman's current meter is one of the most important building stones in the foundation of good streamflow records. Routine servicing, inspection for minor damage, and proper lubrication should be standard operating procedure. The amount of pride taken in maintaining his meter in optimum condition is also a measure of the pride a man can be expected to take in other areas of his work.

This chapter updates the provisional manual "Care and Rating of Current Meters" (1957, out of print).

## Description of the Small Price Current Meter

Rotating-element current meters can be broadly classified into two general categories according to the orientation of the revolving axle; the axis may be vertical, or it may be horizontal and parallel to the direction of flow. Current meters having horizontal axes with propeller-shaped rotors and those having vertical axes with cup or vane-type rotors have been experimented with extensively to determine their respective advantages and disadvantages.

Although many characteristics of different current meters are still unknown, the experiments and investigations thus far conducted are conclusive in one respect, namely, that current meters of either the horizontal- or vertical-axis type when carefully designed and constructed, and when used under favorable conditions, will measure accurately the velocity of flowing water.

When streamflow investigations were undertaken by the Geological Survey in 1888, engineers of the Survey began experimenting with the various types of current meters available at that time to find one that could be used under a wide variety of field conditions. About 1896, as a result of these investigations, they developed a meter containing certain features of the Price acoustic and the large Price electric meters. This meter, which was called the small Price (fig. 1), has since been used by the Survey almost exclusively because of its adaptability to general stream gaging.

The small Price current meter probably has been used more extensively and has been subjected to more investigation than any other type of current meter. As a result of this extensive investigation and because of the natural advantages afforded by the type, the small Price has been perfected in its details; the type-AA Price meter is now better suited to general use than any other meter. It is light and yet strong, sensitive yet durable. It will measure with a high degree of accuracy velocities ranging from 0.1 foot per second to more than 20 feet per second. It is easily repaired, it can be quickly taken apart for cleaning and oiling, and it can be quickly reassembled without change in rating.

To properly use and care for a current meter, the user must be familiar with all of its parts, as well as with the assembled meter. If any part fails completely because of excessive wear or damage, the condition is usually obvious, but small irregularities that may introduce large percentage errors in velocity determinations are not always readily detected. For this reason the parts of the type-AA meter and their functional characteristics are described; the numbers assigned to the various parts in this description correspond to the numbers used in the assembly diagram of the type-AA current meter shown in figure 2.

## Yoke

The yoke (8) is a 1-piece horseshoe-shaped casting made of chromium-plated bronze. A short horizontal rear extension contains a hole for connection of the tailpiece. This extension contains two bosses—one which is slotted vertically and and drilled horizontally for the hanger and hanger screw, and one which is drilled vertically for the keeper screw of the tailpiece. The slot for the hanger is of such dimensions as to limit the tilting of the meter so that neither the yoke nor the tailpiece will strike the weight. The upper arm of the yoke is drilled to receive the stem of the P-shaped contact chamber; the lower arm is drilled to receive the pivot. These holes are coaxial so as to properly aline the rotor assembly and the pivot. The contact chamber and pivot are held in position by a keeper screw having a knurled fillister head.

## Tailpiece

The tailpiece is made of a hard-rolled nickel-plated brass, and it consists of two separate vanes which, when assembled, are locked together at right angles to each other by means of a lever arrangement. This two-piece construction permits the tailpiece to be taken apart readily for convenience in packing. The nosepiece of the tail fits into the rear extension of the yoke. A means to balance the meter assembly is provided in the lower part of the tailpiece by a long horizontal slot containing a short heavy screw that may be adjusted to the proper position to obtain the desired balance.

## Bucket wheel

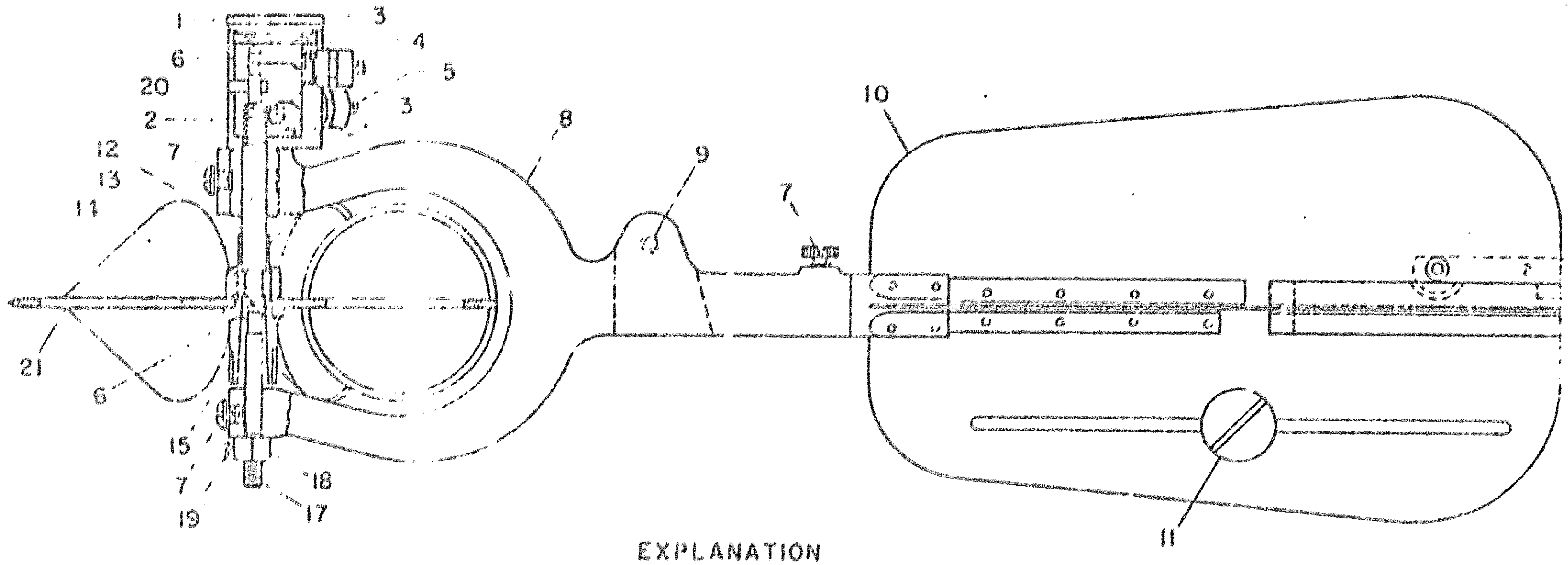
The bucket wheel (21) consists of six cone-shaped cups soldered to a frame to form a symmetrical and balanced assembly 5 inches in diameter and 2 inches high. The cups and frame are made of nickel-plated hard rolled brass. The frame is centrally drilled for the shaft and notched for a dowel pin. The letter "S" is stamped on the frame to identify the top side of the bucket wheel. The year of manufacture is also identified—S-67, S-68, for example.

## Bucket-wheel hub

The bucket-wheel hub (13) encases the pivot bearing and the lower end of the shaft and supports the bucket wheel. The hub is threaded in three places: (1) for the bucket-wheel hub nut, (2) for the bucket-raising nut, and (3) for the shaft. A small dowel pin maintains the bucket wheel in a fixed position with reference to the bucket-wheel hub. The bucket-raising nut is provided so that the pivot bearing can be raised from the pivot when the meter is not is use.

## Shaft

The shaft (12) is made of stainless steel and is of sufficient length to extend from the bucket-wheel hub to a point 0.008 inch below the cap of the




EXPLANATION

1. Cap for contact chamber
2. Contact chamber
3. Insulating bushing for contact binding post
4. Single-contact binding post
5. Penta-contact binding post
6. Penta gear
7. Set screw
8. Yoke
9. Hole for hanger screw
10. Tailpiece
11. Balance weight
12. Shaft
13. Bucket-wheel hub
14. Bucket-wheel hub nut
15. Raising nut
16. Pivot bearing
17. Pivot
18. Pivot-adjusting nut
19. Keeper screw for pivot-adjusting nut
20. Bearing lug
21. Bucket wheel

*Figure 2.—Assembly diagram of type-AA Price current meter.*

contact chamber. The upper one-half inch of the shaft is turned to 0.125-inch diameter and is rounded at the top to provide a smooth bearing surface for the thrust of the shaft against the bottom of the contact-chamber cap. An eccentric is cut in the 0.125-inch diameter part of the shaft to provide a means for making an electrical contact for each revolution of the bucket-wheel hub. The shaft also contains an acme thread that meshes with the penta gear within the contact chamber. A small hole is drilled at about the midpoint of the shaft to facilitate the use of a pin for tightening the shaft into the bucket-wheel hub.

### Pivot

The pivot (17) is made of tempered, precipitation-hardening stainless steel. The upper end of the pivot is ground and polished to form an angle of 90° and the point rounded to a radius of 0.005 inch. The lower end of the pivot is threaded to provide for the hexagonal stainless-steel nut that is used to adjust the clearance between the pivot point and the pivot bearing. A slightly tapered flat surface on the pivot above the threads serves as a contact surface for the pivot-keeper screw.

### Pivot bearing

The pivot bearing (16) is made of tungsten carbide and has highly polished bearing surfaces. It is pressed into the cylindrical recess in the lower end of the bucket-wheel hub. The bearing being of greater hardness than the pivot causes the major part of the wear to take place on the pivot which is easily replaceable.

### Penta gear

The penta gear (6) is made of stainless steel and is fitted to mesh smoothly with the acme threads on the shaft. The gear makes one complete revolution for each 10 revolutions of the bucket wheel. Two gear teeth, 180° apart, are extended beyond the others to provide a means for making two electrical contacts for each revolution of the gear, with the result that contacts are made at each fifth revolution of the bucket wheel. The gear is mounted in a bronze frame in a horizontal position, and the assembly is housed in the contact chamber where it is held in place by means of a brass screw. The base of the frame through which this screw passes is slotted to permit the adjustment of the gear teeth with the worm on the shaft.

### Contact chamber

The contact chamber (2) is a P-shaped chromium-plated brass unit which houses the penta gear, the upper part of the shaft, the shaft bearing, and the single- and penta-contact binding posts. The upper end of the chamber is drilled and threaded internally to carry a knurled cap. A small phosphor-bronze lug, brazed to the chamber wall, serves as the upper bearing for the shaft. The stem of the contact chamber extends through the upper arm of the yoke and is drilled axially so that the shaft can pass into the chamber with ample clearance. The cap is tightly fitted so that the chamber serves as an air trap to prevent silty water from entering the bearing.

### Binding posts

Two stainless-steel binding posts (4) and (5) are placed at the rear of the contact chamber. One post is designed to contact the eccentric of the shaft and the other to contact the two extended teeth of the penta gear. They are identical in construction except for the lengths of the slender stainless steel cables that terminate in beads of silver solder through which the contacts are made. Each binding post is insulated from the contact chamber by a bushing (3) made of nylon.

## Calibration of Current Meters

The principal of operation of a rotating-element type velocity meter is based on the proportionality between the local flow velocity and the resulting angular velocity of the meter rotor. The velocity of the water is determined by counting the number of revolutions of the rotor during a measured interval of time and consulting the meter calibration table.

If an ideal current meter, that is, one equipped with a correctly shaped rotor and a frictionless bearing mechanism, were to measure the flow velocity of a perfect liquid, the relation between the flow velocity and the rotor speed would be very simple:

$$V = KN \quad (1)$$

here V denotes the local flow velocity, K is the proportionality constant, and N is the rotor speed expressed in revolutions per unit of time. In actual practice there are resistances opposing rotation caused by friction between the liquid and the rotor and by the mechanical friction of the bearings. Consequently, this simple relationship does not exist, and one must be determined empirically. The establishment of this relation, known as "rating the current meter," is done for the Survey by the National Bureau of Standards.

The current-meter rating station operated by the National Bureau of Standards in Washington, D.C., consists of a sheltered reinforced concrete basin 400 feet long, 6 feet wide, and 6 feet deep. Atop the vertical walls of the basin and extending its entire length are steel rails that carry an electrically driven rating car. This car is operated to move the current meter at a constant rate through the still water in the basin. Although the rate of travel can be accurately adjusted, the average velocity of the moving car is determined for each run by making an independent measurement of the distance it travels during the time that the revolutions of the bucket wheel are electrically counted. A scale graduated in feet and tenths is used for this purpose.

A small Price meter is rated by towing it at eight different velocities (0.25, 0.50, 0.75, 1.10, 1.50, 2.20, 5.00, and 8.00 feetp ersecond). A pair of runs are made at each velocity. A pair consists of two traverses of the basin, one in each direction. The data obtained consists of 16 observations of the velocity of the car (V) and revolutions per second of the rotor (N). The meter rating is determined from these data and is expressed as two linear equations:

For $N$ less than 1.00,

$$V = K_1N + C_1, \quad (2)$$

For $N$ greater than 1.00,

$$V = K_2N + C_2, \quad (3)$$

where

$$K_2 = K_1 + C_1 - C_2. \quad (4)$$

Because there is rigid control in the manufacture of the small Price meter, virtually identical meters are produced and, for all practical purposes, their rating equations are identical.

Therefore, there is no need to calibrate each meter individually. Instead, a standard rating is established by calibrating a large number of meters that have been constructed according to Survey specifications, and this rating is then supplied with each meter.

To insure that all small Price meters are virtually identical, dies and fixtures for their manufacture were purchased by the Water Resources Division and supplied to the manufacturer in 1967 for use in constructing meters. These same dies and fixtures will be supplied to the successful bidder in subsequent years. All rotors manufactured by use of the standard dies and fixtures are stamped "S" on the top side of the bucket wheel. The year of manufacture is also identified—S-67, S-68, for example. To further insure that all meters are identical, quality control procedures are followed, including the rating of a sample of meters from each new group procured.

For convenience in field use, the data from the current-meter ratings are reproduced in tables, a sample of which is shown in figure 3. The velocities corresponding to a range of 3-350 revolutions of the bucket wheel within a period of 40-70 seconds are listed in the tables. This range in revolution and time has been found to cover general field requirements. To provide the necessary information for the few instances where extensions are required, the equations of the rating table are shown in the spaces provided in the heading. Because of limited space, the equations are presented in an abbreviated form.

The expression V = 2.140N + 0.015 (2.155) V = 2.150N + 0.005 shown in the heading of the table in figure 3 is to be interpreted as follows:

$V$ represents velocity in feet per second.

$N$ represents the number of revolutions of the bucket wheel per second.

That part, V = 2.140N + 0.015, to the left of the parentheses is the equation used for computing velocities shown in the table less than 2.155 feet per second.

That part, V = 2.150N + 0.005, to the right of

DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY
Water Resources Division

RATING TABLE FOR TYPE AA CURRENT METER

EQUATIONS: V = 2.140N + 0.015 (2.155)   V = 2.150N + 0.005   STANDARD RATING NO. X

| Time in Seconds | VELOCITY IN FEET PER SECOND — Revolutions 3 | 5 | 7 | 10 | 15 | 20 | 25 | 30 | 40 | Time in Seconds |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | .176 | .282 | .390 | .550 | .818 | 1.08 | 1.36 | 1.62 | 2.15 | 40 |
| 41 | .172 | .276 | .380 | .537 | .798 | 1.06 | 1.32 | 1.58 | 2.10 | 41 |
| 42 | .168 | .270 | .372 | .526 | .779 | 1.03 | 1.29 | 1.54 | 2.05 | 42 |
| 43 | .164 | .264 | .363 | .513 | .762 | 1.01 | 1.26 | 1.51 | 2.01 | 43 |
| 44 | .161 | .258 | .355 | .501 | .746 | .988 | 1.23 | 1.47 | 1.96 | 44 |
| 45 | .158 | .253 | .348 | .491 | .728 | .966 | 1.20 | 1.44 | 1.92 | 45 |
| 46 | .155 | .248 | .341 | .480 | .713 | .946 | 1.18 | 1.41 | 1.88 | 46 |
| 47 | .152 | .243 | .334 | .470 | .698 | .928 | 1.16 | 1.38 | 1.84 | 47 |
| 48 | .149 | .238 | .327 | .461 | .684 | .907 | 1.13 | 1.36 | 1.80 | 48 |
| 49 | .146 | .233 | .321 | .452 | .670 | .888 | 1.11 | 1.33 | 1.76 | 49 |
| 50 | .143 | .229 | .315 | .443 | .657 | .871 | 1.09 | 1.30 | 1.73 | 50 |
| 51 | .141 | .226 | .309 | .436 | .644 | .854 | 1.06 | 1.27 | 1.69 | 51 |
| 52 | .138 | .221 | .303 | .427 | .632 | .838 | 1.04 | 1.25 | 1.66 | 52 |
| 53 | .136 | .217 | .298 | .419 | .621 | .823 | 1.02 | 1.23 | 1.63 | 53 |
| 54 | .134 | .213 | .292 | .411 | .609 | .808 | 1.01 | 1.20 | 1.60 | 54 |
| 55 | .132 | .210 | .287 | .404 | .599 | .793 | .988 | 1.18 | 1.57 | 55 |
| 56 | .130 | .206 | .282 | .397 | .588 | .779 | .970 | 1.16 | 1.54 | 56 |
| 57 | .128 | .203 | .278 | .390 | .578 | .766 | .954 | 1.14 | 1.52 | 57 |
| 58 | .126 | .199 | .273 | .384 | .568 | .753 | .937 | 1.12 | 1.49 | 58 |
| 59 | .124 | .196 | .269 | .378 | .559 | .740 | .922 | 1.10 | 1.47 | 59 |
| 60 | .122 | .193 | .265 | .372 | .550 | .728 | .907 | 1.09 | 1.44 | 60 |
| 61 | .120 | .190 | .261 | .366 | .541 | .717 | .892 | 1.07 | 1.42 | 61 |
| 62 | .119 | .188 | .257 | .360 | .533 | .706 | .879 | 1.05 | 1.40 | 62 |
| 63 | .117 | .185 | .253 | .355 | .525 | .694 | .864 | 1.03 | 1.37 | 63 |
| 64 | .116 | .182 | .249 | .349 | .517 | .684 | .851 | 1.02 | 1.35 | 64 |
| 65 | .114 | .180 | .246 | .344 | .509 | .673 | .838 | 1.00 | 1.33 | 65 |
| 66 | .112 | .177 | .242 | .339 | .501 | .663 | .826 | .988 | 1.31 | 66 |
| 67 | .111 | .175 | .239 | .334 | .494 | .654 | .814 | .973 | 1.29 | 67 |
| 68 | .109 | .172 | .235 | .330 | .487 | .644 | .802 | .959 | 1.27 | 68 |
| 69 | .108 | .170 | .232 | .325 | .480 | .635 | .790 | .945 | 1.26 | 69 |
| 70 | .107 | .168 | .229 | .321 | .474 | .626 | .779 | .932 | 1.24 | 70 |
| | 3 | 5 | 7 | 10 | 15 | 20 | 25 | 30 | 40 | |

| Time in Seconds | VELOCITY IN FEET PER SECOND — Revolutions 50 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | Time in Seconds |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 2.69 | 3.23 | 4.30 | 5.38 | 8.07 | 10.76 | 13.44 | 16.13 | 18.82 | 40 |
| 41 | 2.63 | 3.15 | 4.20 | 5.25 | 7.87 | 10.49 | 13.11 | 15.74 | 18.36 | 41 |
| 42 | 2.56 | 3.08 | 4.10 | 5.12 | 7.68 | 10.24 | 12.80 | 15.36 | 17.92 | 42 |
| 43 | 2.50 | 3.00 | 4.00 | 5.00 | 7.50 | 10.00 | 12.50 | 15.00 | 17.50 | 43 |
| 44 | 2.45 | 2.94 | 3.91 | 4.89 | 7.33 | 9.78 | 12.22 | 14.66 | 17.11 | 44 |
| 45 | 2.39 | 2.87 | 3.83 | 4.78 | 7.17 | 9.56 | 11.95 | 14.34 | 16.73 | 45 |
| 46 | 2.34 | 2.81 | 3.74 | 4.68 | 7.02 | 9.36 | 11.69 | 14.03 | 16.36 | 46 |
| 47 | 2.29 | 2.75 | 3.66 | 4.58 | 6.87 | 9.16 | 11.44 | 13.73 | 16.02 | 47 |
| 48 | 2.24 | 2.69 | 3.59 | 4.48 | 6.72 | 8.96 | 11.20 | 13.44 | 15.68 | 48 |
| 49 | 2.20 | 2.64 | 3.51 | 4.39 | 6.59 | 8.78 | 10.97 | 13.17 | 15.36 | 49 |
| 50 | 2.15 | 2.58 | 3.44 | 4.30 | 6.45 | 8.60 | 10.76 | 12.90 | 15.05 | 50 |
| 51 | 2.11 | 2.53 | 3.38 | 4.22 | 6.33 | 8.44 | 10.54 | 12.65 | 14.76 | 51 |
| 52 | 2.07 | 2.49 | 3.31 | 4.14 | 6.21 | 8.27 | 10.34 | 12.41 | 14.48 | 52 |
| 53 | 2.03 | 2.44 | 3.25 | 4.06 | 6.09 | 8.12 | 10.15 | 12.17 | 14.20 | 53 |
| 54 | 2.00 | 2.39 | 3.19 | 3.99 | 5.98 | 7.97 | 9.96 | 11.95 | 13.94 | 54 |
| 55 | 1.96 | 2.35 | 3.13 | 3.91 | 5.87 | 7.82 | 9.78 | 11.73 | 13.69 | 55 |
| 56 | 1.93 | 2.31 | 3.08 | 3.84 | 5.76 | 7.68 | 9.60 | 11.52 | 13.44 | 56 |
| 57 | 1.89 | 2.27 | 3.02 | 3.78 | 5.66 | 7.55 | 9.43 | 11.32 | 13.21 | 57 |
| 58 | 1.86 | 2.23 | 2.97 | 3.71 | 5.56 | 7.42 | 9.27 | 11.13 | 12.98 | 58 |
| 59 | 1.83 | 2.19 | 2.92 | 3.65 | 5.47 | 7.29 | 9.12 | 10.94 | 12.76 | 59 |
| 60 | 1.80 | 2.15 | 2.87 | 3.59 | 5.38 | 7.17 | 8.96 | 10.76 | 12.55 | 60 |
| 61 | 1.77 | 2.12 | 2.82 | 3.53 | 5.29 | 7.05 | 8.82 | 10.58 | 12.34 | 61 |
| 62 | 1.74 | 2.09 | 2.78 | 3.47 | 5.21 | 6.94 | 8.67 | 10.41 | 12.14 | 62 |
| 63 | 1.71 | 2.05 | 2.74 | 3.42 | 5.12 | 6.83 | 8.54 | 10.24 | 11.95 | 63 |
| 64 | 1.69 | 2.02 | 2.69 | 3.36 | 5.04 | 6.72 | 8.40 | 10.08 | 11.76 | 64 |
| 65 | 1.66 | 1.99 | 2.65 | 3.31 | 4.97 | 6.62 | 8.27 | 9.93 | 11.58 | 65 |
| 66 | 1.64 | 1.96 | 2.61 | 3.26 | 4.89 | 6.52 | 8.15 | 9.78 | 11.41 | 66 |
| 67 | 1.61 | 1.93 | 2.57 | 3.21 | 4.82 | 6.42 | 8.03 | 9.63 | 11.24 | 67 |
| 68 | 1.58 | 1.90 | 2.53 | 3.17 | 4.75 | 6.33 | 7.91 | 9.49 | 11.07 | 68 |
| 69 | 1.56 | 1.88 | 2.50 | 3.12 | 4.68 | 6.24 | 7.79 | 9.35 | 10.91 | 69 |
| 70 | 1.54 | 1.85 | 2.46 | 3.08 | 4.61 | 6.15 | 7.68 | 9.22 | 10.76 | 70 |
| | 50 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | |

Figure 3.—Sample current-meter rating table.

the parentheses is the equation used for computing the values for V more than 2.155 feet per second.

The term within parentheses (2.155) is the velocity common to both equations.

Data do not indicate that there is any significant difference between a rod rating and a cable suspension rating when Columbus-type weights and hangers are properly used with the meter. Therefore, no suspension coefficient is indicated, and none should be used.

# Assembly and Disassembly of the Small Price Current Meter

To provide the proper care to a current meter, which is of extreme importance as pointed out earlier, each fieldman should become thoroughly acquainted with all the component parts as well as with the assembled meter. He should also be familiar with the steps outlined below, which are necessary to assemble or disassemble a meter.

## Assembly

The procedure in assembling the small Price current meters may best be followed by referring to figure 2 which shows a sectional view of a type-AA meter and the names of the parts.

1. Assemble the two vanes of the tailpiece (10).
2. Insert the tailpiece assembly, with balance weight underneath, into the yoke (8) and tighten the tailpiece set screw (7).
3. Place the bucket wheel (21) onto the bucket-wheel hub (13) with the side marked "S" upward, and with the dowel pin on the hub fitting the notch in the bucket-wheel frame. These parts are held together by means of the bucket-wheel hub nut.
4. Place the bucket-wheel assembly within the arms of the yoke (8) and pass the shaft (12) through the hole in the upper arm of the yoke. Screw the shaft directly into the bucket-wheel hub (13), then insert a pin into the hole in the shaft and use the pin to tighten the shaft in the hub.
5. Loosen the penta gear (6) in the contact chamber (2) by a single turn of the small screw that passes through the adjusting slot of the gear pad. Do not remove this screw completely as it is difficult to replace.
6. Slip the contact chamber, with the cap (1) removed, over the upper end of the shaft and into the hole in the upper limb of the yoke. This should be done with great care in order not to damage either the threaded shaft or the penta gear.
7. Aline the contact chamber with the yoke by making the centerline of the yoke bisect the angle formed by the two contact binding posts. Some meters have been provided with grooved marks on the front of the contact chamber and on top of the upper arm of the yoke; making these marks coincide insures the proper alinement.
8. Tighten the yoke set screw (7) to hold the contact chamber in place.
9. Screw the cap (1) onto the contact chamber.
10. Insert the pivot (17) through the hole in the lower arm of the yoke after placing a drop of oil in the lower bearing and on the pivot.
11. Adjust the pivot as described in table 1. This adjustment allows a vertical play of 0.008 inch, the amount of play used when the meter is rated.
12. Return the meter to an upright position, and remove the cap from the contact chamber. Adjust the penta gear to mesh properly with the threads on the shaft and tighten the small (unnumbered) screw which holds the penta gear assembly.
13. Spin the bucket wheel rapidly while

Table 1. Adjustment of pivot

| *Sequence* | *Operation* |
|---|---|
| 1..... | Make sure that the meter has been properly oiled; then hold meter in inverted position with pivot uppermost. |
| 2..... | Release keeper screw (19) for pivot adjusting nut (18) and unscrew the nut a few turns. |
| 3..... | Release set screw (7) and advance pivot until all vertical play of the hub assembly is eliminated. |
| 4..... | Tighten set screw (7) temporarily and advance pivot adjusting nut (18) until it touches the yoke. |
| 5..... | Release set screw (7) (not too far because the pivot should not revolve) and advance the pivot adjusting nut one-fourth turn. Then tighten keeper screw (19). |
| 6..... | Push the pivot inward as far as it will go and tighten set screw (7). |

watching the action of the penta gear to make sure that there is complete freedom of action between the gear and the threads on the shaft. Then apply oil to the penta gear and to the three bearing surfaces (one drop on the vertical shaft and two on the horizontal shaft that supports the gear).

14. Adjust the contact wires so that these wires touch the edge of the single and penta eccentrics very lightly. Then replace the cap on the contact chamber and listen with a headset for a sharp click.

15. Place the assembled meter on a solid surface with the shaft vertical, and make a spin test (see page 10).

### Disassembly

In general, the disassembly of small Price current meters offers no difficulties and hence it will not be described in detail. The following precautions, however, should be observed.

1. Removal of the contact chamber from the yoke should be done carefully and without exerting appreciable force, so that the penta gear and shaft will not be damaged.

2. The contact-chamber cap should never be unscrewed when the upper end of the shaft bears forcibly against its underside, a condition which exists if the bucket-wheel raising nut has been previously tightened, and if the pivot adjustment has been made so tight that there is no play between the end of the shaft and the underside of the cap.

When the bucket-raising nut has been tightened, the upper end of the shaft bears against the underside of the cap at a point that is about three-sixteenths of an inch "off center" with respect to the center of the cap. If those two parts are in contact with each other when the cap is being either tightened or loosened, a severe bending force occurs at the point where the upper end of the shaft emerges from the upper bearing. Lack of attention to this subject is a common cause for "bent shafts" on Price-type current meters.

When the bucket-wheel-and-hub assembly is raised from the pivot by means of the raising nut, the bucket wheel should always be held stationary and the raising nut should be turned by hand. The bucket wheel should never be spun with the raising nut held stationary, as this method may cause several excess turns which may result in the shaft becoming bent or the yoke becoming sprung.

## Inspection and Repair of Current Meters

To make sure that the current meter is in good condition and is properly lubricated, the operator should examine it, both before and after each discharge measurement, with regard to the details under the heading immediately following. Because all meter parts are manufactured to be interchangeable without affecting the calibration of the meter, replacement of any of the component parts can be made in the field.

### Rotor and shaft alinement

By spinning the bucket wheel slowly and then watching the metal frame to which the cups are fastened, eccentricity in the bucket-wheel-and-hub assembly may be readily detected. If eccentricity is observed while making this test, either the wheel or shaft is bent, and further tests should be made to find the source of the eccentricity. The cap should be removed and the movement of the shaft inside the contact chamber should be observed. If, while the bucket wheel is rotating, any eccentricity in the movement of the top of the shaft is observed, the shaft should be removed from the assembly and should be further tested by observing its performance while rolling it on a clean flat surface. Any meter found to have a bent shaft should be repaired by replacing that shaft with a new one. If eccentricity is not found in the shaft, it may be present in the bucket wheel. Should the fault lie there, the rotor should be replaced with a new one.

### Sprung yoke

The yoke may become sprung so that the distance between the upper and lower arms is too small or too great to permit proper adjustment of the rotor assembly within this space. It may also be distorted so that the coaxial holes will no longer properly aline the rotor assembly and the pivot. If either of these conditions is suspected, the alinement and spacing should be checked with a special yoke alinement gage that is available from the Property Maintenance Section, Silver Spring, Md.

In addition to the above, the stem of the yoke (that part from the slot for the hanger to the end onto which the tailpiece fits) occasionally becomes bent. A bent stem causes the bucket wheel to assume a position that is out of proper alinement with the flow lines of the water. If the amount of distortion in the yoke is minor and can be properly straightened, this should be done; if not, the yoke should be replaced with a new one.

## Damaged cups

The bucket wheel and cups on it have more influence on the meter rating than has any other component. Cups should therefore be examined closely as any small distortion will cause a change in rating. Only for the most minor dents where the cups can be straightened to "like new" condition should repairs be attempted; otherwise the bucket wheel should be replaced with a new one.

## Damaged tailpiece

The tailpiece should be examined for damage. It may be straightened if the damage is not too serious; otherwise it should be replaced with a new one.

## Contact chamber

The contact chamber should be examined for proper meshing of the penta gear with the acme thread on the shaft and for proper adjustment of the contact wires. Proper adjustment of these parts should be maintained at all times. It should also be inspected for excessive wear of the upper bearing. Any missing or damaged parts such as screws, chamber caps, or binding posts should be replaced. Should the need arise, the entire contact chamber may be replaced with a new one.

## Pivot and bearings

The pivot should be examined with a magnifying glass to see whether the point is fractured, rough, or warn flat at the apex. The point of a new pivot is rounded to a radius of approximately 0.005 inch; wear resulting in a radius greater than 0.010 inch is excessive. If any of these conditions exist, the pivot should be replaced with a new one.

To examine the pivot bearing conveniently, the contact chamber should be removed carefully and the bucket-wheel-and-hub assembly should be tilted to one side so that the lower arm of the yoke will not obstruct examination. The pivot bearing should then be examined for possible fracture, pits, or roughness. If any of the above are found, the entire hub assembly should be replaced with one containing a new pivot bearing.

No current meter should be packed or transported with the pivot bearing resting on the pivot. The pivot and pivot bearing should always be separated by the raising nut.

## Lubrication

All bearing surfaces should be inspected to see that they have a thin coating of instrument oil. The small Price current meter has bearing surfaces above the bucket wheel in addition to the pivot bearing. These consist of (1) the bearing surfaces between the penta gear and the acme threads on the shaft, (2) the cylindrical bearing of the small shaft of the penta gear, (3) the cylindrial bearing of the shaft within the bearing lug, and (4) the thrust bearing between the shaft and the cap.

## Spin tests

The spin test is an easy method of determining the condition of the bearings of a current meter. In making this test, the meter should be placed so that the shaft is in a vertical position and the bucket wheel is protected from air currents. The bucket wheel is then given a quick turn by hand to start it spinning, the duration of which is timed with a stopwatch. As the rotating bucket nears the stopping point, its motion should be carefully observed to see whether the stop is abrupt or gradual. Regardless of the duration of the spin, if the bucket wheel comes to an abrupt stop, the cause of such behavior should be found and corrected before the meter is used. In such instances, a lack of oil, the maladjustment of the penta gear, and a misalinement of the yoke are possible sources of trouble that should receive early attention.

The normal spin for a small type-AA Price should be approximately 4 minutes and should under no circumstances be less than 1½ minutes. Large variations in the duration of the spin test will be introduced by slight varations from the vertical position of the shaft. Some operators accordingly provide themselves with a small circular level vial that can be placed on the cap of the meter to help them make such a test with the shaft alined in a truly vertical position.

Another common test to determine the condition of the bearing of a current meter is to hold the meter so that the shaft is in a vertical position and while keeping the shaft in as nearly a fixed position as possible, to revolve the yoke and tailpiece in a horizontal plane around it. If the bucket wheel remains in a fixed position, it is an indication that the bearings are satisfactory, whereas if the bucket wheel tends to revolve with the yoke and tailpiece, it is an indication that the meter requires attention.

## Routine Cleaning and Oiling of Current Meters

At the end of each day's use, the current meter should be thoroughly cleaned and oiled. The pivot and pivot bearing need special attention; unlike all other parts of the meter they are subject to rusting and, therefore, it is desirable that they be dried before they are oiled.

The outline below gives a step-by-step procedure for the cleaning and oiling of current meters.

Equipment:

1. Screwdrivers of proper size for use on set screws in the yoke and on the pivot-adjusting nut.
2. Large soft cloth that will readily absorb water for wiping the outer surfaces of the meter.
3. Cotton-tipped swabs for cleaning the bearing surfaces.
4. Supply of oil (instrument oil that is available from the Property Maintenance Section is recommended) in a container with facilities that permit a drop of oil to be applied in places that otherwise are difficult to reach.

Dismantle the current meter as follows:

1. Release the raising nut.
2. Release the two set screws in the yoke, holding the contact chamber and the pivot in place with forefinger and thumb.
3. Remove the contact chamber from the yoke slowly and carefully. Do not remove the cap at this time.
4. Remove the pivot from the yoke.

Clean the parts as follows:

1. Pivot bearing.
   a. Clean and dry the air pocket and the pivot bearing, using a cotton-tipped swab.
   b. Inspect the pivot bearing.
2. Pivot hole in the yoke.
   Swab the pivot hole in the yoke with a cotton-tipped swab.
3. Shaft.
   Clean and dry the shaft—particularly the acme threads.
4. Pivot.
   Wipe the pivot until it is thoroughly dry.
5. Contact chamber.
   a. Remove the cap and shake out any water that may be trapped within the contact chamber. Occasionally, clean the chamber thoroughly by allowing hot water to flow into it under pressure. A jet of water such as that issuing from a hot-water tap is recommended. Hoppe's powder solvent has been used successfully to remove gummed oil if cleaning with hot water is not successful.
   b. Wipe the interior of the stem of the contact chamber.
   c. Swab the hole in the bearing lug by means of a cotton-tipped swab inserted through the stem of the contact chamber. Cleaning the hole in the bearing lug from the top frequently causes the contact wires to bend and eventually break, whereas cleaning it from the bottom neither bends the wires nor affects their adjustment.

Oil as follows:

1. Shaft.
   Apply a film of oil to (a) the acme threads (liberally, so that the excess oil will later spread over the penta gear and the penta shaft), (b) the area that enters the bearing lug, and (c) the uppermost end of the shaft.
2. Pivot bearing.
   Apply a thin film of oil over all exposed parts of the pivot bearing.
3. Pivot hole in yoke.
   Apply a drop of oil to the sides of the hole through which the pivot passes.
4. Pivot.
   Apply a thin film of oil to the pivot.

Reassemble as follows:

1. Replace the pivot and tighten the set screw that holds it in place. Make sure that the pivot lock nut bears against the yoke, and that the set screw bears against the flattened part of the pivot.

2. Fit the contact chamber over the end of [illegible] the yoke. Do this slowly and carefully without applying much force, otherwise the penta gear or shaft may become damaged.

3. Match the marks on the contact chamber and yoke, and tighten the set screw holding the contact chamber in place.

4. Check the contact wires. The adjustment of both the single- and penta-contact wires should be examined to be sure that the adjustments are as light as possible without impairing the electrical contact.

5. Replace the cap on contact chamber.

6. Move the bucket-wheel-and-hub assembly up and down to determine whether the pivot adjustment is correct.

7. Check the operation of the current meter with a spin test.

8. Unless the current meter is to be used immediately, raise the pivot bearing off the pivot by means of the bucket-raising nut.

## Low-Velocity Price Meter

The low-velocity meter differs from the general purpose Price meter in that the penta gear is removed and the single eccentric is replaced by a double eccentric which makes two electrical contacts for each revolution of the bucket wheel. These meters are produced by the same dies and fixtures used in the manufacture of the general purpose meter. Consequently, they also have a single standard rating, and any parts may be replaced without the necessity of calibration. The duration of the normal spin should be 4½–5 minutes, and it should never be less than 2½ minutes.

In all respects other than those pointed out above the two types of meters are identical and all of the preceding paragraphs apply to the low-velocity meter.

## Pygmy Current Meters

The Geological Survey designed the first of its pygmy current meters (see fig. 1) in 1936. The pygmy current meter is of the Price type in that it contains a cup-type bucket wheel mounted on a vertical shaft having bearings that operate in air pockets. The bucket wheel is 2 inches in diameter (two-fifths the size of that in the small Price current meter). The pygmy meter is designed particularly for the measurement of discharges of those streams that are so shallow that the small Price current meter fails to perform accurately, but which have too great a flow to be measured conveniently by either volumetric means or with small weirs.

The pygmy meter differs from the type-AA small Price current meter in respects other than size (see fig. 4). The contact chamber is an integral part of the yoke [illegible] contains a single-revolution contact only. The meter has no tailpiece nor has it any provision for suspension from a cable. There is no bucket-wheel raising nut on the pygmy meter, but a small brass plug is provided to replace the pivot when the meter is stored or transported.

The bucket wheel revolves about 2¼ times as fast as that of the small Price current meter. This relatively high speed, combined with the fact that no multiple-contact arrangement is provided, limits its use to conditions where the revolutions are counted aurally to velocities not exceeding 3 feet per second.

The Survey's pygmy current meters are constructed so that the bucket-wheel-and-hub assembly may be removed from the yoke as a unit for convenience in cleaning and oiling. Instructions for removing and replacing such assemblies follow:

To remove the bucket-wheel-and-hub assembly from the yoke:

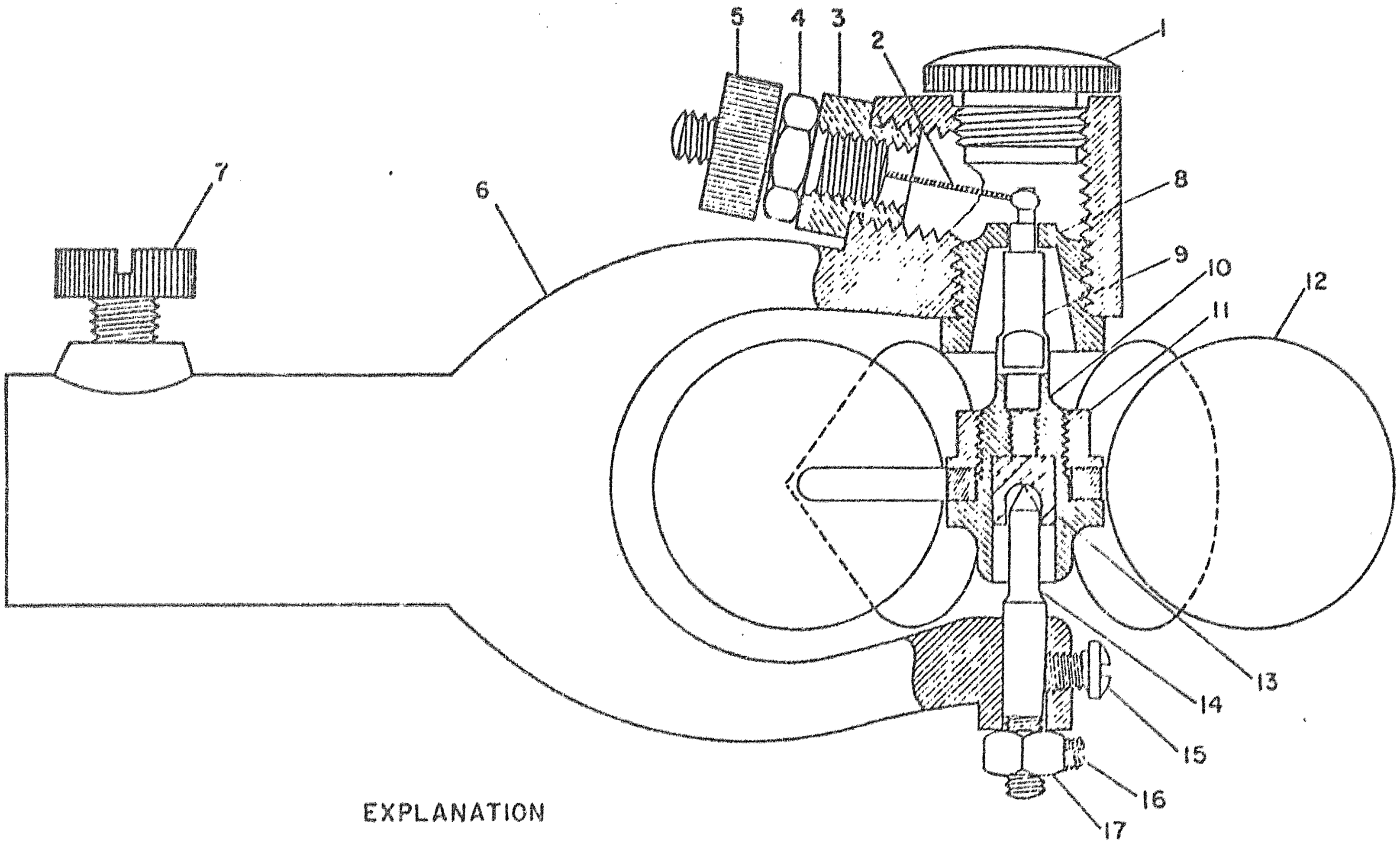
1. Remove the cap.

2. Release the set screw holding the pivot in the yoke.

3. Remove the pivot.

4. Tighten the set screw into the yoke (otherwise, it may offer difficulties in removing the bucket wheel).

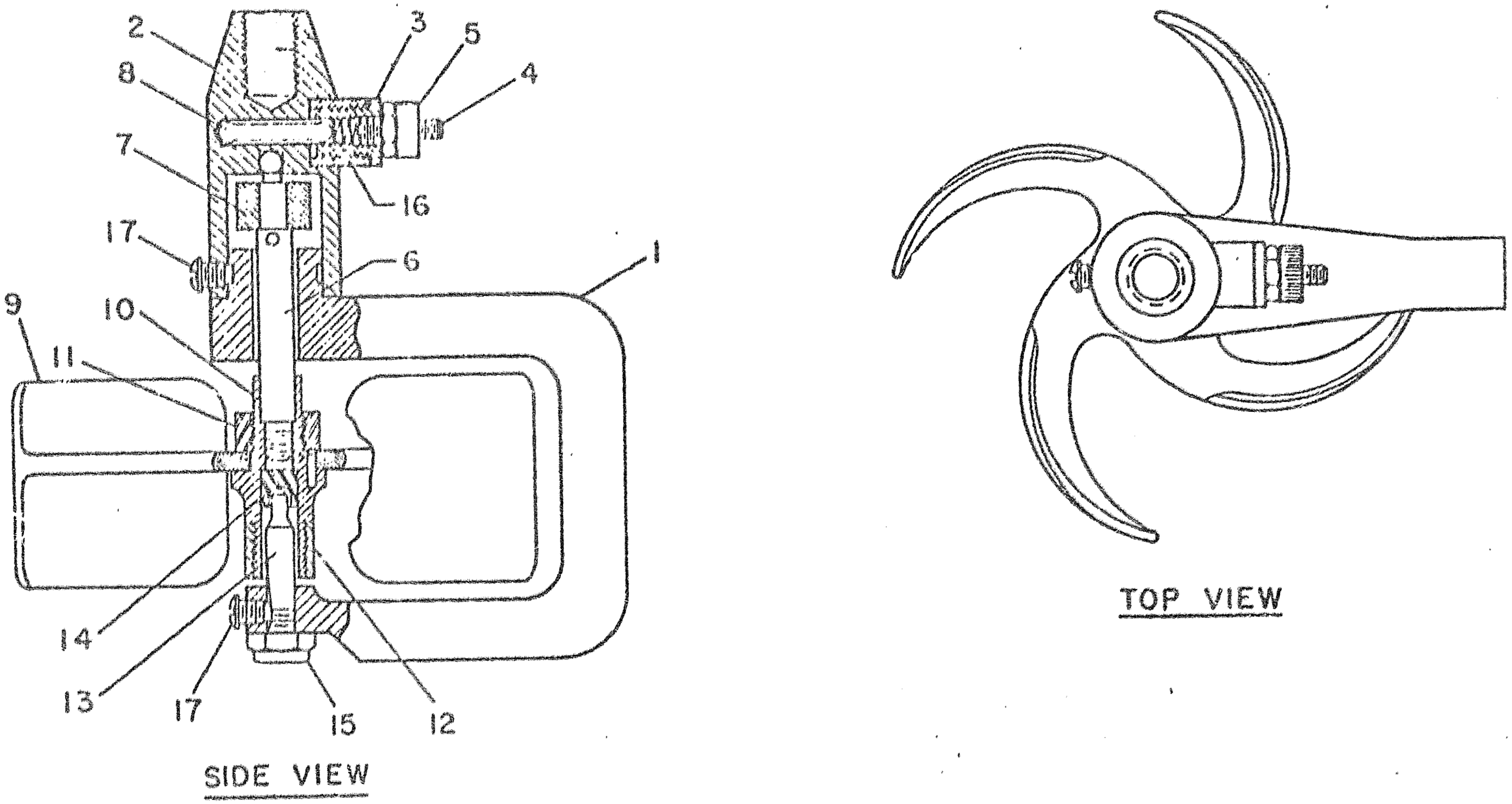
5. Lower the bucket wheel to the lowest position in the yoke and carefully slide it forward and outward. If it is found that the bucket-wheel-and-hub assembly does not come out freely, return it to its original position and rotate it one-sixth of a turn. Repeat this operation until successful. Never apply force in removing the bucket-wheel-and hub assembly because the shaft and eccentric may become bent.




EXPLANATION

1. Cap for contact chamber
2. Binding-post beaded wire
3. Binding-post insulating bushing
4. Binding-post body
5. Binding-post nut
6. Yoke
7. Yoke set screw
8. Upper bearing
9. Shaft
10. Bucket-wheel hub
11. Bucket-wheel hub nut
12. Bucket wheel
13. Pivot bearing
14. Pivot
15. Pivot set screw
16. Pivot-adjusting nut keeper screw
17. Pivot-adjusting nut

Figure 4.—Assembly diagram of pygmy current meter.




EXPLANATION

1. Yoke
2. Contact chamber
3. Binding-post insulating bushing
4. Binding post
5. Binding-post nut
6. Shaft
7. Magnet
8. Glass switch
9. Vane
10. Vane hub
11. Vane hub nut
12. Raising nut
13. Pivot
14. Pivot bearing
15. Pivot-adjusting nut
16. Compression-spring assembly
17. Set screw

Figure 5.—Assembly diagram of ice meter.

To insert the bucket-wheel-and-hub assembly into the yoke:

1. With the pivot removed, set screw tightened, cap removed, and yoke and shaft held upside down, direct the upper end of the shaft into the hole of the upper bearing, and carefully adjust the bucket wheel into position within the arms of the yoke. Do not apply force. If the bucket wheel cannot be placed within the yoke without forcing, remove it, turn it one-sixth of a revolution, and repeat until successful.
2. Unscrew the set screw to a position that will permit the pivot to be inserted.
3. Insert the pivot.
4. Tighten the set screw and turn the yoke right side up.
5. Replace the cap.

Investigations have shown that there are very slight differences in the rotors of pygmy meters that prevent a standardized rating. Because the rotors are not identical, they cannot be replaced in the field. Meters are calibrated individually and each is supplied with its own rating table. A pygmy current meter which has been damaged should be returned to the Property Maintenance Section for repair and recalibration. The duration of the normal spin should be approximately 1½ minutes and should never be less than half a minute.

## Ice Meters

Ice meters (see fig. 1) are also the vertical-axis type but differ from the Price in that the rotor used consists of four curved vanes. Other differences may also be seen in figure 5, which illustrates the assembly diagram of the ice meter. They are:

1. There is no rear extension of the yoke. The meter is supported by a section of special wading rod that screws into the top of the contact chamber. The object of this arrangement is to reduce the size of the ice hole required for inserting the meter.
2. The upper bearing is a small sphere instead of a sleeve.
3. The electrical contact is a magnetically actuated glass-sealed switch. There are two contact closures for each revolution of the rotor, one each time the poles of the magnet are alined with the leaves of the switch.

Assembly or disassembly of the ice meter offers no special problems except that the magnet is very brittle and must be handled with care, as all parts should be. Care and lubrication should be of the same type described for the Price meter.

Investigations have shown that there are very slight differences in the rotors of ice meters that prevent a standardized rating. Because the rotors are not identical, they cannot be replaced in the field. Meters are calibrated individually and each is supplied with its own rating table. An ice meter which has been damaged should be returned to the Property Maintenance Section for repair and recalibration. The duration of the normal spin should be approximately 5 minutes and should never be less than 2 minutes.

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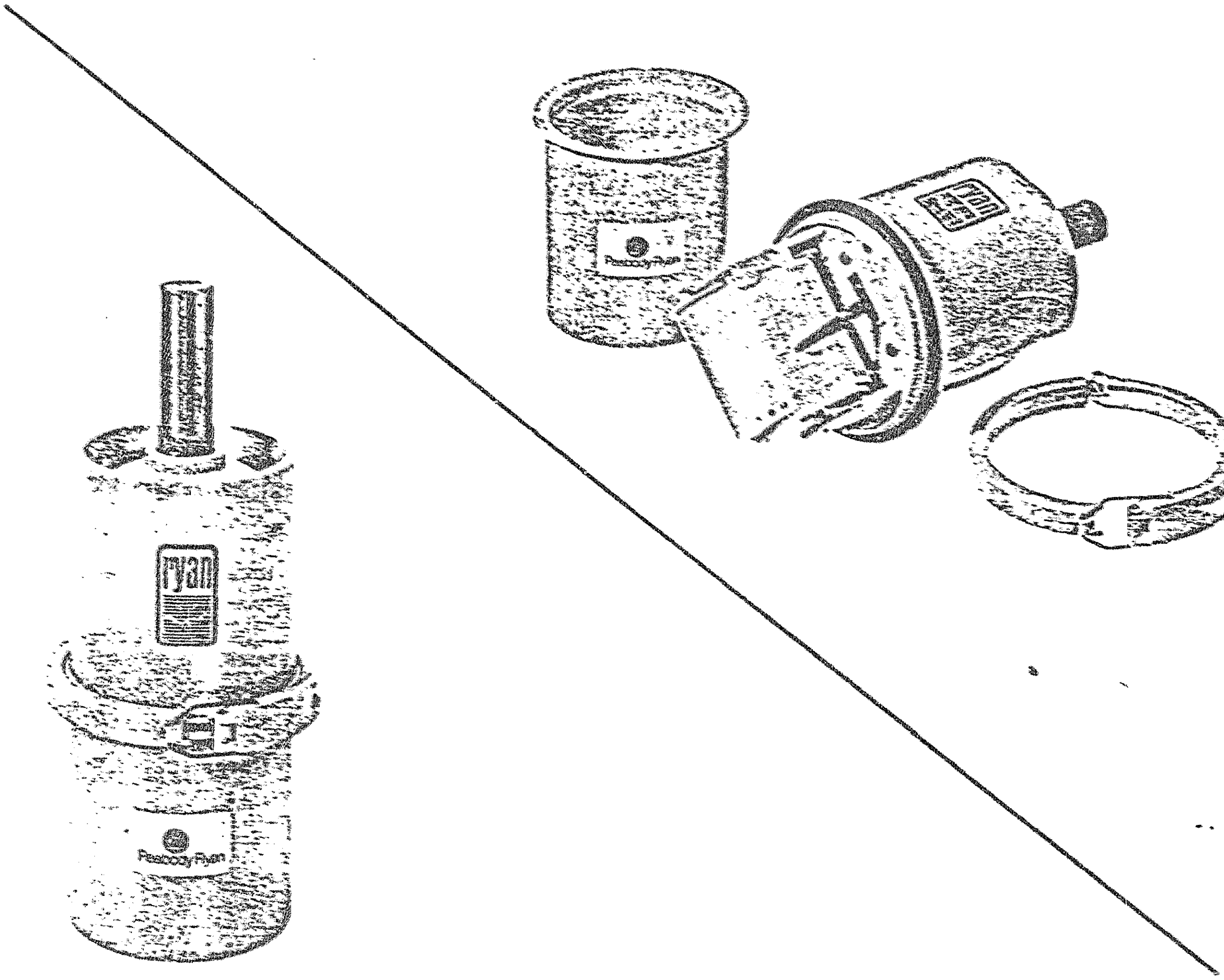



# OPERATING INSTRUCTIONS
## for
# MODEL "J" THERMOGRAPH

**IMPORTANT: READ CAREFULLY**

# TEMPERATURE CONVERSION TABLE

| C° | F° | C° | F° |
|---|---|---|---|
| -5 | 23.0 | 21 | 69.8 |
| -4 | 24.8 | 22 | 71.6 |
| -3 | 26.6 | 23 | 73.4 |
| -2 | 28.4 | 24 | 75.2 |
| -1 | 30.2 | 25 | 77.0 |
| 0 | 32.0 | 26 | 78.8 |
| 1 | 33.8 | 27 | 80.6 |
| 2 | 35.6 | 28 | 82.4 |
| 3 | 37.4 | 29 | 84.2 |
| 4 | 39.2 | 30 | 86.0 |
| 5 | 41.0 | 31 | 87.8 |
| 6 | 42.8 | 32 | 89.6 |
| 7 | 44.6 | 33 | 91.4 |
| 8 | 46.4 | 34 | 93.2 |
| 9 | 48.2 | 35 | 95.0 |
| 10 | 50.0 | 36 | 96.8 |
| 11 | 51.8 | 37 | 98.6 |
| 12 | 53.6 | 38 | 100.4 |
| 13 | 55.4 | 39 | 102.2 |
| 14 | 57.2 | 40 | 104.0 |
| 15 | 59.0 | 41 | 105.8 |
| 16 | 60.8 | 42 | 107.6 |
| 17 | 62.6 | 43 | 109.4 |
| 18 | 64.4 | 44 | 111.2 |
| 19 | 66.2 | 45 | 113.0 |
| 20 | 68.0 | | |

# PLEASE READ CAREFULLY
# BEFORE HANDLING THE INSTRUMENT

Peabody Ryan has been the leading manufacturer of portable thermographs for more than 55 years. Our instruments have proven ideal for unattended, long-term monitoring of ambient air or water temperatures.

The Model "J" is a new generation of portable thermographs. It has not only the fast response of the Ryan Model "F" and "H", but has the timing of the quartz movement. The chart size has been enlarged for easier reading and interpretation and a new type of chart advance has been added to allow longer periods, up to 180 days, unattended. Provisions for unloading and loading during field use have been incorporated into the design.

Ryan thermographs are engineered and built to be as rugged as possible. But, please remember they are precision instruments. Improper handling can damage the sensitive clockworks and mechanical linkage.

These thermographs should always be treated as you would any laboratory instrument. If you follow these instructions thoroughly, and take reasonable care in handling and using the instrument, it will operate reliably and accurately.

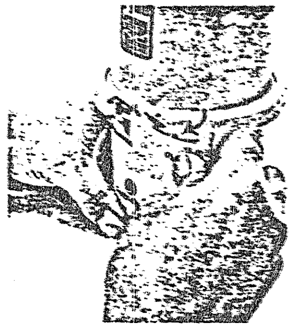
# ENGINEERING DATA

| | |
|---|---|
| Models | J-180 (six months) J-90 (three months) |
| Movement | Quartz timing mechanism |
| Power | One 1-1/2 volt "C" cell battery (included) |
| Chart Advance | Sprocket drive |
| Sensor | Fast response probe: Hi-expansion, liquid filled system operating a bellows mechanism. Time constant: 75 sec. (2/3 span in 75 sec, full span in less than 8 mins.) |
| Chart | Pressure sensitive strip chart perforated to accommodate sprocket drive 2 inches wide, 24 feet long with lineal day span length. |
| Calibration | Chart is 30°C span (86°F) 1°C div |
| Range | 5 ranges: −5° to +25°C, 0 to +30°C, +5° to +35°C, +10° to +40°C, +15° to +45°C |
| Accuracy | Temp ±2% or .6°C<br>Time ±.2% or 3 min / day |
| Weight | 2.5 lbs. |
| Dimensions | Largest diameter: 4.875 in.<br>Tank length: 8.25 in.<br>Sensor extension: 2.90 in. |
| Enclosure | Heavy cross-section polycarbonate thermo plastic, international yellow |
| Maximum depth of use | 500 ft. |
| Accessory items | 1 additional clamp<br>1 additional "0" ring<br>1 additional chart transport with chart |

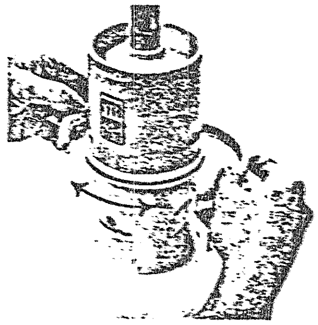
U.S. Patent 3,487,691
Other Patents Pending

# HOW TO OPEN

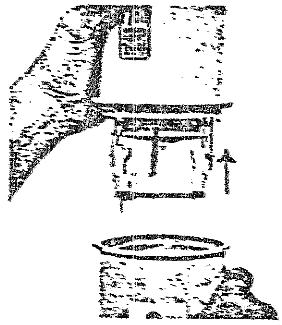
**Please note the hinged coupling around the middle of the instrument. The purpose of this coupling is to maintain the water tight integrity of the unit. (See picture on cover.)**



1 Grip latch of coupling firmly with one hand and the unit with the other. Pull latch in an outward motion allowing it to pivot. The draw wire will then disconnect from the other side of the coupling.



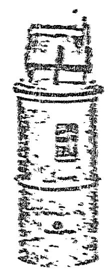
2 Spread coupling and remove from unit. Set aside for reuse in sealing the unit.



3 With one hand, grip the bottom half of the unit and with the other hand grip the top half (cover) of the unit.

4 With an easy pulling motion, separate the two halves.

IMPORTANT NOTE: DO NOT TRY TO REMOVE THE TANK HALF FROM AROUND THE SENSOR UNIT.

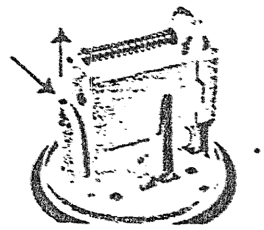


5 Set the lower half on a level surface with opening up. Then turn the other half upside down (sensor pointing down) and set inside the other half with sensor down inside.

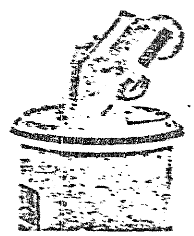
# REMOVING CARTRIDGE FROM UNIT

**This unit has a removable cartridge for easier loading and unloading. The chart has approximately 22 ft. of usable length, if used continuously: a rate of 1-1/2" per day on the 180 day unit and 3" per day on the 90 day unit. The charts are pre-rolled on a core to make loading easier.**

1 With the pen assembly facing you, find the locking screw on the left side of the instrument. Unscrew this screw until the end of it clears the top of the shaft.



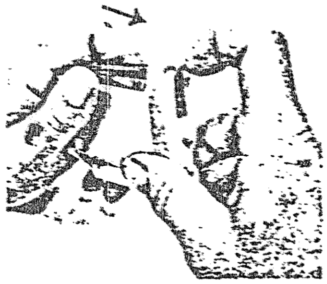
2 Grip instrument firmly with one hand and with other rotate cartridge from the top holding grooves.



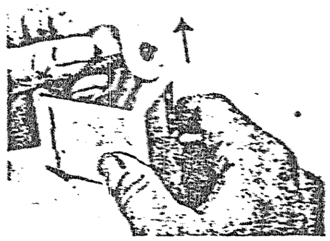
3 Firmly pull the cartridge from the bottom holding grooves in an outward motion at approximately the same angle as the grooves.

# INSTALLING CHART INTO CARTRIDGE

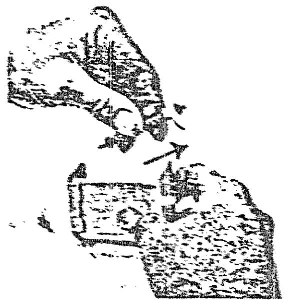
1 Holding the cartridge firmly in one hand, release the core shaft retaining clip. This can be done with a slight pulling motion with the finger nail.



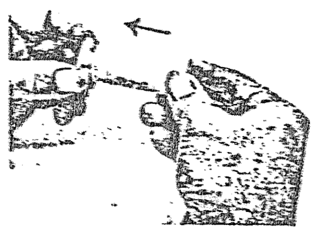
2 Lift the shaft assembly from the groove in an upward motion until the gear clears the edge of the cartridge.



3 Shaft assembly should then pull away from cartridge with ease. Set cartridge aside.

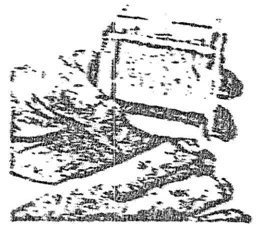


4 With the shaft assembly in one hand, pick up a pre-rolled chart. Insert the shaft assembly into the spool core. Line up lugs on gear with grooves in chart core. Seat firmly against gear.



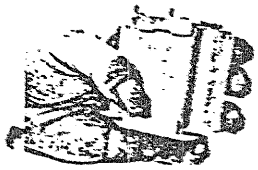
NOTE: MAKE SURE THE SPROCKET HOLES IN THE CHART ARE ON THE OPPOSITE SIDE OF THE WHITE GEAR.

5 Insert small shaft end into the cartridge, then slip flatted shaft end into groove until retaining clip locks shaft in place.

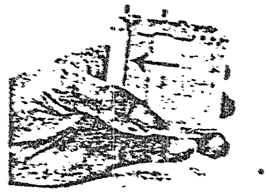


# THREADING AND ATTACHING CHART

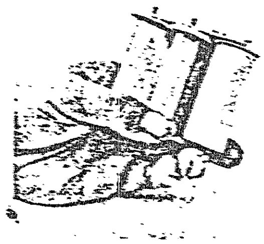
1 Remove the tape from the end of chart. Hold chart firmly so that it will roll, but not unravel.



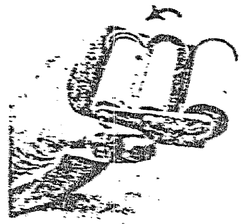
2 Thread chart across platten (under the guides) around the drive sprocket and under the take-up spool.



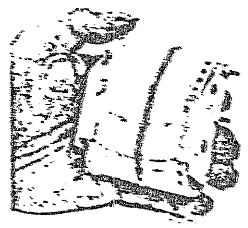
3 Attach the end of the chart (gray backing side up) to the take-up spool with a piece of tape.



4 Rotate the take-up spool one or two turns. Maintain a light pressure on the chart roll. This will eliminate buckling or bulging of the chart.



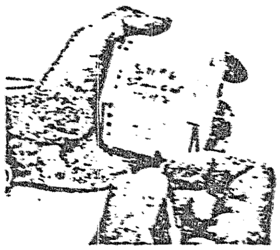
**NOTE: IF CARTRIDGE IS NOT TO BE USED IMMEDIATELY, WRAP A LIGHT RUBBER BAND AROUND CARTRIDGE TO KEEP THE CHART FROM UNROLLING.**



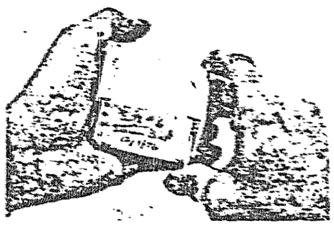
The unit comes with an extra cartridge so preloading of the chart can be done in the lab and the cartridge used later at the site location.

# LOADING CARTRIDGE INTO UNIT

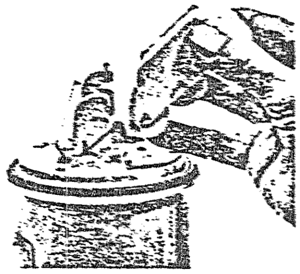
## NOTE: IF RUBBER BAND WAS USED, REMOVE IT.



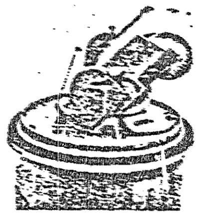
**Before loading the cartridge into the unit, reference data may be placed on the chart. Place cartridge on a flat, dry surface and write data across chart using the flat part of the cartridge as a writing surface.**



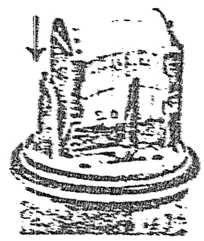
1 Before loading cartridge, rotate take-up spool until the top of the reference data is at the edge of the flat portion of the cartridge.



2 Gripping cartridge and instrument firmly, with flat side of cartridge facing the penpoint. slide the shaft ends into the bottom holding grooves. Push firmly until they are well seated.

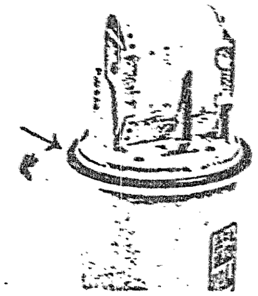


3 Rotate cartridge so the other set of shaft ends slide into top holding grooves. Make sure they are well seated.



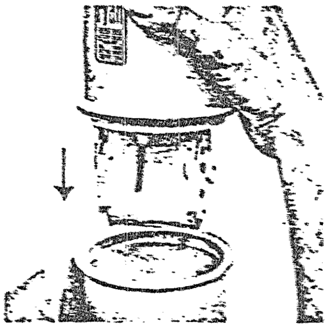
4 With your screw driver, reset the locking screw.

# CLOSING AND SEALING UNIT

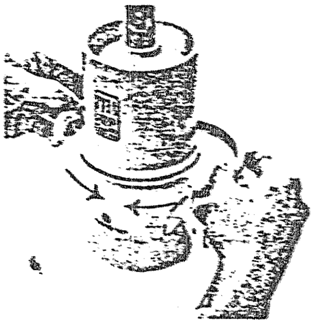


1 Check "0" ring to be sure it is clean.

Use vasaline on the "O" ring!

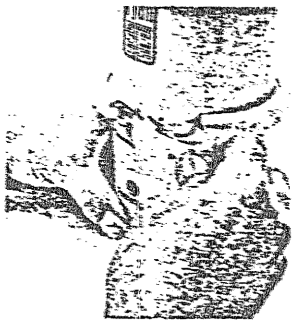


2 With one hand holding the bottom half, pick up the other half (with sensor and chart transport). Reverse it so the sensor is pointing up. carefully insert the chart transport into the opening of the other half.

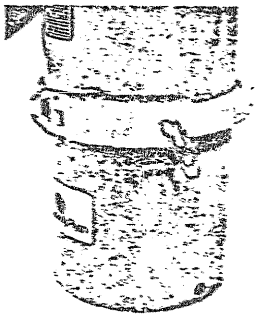


3 Make sure two tank halves are seated evenly over the "0" ring.

4 Pick up clamp and place it around the flanges in the center of the tank. Make sure the flanges are inside the clamp groove all the way around.

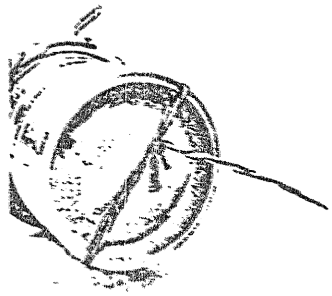


5 Holding the clamp firmly around unit with one hand, attach the draw wire over the hook on the opposite clamp half. Pivot the clamp latch toward the instrument. (If excessive force is required, check to see if the "0" ring is seated on the flanges and if the clamp is seated over the tank flanges.)



6 When the clamp is secured, there is a post on the clamp with a hole in it protruding through the hole in the latch. Insert a paperclip or small piece of wire into the hole in the post and bend it over so that it will not fall out. This will prevent the latch from coming undone while the unit is in use.

# INSTALLING YOUR INSTRUMENT

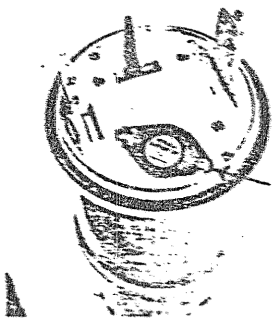


**Because of the air trapped inside the sealed container, it may have a tendency to float.**

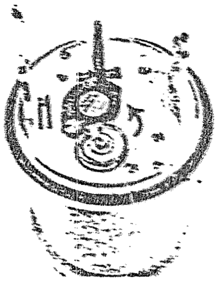
When the instrument is installed at the site location, it should be anchored securely to some object that will not readily move. This can be done by looping a cord or wire through the holes in the outside of either end of the instrument and then securing the cord or wire to the object.

# CHANGING THE BATTERY

**To change the battery, first remove the chart transport assembly according to the instructions.**



**1** With a flat tip screw driver, loosen the slotted screw.



**2** Pivot the cover plate, exposing the battery.

**3** Turn the instrument upside down and the battery will fall out.

**4** Replace with a new battery, size C, 1-1/2 volts. (Recommend use of Eveready Alkaline Powercell.) Make sure ( + ) is pointing up.

Push battery down slightly and pivot cover plate back into position. Tighten slotted head screw and replace transport assembly.

There is a sticker on the cover plate indicating when the battery should be replaced. An Eveready Alkaline Powercell should give at least 12 months of continual use.

# REMOVING USED CHART

**Follow the same procedure from "How to Open" through "Removing Cartridge from unit".**

**If the chart was allowed to run the full length:**

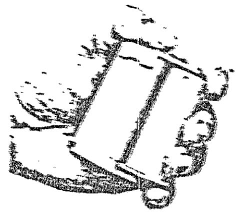
1 Take the loose end (should have a piece of tape already on it) and re-attach it to the spool core.

2 Rewind it and follow 1 through 3 of "Installing Chart into Cartridge".

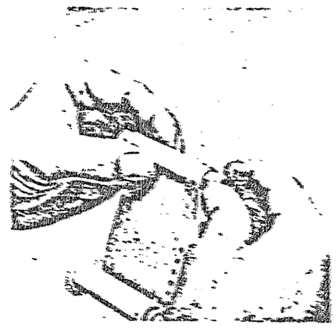
3 Remove used chart and reload with new chart.

**If the chart has run for only a portion of the length:**

1 With a sharp object, cut the chart along the edge of the platten. Hold Chart Spools so it will not unroll.



2 Stick a small piece of tape on the end of the chart.



3 Using a cylindrical object, attach the loose end of the used chart with a piece of tape and unroll the chart from the take-up spool onto the cylinder.

4 From here, follow procedure outlined in "Threading and Attaching Chart".

# REPAIR AND MAINTENANCE

If the unit does not work properly, or is damaged, return to:

Ryan Instruments, Inc.
402 6th St. South,
Kirkland, WA 98033

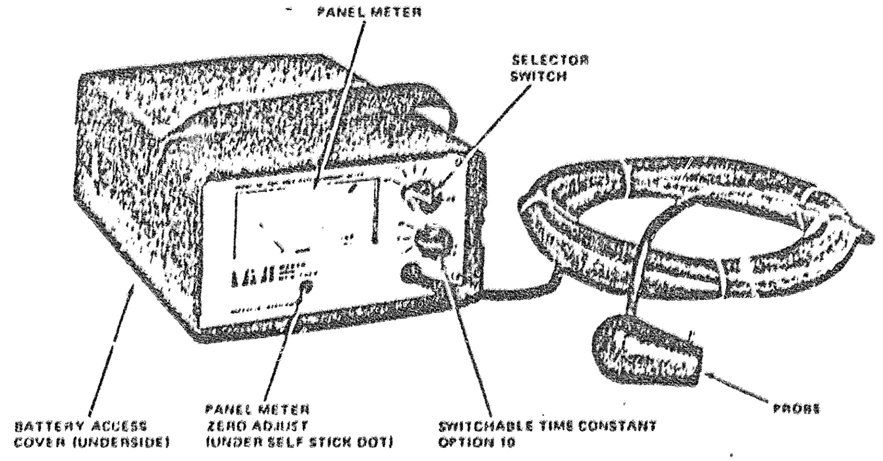
Any questions concerning the operation of the instrument, phone: (206) 827-9572.

After each use, and BEFORE the instrument is opened, clean off all grit or other matter, and wipe the case and clamp completely dry.

NOTE: THE AIR THAT WAS TRAPPED INSIDE THE SEALED INSTRUMENT MAY HAVE A TENDENCY TO CONDENSATE AND CAUSE SMALL AMOUNTS OF MOISTURE. EACH TIME THE UNIT IS OPENED, WIPE DRY THE INSIDE OF THE TANK AND AS MANY OF THE OTHER PARTS AS POSSIBLE. MAKE EVERY EFFORT TO KEEP THE INSIDE OF THE INSTRUMENT AS CLEAN AND DRY AS POSSIBLE.

The large "0" ring on these instruments may be used dry, but should be cleaned each time the unit is opened. The flanges of the tank should be cleaned before reseating the "0" Ring.

The small probe port "0" ring on the Model J was installed at the factory and not accessible for close examination. Lightly clean grit and other matter off the ring area so it will not nick the ring and possibly cause leaking. Do not use a lot of force, as it might cause the seal to be broken.




## GENERAL DESCRIPTION

The Marsh-McBirney Model 201 Portable Water Current Meter is a general purpose instrument, designed for maximum versatility in both laboratory and field applications. The instrument consists of (1) a transducer probe with cable, and (2) a signal processor housed in a portable case.

The instrument senses water velocity in one direction and presents this velocity reading directly in feet per second on a panel meter.

The instrument is powered by six standard D size cells contained in a battery compartment in the instrument case. Access to this compartment is through a cover plate on the bottom of the case.

The case is approximately 7 inches wide by 4 inches high by 10 inches deep. The standard length of the cable attached to the transducer probe is 20 feet.

## RANGE OF MEASUREMENT

The instrument will measure flow velocities up to 10 feet per second. The panel meter has three full scale ranges: 2.5, 5, and 10 feet per second, any of which can be selected by a rotary switch on the front panel.

## ACCURACY

The overall accuracy of the instrument is based upon three factors:

1. Long term zero drift which is less than ±0.07 ft./sec.
2. Linearity of response which is ±2% of reading.
3. Absolute calibration which is ±2% of reading.

### Long Term Zero Drift

The Model 201 incorporates features which reduce long term zero drift to less than ±0.07 feet per second. This effect is separate and distinct from the slight motion of the panel meter which is due to electronic noise.

### Linearity of Response

The reading can deviate from an exactly linear response to increasing water flow due to minor variations in flow streamlines at increasing velocity. This factor is small enough to guarantee that the reading is within 2% of nominal over the velocity range of the instrument.

### Absolute Calibration

Calibration of all MMI water current meters is traceable to a calibration facility where the flow is known to within ±1%.

# SECTION 2
# OPERATING INSTRUCTIONS

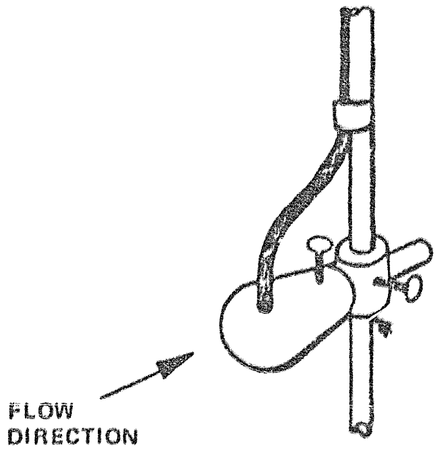
## UNPACKING AND PRELIMINARY SETUP

1. Carefully remove the instrument from the shipping carton.

2. Remove the battery compartment cover (bottom side of instrument) and insert six D size cells according to the polarity indicated in each battery slot. If the probe connector option is included, plug the probe connector into the mating connector on the front panel.

3. Set the selector switch to the CAL position. The meter should indicate in the CALibrate sector of the scale. This indicates the batteries are good and the instrument is operating properly. Insert new batteries if the meter fails to register in the CAL sector. If the meter still fails to register correctly, contact the factory.

4. Place the probe in a non-metallic (plastic) bucket filled with water, and rotate the selector switch to the 2.5 ft./sec. setting. Move the probe gently in the bucket, and

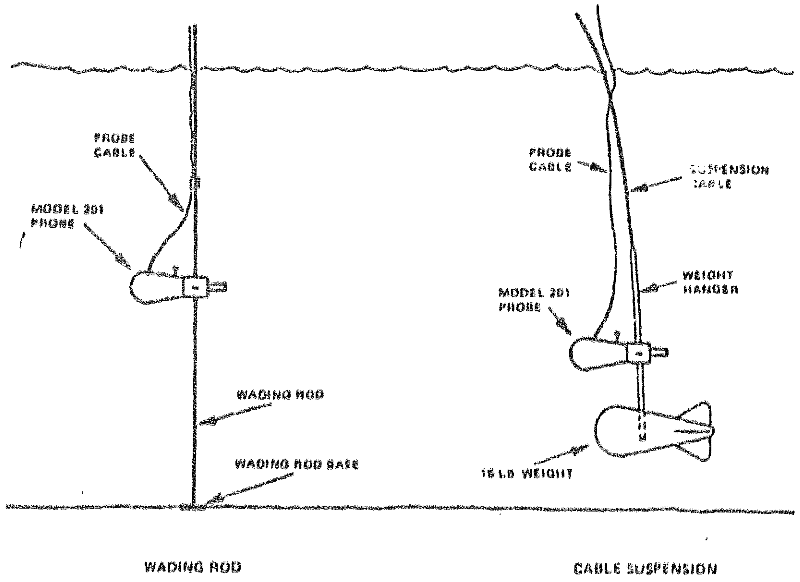



PROBE ORIENTATION TO FLOW DIRECTION

the meter should respond to the motion by indicating the velocity of the probe. Remember that the instrument has a filter which will cause the meter output to lag behind the actual velocity of the probe when it is oscillated.

This filter time constant can be changed if required; contact the factory for details. If the instrument reading appears erratic, see Section 5.

5. Mount the probe in either a wading rod or cable suspension configuration as shown. The meter is now ready for making measurements. Remember to wait at least 20 seconds after positioning the probe before reading the panel meter.




MOUNTING CONFIGURATIONS

## EXTERNAL CONTROLS AND CONNECTIONS

The photograph on page 1 shows the external features of the Model 201 Portable Water Current Meter. The following items are called out in the figure.

1. Panel Meter.
2. Selector Switch – selects meter function.
   a. OFF – turns entire unit off.
   b. CAL – checks both the meter circuits and the batteries.
   c. 2.5, 5, 10 – selects meter full scale range.
3. Battery cover location.
4. Panel Meter Zero Adjust.
5. Probe.

# SECTION 3
# THEORY OF OPERATION

The Model 201 consists of a sensor probe with attached cable and an electronic processor with a panel meter readout. The probe consists of an electromagnet inside a molded plastic housing and a pair of electrodes spaced 180° apart on the sensor surface. Water flowing around the sensor probe interacts with the electromagnetic field to produce a small voltage in the water near the probe which is sensed by the electrodes. This extremely small voltage is amplified, demodulated, filtered, and displayed on the panel meter as shown in the block diagram on page 13.

## SECTION 4
## CIRCUIT DESCRIPTION

This instrument is a sophisticated measuring device consisting entirely of solid state circuitry. The circuits which are used have been designed in a straight-forward manner for ease in troubleshooting. These circuits can be divided into the following major areas.

1. Digital Processor and Magnet Driver.
2. Amplifier and Detector.
3. Calibrate Circuit.

The block diagram provided on page 13 depicts the signal paths through the instrument.

### DIGITAL PROCESSOR AND MAGNET DRIVER

The digital processor generates signals used in the magnet driver, calibrate circuit, sample and hold circuit, and phase sensitive demodulator. The digital processor consists of an integrated circuit oscillator and digital decoders to generate a 50-50 duty cycle square wave at 30 Hz. This signal drives a power amplifier which controls the electrical current flowing in the electromagnet contained in the probe.

### AMPLIFIER AND DETECTOR

This circuit first amplifies the flow-induced voltage (approximately 6 microvolts per foot per second) which is present at the electrodes mounted on the probe surface. Then it samples this signal, amplifies the sampled signal, and synchronously detects and filters the signal to provide an output which drives the panel meter.

### CALIBRATE CIRCUIT

A resistor in series with the magnet leads generates a voltage proportional to magnet current. This voltage is then reduced by a resistor divider to a level comparable to the flow voltage. When the front panel switch is in the CAL position, this voltage is injected into the unit before the sample gate, testing most of the circuitry. Proper operation is indicated by the meter remaining within the CAL region.

### EXTERNAL FEATURES

The Model 201 contains the following front panel features:

1. Selector Switch –
   a. Provides a sensitivity control for the panel meters.
   b. Allows the user to verify that the unit is still in calibration.
   c. Provides a check on the condition of the batteries.
2. Meter – The panel meter has three scales which are selectable by the panel switch. This switch changes the resistor in series with the panel meter.

### POWER SUPPLY

The standard operating voltages of the instrument are plus and minus 4.5 volts DC provided by six D size batteries. The batteries can operate the instrument for over 100 hours continuously. Normal battery drainage is approximately $\pm$40 ma at $\pm$4.5 volts.

# SECTION 5
# MAINTENANCE

## PERIODIC MAINTENANCE

Routine maintenance of this instrument is confined simply to cleaning of the probe with a mild soap and water to keep the electrodes free of non-conductive grease and oils. The meter face, switch knob, and front panel can also be cleaned with soap and water. Do not use any hydrocarbon solvents on the meter face or probe as these may damage the surface.

To check the meter zero, place the probe in the center of a non-metallic (plastic) container of fresh water, wait 30 minutes to insure that the water is stationary, and then proceed as follows:

1. Set the Selector Switch to the 2.5 ft./sec full scale position.

2. Note the meter reading. If less than 0.1 ft./sec., zero is satisfactory.

Routinely check the condition of the batteries by setting the front panel Selector Switch to the CAL position and noting that the meter indicates in the CAL section of the scale. If the meter does not indicate properly, replace the batteries as instructed on page 3, step 2.

## TROUBLESHOOTING

### Initial Operation

Initial operation of the instrument may require familiarity with its characteristics. The following notes may assist the first time user.

1. Symptom: Noisy or erratic zero while held stationary in a small container of water.

Cause: Using the probe in a confined space is an artificial environment. Holding the probe near the side of the container exaggerates the anomaly by interfering with the free field magnetic and electrical fields. This is especially true if the container is electrically conductive and made of ferrous material.

Remedy:

a. Use the largest water container available.

b. Use only a nonconductive, non-magnetic container.

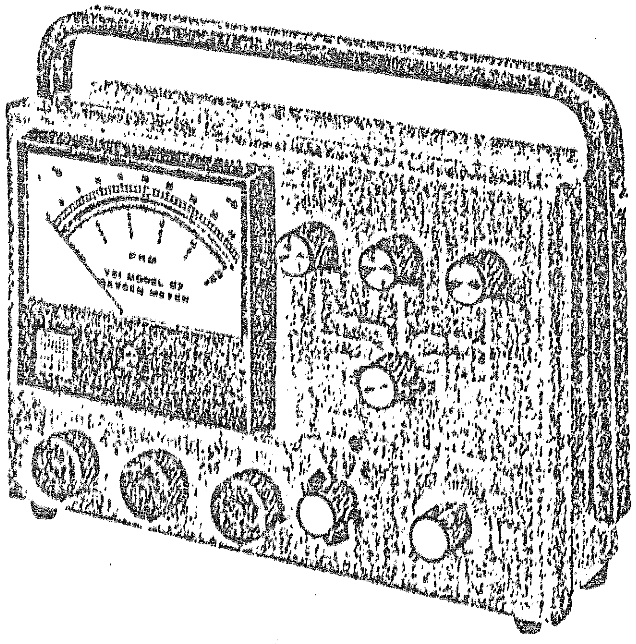
c. Hold the probe away from any container walls.

2. Symptom: Noisy or erratic zero when probe is initially immersed in water, which improves after several minutes for no apparent reason.

Cause: The electrode material requires immersion for a short length of time to become completely wetted. This problem may also appear momentarily when testing between water samples of sharply different conductivities, such as between fresh and salt water.

Remedy: Immerse probe for several minutes in the water to be used before taking readings. This problem is normally only noted with new probes, but could occur if a probe is completely dry from lack of use. Washing the probe with a mild soap and warm water will aid in removing any nonconductive films. It is permissible to lightly wet sand the electrodes with 600 grit sandpaper if washing does not reduce the noise level.

# INSTRUCTION MANUAL
# YSI MODEL 57
# DISSOLVED OXYGEN METER







Scientific Division
Yellow Springs Instrument Co., Yellow Springs, Ohio 45387

## SUMMARY OF OPERATING INSTRUCTIONS

1. CALIBRATION
   A. Switch instrument to OFF and adjust meter mechanical zero.
   B. Switch to RED LINE and adjust.
   C. Prepare probe for operation, plug into instrument, wait up to 15 minutes for probe to stabilize. Probe can be located in calibration chamber (see instruction manual) or ambient air.
   D. Switch to ZERO and adjust.
   E. Adjust SALINITY knob to FRESH.
   F. Switch to TEMP and read.
   G. Use probe temperature and true local atmospheric pressure (or feet above sea level) to determine correct calibration values from Table I and II. (See pages 13 and 14).

      EXAMPLE: Probe temp = 21°C, Altitude = 1000 ft. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the altitude factor for 1000 ft. is about .96. The correct calibration value is:

      9.0 PPM X .96 factor = 8.64 PPM
   H. Switch to desired dissolved oxygen range 0-5, 0-10, or 0-20 and with calibrate control adjust meter to correct calibration value determined in Step G.

      NOTE: It is desirable to calibrate probe in a high humidity environment. See instruction manual for more detail on calibration and other instrument and probe characteristics.

2. MEASUREMENT
   A. Adjust the SALINITY knob to the salinity of the sample.
   B. Place the probe and stirrer in the sample and switch the STIRRER control to ON.
   C. When the meter has stabilized switch to the appropriate range and read D.O.
   D. We recommend the instrument be left on between measurements to avoid necessity for repolarizing the probe.

3. GENERAL CARE
   A. Replace the instrument batteries when unable to adjust to red line. Use (2) Eveready No. 935 "C" size or equivalent.
   B. In the BATT CHECK position the voltage of the stirrer batteries is displayed on the red 0-10 scale. Do not discharge below 6.0 Volts. Recharge for 14-16 hrs. with YSI No. 5728 charger.
   C. Membranes will last indefinitely, depending on usage. Average replacement is 2-4 weeks. Probe should be stored in humid environment to prevent drying out.
   D. Calibrate daily.

## TABLE OF CONTENTS

## GENERAL DESCRIPTION

The YSI Model 57 Dissolved Oxygen Meter is intended for dissolved oxygen and temperature measurement in water and wastewater applications, but is also suitable for use in certain other liquids. Dissolved Oxygen is indicated in PPM (parts per million) on 0-5, 0-10, and 0-20 PPM scales. Temperature is indicated in °C on a -5° to +45°C scale. The dissolved oxygen ranges are automatically temperature compensated for solubility of oxygen in water and permeability of the probe membrane, and manually salinity compensated.

The probes use Clark-type membrane covered polarographic sensors with built in thermistors for temperature measurement and compensation. A thin, permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows oxygen and certain other gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

## SPECIFICATIONS

I. Instrument

**Oxygen Measurement**

Ranges: 0-5, 0-10, and 0-20 PPM (0-2.5, 0-5 and 0-10 PPM with YSI 5776 High Sensitivity Membrane)

Accuracy: ±1% of full scale at calibration temperature (±0.1 PPM on 0-10 scale), or 0.1 PPM (whichever is larger).

Readability: .025 PPM on 0-5 scale; .05 PPM on 0-10 scale; 0.1 PPM on 0-20 scale.

**Temperature Measurement**

Range: -5° to +45°C

Accuracy: ±0.5°C plus probe which is ±0.1°C

Readability: 0.25°C

**Temperature Compensation**

±1% of D.O. reading for measurements made within ±5°C of calibration temperature.

±3% of D.O. reading over entire range of -5 to +45°C probe temperature.

**System Response Time**

Typical response for temperature and D.O. readings is 90% in 10 seconds at a constant temperature of 30°C with YSI 5775 Membranes. D.O.

**Operating Temperature Range**

Instrument and probe operating range is -5° to +45°C. Large ambient temperature changes will result in 2% loss of accuracy unless Red Line and Zero are reset.

**Recorder Output**

0 to 114-136 mV. Recorder should have 50,000 ohms minimum input impedance.

**Power Supply**

The YSI Model 57 is powered by two disposable "C" size carbon zinc batteries (Eveready 935C or equal) providing approximately 1000 hour operation.

II. Probe

Cathode: Gold
Anode: Silver
Membrane: .001" FEP Teflon
(.0005" FEP Teflon available)
Electrolyte: Half saturated KCl
Temperature Compensation: (See SPECIFICATIONS, I. Instrument)
Pressure Compensation: Effective 1/2% of reading with pressures to 100 psi (230 ft. sea water)
Polarizing Voltage: 0.8 volts nominal
Probe Current: Air at 30°C = 19 microamps nominal
Nitrogen at 30°C = .15 microamps or less

III. Accessories and Replacement Parts

YSI 5720 — Self Stirring BOD Bottle Probe
YSI 5750 — Non Stirring BOD Bottle Probe
YSI 5739 — Oxygen Temperature Probe for field use. Combine with one of the following 4 cables for desired lead length:
Detachable leads for use with YSI 5739:

| | |
|---|---|
| YSI 5740- 10 | 10' Cable |
| YSI 5740- 25 | 25' Cable |
| YSI 5740- 50 | 50' Cable |
| YSI 5740-100 | 100' Cable |
| YSI 5740-150 | 150' Cable |
| YSI 5740-200 | 200' Cable |

YSI 5721 — Battery and charger pack operates YSI 5791 and 5795 Submersible Stirrers.
YSI 5791 — Submersible Stirrer for field use.
YSI 5795 — Submersible Stirrer.
YSI 5075 — Calibration Chamber for use with field probe.
YSI 5988 — Carrying Case.
YSI 5775 — Membrane and KCl Kit, Standard — includes 2 each 15-membrane packets (.001" thick standard membranes) and a 30 ml bottle KCl with

YSI 5945 — "O" Ring Pack — includes (6) "O" rings for each YSI DO Probe.
YSI 5486 — Beater Boot Kit — includes (6) A-05486 Boot, (1) A-05484 Tip, (4) A-05485 Spring. Used only on 5720 and discontinued 5420A.
YSI 5986 — Diaphragm Kit for use only with YSI 5739 D.O. Probe.
YSI 5734 — Adaptor makes is possible to use discontinued YSI 5400 Series Probes with YSI Model 57.
YSI 5735 — Adaptor makes it possible to use YSI 5739, YSI 5720 and YSI 5750 Probes with discontinued YSI Models 51A, 54RC and 54BP.

## OXYGEN PROBES AND EQUIPMENT

There are three oxygen probes for use with the YSI Model 57 Dissolved Oxygen Meters. Descriptions of where they are used are contained in the following paragraphs.

### I. YSI 5739 D.O. Probe

The YSI 5739 probe, with built-in lead weight and pressure compensation, is an improved design that replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1)

For user convenience the probe is equipped with a disconnecting cable to facilitate changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is *not* designed for casual disconnection and should only be disconnected when necessary.

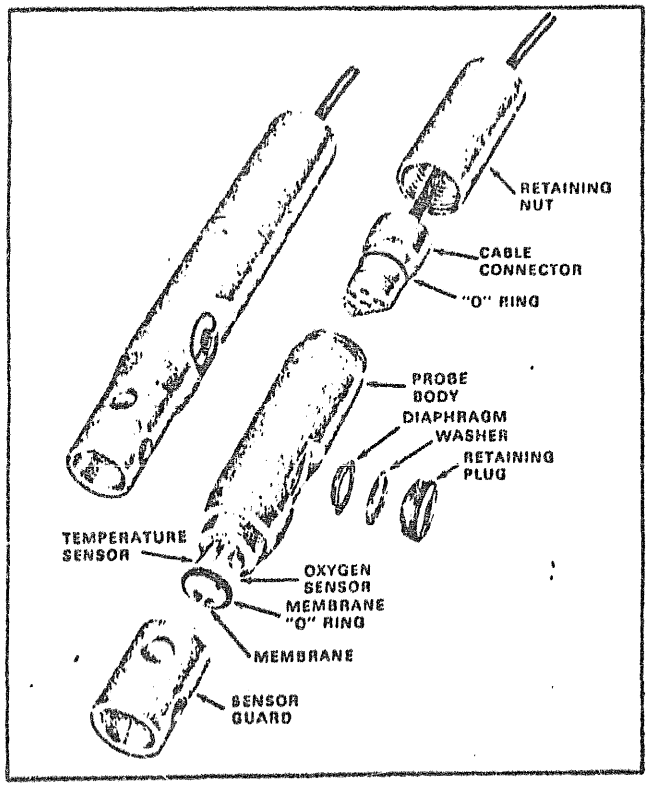



FIGURE 1

To disconnect the cable unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reasssembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, *hand tight only.* NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present, dry out and reconnect, replacing the "O" ring, if necessary.

#### Pressure Compensation

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. (See OPERATING PROCEDURES.) The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

### II. YSI 5720 B.O.D. Bottle Probe

The YSI 5720 B.O.D. Bottle Probe replaces the discontinued YSI 5420A B.O.D. Bottle Probe for measuring dissolved oxygen and temperature in standard B.O.D. bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50-60 Hz) or 230VAC (200-250VAC, 50-60 Hz) operation. (See Figure 2)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B.O.D. bottle and switch agitator "ON" with switch on top of probe. The probe should be operated with a minimum of trapped air in the B.O.D. bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

#### Stirrer Boot

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases,

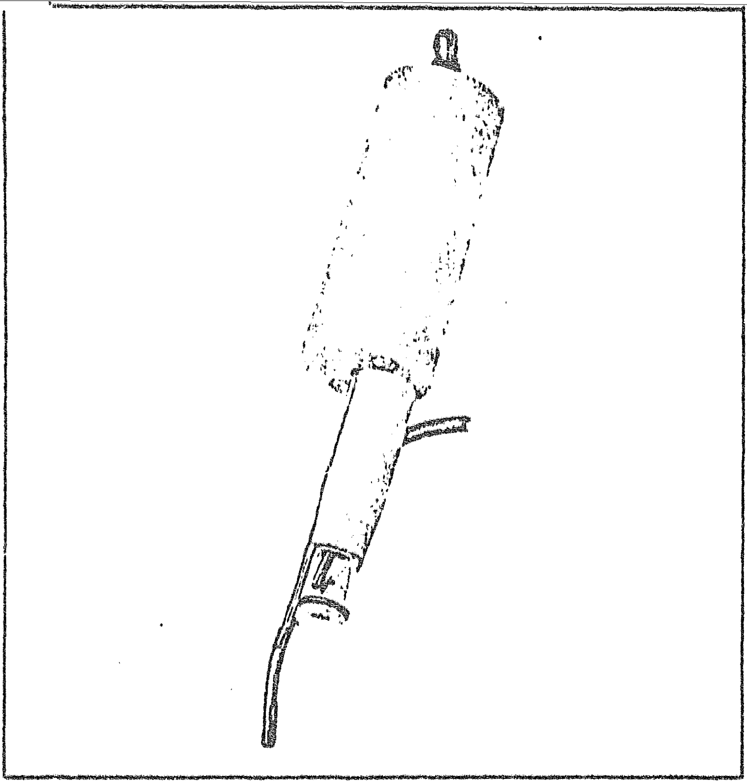


FIGURE 2

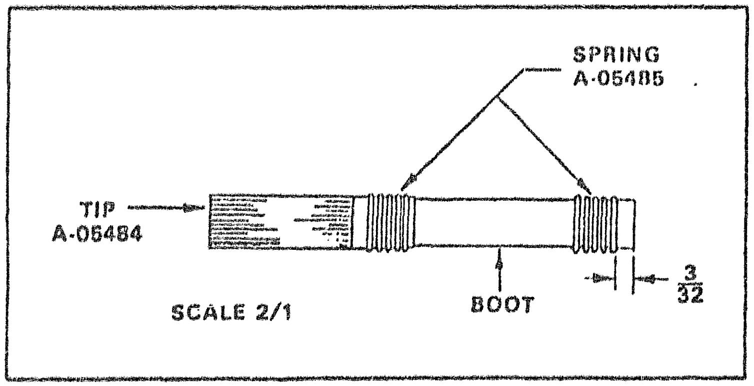



FIGURE 3

ozone, or direct sunlight. For maximum life rinse the boot after use in contaminated samples. (See Figure 3)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

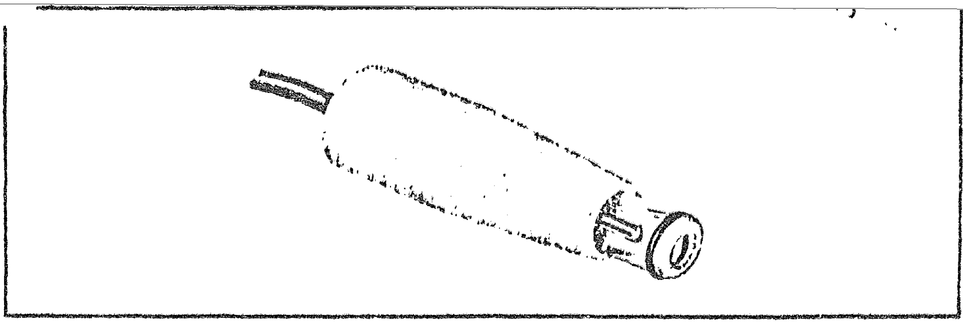


FIGURE 4

### III. YSI 5750 B.O.D. Bottle Probe

The YSI 5750 B.O.D. Bottle Probe replaces the discontinued YSI 5450 B.O.D. Bottle Probe. It is similar to the YSI 5720 B.O.D. Bottle Probe, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 4)

### IV. Cable Adaptors

All YSI 5700 Series Probes are designed for direct use with the YSI Model 57 Dissolved Oxygen Meter. However, to use the discontinued YSI 5400 Series Probes with the YSI Model 57, cable adaptor YSI 5734 is required. (See Figure 5)

### V. YSI 5791 and 5795 Submersible Stirrers

The YSI submersible stirrers are accessories that perform the function of stirring the sample being studied when making dissolved oxygen measurements in the field. The YSI 5791 stirrer can be used with the following dissolved oxygen probes: YSI 5418, 5419, 5718, 5719, and 5739. The YSI 5795 stirrer is only for use with the YSI 5739 Probe. (See Figure 6)

When a stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor. (See sales literature and instruction sheets for further information).

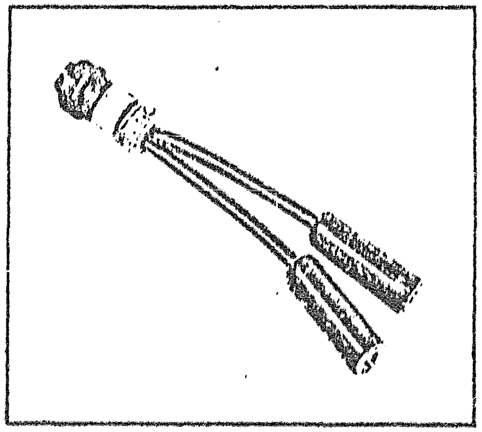


FIGURE 5

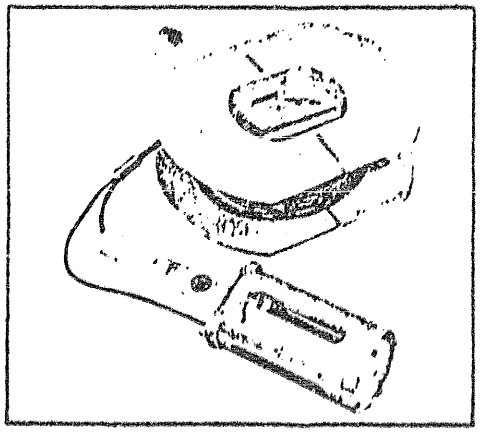


FIGURE 6

VI. YSI 5721 Battery Pack and Charger

The YSI 5721 Battery Pack and Charger is offered as an accessory to operate either the YSI 5791 or 5795 Submersible Stirrer when the stirrer is used in conjunction with the YSI Model 57 Oxygen Meter. The YSI 5721 can be purchased with the YSI Model 57 or installed at a later time. (See sales literature and instruction sheet for further information).

## OPERATING PROCEDURES

I. Preparing the Probe

All YSI 5700 Series Probes have similar sensors and should be cared for in the same manner. They are precision devices relying on good treatment if high accuracy measurements are to be made. Prepare the probes as follows. (See Figure 7)

ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the "O" ring and membrane. Thoroughly rinse the sensor with KCl solution.
3. Fill the probe with electrolyte as follows:
   - A. Grasp the probe in your left hand. When preparing the YSI 5739 probe the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720 and 5750 probes, simply fill the sensor body until no more air bubbles appear.
   - B. Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode. NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
   - C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
   - D. Using a continuous motion *stretch* the membrane *UP, OVER,* and *DOWN* the other side of the sensor. Stretching forms the membrane to the contour of the probe.
   - E. Secure the end of the membrane under the forefinger of the hand holding the probe.
   - F. Roll the "O" ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the "O" ring.
   - G. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess KCl and reinstall the sensor guard.
5. A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720 and 5750 probes can be stored in a B.O.D. bottle

KCL solution & membranes in slit in foam or in wood cabinet in bin

6. Membranes will last indefinitely, depending on usage. Average repl .nent is 2-4 weeks. However, should the electrolyte be allowed to evaporate and an excessive amount of bubbles form under the membrane, or the membrane become damaged, thoroughly flush the reservoir with KCl and install a new membrane.
7. Also replace the membrane if erratic readings are observed or calibration is not stable.
8. "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
9. The gold cathode should always be bright and untarnished. To clean, wipe with a clean lint-free cloth or hard paper. NEVER USE ANY FORM OF ABRASIVE OR CHEMICAL. Rinse the sensor several times with KCl, refill, and install a new membrane.
10. Some gases contaminate the sensor, evidenced by discoloration of the gold. If the tarnish cannot be removed by vigorous wiping with a soft cloth, lab wipe, or hard paper, return the probe to the factory for service.
11. $H_2S$, $SO_2$, Halogens, Neon, and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause.
12. If the probe has been operated for extended periods with a loose or wrinkled membrane the gold cathode may become plated with silver. In this event return the probe to the factory for refinishing.

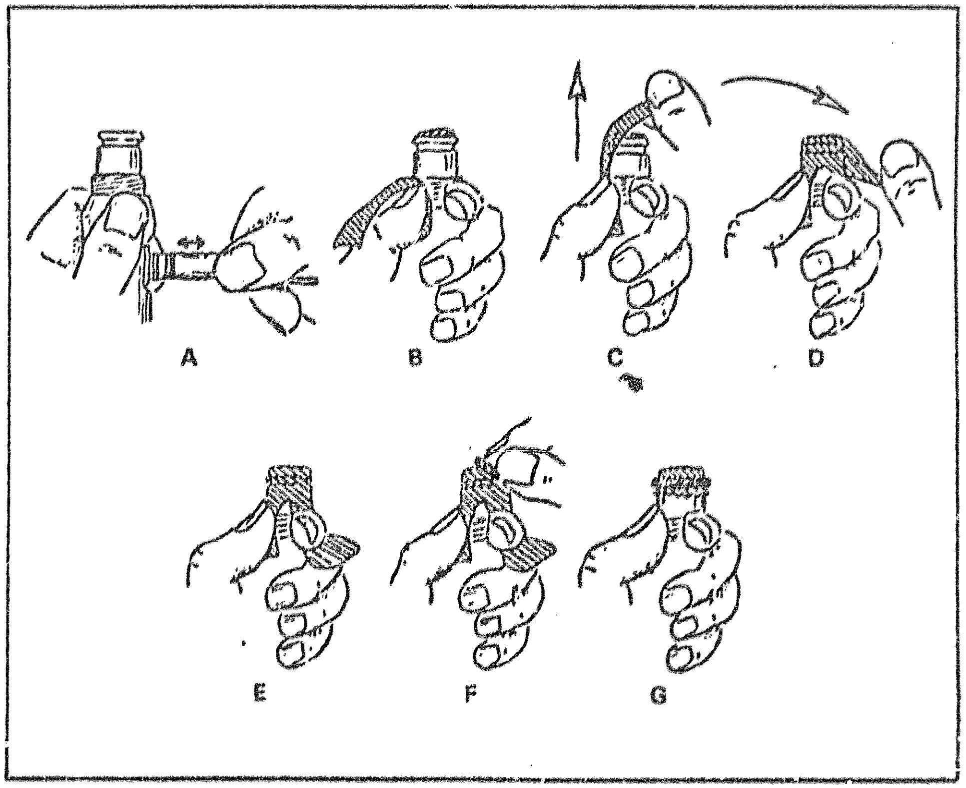



FIGURE 7

## II. Preparing the Instrument

It is important that the instrument be placed in the intended operating position vertical, tilted, or on its back — before it is prepared for use and calibrated. (See Figure 8). Readjustment may be necessary when the instrument operating position is changed. After preparing the probe proceed as follows:

1. With switch in the OFF position, adjust the meter pointer to Zero with the screw in the center of the meter panel. Readjustment may be necessary if the instrument position is changed.
2. Switch to RED LINE and adjust the RED LINE knob until the meter needle aligns with the red mark at the 31°C position.
3. Switch to ZERO and adjust to zero with zero control knob.
4. Attach the prepared probe to the PROBE connector of the instrument and adjust the retaining ring finger tight.
5. Before calibrating allow 15 minutes for optimum probe stabilization. Repolarize whenever the instrument has been OFF or the probe has been disconnected.

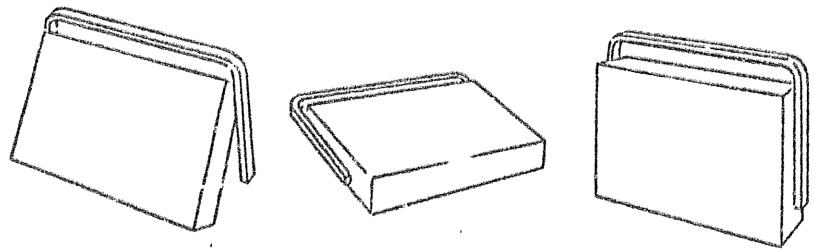


FIGURE 8

## III. Calibration

The operator has a choice of three calibration methods — Winkler Titration, Saturated Water, and Air. Experience has shown that air calibration is quite reliable, yet far simpler than the other two methods. The three methods are described in the following paragraphs.

### Winkler Titration

1. Draw a volume of water from a common source and carefully divide into four samples. Determine the oxygen in three samples using the Winkler Titration technique and average the three values. If one of the values differs from the other 2 by more than 0.5 ppm, discard that value and average the remaining two.
2. Place the probe in the fourth sample and stir.
3. Set the SALINITY control to zero or the appropriate salinity value of the sample.
4. Switch to desired PPM range and adjust the CALIBRATION control to the average value determined in Step 1. Allow the probe to remain in the sample for at least two minutes before setting the calibration value, and leave in the sample for an additional 2 minutes to verify stability. Readjust if necessary.

### Saturated Water

1. Air saturate a volume of water (300-500cc) by aerating or stirring for at least 15 minutes at a relatively constant temperature.
2. Place the probe in the sample and stir. Switch to TEMPERATURE. Refer to Table I for the PPM value corresponding to the temperature.
3. Determine local altitude or the "true" atmospheric pressure (note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level). Using Table II determine the correct factor for your pressure or altitude.
4. Multiply the PPM value from Table I by the correction factor from Table II to determine the corrected calibration value for your conditions.
   EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the correction factor for 1000 feet is about 0.96. The corrected calibration value is 9.0 PPM X 0.96 = 8.6 PPM
5. Switch to an appropriate PPM range, set the SALINITY knob to zero, and adjust the CALIBRATE knob while stirring until the meter reads the corrected calibration value from Step 4. Leave the probe in the sample for two minutes to verify calibration stability. Readjust if necessary.

### Air Calibration

1. Place the probe in moist air. BOD probes can be placed in partially filled (50 mL) BOD bottles. Other probes can be placed in the YSI 5075 Calibration Chamber (refer to the following section describing calibration chamber) or the small storage bottle (the one with the hole in the bottom) along with a few drops of water. The probe can also be wrapped loosely in a damp cloth taking care the cloth does not touch the membrane. Wait approximately 10 minutes for temperature stabilization.
2. Switch to TEMPERATURE and read. Refer to Table I — Solubility of Oxygen in Fresh Water, and determine calibration value.
3. Determine altitude or atmospheric correction factor from Table II.
4. Multiply the calibration value from Table I by the correction factor from Table II.
   EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the correction factor for 1000 ft. is about 0.96. Therefore, the corrected calibration value is 9.0 PPM X 0.96 = 8.6 PPM.
5. Switch to the appropriate PPM range, set the SALINITY knob to zero and adjust the CALIBRATE knob until the meter reads the correct calibration value from Step 4. Wait two minutes to verify calibration stability. Readjust if necessary.

The probe is now calibrated and should hold this calibration value for many measurements. Calibration can be disturbed by physical shock, touching the membrane, or drying out of the electrolyte. Check calibration after each series of measurements and in time you will develop a realistic schedule for recalibration. For best results when not in use, follow the storage procedures recommended for the various probes described under OXYGEN PROBES AND EQUIPMENT. This will reduce drying out and the need to change membranes.

**Calibration Chamber**

The YSI 5075 Calibration Chamber is an accessory that helps obtain maximum accuracy when air calibrating in the field and is also a useful tool when measuring in shallow water (less than 4 ft). As shown in Figure 9, it consists of a 4 1/2 ft. stainless steel tube (1) attached to the calibration chamber (5) and the measuring ring (7). For calibration insert the solid rubber stopper (6) into the bottom of the calibration chamber (5). Push the probe (4) through the hollow rubber stopper (3) as shown in Detail A. For maximum accuracy wet the inside of the calibration chamber (5) with fresh water. This creates a 100% relative humidity environment for calibration. Insert the probe-stopper assembly in the top of the calibration chamber.

During calibration hold the calibration chamber under water and calibrate as described in the Air Calibration procedure. Keep the handle above the water at all times. After calibration the chamber can be used as a measuring aid by removing the probe-stopper assembly from the calibration chamber (5) and placing it in measuring ring (7). (See Detail C). Slowly stir the water with the wand when measuring.

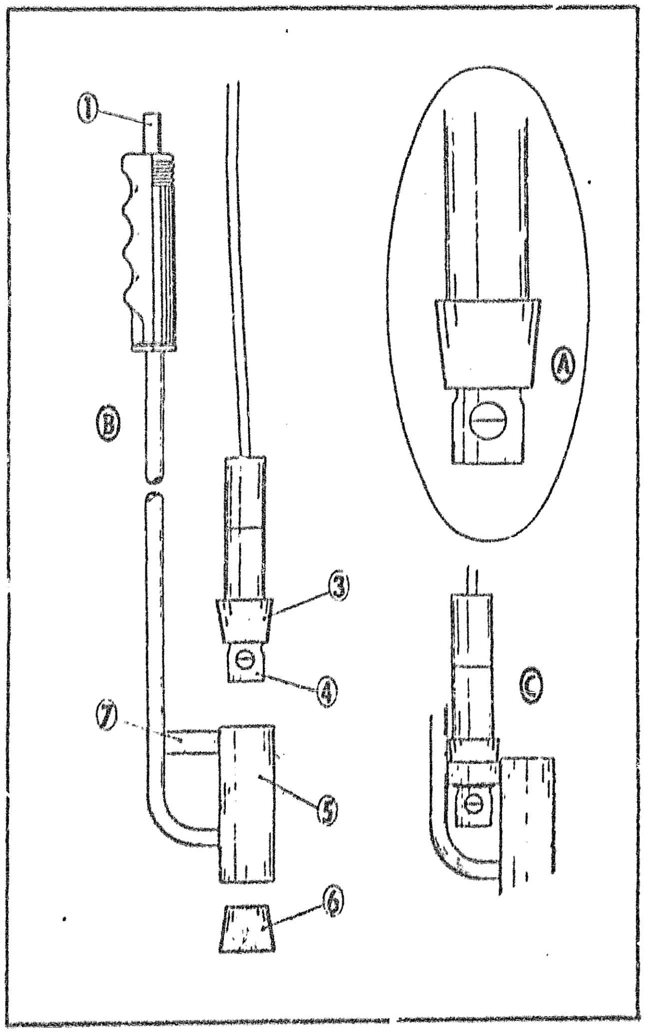



FIGURE 9

## IV. Dissolved Oxygen Measurement

With the instrument prepared for use and the probe calibrated, place the probe in the sample to be measured and provide stirring.

1. Stirring for the 5739 Probe can best be accomplished with a YSI submersible stirrer. Turn the STIRRER knob ON. If the submersible stirrer is not used, provide manual stirring by raising and lowering the probe about 1 ft. per second. If the 5075 Calibration Chamber is used, the entire chamber may be moved up and down in the water at about 1 ft. per second.
2. The YSI 5720 has a built-in power driven stirrer.
3. With the YSI 5750 sample stirring must be accomplished by other means such as with the use of a magnetic stirring bar.
4. Adjust the SALINITY knob to the salinity of the sample.
5. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen. Read dissolved oxygen.

## V. Calibration Tables

Table I shows the amount of oxygen in PPM that is dissolved in air saturated fresh water at sea level (760 mmHg atmospheric pressure) as temperature varies from 0° to 45°C.

**Table I — Solubility of Oxygen in Fresh Water**

| Temperature °C | PPM Dissolved Oxygen | Temperature °C | PPM Dissolved Oxygen |
|---|---|---|---|
| 0 | 14.6 | 23 | 8.7 |
| 1 | 14.2 | 24 | 8.5 |
| 2 | 13.9 | 25 | 8.4 |
| 3 | 13.5 | 26 | 8.2 |
| 4 | 13.2 | 27 | 8.1 |
| 5 | 12.8 | 28 | 7.9 |
| 6 | 12.5 | 29 | 7.8 |
| 7 | 12.2 | 30 | 7.7 |
| 8 | 11.9 | 31 | 7.5 |
| 9 | 11.6 | 32 | 7.4 |
| 10 | 11.3 | 33 | 7.3 |
| 11 | 11.1 | 34 | 7.2 |
| 12 | 10.8 | 35 | 7.1 |
| 13 | 10.6 | 36 | 7.0 |
| 14 | 10.4 | 37 | 6.8 |
| 15 | 10.2 | 38 | 6.7 |
| 16 | 9.9 | 39 | 6.6 |
| 17 | 9.7 | 40 | 6.5 |
| 18 | 9.5 | 41 | 6.4 |
| 19 | 9.3 | 42 | 6.3 |
| 20 | 9.2 | 43 | 6.2 |
| 21 | 9.0 | 44 | 6.1 |
| 22 | 8.8 | 45 | 6.0 |

Source: Derived from "Standard Methods for the Examination of Water and Wastewater."

Table II shows the correction factor that should be used to correct the calibration value for the effects of atmospheric pressure or altitude. Find true atmospheric pressure in the left hand column and read across to the right hand column to determine the correction factor. (Note that "true" atmospheric pressure is as read on a barometer. Weather Bureau reporting of atmospheric pressure is corrected to seal level.) If atmospheric pressure is unknown, the local altitude may be substituted. Select the altitude in the center column and read across to the right hand column for the correction factor.

Table II — Altitude Correction Factor

| Atmospheric Pressure mmHg | or | Equivalent Altitude Ft. | = | Correction Factor |
|---|---|---|---|---|
| 775 | | 540 | | 1.02 |
| 760 | | 0 | | 1.00 |
| 745 | | 542 | | .98 |
| 730 | | 1094 | | .96 |
| 714 | | 1688 | | .94 |
| 699 | | 2274 | | .92 |
| 684 | | 2864 | | .90 |
| 669 | | 3466 | | .88 |
| 654 | | 4082 | | .86 |
| 638 | | 4756 | | .84 |
| 623 | | 5403 | | .82 |
| 608 | | 6065 | | .80 |
| 593 | | 6744 | | .78 |
| 578 | | 7440 | | .76 |
| 562 | | 8204 | | .74 |
| 547 | | 8939 | | .72 |
| 532 | | 9694 | | .70 |
| 517 | | 10472 | | .68 |
| 502 | | 11273 | | .66 |

Source: Derived from "Standard Methods for the Examination of Water and Wastewater."

## VI. HIGH SENSITIVITY MEMBRANE

Use of high sensitivity .0005" membranes (YSI 5776) in place of standard .001" membranes (YSI 5775) when measurements are to be made consistently at low temperatures (less than 15°C). Calibration and readings will be made just as if the standard YSI 5775 membrane was being used.

The YSI 5776 High Sensitivity Membrane can also be used in certain situations to increase sensitivity at temperatures above 15°C. The ranges thus become 0.25, 0-5 and 0-10 PPM. When calibration with high sensitivity membranes is attempted at temperatures greater than 15°C the selector switch must be set to 0-20 PPM. Multiply the calculated calibration value by 2. For example: at 21°C and 1000 ft. altitude the calibration value would be 8.6 x 2 or 17.2. Remember the 0-5, 0-10 and 0-20 PPM ranges are now 0-2.5, 0-5 and 0-10 PPM, and all PPM readings must be divided by 2 for a final reading. When operating in this manner accuracy will be degraded slightly.

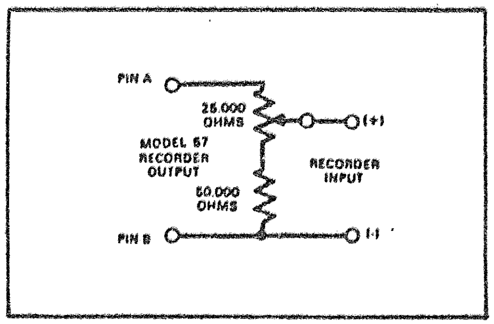
## VII. RECORDER OUTPUT

Output at full scale is 114 to 1?36 mV.

Use a 50K or higher input impedance recorder and operate it with the terminals ungrounded. (The YSI Models 80A and 81A strip Chart recorders are compatible with this system for laboratory use).

Many recorders have an adjustable full scale sensitivity feature. When using this type, use the 100 mV range and adjust the full scale (span, range control, sensitivity, etc.) control to give full scale chart deflection with full scale oxygen meter deflection. Refer to the recorder instructions. For recorders without this feature, a simple driver network as shown below can be constructed. This is adequate to adjust the signal for full scale chart and meter deflection on the 100 mV fixed range recorders.

FIGURE 10




### Recorder Output Plug

The YSI Model 57 is supplied with the necessary parts to construct a waterproof recorder plug for the YSI Model 57 Dissolved Oxygen Meter. The cable and potting materials are not included. (See Figure 11).

General purpose epoxy potting materials of medium viscosity and moderate cure rate are recommended. The two tube kits available in hardware stores are satisfactory.

1. Prepare the cable end by stripping back 3/16" (5MM) of insulation. Tin the ends with rosin core solder. If polarity is important pin "A" is the (+) terminal.
2. Disassemble the connector pieces and slide the mold, ring, extension, and coupling nut over the cable. Solder the leads to the appropriate connector pins with rosin core solder.
3. Check all connections. The two leads should show electrical continuity to the pins and should not contact the body or each other.
4. Re-assemble the pieces and hold the connector upright. Pour the epoxy mix into the plastic mold until full. Refill as the epoxy settles.
5. After the epoxy cures the plastic mold may be removed with pliers or knife.

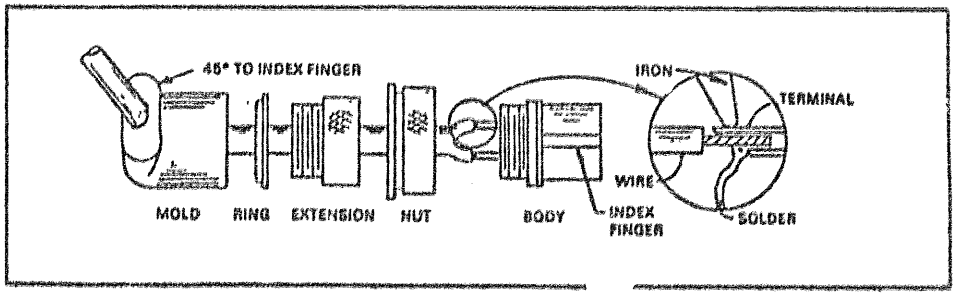



FIGURE 11

## DISCUSSION OF MEASUREMENT ERRORS

There are three basic types of errors which can occur. Type I errors are related to limitations of the instrument design and tolerances of the instrument components. These are chiefly the meter linearity and resistor tolerances. Type II errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type III errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, Type III errors are appropriately reduced.

### Individual Sources of Error

This description of sources of error can be used to attach a confidence to any particular reading of dissolved oxygen. The particular example given is for a near extreme set of conditions. As a generality, overall error is diminished when the probe and instrument are calibrated under conditions of temperature and dissolved oxygen which closely match the sample temperature and dissolved oxygen.

### Type I

A. Is the error due to the meter linearity.
   Error = ±1% of full scale of the measurement range.

B. Is the error due to tolerances in the instrument when transferring a reading from one range to another.
   Error = ±1% of the meter reading if the reading is taken on a range one range away from the calibration range.
   Error = ±2% of the meter reading if the reading is taken on a range two ranges away from the calibration range.

C. Is the error due to the design and components of the instrument salinity compensation circuit.
   $$\text{Error} = \pm 2.5\% \text{ of the meter reading } X \frac{\text{sample salinity ppt}}{\text{40 ppt salinity}}$$

### Type II

A. errors are due to probe background current.
   $$\text{Error} = 0.5\%\left(\frac{\text{meter reading ppm}}{\text{1-Calib. value}}\right) \text{ X calib. value, P.P.M.}$$

B. errors are due to the probe non-linearity
   Error = 0.3% of reading

C. error is caused by variability in the probe membrane temperature coefficient.
   Error = zero if readings are taken at the calibration temperature.
   Error = ± 1% of meter reading if readings are taken with 5°C of the calibration temperature.
   Error = ±3% of meter reading all other conditions.

### Type III

A. errors are due to the accuracy of the instrument thermometer when used to measure the exact probe temperature during calibration.
   Error = ±1.5% of reading.

B. errors are due to the assumption of mean, barometric pressure.
   Daily variation is usually less than 1.7%
   Error = ±1.7% of reading

C. errors assume an ability to estimate altitude to within ±500 ft. when computing the altitude correction factor.
   Error = 1.8% of reading.

D. errors consider the possibility of only 50% relative humidity when calibrating the probe. If the actual relative humidity is 50% instead of 100% the errors will be as follows:

| Calibration Temperature ± C | Error in Percent of Reading |
|---|---|
| 0 | (-) 0.3 |
| 10 | (-) 0.6 |
| 20 | (-) 1.15 |
| 30 | (-) 2.11 |
| 40 | (-) 3.60 |

### Example of a Typical Error Calculation

The example given presumes the air calibration technique. If calibration is done with air saturated water, the relative humidity consideration (III-D) is eliminated. If the Winkler calibration method is used, Type III errors are deleted and replaced by the uncertainty attributable to the overall Winkler determination.

Data: Instrument calibrated at 25°C, elevation estimated at 2000 ft.. ±500 feet, normal barometric pressure presumed, calibrated on 0-10 ppm scale at 7.8 PPM. Readings taken on 0-5 ppm range at 4.5 ppm, temperature 20°C. Salinity of 20 ppt.

| Type | Description | Calculations | Error ppm |
|---|---|---|---|
| IA | Linearity | = .01 x 4.5 ppm | .045 |
| IB | Range Change | = .01 x 4.5 ppm | .045 |
| IC | Salinity | $= .025 \times 4.5 \text{ ppm} \times \frac{20 \text{ ppt}}{40 \text{ ppt}}$ | .056 |
| IIA | Probe Background | $= .005 \times \left(1 - \frac{4.5 \text{ ppm}}{7.8 \text{ ppm}}\right) \times 7.8 \text{ ppm}$ | .016 |
| IIB | Probe Linearity | = .003 x 4.5 ppm | .014 |
| IIC | Temp. Compensation | = .01 x 4.5 ppm | .045 |
| IIIA | Temp. Measure | = .015 x 4.5 ppm | .068 |
| IIIB | Pressure | = .017 x 4.5 ppm | .076 |
| IIIC | Altitude | = .018 x 4.5 ppm | .081 |
| IIID | R.H. | = .016 x 4.5 ppm | .072 |
| | | Maximum possible error = | .518 ppm |
| | | Probable Error | ±.259 |

Considering a statistical treatment of the probable error at any time for any instrument, it is likely that the actual error in any measurement will be about 1/2 of the possible error. In this case the probable error is about ±.26 ppm out of a reading of 4.5 ppm or 5.8% of the reading.

## INSTRUMENT CASE

The instrument case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case should be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The instrument case is opened by removing the screws on the rear cover and lifting the cover off.

PRICE $1.00

# INSTRUCTIONS FOR YSI 5791A AND 5795A SUBMERSIBLE STIRRERS AND YSI 5492A AND 5721 BATTERY PACKS

The YSI submersible stirrers and battery packs are accessories for YSI dissolved oxygen meters. They perform the function of stirring the sample being measured when conducting dissolved oxygen measurements in the field or in the lab.

## INSTALLATION — YSI 5791A SUBMERSIBLE STIRRER

The YSI 5791A stirrer is for use with the following YSI dissolved oxygen probes: YSI 5418, 5419, 5718, 5719 and 5739.

When the stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor.

All probes are installed in the same manner by simply removing the guard from the probe and screwing the probe into the stirrer until it bottoms out, about three turns. To avoid entanglement of the probe cable, it may be helpful to twist the probe and cable three turns in the opposite direction before screwing the probe into the stirrer. This is preferable to disconnecting the cable.

The dimension between the end of the probe and the stirrer impeller is critical for proper stirring (see Figure 1). If necessary to achieve proper spacing, the diaphragm on the bottom of the stirrer can be removed and the impeller and motor assembly raised or lowered by adjusting the locknuts on the motor assembly mounting screw. The motor and housing assembly is hermetically sealed at the factory; don't tamper with it.

The probe and stirrer cables can be taped or tied together to facilitate handling.

If the stirrer is to be used in fast running streams or if the probe is being used as a depth indicator, additional weight may be desirable. A hole in the motor mounting stud is provided for attaching weights. Weights over 16 oz. are not recommended.

After completing assembly connect the stirrer cable to the YSI 5492A Battery Pack when using any of the YSI Model 51 or 54 instruments, or to the stirrer/charger connector on the YSI Model 57. (See battery pack installation elsewhere in this instruction sheet, plus the instruction manual for the instrument being used.)

## INSTALLATION — YSI 5795A SUBMERSIBLE STIRRER

The YSI 5795A stirrer is for use only with the YSI 5739 probe. It differs from the YSI 5791A by offering the convenience of a single cable for both stirrer and proble instead of separate cables for each.

The probe is mounted in the stirrer and the stirrer connected to the power supply in the same manner as described for the YSI 5791A stirrer.

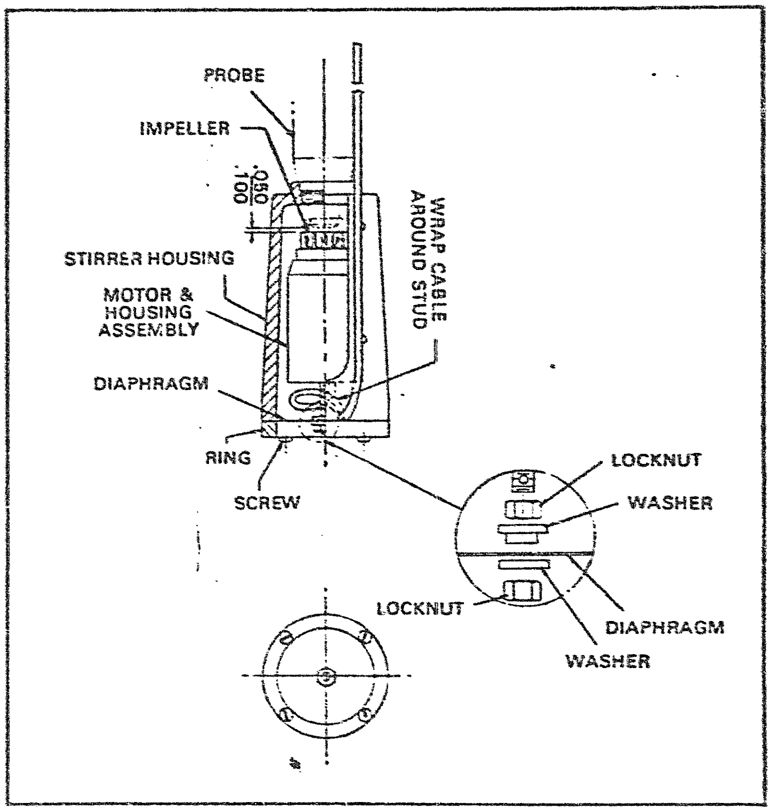



Figure 1

## MAINTENANCE OF SUBMERSIBLE STIRRERS

The YSI 5791A and 5795A stirrers are made with all exposed parts fabricated from plastic or stainless steel to minimize maintenance. Some routine procedures will greatly aid in optimizing performance and stirrer life. Most important is to keep the assembly clean; sand, mud or other debris on the impeller may seriously affect stirring. Inspect occasionally and flush off as needed.

Adequate stirring can be verified by moving the operating probe-stirrer assembly up and down in the water at about 1 ft. per second. If the oxygen reading increases while this is being done, stirring speed is probably too slow. Three items to check are: impeller, diaphragm, and power supply voltage. (See battery pack instructions.) If the impeller is grossly damaged with one or more broken blades, continued use is not recommended and the motor and housing assembly should be replaced.

## SUBMERSIBLE STIRRER REPLACEMENT PARTS

YSI 077512 — Motor & Housing Assembly (includes locknuts)
YSI 077519 — Case
YSI 050824 — Diaphragm Clamp
YSI 077510 — Diaphragm

## INSTALLATION — YSI 5492A BATTERY PACK

The YSI 5492A Battery Pack can be attached to the case of . of the Model 51 or 54 dissolved oxygen instruments to ovide power for operating either of the submersible stirrers. To install the battery pack remove the six screws and rear cover of the instrument. Sandwich the battery pack between the instrument and rear cover and fasten with the longer screws provided (See Figure 2). It is important to keep the nameplate and serial number in case questions arise concerning service or warranty. CAUTION: Disconnect battery charger before unscrewing cover of the Model 54 instrument.

Remove the batteries from the battery pack by unscrewing the knobs at the ends of the battery pack. Take off the plastic bags and reinstall the batteries so the terminals contact the battery pack terminals. Only ONE battery position will work.

The batteries provide adequate stirring until discharged to 5.25 volts under load, over 60 hours of use with a 4 hour/day duty cycle. To determine battery discharge measure the voltage across each battery under 100 mA load. If this is not feasible, adequate stirring can be verified as described in MAINTENANCE OF SUBMERSIBLE STIRRERS. If battery replacement is indicated, replace with Ray-O-Vac 941 or equal 6 volt spring terminal lantern batteries.

NOTE: When using the YSI Model 51 or 54 instruments an alternate power source, which can be used in place of the YSI 5492A Battery Pack, is any 6 VDC battery that will deliver .050 amp current. A 12 VDC battery can be used in conjunction with a resistor in series. Consult the factory for details.

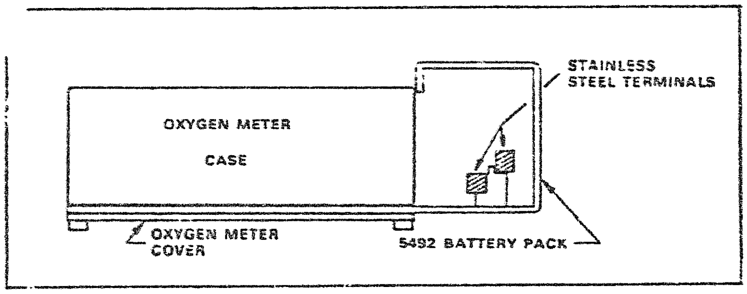



Figure 2

## INSTALLATION — YSI 5721 BATTERY & CHARGER PACK

The YSI 5721 is offered as an accessory to operate either submersible stirrer when used in conjunction with the YSI Model 57 dissolved oxygen meter. The battery pack consists of 5 nickel cadmium batteries and a line operated charger. (Specify either 117 VAC or 230 VAC input when ordering.)

The batteries fit inside the YSI Model 57 instrument case. Remove the instrument rear cover and install the five batteries with the plus (+) terminal of each battery in the red cup end of the battery holder. As shipped, the batteries are charged and proper installation can be checked by switching to the BATT CHECK position. The meter should display at least 6.0 volts on the red 0-10 PPM scale. If there is no indication the batteries should be checked for proper contact in their holders. If the reading is low, one battery may be reversed or one of all cells may require recharging. Plugging the charger into the stirrer/charger receptacle should immediately bring the meter reading to 6.0 volts or more if all cells are properly installed. (See Figure 3.)

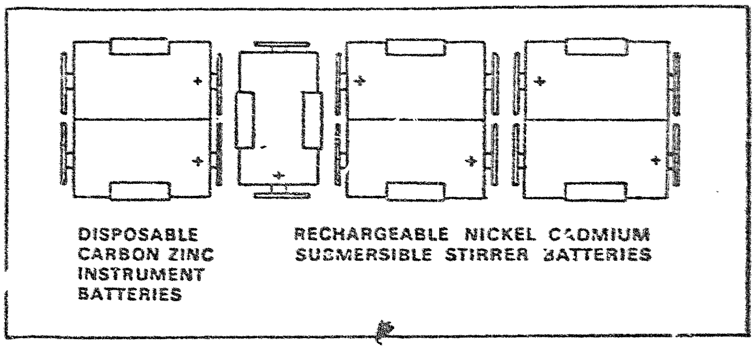



Figure 3

The rechargeable batteries should have a service life of 500 to 1000 recharge cycles, depending on variables of individual batteries and charging and discharging conditions. If the batteries will not hold a charge above 6.4 volts, one or all batteries may require replacement. To locate a defective battery fully charge the batteries and check each battery voltage with a voltmeter while operating the submersible stirrer. If an individual battery is generating less than 1.2 volts, or shows any signs of leakage, it should be replaced. Replace batteries in sets or with exact replacement types. Mixing batteries of different manufacture can shorten life of the set.

## GUARANTEE AND REPAIR

All YSI products carry a one-year unconditional guarantee on workmanship and parts, exclusive of batteries. Damage through accident, misuse or tampering will be repaired at a nominal charge, if possible. If you are experiencing difficulty with a YSI product, even if the guarantee has expired, it may be returned for repair to any authorized YSI dealer or to the factory.


Customer Service Department
Yellow Springs Instrument Co., Inc.
Yellow Springs, Ohio 45387, U.S.A.
Phone: 513-767-7242



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# INSTRUCTIONS FOR YSI 5700 SERIES DISSOLVED OXYGEN PROBES

The probes described in this instruction sheet are designed for direct use with YSI Models 51B, 54ABP, 54ARC and 57 Dissolved Oxygen Meters. The probes can also be used with discontinued YSI Models 51A, 54BP and 54RC Dissolved Oxygen Meters when the YSI 5735 Cable Adaptor is employed (See Accessories).

## I. PRINCIPLE OF OPERATION

Each YSI 5700 Series Probe is a complete polarographic system in itself. A thin permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure under the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the adsolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

## II. SPECIFICATIONS

Cathode — Gold
Anode — Silver
Membrane — .001" FEP Teflon (.0005" FEP Teflon available)
Electrolyte — Half saturated KCl
Temperature Compensation — (See instrument specifications)
Pressure Compensation — effective to 1/2% of reading over a 100 psi range (230 ft. water)
Response Time — 90% DO value in 10 seconds
Polarizing Voltage — 0.8 volts nominal
Probe Current — Air at 30°C = 19 microamps nominal
Nitrogen at 30°C = .15 microamps or less

## ACCESSORIES AND REPLACEMENT PARTS

YSI 5986 — Diaphragm Kit
YSI 5775 — Membrane and KCl Kit, Standard — includes 2 each 15-membrane packets (.001" thick standard FEP Teflon membranes) and a 30 ml bottle KCl with Kodak Photo Flo.
YSI 5776 — Membrane and KCl Kit, High Sensitivity — includes 2 each 15-membrane packets (.0005" thick FEP Teflon membranes) and a 30 ml bottle KCl with Kodak Photo Flo.
YSI 5945 — "O" ring pack — contains replacement "O" rings for all YSI 5700 Series Probes.

Detachable cable:

| | |
|---|---|
| YSI 5740-10 | 10' cable |
| YSI 5740-25 | 25' cable |
| YSI 5740-50 | 50' cable |
| YSI 5740-100 | 100' cable |
| YSI 5740-150 | 150' cable |
| YSI 5740-200 | 200' cable |

YSI 5735 — Cable Adaptor to mate YSI 5700 Series Probes with discontinued YSI Models 51A, 54BP and 54RC Dissolved Oxygen Meters.
YSI 5486 — Beater Boot Assembly for YSI 5720 Probe.

## III. YSI 5739 DISSOLVED OXYGEN PROBE

The YSI 5739 probe, with built-in lead weight, is an improved design that replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1.)

The complete probe consists of the YSI 5739 probe body plus a YSI 5740 detachable cable. The detachable cable is a convenience feature that facilitates changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is not designed for casual disconnection and should only be disconnected when necessary.

To disconnect the cable unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

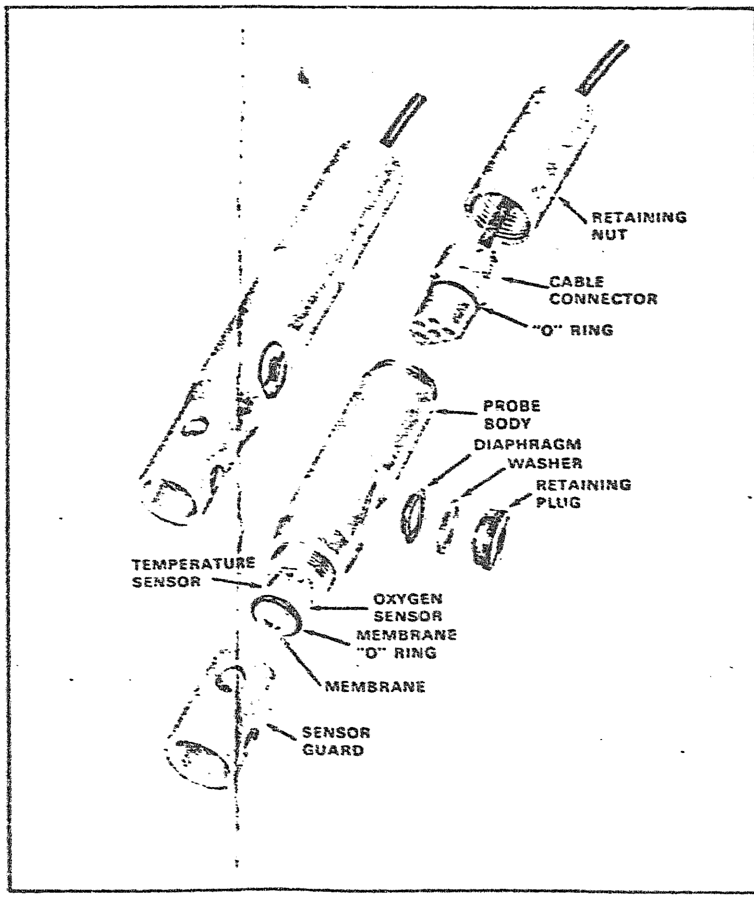


Figure 1



PRICE $1.00

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reassembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, hand tight only. NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present, dry out and reconnect, replacing the "O" ring, if necessary.

## PRESSURE COMPENSATION

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. Large accumulation of salt crystals around the diaphragm plug may be due to a poorly tightened plug or dirt underneath the diaphragm. Cleaning the parts in water and retightening may be tried before diaphragm replacement. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

## PROBE SCHEMATIC

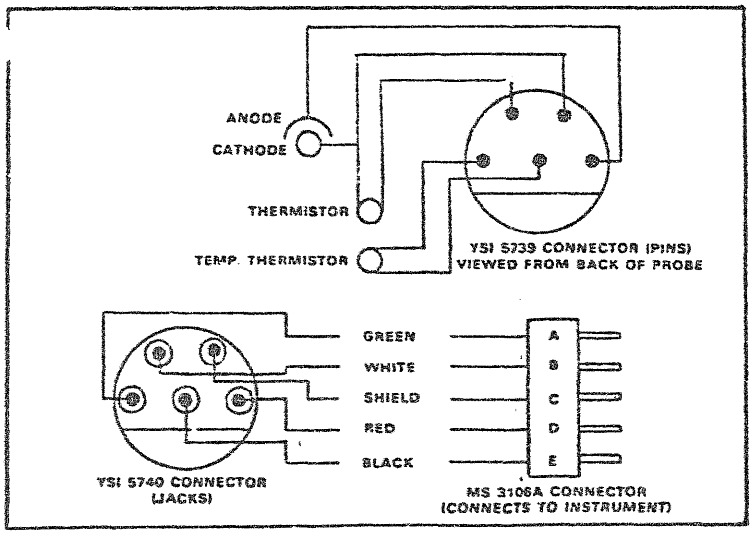


Figure 2

## IV. YSI 5720 B.O.D. BOTTLE PROBE

The YSI 5720 B.O.D. Bottle Probe replaces the discontinued YSI 5420A B.O.D. Bottle Probe for measuring dissolved oxygen and temperature in standard B.O.D. bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50/60 Hz) or 230VAC (190-250VAC, 50/60 Hz) operation. (See Figure 3.)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B.O.D. Bottle and switch agitator "ON" with switch on top of probe. The probe should be operated with a minimum of trapped air in the B.O.D. bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

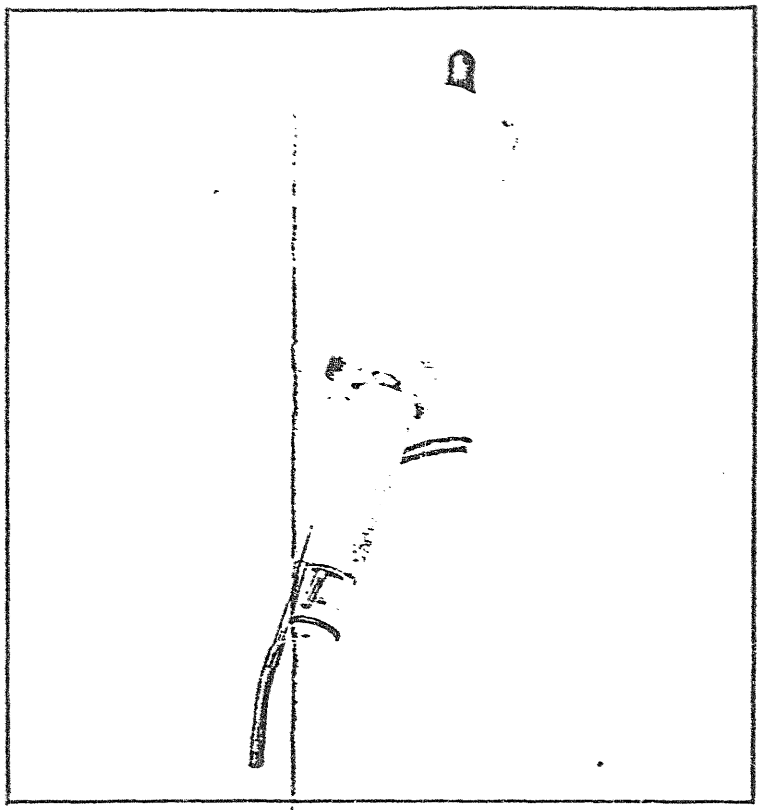

Figure 3

## STIRRER BOOT

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases, ozone, or direct sunlight. For maximum life rinse the boot after use in contaminated samples. (See Figure 4.)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

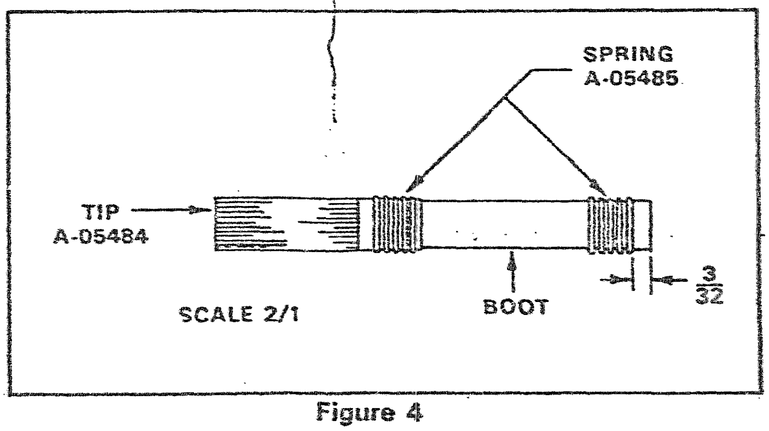


Figure 4

## V. YSI 5750 B.O.D. BOTTLE PROBE

The YSI 5750 B.O.D. Bottle Probe replaces the discontinued YSI 5450 B.O.D. Bottle Probe. It is similar to the YSI 5720 B.O.D. Bottle Probe, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 5.)

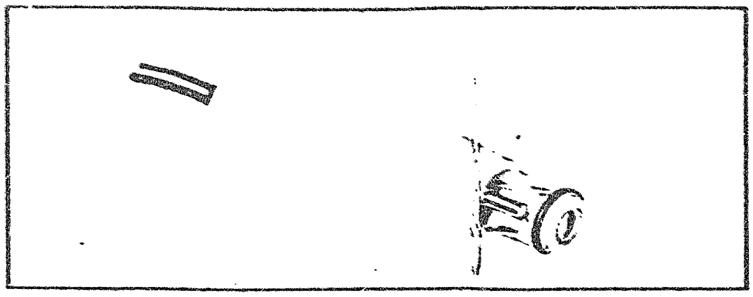

Figure 5

## VI. PROBE PREPARATION AND CARE

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the "O" ring and membrane. Thoroughly rinse the sensor with KCl solution.
3. Fill the probe with electrolyte as follows:
   ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS.
   A. Grasp the probe in your left hand. (See Figure 6.) When preparing the YSI 5739 probe, the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720 and 5750 probes, simply fill the sensor body until no more air bubbles appear.
   B. Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode. NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
   C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
   D. Using a continuous motion STRETCH the membrane UP, OVER, and DOWN the other side of the sensor. Stretching forms the membrane to the contour of the probe.
   E. Secure the end of the membrane under the forefinger of the hand holding the probe.
   F. Roll the "O" ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the "O" ring.
   G. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess KCl and reinstall the sensor guard.
5. A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720 and 5750 probes can be stored in a B.O.D. bottle containing about 1" of water.
6. Membranes will last indefinitely if properly installed and treated with care during use. The result of poor membrane application or damage is erratic readings. The cause of erratic behavior can be loose, wrinkled or fouled membranes (by algae for example), or bubbles in the probe from electrolyte loss. If any of these signs occur it is good practice to thoroughly flush the reservoir with new KCl and replace the membrane.
7. "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
8. The gold cathode should always be bright and untarnished. To clean, wipe with a clean lint-free cloth or hard paper. NEVER USE ANY FORM OF ABRASIVE OR CHEMICAL. Rinse the sensor several times with KCl, refill, and install a new membrane.
9. Some gases contaminate the sensor, evidenced by discoloration of the gold. If the tarnish cannot be removed by vigorous wiping with a soft cloth, lab wipe, or hard paper, return the probe to the factory for service.
10. $H_2S$, $SO_2$, Halogens, Neon, and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause.
11. If the probe has been operated for extended periods with a loose or wrinkled membrane the gold cathode may become plated with silver. In this event return the probe to the factory for refinishing.

## VII. GUARANTEE AND REPAIR

All YSI products carry a one-year unconditional guarantee on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the guarantee has expired. YSI maintains complete facilities for prompt servicing of all YSI products.

Yellow Springs Instrument Co., Inc.
Service Department
P.O. Box 279
Yellow Springs, Ohio, 45387, U.S.A.
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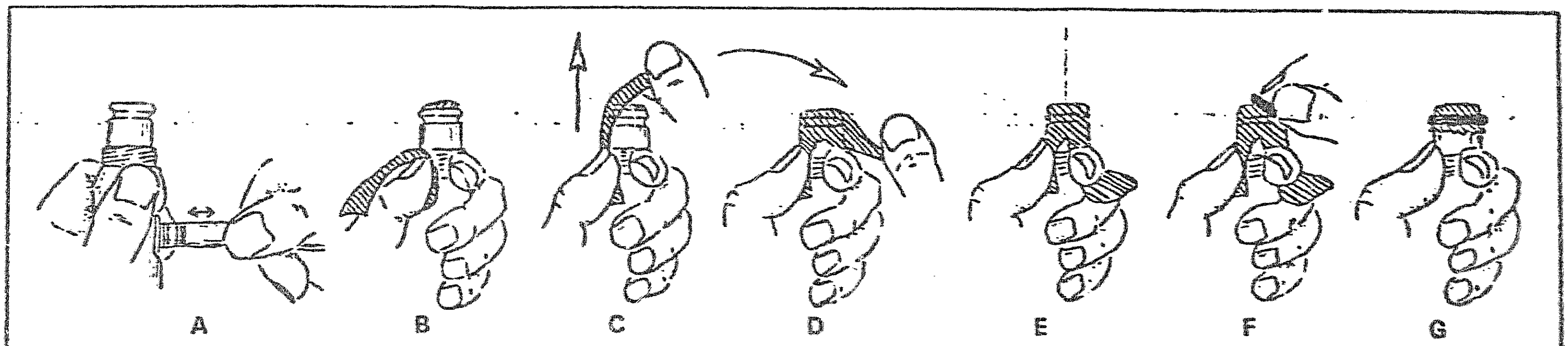


Figure 6

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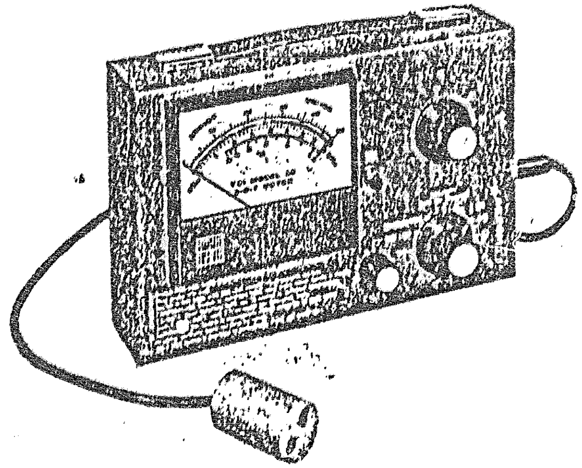
## 5075 CALIBRATION CHAMBER - SUPPLEMENT TO INSTRUCTIONS

When using the 5075 Calibration Chamber with the YSI oxygen probe 5739, a total immersion depth of two (2) feet is recommended. Exceeding this depth could cause errors in calibration.

If the probe is at a significantly (i.e., 5 degrees C) different temperature from the calibrating temperature, quicker calibration will be achieved by placing the probe in the water for a minute to allow it to come to calibrating temperature. Then shake the probe dry and assemble into the chamber as described in the instrument instruction manual. Proceed as usual following those instructions.

Sport Fish

# INSTRUCTIONS FOR
# YSI MODEL 33 S-C-T METER



Scientific Division

Yellow Springs Instrument Co., Yellow Springs, Ohio 45387

PRICE $5.00

## TABLE OF CONTENTS

## GENERAL DESCRIPTION

The YSI Model 33 S-C-T Meter is a portable, battery powered, transistorized instrument designed to accurately measure salinity, conductivity and temperature. It uses a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single probe.

Conductivity in umhos/cm is the measurement of electrical conductance a sample would have shown if measured between opposite faces of a 1 cm cube. Salinity is the number of grams of salt/kilogram of sample (‰ = parts per thousand). This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated, however, a temperature function is provided on the instrument to aid with calculation of corrections. Also, when just temperature and conductivity are known it is possible to calculate salinity, and when only temperature and salinity are known it is possible to calculate conductivity.

## SPECIFICATIONS

### Conductivity

| | |
|---|---|
| Ranges: | 0-500, 0-5,000, 0-50,000 μmhos/cm with YSI 3300 Series Probes. (Note: The "μmho" designations on the instrument are a shorthand form for "μmho/cm".) |
| Accuracy: | ± 2.5% max. error at 500, 5,000 and 50,000 plus probe<br>± 3.0% max. error at 250, 2,500 and 25,000 plus probe<br>See Error Section |



| | |
|---|---|
| Readability: | 2.5 μmhos/cm on 500 μmho/cm range<br>25 μmhos/cm on 5000 μmho/cm range<br>250 μmhos/cm on 50000 μmho/cm range |
| Temperature Compensation: | None |

### Salinity

| | |
|---|---|
| Range: | 0-40 ‰ (parts per thousand) over temperature range -2 to +45°C. |
| Accuracy: | Above 4°C, ± 0.9 ‰ at 40 ‰ and ± 0.7 ‰ at 20 ‰ plus conductivity probe.<br>Below 4°C, ±1.1 ‰ at 40 ‰ and ± 0.9 ‰ at 20 ‰ plus conductivity probe. See Error Section. |
| Readability: | 0.2 ‰ on 0-40 ‰ range |
| Temperature Compensation: | Manual by direct dial from -2° to +45°C |

### Temperature

| | |
|---|---|
| Range: | + 50 to -2°C |
| Accuracy: | ± 0.1°C at -2°C, ± 0.6°C at 45°C plus probe.<br>See Error Section. |
| Readability: | ± 0.15°C at -2°C to ± 0.37°C at 45°C |

### Power Supply

Two D size alkaline batteries, Eveready E95 or equivalent, provide approximately 200 hrs. of operation.

| | |
|---|---|
| Probe | YSI 3300 Series Conductivity/Temperature Probe<br>Nominal Probe Constant: K =5 |
| Accuracy: | ±2% of reading for conductivity and salinity.<br>Error of ±0.1°C at 0°C and ±0.3°C at 40°C |
| Instrument Ambient Range: | Satisfactory operation -5 to +45°C. A maximum error of ± 0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is readjusted to redline for each reading. |

(c) ... into the probe jack on the side of the ...

(d) ... in the solution to be measured ...

2. **Temperature**

Set the switch to temperature. Read the temperature on the bottom scale of the meter in degrees Celsius. Allow time for the probe temperature to come to equilibrium with that of the water before reading.

3. **Salinity**

(a) Transfer the temperature reading from Step 2 to the temperature knob on the instrument.

(b) Switch the instrument to the SALINITY position and read salinity on the red 0-40 ‰ meter range.

(c) Depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

4. **Conductance**

(a) Switch ...

Example: ...

Answer ...

(b) When measuring on the X100 and X10 ranges, depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

NOTE: The CELL TEST does not function on the X1 range.

5. Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

(1) Temperature

The temperature scale is designed to give the minimum salinity error when the temperature readings are used to compensate salinity measurements.

Figure 1 shows total error for probe and instrument versus °C reading.

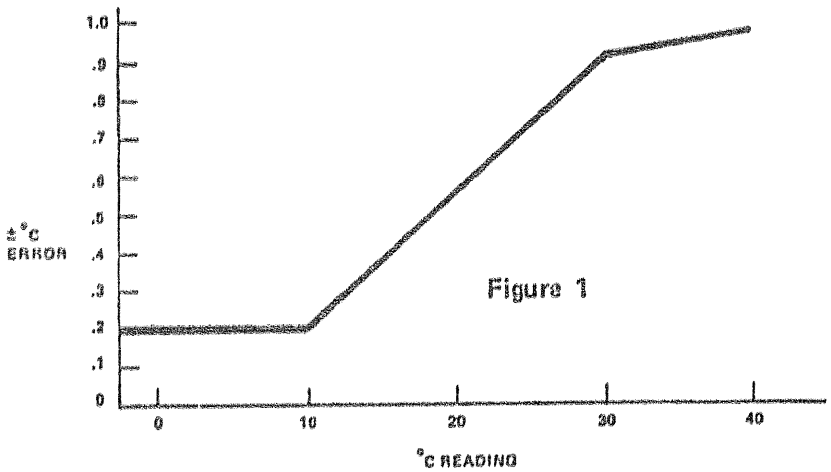



Figure 1



| | | |
|---|---|---|
| Example: | Reading | 15°C |
| Total | Error | 0.4°C |
| | Accuracy | 15°C ± 0.4°C for probe and instrument combined |

(2) Conductivity

Figure 2 shows the worst case conductivity error as a function of the conductivity reading for the probe and instrument combined.

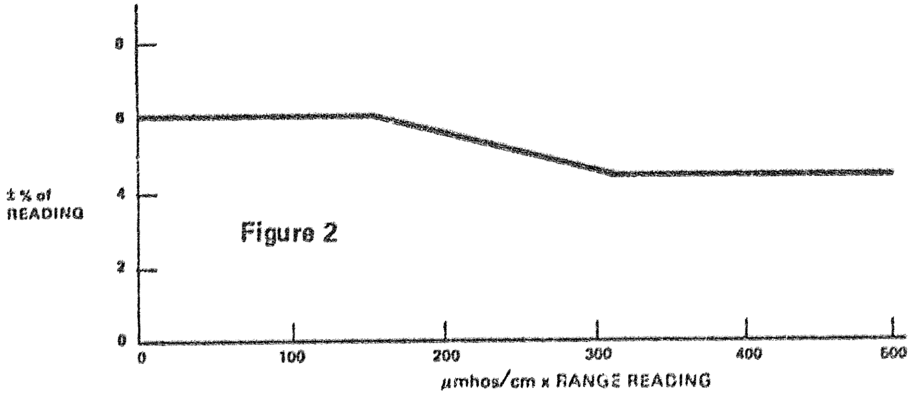



Figure 2

| | | |
|---|---|---|
| Example: | Reading | 360 μmhos/cm |
| | Range | X10 |
| | % Reading Error | ± 4.5% |
| | Accuracy | 3600 ± 162 μmhos/cm for probe and instrument |

### Calibration Chamber

The YSI 5075 Calibration Chamber is an accessory that helps obtain maximum accuracy when air calibrating in the field and is also a useful tool when measuring in shallow water (less than 4 ft). As shown in Figure 9, it consists of a 4-1/2 ft. stainless steel tube (1) attached to the calibration chamber (5) and the measuring ring (7). For calibration insert the solid rubber stopper (6) into the bottom of the calibration chamber (5). Push the probe (4) through the hollow rubber stopper (3) as shown in Detail A. For maximum accuracy wet the inside of the calibration chamber (5) with fresh water. This creates a 100% relative humidity environment for calibration. Insert the probe-stopper assembly in the top of the calibration chamber.

During calibration hold the calibration chamber under water and calibrate as described in the Air Calibration procedure. Keep the handle above the water at all times. After calibration the chamber can be used as a measuring aid by removing the probe-stopper assembly from the calibration chamber (5) and placing it in measuring ring (7). (See Detail C). Slowly stir the water with the wand when measuring.

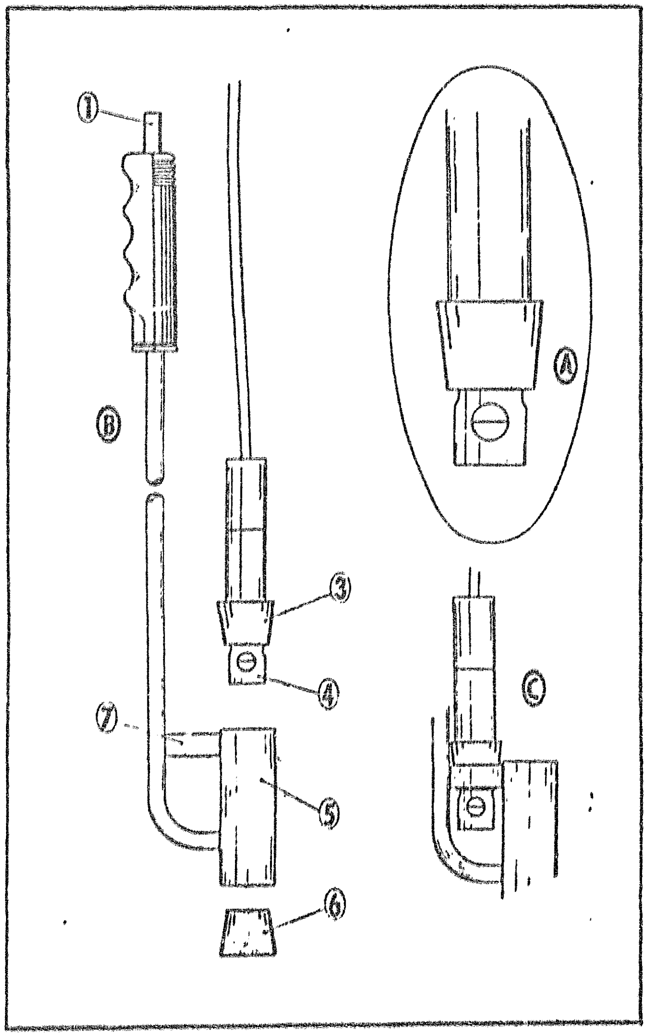



FIGURE 9

### IV. Dissolved Oxygen Measurement

With the instrument prepared for use and the probe calibrated, place the probe in the sample to be measured and provide stirring.

1. Stirring for the 5739 Probe can best be accomplished with a YSI submersible stirrer. Turn the STIRRER knob ON. If the submersible stirrer is not used, provide manual stirring by raising and lowering the probe about 1 ft. per second. If the 5075 Calibration Chamber is used, the entire chamber may be moved up and down in the water at about 1 ft. per second.
2. The YSI 5720 has a built-in power driven stirrer.
3. With the YSI 5750 sample stirring must be accomplished by other means such as with the use of a magnetic stirring bar.
4. Adjust the SALINITY knob to the salinity of the sample.
5. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen. Read dissolved oxygen.

### V. Calibration Tables

Table I shows the amount of oxygen in PPM that is dissolved in air saturated fresh water at sea level (760 mmHg atmospheric pressure) as temperature varies from 0° to 45°C.

**Table I — Solubility of Oxygen In Fresh Water**

| Temperature °C | PPM Dissolved Oxygen | Temperature °C | PPM Dissolved Oxygen |
|---|---|---|---|
| 0 | 14.6 | 23 | 8.7 |
| 1 | 14.2 | 24 | 8.5 |
| 2 | 13.9 | 25 | 8.4 |
| 3 | 13.5 | 26 | 8.2 |
| 4 | 13.2 | 27 | 8.1 |
| 5 | 12.8 | 28 | 7.9 |
| 6 | 12.5 | 29 | 7.8 |
| 7 | 12.2 | 30 | 7.7 |
| 8 | 11.9 | 31 | 7.5 |
| 9 | 11.6 | 32 | 7.4 |
| 10 | 11.3 | 33 | 7.3 |
| 11 | 11.1 | 34 | 7.2 |
| 12 | 10.8 | 35 | 7.1 |
| 13 | 10.6 | 36 | 7.0 |
| 14 | 10.4 | 37 | 6.8 |
| 15 | 10.2 | 38 | 6.7 |
| 16 | 9.9 | 39 | 6.6 |
| 17 | 9.7 | 40 | 6.5 |
| 18 | 9.5 | 41 | 6.4 |
| 19 | 9.3 | 42 | 6.3 |
| 20 | 9.2 | 43 | 6.2 |
| 21 | 9.0 | 44 | 6.1 |
| 22 | 8.8 | 45 | 6.0 |

Source: Derived from "Standard Methods for the Examination of Water and Wastewater."

(3) Salinity

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both. The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale errors.

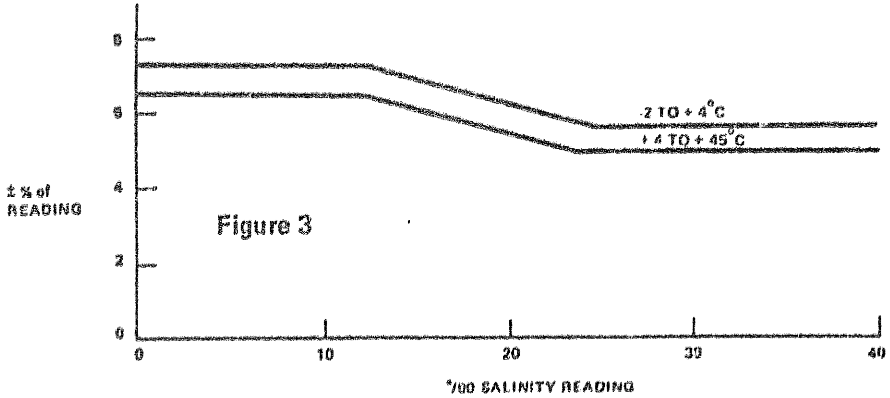



Figure 3

Example: Reading 10 part/thousand, @ 10°C

% of Reading Error 6.5%

Accuracy 10 ‰ ± 0.65 ‰ for all errors, combined worst case.

## CIRCUIT DESCRIPTION, MAINTENANCE AND CALIBRATION

### 1. Description

The circuit is composed of two parts; a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus providing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a user-adjusted temperature compensator. In the temperature, redline and X1 positions the multivibrator operated at 100 Hz. In the salinity, X100 and X10 positions the multivibrator operates at 600 Hz and on these ranges pushing the CELL TEST button drops the frequency to 100 Hz allowing the operator to judge the degree of probe polarization.

### 2. Maintenance

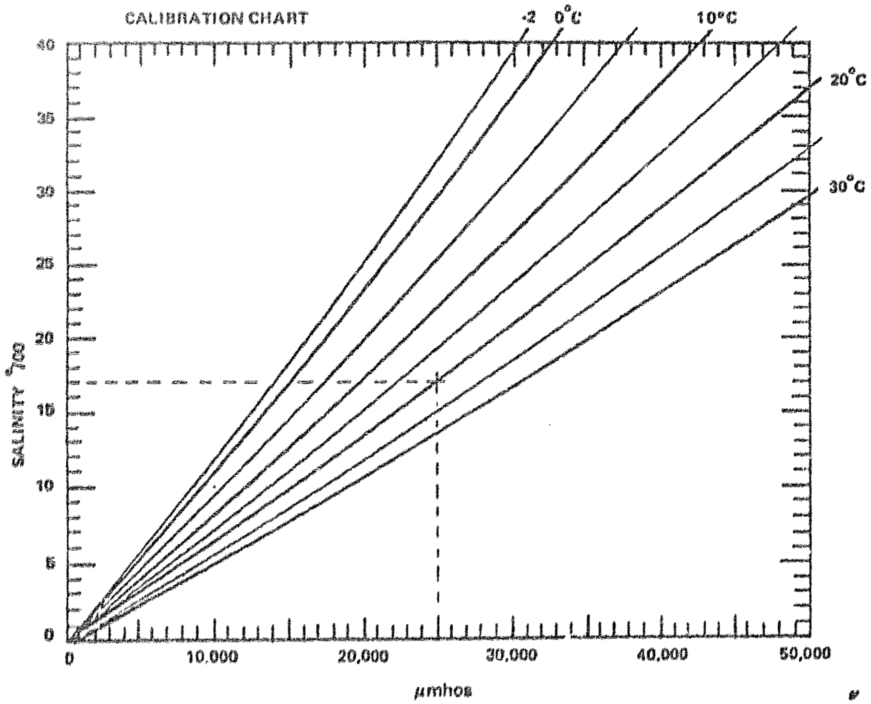
The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent batteries will provide 200 hrs. of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.
Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the rear plate. The battery holders are color coded. The Positive (+ button) end must go on red.

### 3. Calibration

It is possible for the temperature knob to become loose or slip from its normal position. In an emergency the dial can be re-positioned. It must be emphasized that this is an emergency

...re only, and that the instrument should be returned to the ...ory for proper recalibration at the earliest opportunity.

(a) Read the temperature and conductance of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductance value until it intersects the appropriate °C line (interpolate as required for






temperatures between the given °C lines). From this intersection extend a line horizontally to the edge of the graph. This determines the salinity for this sample.
Example: 25000 μmhos and 20° C gives a salinity of 17.

(b) Remove the °C knob, switch to SALINITY, and turn the control shaft until the meter needle indicates the salinity value determined in Step (a). In the example given, the value is 17.

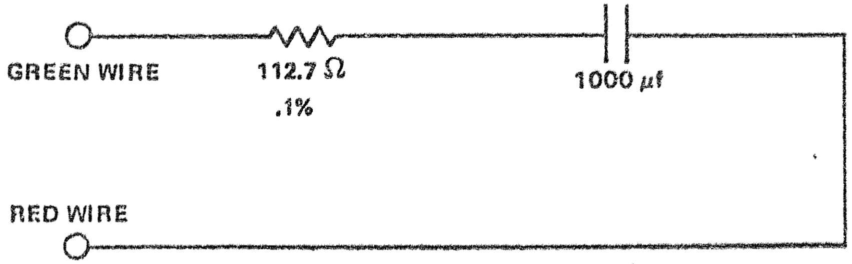
(c) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a); if not, begin again at Step (a).) Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

At earliest opportunity recalibrate using the following procedure or return the instrument to factory for service.

(a) Set the instrument for a salinity measurement as normal.

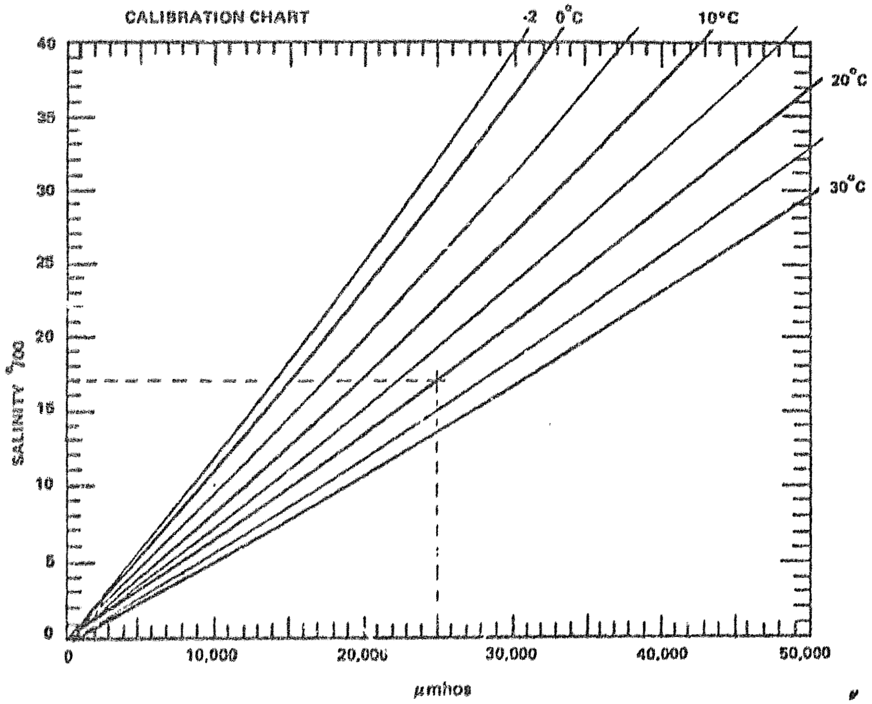
(b) Substitute a 1000 μf capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



procedure only, and that the instrument should be returned to the factory for proper recalibration at the earliest opportunity.

(a) Read the temperature and conductance of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductance value until it intersects the appropriate °C line (interpolate as required for






temperatures between the given °C lines). From this intersection extend a line horizontally to the edge of the graph. This determines the salinity for this sample.
Example: 25000 µmhos and 20° C gives a salinity of 17.

(b) Remove the °C knob, switch to SALINITY, and turn the control shaft until the meter needle indicates the salinity value determined in Step (a). In the example given, the value is 17.

(c) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a); if not, begin again at Step (a).) Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

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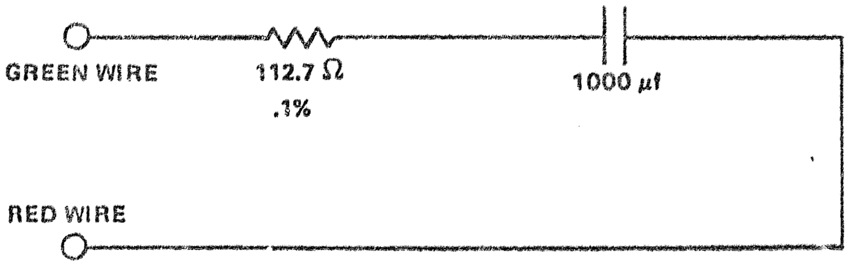
Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



(c) Turn the temperature dial until the meter reads redline. Now install the temperature knob with the arrow at 25°C. This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

PROBE

1. Description of YSI 3300 Series Conductivity/Temperature Probe

The YSI 3300 Series Conductivity Probes are designed for field use, embodying construction and design for rugged, accurate service.

Each probe features a built-in cell constant of 5.00 ±0.1, a precision YSI thermistor temperature sensor of ±0.1°C accuracy, at 0°C and ±0.3°C at 40°C and a low capacitance cable assembly terminating in a three terminal 0.25" dia. phone type connector.

The 3310 has a 10 ft. cable and the 3311 is a 50 ft. version. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinized pure nickel electrodes, and a durable cable, providing resistance to a wide range of water-borne substances.

2. Maintenance

(a) Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as: Dow Chemical "Bathroom Cleaner"; Horizon Industries "Rally, Tile, Porcelain, and Chrome Cleaner"; Johnson Wax "Envy, Instant



Cleaner"; or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HC1 can be used.

Always rinse the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinizing is required.

(b) Re-Platinizing

Equipment Required —

(1) YSI #3140 Platinizing Solution, 2 fl. oz. (3% Platinum Chloride dissolved in .025% lead acetate solution).
(2) YSI Model 33 S-C-T Meter.
(3) 50 m1 glass beaker or equivalent bottle.
(4) Distilled water.

Procedure —

(1) Clean the probe as in Section (a) — either method.
(2) Place the cell in the beaker and add sufficient solution to cover the electrodes. Do not cover the top of the probe
(3) Plug the probe into the Model 33, switch to the X100 range to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below:

| Meter Reading ($\mu$mhos) | Time (minutes) |
|---|---|
| 30,000 | 5 |
| 25,000 | 6 |
| 20,000 | 8 |
| 15,000 | 11 |
| 10,000 | 16 |

(4) After the elapsed time remove the probe and rinse in fresh water.

(5) Return the solution to its container. 2 oz. of solution should be sufficient for 50 treatments.

3. Probe Use

(a) Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.

(b) Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.

(c) Gentle agitation by raising and lowering the probe several times during a measurement insures flow of specimen solution through the probe and improves the time response of the temperature sensor.

4. Cell Calibration & Standard Solutions

The YSI #3300 Series Cells are calibrated to absolute acaccuracy of ±1-1/2% based on a standard solution. Since the literature on conductivity does not indicate a consistently accepted standardization methods, we have chosen the .01 demal KCl solution method as determined by Jones and Bradshaw in 1937 as our standard. Recent textbooks, as well as the ASTM standards, concur with this choice.

The solution is prepared by diluting .745 grams of pure dry KCl with distilled water until the solution is 1 kilogram. The table below



shows the values of conductivity this solution would have if the distilled water were non-conductive. However, since even high purity distilled water is slightly conductive, the measured conductivity will be higher by an amount equal to the water's conductivity.

| Temperature °C | Conductivity (Absolute Micromhos/cm³) |
|---|---|
| 15 | 1141.5 |
| 16 | 1167.5 |
| 17 | 1193.6 |
| 18 | 1219.9 |
| 19 | 1246.4 |
| 20 | 1273.0 |
| 21 | 1299.7 |
| 22 | 1326.6 |
| 23 | 1353.6 |
| 24 | 1380.8 |
| 25 | 1408.1 |
| 26 | 1436.5 |
| 27 | 1463.2 |
| 28 | 1490.9 |
| 29 | 1518.7 |
| 30 | 1546.7 |

The operator may use the standard solution and the table to check accuracy of a cell's constant or to determine an unknown constant. The formula is shown below:

$$K = \frac{R(C_1 + C_2)}{10^6}$$

where: $K$ = Cell Constant
$R$ = measured resistance in ohms
$C_1$ = conductivity in absolute micromhos
$C_2$ = conductivity in absolute micromhos of the distilled water used in makin[illegible] olution

R, $C_1$ and $C_2$ must either be determined at the same temperature or corrected to the same temperature to make the equation valid.

Note: For further information on conductivity and the above standard information, refer to ASTM Standards Part 23 – Standard Methods of Test for Electrical Conductivity, or Water and Industrial Waste Water – ASTM Designation D1125-64.

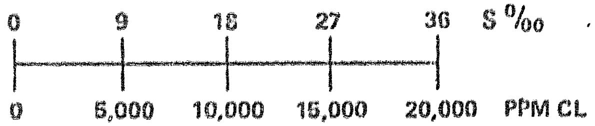
## YSI MODEL 33 USED WITH YSI 51A, 54 and 57 OXYGEN METERS

If the Model 33 salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorosity. The formula is:

$$\text{PPM Chlorosity} = \frac{\text{Salinity ‰} - 0.03}{1.8} \times 10^3$$

For these instruments the 0.03 can be neglected so the equation simplifies to:

$$\text{PPM Cl} = \frac{\text{SS ‰}}{1.8} \times 10^3$$




For salinity correction when using the Model 57 use the salinity reading direct from the Model 33. No conversion is necessary.

Model 33 salinity readings taken in conjunction with Model 54 dissolved oxygen readings can be used to correct the Model 54 for salinity and to make post measurement salinity corrections to dissolved oxygen data. Correction tables are available from the factory.



## REPAIR FACILITIES

If you are experiencing difficulty with a YSI product, it may be returned to the YSI Customer Service Department for repair, even if the guarantee has expired. YSI maintains complete facilities for prompt servicing of all YSI products.

## GUARANTEE

The Model 33 S-C-T Meter carries a one year unconditional guarantee on all workmanship and components. Damage through accident, misuse, or tampering will be repaired at a nominal charge when the instrument is returned to our plant. Cells are similarly guaranteed.

Note: In communications regarding this instrument, please mention model number and serial number and the type of failure experienced.

## ACCESSORIES AND REPLACEMENTS

5992-20 Replacement pH Electrode for Model 5985-20 Meter

5992-50 Replacement pH Electrode for Model 5985-40 Meter

5985-05 AC Adapter for 115/230vAC operation

5977-04 pH Buffer, 4.00, vial of 12 capsules

5977-07 pH Buffer, 7.00, vial of 12 capsules

5977-09 pH Buffer, 9.00, vial of 12 capsules

5977-10 pH Buffer, 10.00, vial of 12 capsules

### READY-TO-USE BUFFER SOLUTIONS

These prepared buffer solution standards offer excellence in precision and consistency. With these ready-to-use buffer solutions, you are guaranteed an accuracy of ±0.01 pH at 25°C. These buffer solutions are dated to assure freshness. Double protection against contamination — unbreakable plastic bottles have shrink-sealed caps and are packed in individual plastic bags. Color-coded solutions.

| Container Volume | pH 4.01, Red Cat. No. | pH 7.00, Green Cat. No. | pH 10.00, Blue Cat. No. |
|---|---|---|---|
| Pint | 5942-20 | 5942-40 | 5942-60 |
| Quart | 5942-22 | 5942-42 | 5942-62 |
| Gallon | 5942-24 | 5942-44 | 5942-64 |



# INSTRUCTIONS FOR DIGI-SENSE® pH METER

## I. GENERAL RECOMMENDATIONS

Whenever transferring the electrode from one solution to another, it is essential that the electrode be thoroughly rinsed in water and any excess water should be shaken off. Doing this will prevent contamination between samples.

When immersing the electrode in sample or buffer give a moderate stirring action to the electrode. This improves electrode response and gives more accurate reading.

If you store your electrode for an extended period, put several drops of distilled water in the plastic cap and place cap on the end of the electrode.

For improved accuracy and consistency of readings it is important that buffers and samples are at the same temperature.

## II. PREPARATION FOR FIELD OPERATION

Install batteries by removing the four screws from rear of pH meter and inserting batteries supplied.

### BATTERY REPLACEMENT

"BAT. LOW" indicator will signal when it is time to replace batteries. Just remove the four screws from back of meter case and replace the six 1.5 volt, size "AA", alkaline batteries.

### PREPARATION FOR AC OPERATION

Set the optional AC adapter, using switch on rear of adapter, to appropriate voltage (either 115 vAC or 230 vAC) then connect adapter to pH meter and power outlet. Meter is now "on" and should be calibrated by following steps in calibration procedure.

## III. CALIBRATION PROCEDURE

1. Connect electrode to meter.

2. Set "temperature" knob to the temperature of the buffers.

3. Immerse electrode in buffer pH 7, press push-button "on" switch located at left side of meter, and adjust "standarize" knob to reading of 7.0.

4. Rinse electrode in water.

5. Immerse electrode in the second buffer, depress "on" switch and adjust "temperature" knob to reading of the buffer.

6. Rinse electrode in water. Your DIGI-SENSE is now ready for use.

NOTE: The "temperature" knob serves the dual purpose of both temperature compensation and meter calibration. Therefore, upon completion of the calibration procedure the temperature knob does not necessarily indicate the actual buffer temperature.

## IV. TROUBLE SHOOTING

In many cases poor performance or lack of performance can be traced to causes other than instrument malfunction. Some of these are defective electrode, weak batteries, contaminated buffers, temperature difference between buffers and poor calibrating and measurement technique.

If your pH meter is not operating satisfactorily the following checks should be made:

Try a new or another set of batteries.

Check meter by recalibrating with fresh buffer solutions.

Review your calibrating procedure.

Use another electrode of assured accuracy in above checks.

The following problems and corrective action will help in locating the trouble source:

1. *Sluggish response*: use a mild detergent to remove any dirt or film on the electrode tip, and rinse thoroughly. If condition persists, replace electrode.
2. *Excessive drift*: same procedure as above.
3. *Same reading from two different buffers*: replace electrode.

NOTE: Repeated fluctuations of more than ±0.1 pH unit is an indication that the batteries are nearing the end of their life and should be replaced.

161 - Series Digital pH Meter

ELECTRODE INSTRUCTIONS

Sealed Combination Electrodes - - (Ag-AgCl Reference) - - 8mm

(1) Wet entire outside of electrode, except the cap, in tap water. Carefully remove the lower rubber sleeve. NOTE: This lower sleeve is used only for storage and shipping.

(2) Use a wet paper towel and clean the wick area by wiping several times.

(3) For first time usage, or after long storage, soak the lower end of the electrode (including the wick) in tap water for five minutes. This will allow the wick to commence flowing.

(4) If air bubbles are present in the bulb area, shake downwards to fill the bulb with the solution.

pH Measurement

(5) After following the above instructions, thoroughly rinse the electrode tip in distilled water. Next insert the electrode tip in a known buffer, close to the sample to be tested.

(6) Adjust the standardize control on pH meter until meter reads the value of the buffer.

(7) Thoroughly rinse electrode with distilled water, then insert electrode in solution to be tested. NOTE: This electrode tip should be rinsed in distilled water between each measurement to prevent contamination of the next solution.

Cleaning the Electrode

(8) It is necessary to clean the wick and bulb area thoroughly before using the electrode. Improper cleaning may produce drift or slow response.

Storage

(9) Storage of the electrode for a short period, immerse the membrane in a buffer of 4 or 7. During this period, the rubber sleeve should be over the filling hole. The wick rubber sleeve should be off.

(10) For long storage (over one week) the plastic cap should be placed into position as when the electrode was received. Then place back in the box and store.

# OPERATING INSTRUCTIONS for the DIGI-SENSE pH METER

Calibrate with pH buffer solutions 4.00 and 7.00 for expected readings below 7 pH; calibrate with 7.00 and 10.00 for above 7 pH. Prepare buffer solutions by emptying contents of buffer capsules supplied into clean containers and dissolving each with 100 ml of water (distilled water if available). Solutions being checked for pH should be stirred. NOTE: Cleaning probe regularly will assure maximum accuracy and probe life—frequency of cleaning should be determined by operating conditions.

## FIELD OPERATION

1. Install batteries by removing the four screws from rear of pH meter and inserting batteries supplied.
2. Connect electrode to meter.
3. Set "TEMPERATURE" knob to approximate temperature of buffer.
4. Immerse electrode in buffer 7.00, press push-button "ON" switch located at left side of meter, and adjust "STANDARDIZE" knob for a digital readout of 7.0 (7.00 for four-digit model).
5. Rinse electrode in water.
6. Immerse electrode in buffer 4.00 or 10.00, depress "ON" switch, and adjust "TEMPERATURE" knob for a digital readout of 4.0 or 10.0 (4.00 or 10.00 for four-digit model).
7. Rinse electrode in water.

## AC OPERATION

Set the optional AC adapter, using switch on rear of adapter, to appropriate voltage (either 115vAC or 230vAC). Then connect adapter to pH meter and power outlet. Meter is now "on" and should be calibrated following steps (2) through (6) above.

## BATTERY REPLACEMENT

"BAT. LOW" indicator will signal when it is time to replace batteries. Just remove the four screws from back of meter case and replace the six 1.5 volt, size "AA", alkaline batteries.

## ACCESSORIES AND REPLACEMENTS

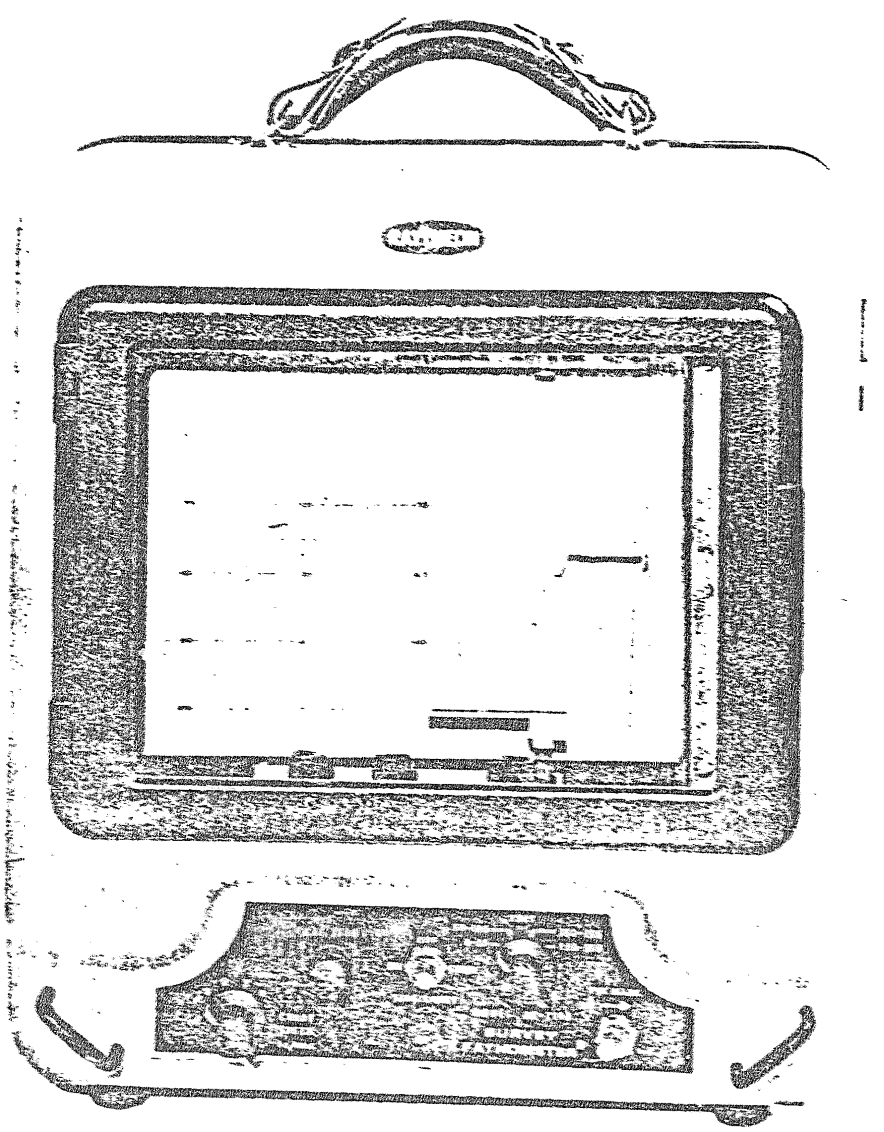
5992-20 Replacement pH Electrode for.

5985-05 AC Adapter for 115/230vAC operation.

5977-04 pH Buffer, 4.00, vial of 12 capsules.
5977-07 pH Buffer, 7.00, vial of 12 capsules.
5977-10 pH Buffer, 10.00, vial of 12 capsules.

# DE-719B
# FATHOMETER®
# PRECISION SURVEY DEPTH RECORDER

## INSTRUCTION MANUAL



100 95

FEBRUARY 1977

RAYTHEON

# Raytheon Marine

# Limited Warranty

## Marine Products

Raytheon Marine Company warrants all parts of each new product against defects in material and workmanship under normal use, and will repair or exchange any parts proven to be defective at no charge for a period of TWO YEARS from the date of original installation, EXCEPT AS PROVIDED BELOW.

Defects will be corrected by an authorized Raytheon Marine Company Service Station. There will be no charge for labor for a period of ONE YEAR from date of original installation, EXCEPT AS PROVIDED BELOW, and during this time Raytheon Marine Company will assume travel costs of its Authorized Service Station Representative up to a total of 100 highway miles.

### WARRANTY LIMITATIONS

Raytheon Marine Company will not be responsible for equipment which has been subjected to accident, abuse, or misuse, nor any equipment on which the serial plate has been removed, altered, or mutilated.

Except where Raytheon Marine Company has performed the installation, it assumes no responsibility for damage incurred during installation.

This warranty is effective only with respect to the original purchaser from Raytheon Marine Company or an authorized Raytheon Marine Company Representative.

A validated warranty certificate and station logbook (if applicable) must be made available to the authorized Raytheon Marine Service Station Representative at the time of service.

On radar installations, the magnetron, T/R cell, klystron, and modulator tube (if applicable), and cathode ray tube are warranted for SIX MONTHS from date of original installation.

Chart paper, stylii, stylus belts, lamps, and fuses are consumable items, and are not covered by this warranty.

Any cost associated with transducer replacement, other than the cost of the transducer itself, is specifically excluded from this warranty.

Travel costs will not be accepted for products that do not require installation by an Authorized Service Station.

Raytheon Marine Company equipment or parts thereof which have been repaired or altered outside of its plant except by Authorized Raytheon Marine Company Service Stations are not warranted in any respect.

This warranty is STRICTLY LIMITED to the terms indicated herein, and no other express warranties or remedies thereunder shall be binding on Raytheon Marine Company. TO THE EXTENT CONSISTENT WITH STATE AND FEDERAL LAW: (1) ANY IMPLIED WARRANTIES SHALL BE LIMITED TO THE SAME TIME PERIODS STATED HEREIN FOR EXPRESS WARRANTIES, AND (2) RAYTHEON MARINE COMPANY SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES UNDER ANY EXPRESS OR IMPLIED WARRANTIES RELATING TO THIS EQUIPMENT.

RAYTHEON MARINE COMPANY
676 Island Pond Road, Manchester, New Hampshire 03103

86-52 (4/77)

NOTE: THE SAMPLE WARRANTY STATEMENT IS FURNISHED FOR REFERENCE ONLY. PLEASE REFER TO THE WARRANTY CERTIFICATE ISSUED WITH YOUR EQUIPMENT FOR SPECIFIC TERMS AND CONDITIONS.

# PURPOSE

THIS MANUAL CONTAINS IMPORTANT INFORMATION ON THE INSTALLATION, OPERATION AND MAINTENANCE OF YOUR EQUIPMENT.

RAYTHEON MARINE COMPANY products are supported by a worldwide network of Authorized Service Representatives.

The below-listed Raytheon Marine Company Factory Service Centers will either assist you directly, or refer you to an Authorized Service Representative.

# FACTORY SERVICE CENTERS

CALIFORNIA:
633 N. Marine Avenue
Wilmington, Ca. 90744
(Los Angeles)
Phone: (213) 835-0147

FLORIDA:
1107 N. Ward Street
Tampa, Fl. 33607
Phone: (813) 877-9418

LOUISIANA:
525 Jefferson Street
New Orleans, La. 70121
Phone: (504) 835-6491

NEW HAMPSHIRE:
25 Industrial Village
Londonderry, N.H. 03053
(Manchester)
Phone: (603) 668-1600

NEW YORK:
756 5th Avenue
Brooklyn, N.Y. 11232
Phone: (212) 768-2511

DENMARK:
Rayscan-Copenhagen
Siljangade 6-8 DK2300
Copenhagen S Denmark
Phone: 451-550702

TEXAS:
1203 Galveston Street
South Houston, Tx. 77
Phone: (713) 941-2700

WASHINGTON:
4800 20th Ave. NW
Seattle, Wa. 98107
Phone: (206) 782-0242

JAPAN:
3-12-1
Kaigan Dori Naka-Ku
Yokohama, Japan 231
Phone: 045-212-3633

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LIST OF ILLUSTRATIONS

## SECTION 1

## INTRODUCTION

### 1.1 PRINCIPLES OF ECHO DEPTH SOUNDING

Echo depth sounding is a method of measuring water depth by computing the time interval required for sound waves to travel, at a known velocity, from a known point to a reflecting surface and return. If the time is measured between the transmission of a sound and the reception of its echo, the distance may be computed by multiplying one-half of this time interval by the velocity of sound in water.

From fresh water at the freezing point to the warmest water of the highest saline content likely to be encountered, there can be a variation in the speed of sound of from approximately 4550 to 5050 feet per second; the speed increasing with both higher temperature and salinity. The division of change is roughly three fifths for temperature and two fifths for salinity. The speed of sound also increases slightly with increasing pressure; however for water depths measured with the DE-719B equipment, the correction for pressure would be negligible and therefore will not be considered in this text.

The foregoing shows that under widely differing water conditions the sounding accuracy could be affected as much as ±5% due to the speed of sound in water variation. Under normal conditions of operation in a given area, variations of the speed of sound in water will usually be less than ±0.5%. The DE-719B equipment is calibrated for a speed of sound in water of 4800 feet per second, which is the figure commonly used for navigational purposes in salt water. However, for accurate survey work a speed of sound correction must be applied to the soundings to obtain the accuracy designed into the equipment.

### 1.2 EFFECTS OF FOREIGN MATERIAL, THERMAL GRADIENTS, ETC.

A hard bottom, such as rock or sand, provides the best reflecting surface for sound waves; however, strong reflection is also possible from air bubbles in the water, such as are present in the wake of another vessel. Weaker sound reflections (echoes) are generated by small fish, bits of seaweed and even by temperature variations in the water. If the sensitivity (gain) control of a depth sounder is set too high, it is sometimes possible to obtain sufficient echo return from the water itself to mark the chart to a depth of as great as one hundred feet. At a slightly lower setting of the sensitivity control, it is sometimes possible to observe thermal or salinity gradients and micro-organisms.

SECTION 2

DESCRIPTION

## 2.1 GENERAL

The DE-719B portable, precision, survey-type Fathometer® Depth Recorder is a complete echo depth sounder designed to provide a detailed permanent recording of underwater topography in water depths between 2 and 410 feet. Ease of set-up and operation, plus the extreme accuracy and low power consumption makes this an ideal instrument for underwater surveying.

The DE-719B Recorder is designed primarily for portability; however, it may be mounted on a bulkhead. For maximum portability, space is provided in the rear half of the case for stowing the transducer, rigging and power cable. A zippered canvas cover is provided for protection during handling and transportation.

A bracket, designed to support the recorder in an inclined position for easy viewing and operation, is built into the back portion of the case. Additional brackets and clips are incorporated in the back section for securing the transducer, cabling, and extension pipe.

The DE-719B is advance design equipment using completely solid-state circuitry, magnetic keying and electronically controlled chart speed. The equipment is housed in a splash-proof, aluminum case to assure maximum protection when operated under adverse conditions. The viewing window in the front cover is hinged to permit access to the chart paper for annotations. A safety guard covers the stylus and belt assembly to prevent accidental contact with the rotating stylus arm while entering notes and data on the chart paper.

The DE-719B provides high resolution recordings due to the narrow transducer beam width, high sounding rate, four selectable chart speeds and high signal frequency. The versatility of the DE-719B is further enhanced by a TIDE and DRAFT control, a SPEED OF SOUND control and a RANGE doubling control. Any changes in the setting of the preceding controls is permanently recorded on the chart paper for future reference. Fix marks can be inscribed on the chart by the FIX MARK switch. (A remote switch may be connected.)

The operating controls such as the power OFF/STANDBY/ON, RANGE SELECTOR, SENSITIVITY, CHART SPEED and the FIX MARK control and the RANGE X2 (doubles range on all scales) control are located inside and are accessible through the hinged front window.

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The standard chart paper furnished is graduated in feet; however, chart paper graduated in meters is available as an option from the office where the DE-719B equipment was purchased.

The DE-719B equipment is designed to operate from a 12 VDC source; however, on special order it can be furnished with a built-in power converter to operate from a 115/230 volt, 50-60 Hz power source. This does not affect the ability to operate from a 12 VDC power source.

## 2.2 OPTIONS AVAILABLE

1. 115/230 VDC power supply, #M33105.
2. 7245A narrow beam transducer, #M396005.
3. Metric graduated chart paper, #587630-1.
4. Remote Fix Marker Switch, #7273-5010G1.
5. Maintenance spares kit, #M33125.

## 2.3 TRANSDUCER

The model 200T5HAD transducer is a two-way energy conversion device which functions like the combination microphone/speaker in an intercom unit. During transmission, it converts pulses of electrical energy into pulses of supersonic energy which travel through the water toward the bottom. During reception it receives the echoes of supersonic energy which are reflected from the bottom and converts them to electrical signals. Reference Section 3 for specifications.

## 2.4 SPARE PARTS KIT

A small spare parts kit (P/N 7430-5031G1) is furnished with each DE-719B system. The kit contains replacement fuses, stylus, brushes and chart paper.

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## 2.5 SPECIFICATIONS

| | |
|---|---|
| Depth Range | 0-55, 50-105, 100-155, 150-205 Feet<br>0-16.5, 15-31.5, 30-41.5, 45-61.5 Meters |
| Sounding Rate | 534 Soundings per minute |
| Voltage Input | 12 VDC |
| Current Input | 2.5 Amperes |
| Accuracy | ±0.5% ±1" of indicated depth |
| Operating Frequency | 208 kHz |
| Tranducer | Barium titanate - Model 200T5HAD<br>Optional Model 7245A |
| Transducer Beamwidth | $8^{o}$ at the half power points |
| Chart Paper Speed | 1,2,3,4, inches per minute |
| Chart Paper | 7 inches x 60 feet |
| Recorder Dimensions | Height (including handle) - 18"<br>Width 15-3/8"<br>Depth 9-1/16" |
| Net Weight | Recorder w/transducer and rigging 47 lbs.<br>Recorder only - 38 lbs. |

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SECTION 3

TRANSDUCER DATA

## 3.1 GENERAL

The 7245A transducer has been designed for precision survey work and other applications where a very narrow beam pattern is required. Such an application requirement would result where it is necessary to accurately delineate the sides of a dredged channel, or a trench for the underwater laying of pipe or cable. The narrow beam pattern is also useful for more accurately outlining a submerged object such as a sunken vessel. The transducer is also useful for measuring wave heights, where the narrow beam can differentiate between the peak and trough of the waves. The 7245A transducer has been designed to match the electrical characteristics of the model 200T5HAD transducer supplied with the DE-719B Survey Recorder and is supplied with a cable connector for use with the DE-719B equipment. The model 7245A differs from the model 7245 in that it contains a built-in matching transformer to match a 50 ohm line impedance, which is also the transducer output impedance of the DE-719B equipment.

Because of the larger radiating area and greater directivity index, there will be at least a 6 dB improvement in echo strength compared to the smaller 200T5HAD transducer supplied with the DE-719B equipment.

## 3.2 SPECIFICATIONS

7245A Transducer

| | |
|---|---|
| Operating Frequency: | 204 to 210 kHz. |
| Transducer impedance: | 50 ohms +J18 ±20% at operating frequency. |
| Transducer Beam Width: | 2.75° inclusive at -3 dB points.<br>3.5° inclusive at -6 dB points.<br>4° degrees inclusive at -10 dB points. |
| Minor Lobes: | First lobes down at least 11 dB, peaking 4.5° either side of center; all minor lobes beyond 10° down at least 21 dB, and beyond 35° down at least 40 dB. |

00104

## 7245A Transducer (Cont'd)

| | |
|---|---|
| Cable: | Supplied with 30' of 2 conductor #18 shielded and neoprene jacked cable, having O.D. of 3/8". Supplied with Cannon type XLR-3-12C connector plug for use with DE-719B Survey Recorder. Additional cable up to 1500' in length may be used. |
| Housing Material: | Silicon bronze housing with sound window of polyurethane. |
| Mounting: | The mounting stem should be vertical within 1° of the bottom for best resolution. |
| Beam Pattern: | Reference Figure 3-1. |
| Outline: | Reference Figure 5-1. |

## 200T5HAD Transducer

| | |
|---|---|
| Operating Frequency | 208 kHz. |
| Transducer Impedance: | The impedance at 200 kHz with the transducer immersed in water shall be in the range of 50 ohms ±15%. |
| Transducer Beam Width: | Peak response within 2° of mechanical axis. -3 dB points not more than 10° apart. -10 dB points not more than 18° apart. |
| Minor Lobes: | First sidelobes at least 15 dB below on axis response. Outside ±35° off axis, the response must be at least 20 dB below on axis at any angle including sides and rear. |

200T5HAD Transducer (Cont'd)

| | |
|---|---|
| Cable: | The cable is shielded twin with stranded copper shield, all tin plated. Each conductor is the equivalent of 16 strands of #31 AWG. The total cable length is 30' ±6". |
| Housing Material: | Red brass housing. |
| Mounting: | Same as 7245A. |
| Beam Pattern: | Reference Figure 3-2. |
| Outline: | Reference Figure 5-2. |

## 3.3. OPERATION

The 7245A transducer with connector supplied, is plugged directly into the DE-719B transducer socket. No re-tuning of the equipment is required.

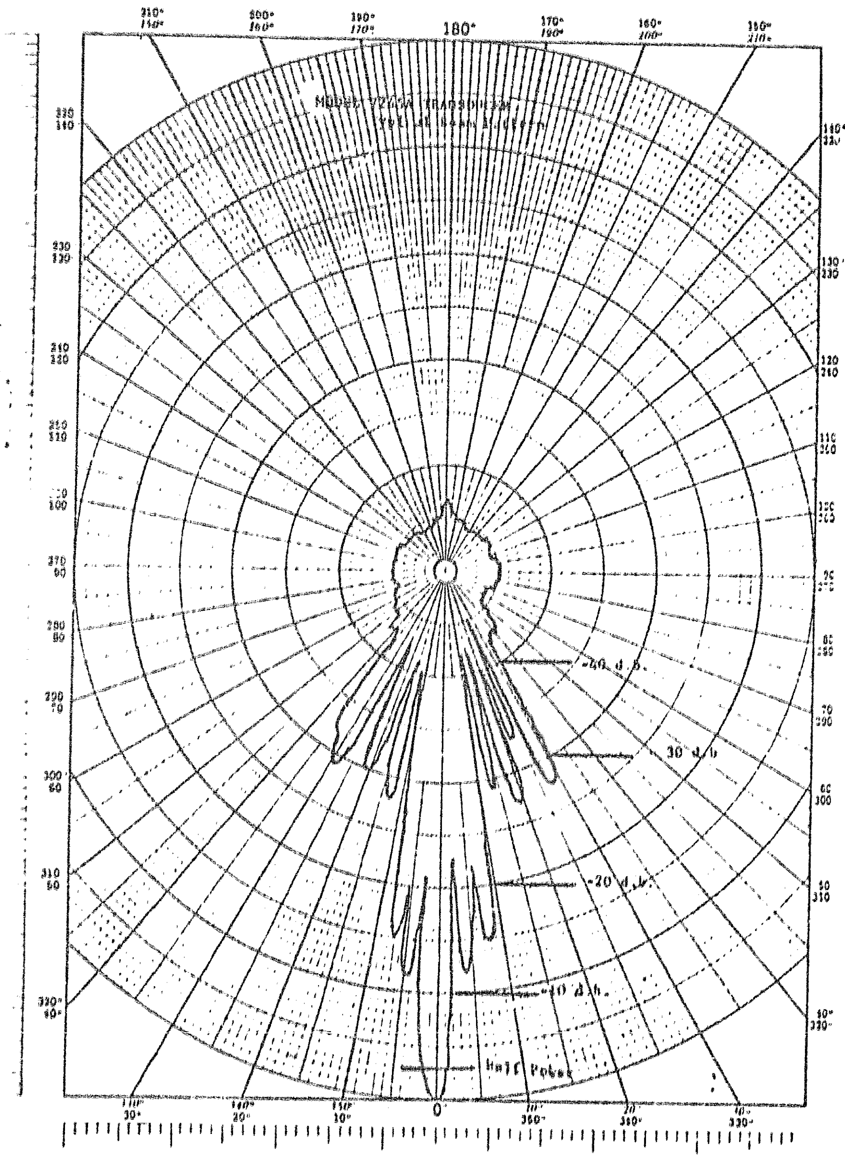


Figure 3-1  7245A Beam Pattern

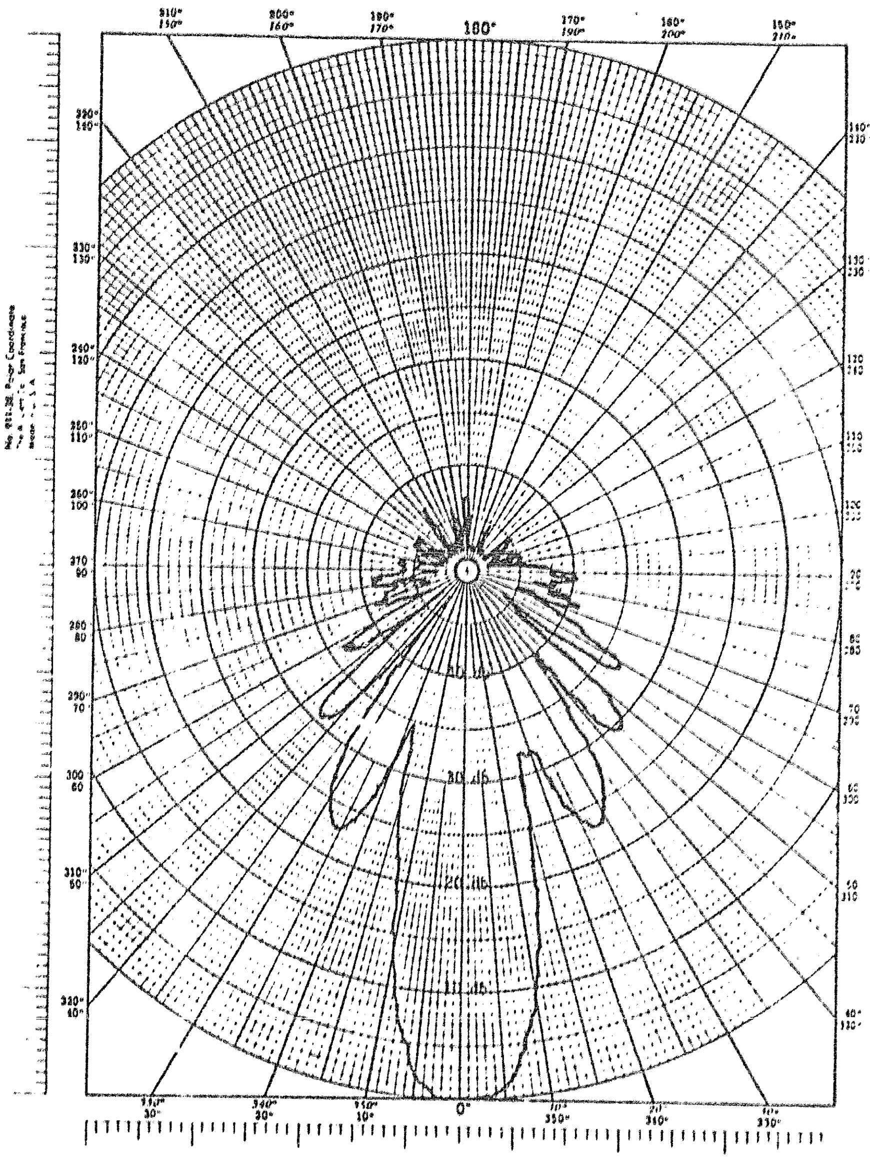


Figure 3-2  200T5HAD Beam Pattern

SECTION 4

# OPERATION

## 4.1 OPERATOR CONTROLS AND FUNCTIONS

1. OFF/STANDBY/ON: Applies power to equipment. In standby chart drive and stylus are disabled but the equipment is warmed up and ready for instant use.

2. SENSITIVITY: Adjusts the receiver sensitivity (gain).

3. FIX MARK SWITCH: A spring loaded switch causes the stylus to inscribe a reference mark the full height of the chart paper. A remote fix-mark switch is available as an optional accessory.

4. TIDE and DRAFT: Adjustment to advance or delay the start of the transmitter pulse to compensate for tide and/or draft differences.

5. SPEED OF SOUND: Enables operator to vary stylus drive motor speed to compensate for salinity content and temperature of water.

6. RANGE X1, X2: Changes speed of stylus to multiply scale by 2 i.e. from 50 feet per phase to 100 feet per phase.

7. CHART SPEED: Selects the rate of chart paper feed; 1, 2, 3 or 4 inches per minute.

8. CAL ZERO: Enables the operator to adjust the first maker line to 0 (zero) on the chart paper. This is to compensate for stylus wear, etc.

9. FEET SWITCH: Selects the desired operating depth range.

## 4.2 OPERATION: INITIAL SET-UP

1. Remove the battery cable and the transducer and support tubes from the back section of the recorder case.

2. Assemble the first section of the support tubing to the transducer. Back off-on the hex nut on the transducer stem far enough to allow the keyhole slot in the tubing to slip over the screw. Tighten the hex nut with a wrench so that it seats firmly in the round part of the keyhole slot.

CAUTION

*Do not turn the screw.*

3. Assemble the remaining sections of the support tubing.

NOTE

*Unscrew, but do not remove, each screw only as far as necessary to clear the keyhole slot. As each section is assembled tighten the screw so that it seats firmly in the circular part of the keyhole.*

4. Slide the clamping ring over the full length of the transducer cable and support tubes. Secure the ring as close to the transducer as possible. Install a guy wire or line in the eye of the clamping ring. This is to provide strain relief for the support tubes when the boat is underway.

5. Clamp the assembled transducer and support tubes to the side of the boat (see Figure 4-1).

NOTE

*Before immersing, wash the transducer face with a solution of liquid detergent and water. (This should be done each time the system is used.) The detergent removes any oil or other-foreign matter which might prevent thorough wetting of the transducer face.*

The support tube should be veritcal in the thwartship plane. In the fore and aft plane the lower end of the support tube should be tilted slightly forward. This will prevent the formation of air bubbles on the transducer face due to cavitation. Adjust the forward guy wire or line to hold this alignment.

NOTE

*The transducer face or radiating surface should be submerged to a depth of at least one foot while underway.*

6. Set the recorder on the seat or deck of the boat. Prop the recorder at an angle with the built-in support. (See Figure 4-2.)

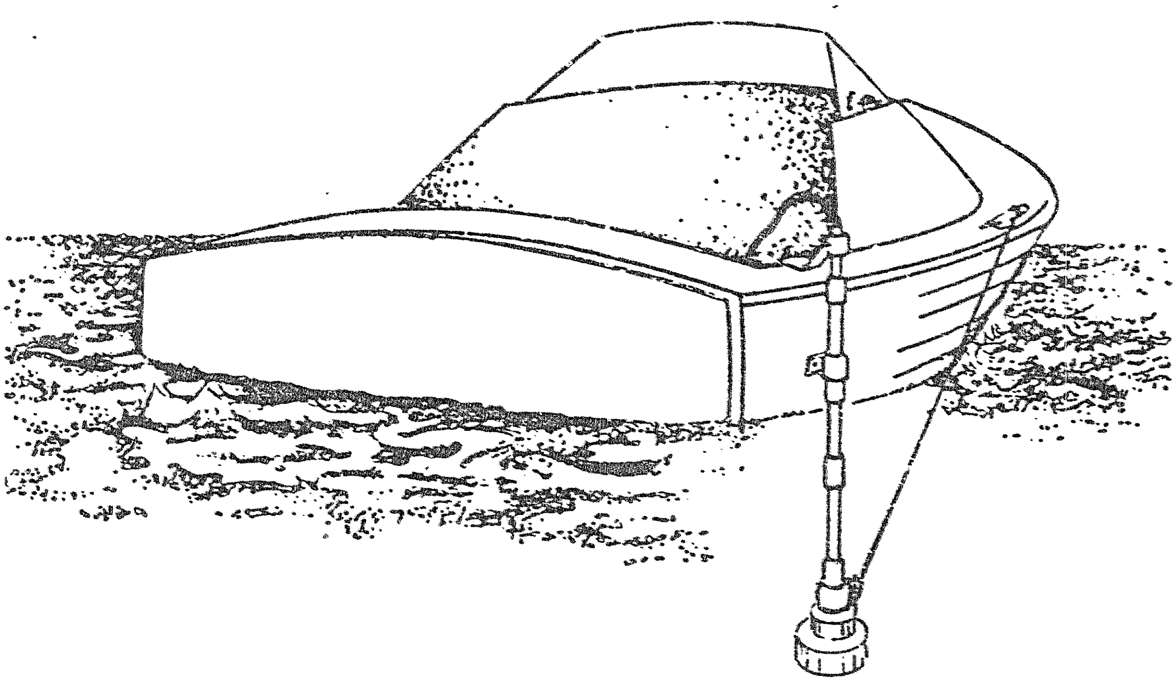

Figure 4-1 Typical Transducer Over-Side Installation

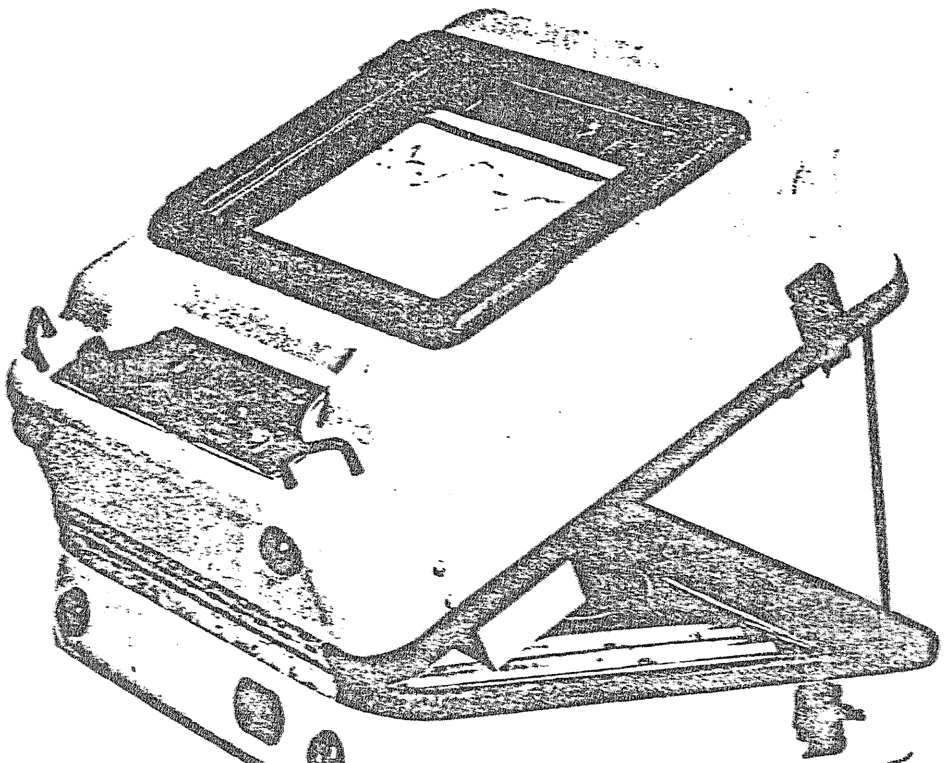

Figure 4-2 Recorder In Operating Position

7. Plug the transducer cable into the appropriate receptacle in the back of the recorder chassis.

8. Plug the battery cable into the BATTERY receptacle on the back of the recorder chassis.

9. Make sure that the OFF/STANDBY/ON control is in the OFF position. Connect the battery clips to a fully charged 12 volt storage battery. BE SURE TO OBSERVE POLARITY.

10. Set the FEET Switch to the 0-55 foot range. Set the RANGE X1, X2 control to X1 (control is located inside hinged front window).

11. Open the front cover of the recorder and rotate the stylus belt counterclockwise through one complete revolution by rotating the upper pulley. Check that the stylus rides in the track at the left side of the assembly and the pulleys turn smoothly. Close the front cover and latch securely.

12. Turn the OFF/STANDBY/ON control to ON. This applies power to the recorder circuitry, stylus drive motor and the chart feed motor.

13. Adjust the front panel CAL ZERO control until the "calibrate zero line" falls on the zero calibration on the chart paper.

*NOTE*

*For this adjustment the direct transmission mark should be moved off the zero calibration by the TIDE and DRAFT control.*

After the CAL ZERO adjustment is completed readjust the TIDE and DRAFT control until the direct transmission mark falls on the chart paper zero line, or as required.

14. Adjust the SPEED OF SOUND control (located inside the hinged window) until the calibrate mark falls on the CALIBRATE line near the bottom of the chart paper. This adjusts the speed of sound to 4800 feet per second.

15. Set the chart paper speed to the desired feed rate: 1, 2, 3 or 4 inches per minute.

16. Turn the FEET switch to the range which brackets the approximate depth reading.

**NOTE**

*The zero transmission mark appears only on the 0-55 foot range.*

17. Advance the SENSITIVITY control slowly clockwise until the bottom echo appears. Continue advancing the control until there is no change in the depth indication. Read the upper edge of the recording for the proper depth reading.

## 4.3 ADDITIONAL CONTROLS

The instructions in Section 4.2 outline the steps required to place the DE-719B in operation. The following controls may be used as required to further utilize the versatility built into this unit.

### 4.3.1 CHART SPEED

There are four distinct chart paper speeds available; 1, 2, 3 and 4 inches per minute. The higher the paper feed the greater the bottom detail.

### 4.3.2 FIX-MARK Switch

This switch when pressed to the right will inscribe a mark on the chart paper for time and/or position reference. Annotations can be made adjacent to the fix mark by opening the hinged window in the front of the recorder. A guard prevents accidental contact with the rotating stylus and belt assembly.

### 4.3.3 TIDE and DRAFT Adjustment

This adjustment permits the operator to advance or delay the transmitter pulse to compensate for tide and/or draft variations. The latitude of adjustment is from a minus 5 feet to plus 30 feet.

### 4.3.4 SPEED OF SOUND Compensation

This control allows the operator to compensate for variations in the temperature and salinity content of the water. Adjustment of this control permits the accuracy of the recorded depth reading to be calibrated to a "check-bar" reading. A calibration marker, indicating the amount of compensation, is permanently recorded on the chart for future reference.

## 4.4 HOW TO INTERPRET RECORDINGS

A basic factor to be considered when interpreting bottom conditions is that a hard bottom will reflect an echo more strongly than a soft bottom. To obtain bottom readings, set the SENSITIVITY control to the minimum position that produces a good consistent record.

A flat bottom composed of rock, sand or packed mud usually results in a fairly thin dark trace on the chart paper. This type of bottom creates multiple echoes in shallow water caused by the signal bouncing back and forth between the bottom and the surface. These echoes show as multiples of the actual depth which is always the shallowest reading.

A soft mud bottom produces a broad echo of light intensity. The broad echo is caused by the reflection of the transmitted signal from the top of the mud and the hard surface beneath the mud. The thickness of the soft mud layer can often be determined by a split in this type of echo.

Another indication of the type of bottom is the the relative setting of the SENSITIVITY control required to obtain recordings at various depths. The strongest echoes are generally obtained from the air-water interface. Rock, sand, metal, wood, fish and plankton return echoes in a diminishing order of strength. The air-to-water transistion may occur when passing over your own or another vessels wake.

During deep water soundings, the conical sound beam propagated from the transducer is reflected from a large area of the bottom resulting in a wide echo; whereas in shallow water the sound wave is reflected from a smaller area and produces a narrower echo.

## 4.5 OPERATOR REPLACEMENTS

### 4.5.1 Chart Paper Removal Procedure (Figures 4-3, 4-5)

1. Disconnect power from the equipment.

2. Release case latches and swing front cover down.

3. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

4. Rotate take-up knob (16) to wind chart paper onto the paper take-up roll (20). Guide paper by hand to avoid fouling.

5. Release quick-lock (1) and swing platen assembly (14) to the right.

6. Grasp paper take-up roll (20) in left hand, lift up spring loaded paper take-up arm (17) with right hand to disengage upper end cap.

00113

7. Grasp paper take-up roll (20) in left hand, lift up spring loaded paper take-up arm (17) with right hand to disengage upper end cap.

8. Lift and tilt the paper take-up roll (20) to disengage it from lower end cap (21), and remove the roll.

4.5.2 Chart Paper Installation Procedure

1. Disconnect power from the equipment.

2. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

3. Release quick-lock (1) and swing platen assembly (14) to the right.

4. Pull up knurled, spring-loaded paper supply knob (27), tilt paper supply roll shaft (26) away from the platen.

5. Remove the empty chart paper spool from the paper supply roll shaft (26) and install it in position on paper take-up roll (20) by raising paper take-up arm (17), taking care to engage spool end slots with key projections on end caps (19) and (21).

6. Hold paper retard spring (25) to one side and slide new roll of chart paper down over paper supply roll shaft (26), taking care to engage slotted end of chart paper spool with key projections on end cap (22). Release paper retard spring (25).

7. Tilt paper supply roll shaft (26) back to normal position, pull up paper supply knob (27) so it clears the frame. Release paper supply knob (27), making sure that it seats securely in its frame socket. Check position of paper retard spring (25) against paper supply roll.

8. Thread leading end of chart paper to the left around paper feed roller assembly (24), under the stylus guide block (10).

9. Swing platen assembly (14) to the left to its normal position.

10. Draw the loose end of the chart paper across the platen assembly (14) to the live roller assembly (15).

11. Swing platen assembly (14) to the right to its open position while continuing to draw chart paper around live roller assembly (15), threading paper between frame and paper take-up roll.

00114

12. Attach loose end of chart paper to spool with the tape supplied with the new roll.

13. Rotate the take-up knob (16) to wind two or three layers of paper onto the paper take-up roll (20), guiding the paper by hand so it aligns properly. When all the slack is removed from the paper, it should lie flat and wrinkle-free on the platen assembly (14).

14. Swing the platen assembly (14) to the left and fasten the quick-lock (1).

15. Rotate the drive pulley (13) counterclockwise and check the recording stylus (8) for straight and smooth travel over the chart paper.

16. Raise the front cover up into the closed position and secure the latches.

17. Operate the equipment at maximum chart speed to check chart paper travel and stylus function.

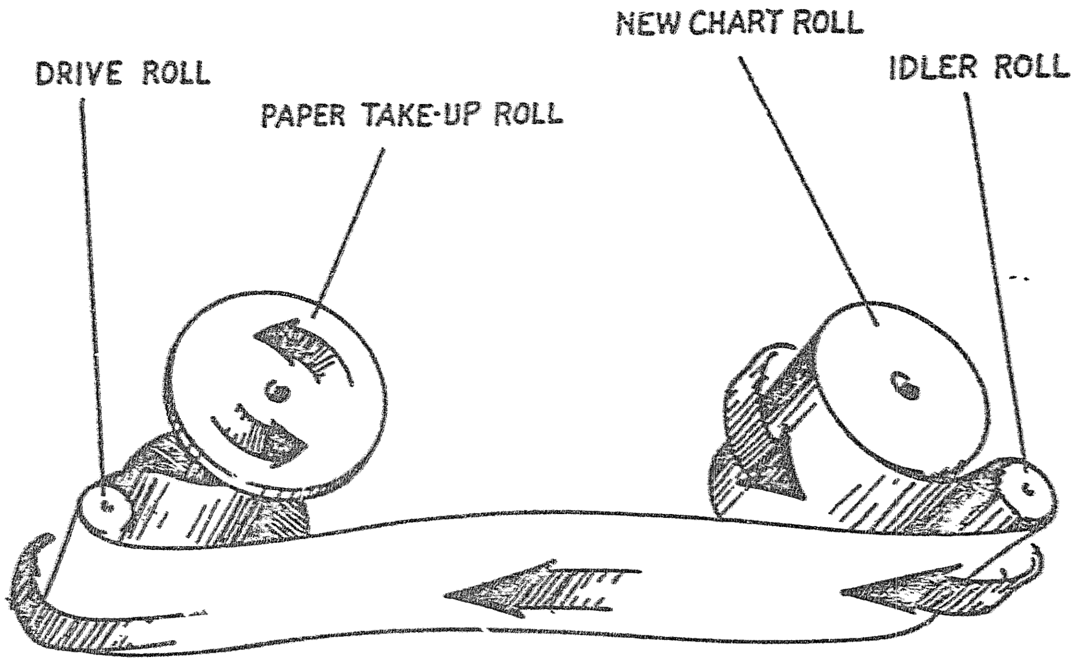


Figure 4-3 Chart Paper Threading

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4.5.3 <u>Recording Stylus Removal Procedure</u> (Figures 4-4 and 4-5)

1. Disconnect all power from the equipment.

2. Release the latches and lower the front cover.

3. Rotate the drive pulley (13) slowly counterclockwise to position the recording stylus (8) off the paper.

4. Remove stylus from holder by compressing the ends sufficiently to clear the holder hooks. Push down lightly to compress the sponge pad and permit disengagement from the center hooks.

4.5.4 <u>Recording Stylus Installation Procedure</u>

1. Disconnect all power from the equipment.

2. Release latches and lower the front cover.

3. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

4. Engage center loop of new stylus with center hook on stylus holder. The sponge pad must be depressed to permit insertion of the stylus ends into the end hooks. <u>NOTE</u> - *Hooked end of stylus must be toward the guide.*

5. Rotate drive pulley (13) counterclockwise to insure that one end of the stylus engages the trolley (11) Vee groove, and the other end maintains full contact with the guide rail and the chart paper throughout the full length of travel down the chart paper.

6. Raise the front cover up into the closed position and secure latches.

7. Restore power, turn the equipment on and allow to operate for approximately five minutes, or until the recording stylus (8) inscribes a smooth, straight line when the FIX MARK switch is actuated.

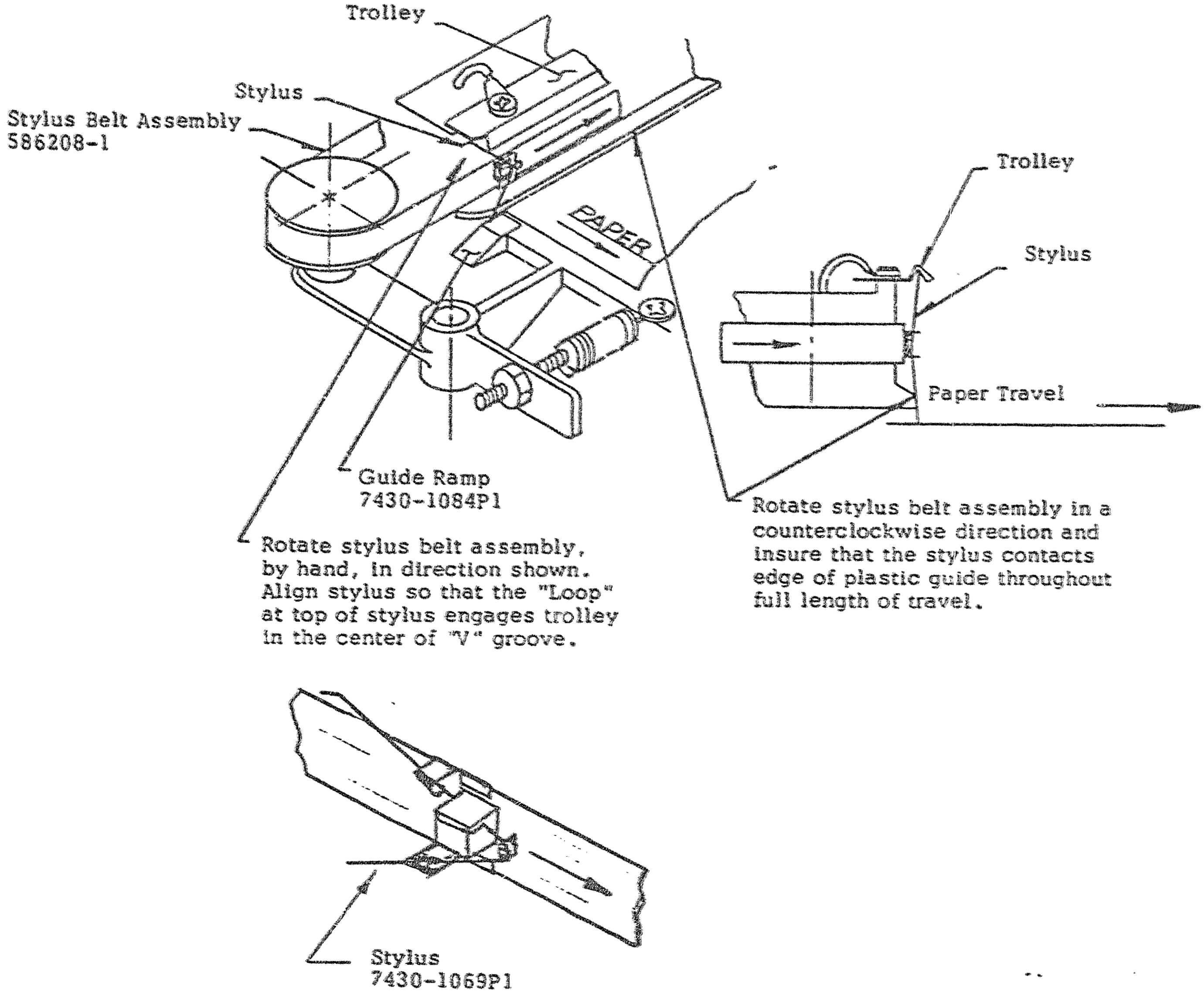
4.5.5 <u>Stylus Belt Removal Procedure</u> (Figures 4-4 and 4-5)

1. Disconnect all power from the equipment.

2. Release latches and lower front cover.

3. Rotate drive pulley (13) slowly counterclockwise to position the stylus off the paper.

00116



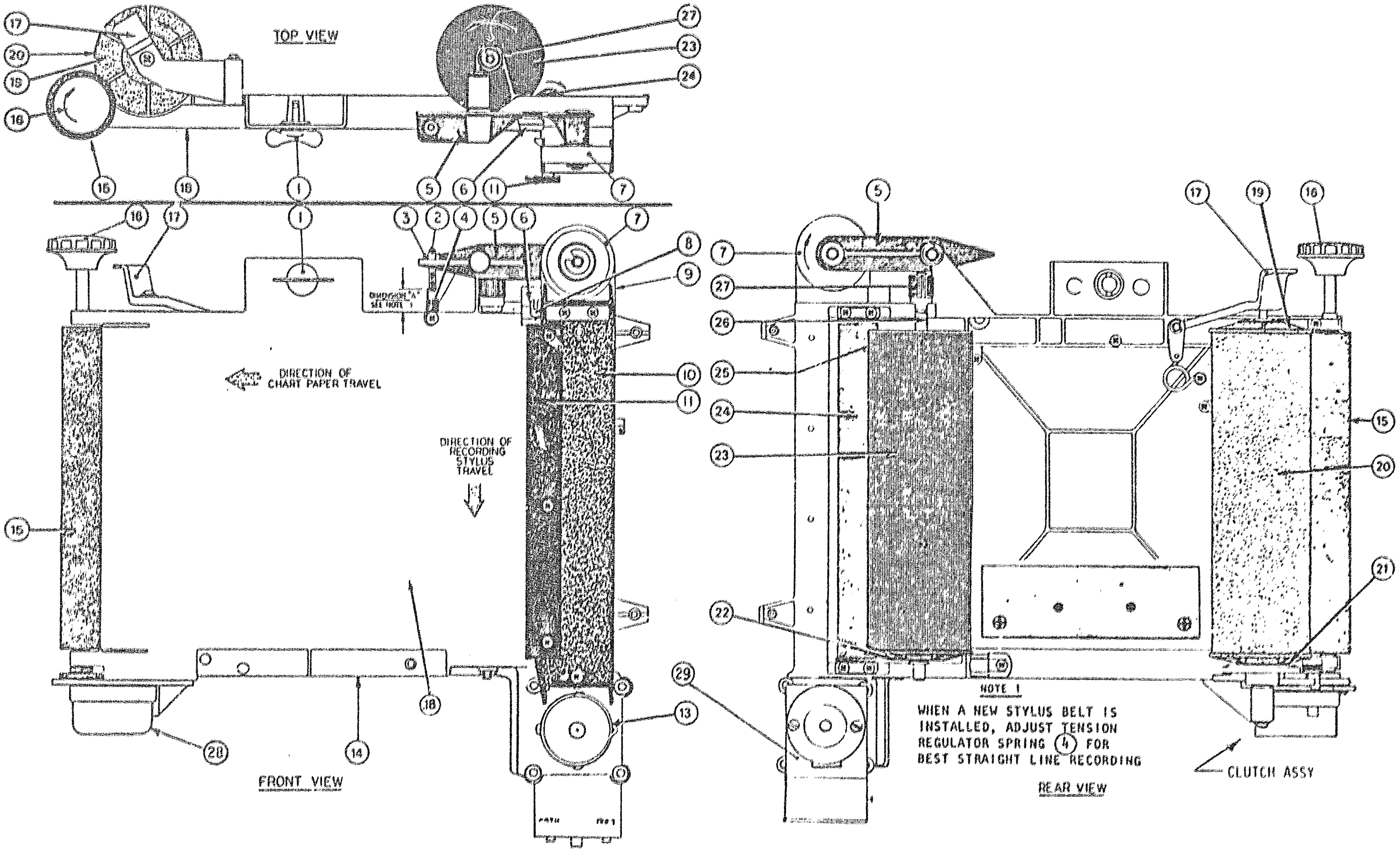

NOTE:

1. When a new stylus is installed, operate the equipment on the X1 RANGE for approximately five minutes, or until the stylus draws a straight line when the FIX MARK switch is actuated. This "break-in" period is necessary to remove any burrs which might be present on the writing end of the stylus.

2. When a new stylus belt is installed, adjust the belt tension for optimum straight line recording. Install stylus and observe mark inscribed on chart paper when FIX MARK is actuated. If mark fluctuates more than 1/16 inch from side to side, increase tension until "track" ceases to fluctuate.

Figure 4-4 Belt and Stylus Replacement

00117




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Quick Loc | 373-7188P1 | 11 | Trolley | 7430-1068P1 | 22 | End Cap | 7430-1025P1 |
| 2 | Tension Req Screw | 7430-1067P1 | 13 | Drive Pulley | 7430-1076G2 | 23 | Paper Supply Roll | 7430-1013P1 |
| 2 | Self Loc-Nut | 203-1011P47 | 14 | Platen Assy | 7430-5013G1 | 24 | Paper Feed Roller Assy | 7430-1079G1 |
| 4 | Reg Tension Spring | 7275-1016P1 | 15 | Live Roller Assy | 7430-1078G2 | 25 | Paper Retard Spring | 7430-1062P1 |
| 5 | Tension Arm | 7430-1006G1 | 16 | Take Up Knob | 231-7184P1 | 26 | Paper Supply Shaft | 7430-1007P2 |
| 6 | Stylus Guide Ramp | 7430-1084P1 | 17 | Paper Take Up Arm | 7430-1008P1 | 27 | Paper Supply Knob | 7430-1014P1 |
| 7 | Idler Pulley | 7430-1076G3 | 18 | Platen | 586090-2 | 28 | Chart Motor | 315-7228P4 |
| 8 | Recording Stylus | 7430-1069P1 | 19 | End Cap, Paper Take | 7430-1026P1 | 29 | Stylus Motor | 315-7223P1 |
| 9 | Stylus Belt Assy | 586208-1 | 20 | Paper Take Up Roll | 7430-1007P4 | | | |
| 10 | Stylus Guide Block | 586166-1 | 21 | End Cap (Lower) | 7430-1026P1 | | | |

Figure 4-5 Platen Assembly



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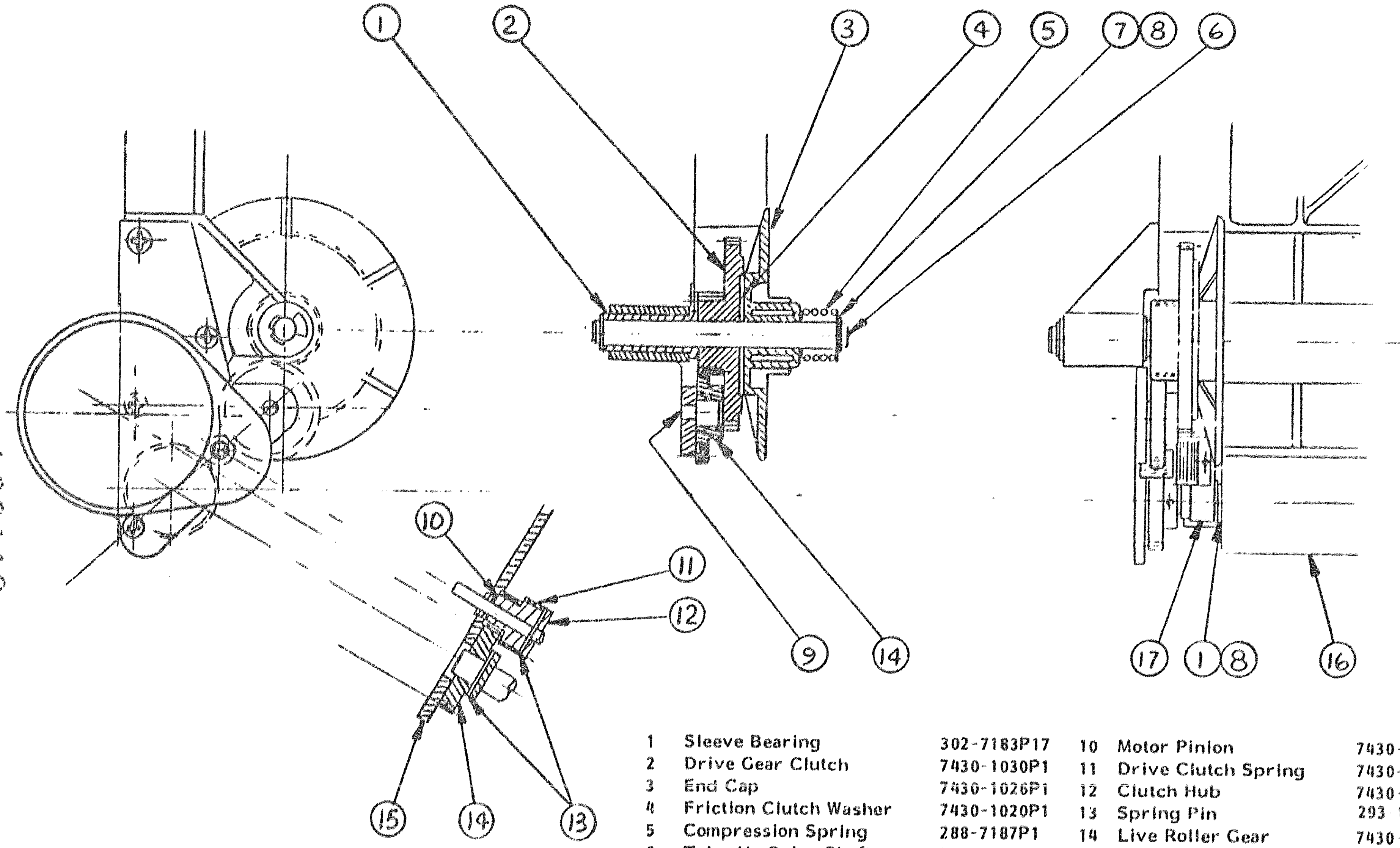


| | | | | | |
|---|---|---|---|---|---|
| 1 | Sleeve Bearing | 302-7183P17 | 10 | Motor Pinion | 7430-1029P1 |
| 2 | Drive Gear Clutch | 7430-1030P1 | 11 | Drive Clutch Spring | 7430-1037P1 |
| 3 | End Cap | 7430-1026P1 | 12 | Clutch Hub | 7430-1017P1 |
| 4 | Friction Clutch Washer | 7430-1020P1 | 13 | Spring Pin | 293-1022P237 |
| 5 | Compression Spring | 288-7187P1 | 14 | Live Roller Gear | 7430-1028P1 |
| 6 | Take-Up Drive Shaft | 7430-1007P4 | 15 | Drive Train Assy | 7430-1036P1 |
| 7 | Retaining Ring | 362-7176P17 | 16 | Live Roller Assy | 7430-1078G2 |
| 8 | Shim Washer | 236-7174P8 | 17 | Bearing Retainer | 7430-1087P1 |
| 9 | Idler Stud | 7430-1016P1 | | | |

Figure 4-5A Platen Clutch Assembly

4. Release tension on stylus belt assembly (9) by pressing down on spring-loaded tension arm (5) while slipping the belt off the idler and drive pulleys.

### 4.5.6 Stylus Belt Installation Procedure

1. Disconnect all power from the equipment.

2. Release latches and lower front cover.

3. Depress the stylus belt tension arm (5) and loop the new belt assembly (9) over the idler pulley (7) and drive pulley (13) so that the recording stylus (8) is in the position illustrated in Figure 4-4; Front View.

4. Rotate the drive pulley (13) counterclockwise by hand to check the belt for proper tracking around the pulley.

5. Check for straight line recording at maximum chart speed. Adjust as required.

6. Install a new stylus as described in Section 4.5, paragraph 4.

7. Restore power to the equipment, turn on and observe the mark inscribed on the chart paper when the FIX MARK switch is actuated. If the mark fluctuates from left to right, increase tension of regular spring (4) until the mark does not deviate.

## 4.6 OPERATOR ADJUSTMENTS

### 4.6.1 Calibration Marker Adjustment (Standard Chart Paper)

The speed of the stylus drive motor can be varied by the operator to compensate for variations in the speed of sound in water using a "check bar" or the calibration marks generated within the DE-719B, as a reference.

The fixed reference marks are generated by a stable time base circuit which produces two sharp pulses spaced exactly 20.833 milliseconds apart. These pulses are electrically superimposed on the analog output to the recording stylus and will fall exactly 50 feet apart on the chart paper when the stylus drive motor speed is adjusted to the speed of sound in water of 4800 feet per second. The sharp line inscribed on the chart by the transmitted pulse is adjustable to the zero depth calibration on the chart by the CAL ZERO control and the line initiated by the second pulse will fall on the 50-foot chart "calibrate" line.

For each one percent change in the speed of the stylus drive motor (from a base speed or 4800 feet/second) the calibrate mark will change position by one-half foot. For example, if the stylus drive motor speed was increased by two percent the calibrate mark would move from the 50-foot "calibrate" line to the 51-foot graduation. Conversely, if the motor speed was decreased by four percent the mark would move from the "calibrate" line to the 58-foot graduation.

The "calibrate" line is also used to indicate the recording phase in use. The line is intermittently broken into a series of one, two, three or four short dashes to indicate the first, second, third or fourth phase.

Adjust as follows:

1. Be sure that the stylus drive motor speed is adjusted to 3350 RPM.

2. Adjust the CAL ZERO control until the calibrate zero line falls directly on the chart paper zero line.

   *NOTE*

   *The direct transmission pulse can be moved off the zero line by the TIDE and DRAFT control while makeing the calibrate zero adjustment.*

3. Adjust potentiometer R210 until the second calibrate pulse falls exactly on the chart paper "calibrate" line.

   *NOTE*

   *Adjustment of the SPEED OF SOUND control, R305, varies the position of the 50-foot calibration line by plus and minus three feet. The calibrate lines (at zero and 50 feet) are not present when operating on the X2 range.*

4.6.2 Calibration Marker Adjustment (Metric Paper)

When your DE-719B is ordered from the factory with metric chart paper installed, the unit will be factory calibrated for metric scales.

If your DE-719B is calibrated for use with the standard chart paper and it is desired to change to the metric chart paper, it will be necessary to re-calibrate the built-in marker calibrate circuit. This is necessary since the 50-foot calibration line does not agree with an even number in meters and the actual calibration point for the metric paper has been set at 15 meters for ease in reading. The ratio between 50 feet and 15 meters is 0.9821 and the calibration marker adjustment (internal) must be changed by this amount.

The adjustment procedure is as follows:

1. With the standard chart paper (feet) installed, adjust the SPEED OF SOUND control so that the calibration marker lines fall at exactly 0 and 50 feet on the chart paper.

2. Remove the plastic cover from the "Motor Control" printed circuit board and adjust potentiometer R210, in the upper right hand corner, until the 50 foot calibrate line falls at 49.1 feet on the chart paper.

3. Remove the standard chart paper and install the metric chart paper. Make certain that the original 50-foot calibrate mark on the standard chart paper now falls at 15 meters on the metric chart paper.

CAUTION

*DO NOT READJUST THE "SPEED OF SOUND" CONTROL DURING THIS OPERATION.*

*NOTE*

*If metric paper (P/N 587630-1) will be used only occasionally it will not be necessary to recalibrate, merely bear in mind that the calibrate mark will fall at 15.27 meters instead of 15 for a speed of sound of 4800 feet per second.*

*When the DE-719B is calibrated for metric operation the drive motor speed will be 3290 RPM rather than the 3350 RPM called out in the manual. In the X2 range the motor speed for metric operation will be 1645 RPM rather than 1675 RPM as specified in the manual.*

## SECTION 5

## INSTALLATION

### 5.1 RECORDER

Although the DE-719B recorder is designed for portable use it may be installed permanently. The slotted key holes in the back of the case permit bulkhead mounting. The battery input power cable (or AC power cable) and the transducer cable enter the case via the two holes in the back. The holes are of sufficient size to provide clearance for the power and transducer cable plugs.

If desired, the recorder may be mounted at a $45^{\circ}$ angle for easy viewing and operation. Installing the recorder with the right side toward the bow of the vessel will make the recording naturally assume the correct correlation with the over-the-bottom travel of the vessel.

### 5.2 TRANSDUCER

The type 200T5HAD transducer (furnished with the DE-719B) may be installed temporarily as described in the Operation section or it may be permanently installed.

#### 5.2.1 Permanent Transducer Installation

1. Select a location which is close to the keel and will not be subject to turbulent water passing across the transducer face. The transducer must be completely immersed when the boat is underway; also the radiating surface must be as nearly parallel to the water line as possible.

2. Leave sufficient space within the hull for tightening the nut on the transducer stem and for routing the cable to the recorder.

3. Remove the screw and locknut from the side of the transducer sleeve (see Figure 5-2).

4. At the selected location bore a 1-1/16 inch hole through the blocks as shown.

5. The block outside the hull should be streamlined to conform to the shape of the transducer to reduce the possibility of water turbulence.

6. The filler block inside the hull must be thick enough so that the nut/washer does not seat against the top of the transducer sleeve before tightening against the filler block.

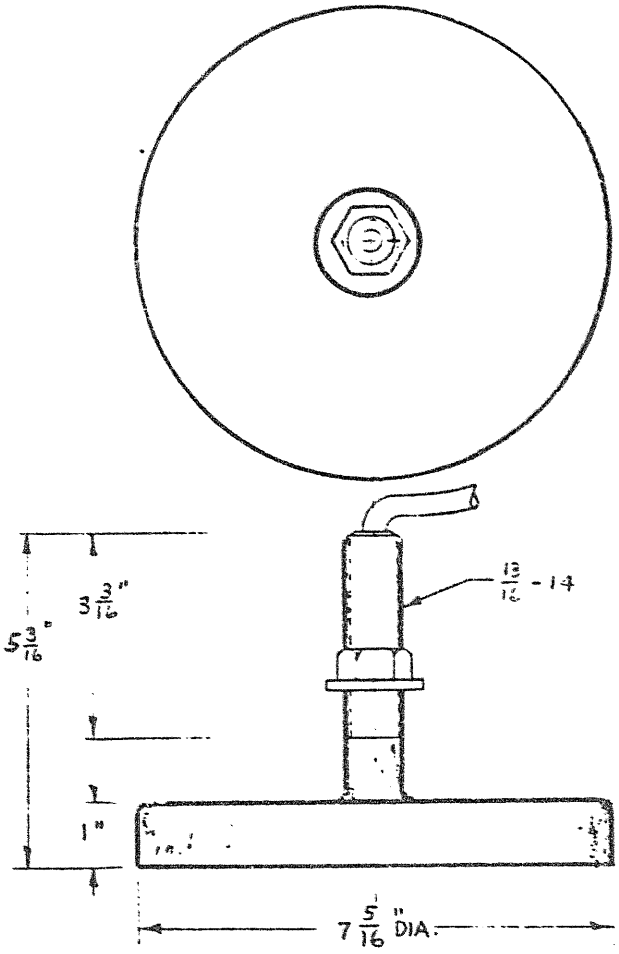


Figure 5-1 7245 Outline

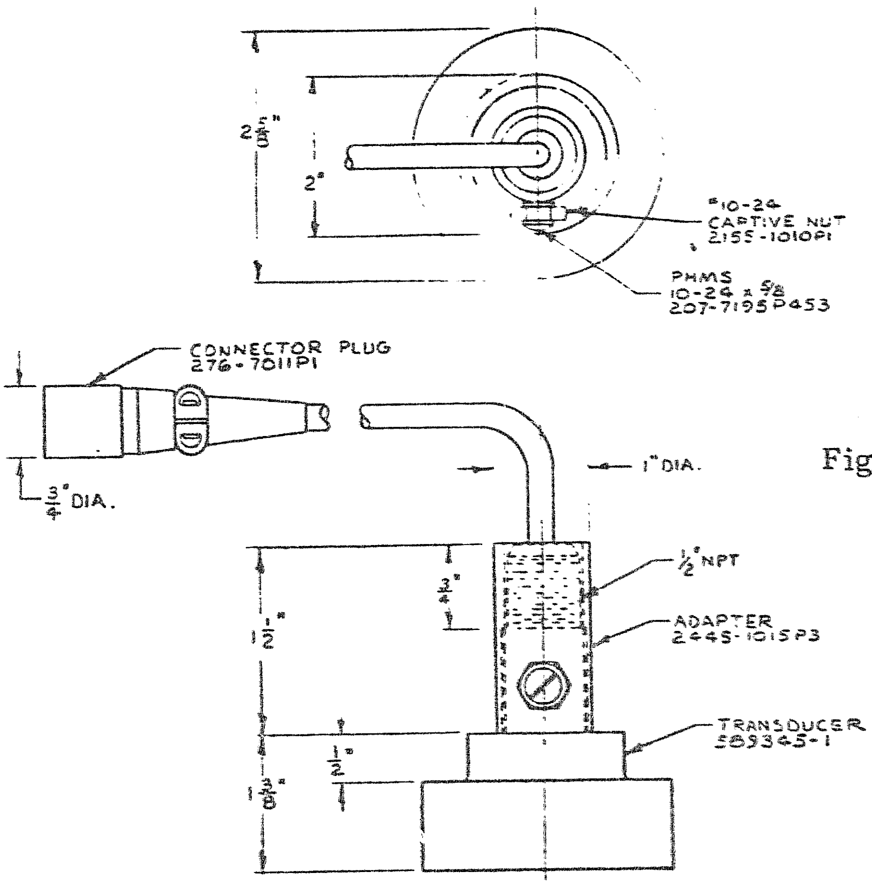


Figure 5-2 200T5HAD Outline

F00124

7. Remove the plug from the cable; do not cut the cable.

8. Coat the inner and outer fairing blocks with a good quality seam filler or bedding compound.

9. Thread the cable through the hole in the outer fairing block and the hole in the hull.

10. Insert the transducer stem up through the outer block and the hull.

11. Before launching the boat, wash the face of the transducer with a solution of liquid detergent and water.

5.2.2 Cable Installation

1. Inside the vessel, thread the cable through the hole in the fairing block, canvas washer (well coated with white lead), and the bronze nut/washer.

2. Place the above, in the order listed, over the protruding stem of the transducer, and tighten nut/washer securely.

3. If the cable end becomes wet with bilge water, wash with fresh water and dry thoroughly.

4. Route the transducer cable to the recorder location by the most direct path keeping the cable as far as possible from ignition wiring.

5. If the cable is too long, coil it and store it out of the way do not cut as this would impair operation.

6. Reinstall the plug.

## 5.3 115/230 VAC POWER SUPPLY INSTALLATION

The AC power supply is designed to mount on the main chassis below the platen assembly as shown in Figure 5-3.

To install:

1. Remove the plastic plug from the hole in the main chassis marked J303.

2. Mount the power supply chassis as shown in the photograph.

3. Connect the black lead to the bottom terminal on TB303.

00125

4. Connect the red lead to the second from the top terminal on TB303.

5. Connect the jumper straps on TB301 for 115 or 230 VAC depending on power source. The strapping diagram is shown on the back of the main chassis panel. (Ref. Figure 7-3.)

6. Connect the AC power to the connector J303.

7. The OFF/STANDBY/ON switch on the front panel will control the application of power to the equipment.

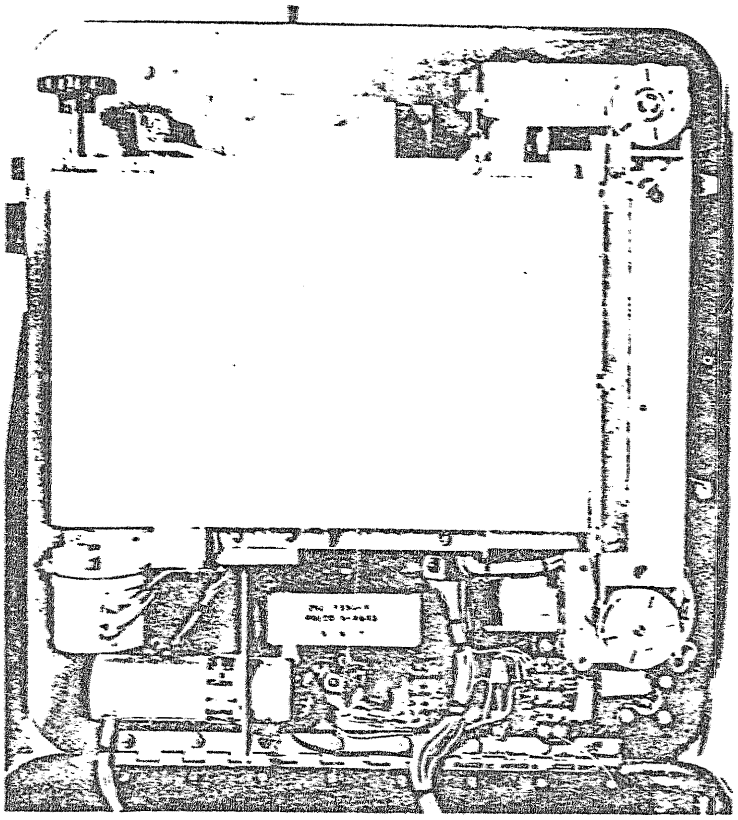

Figure 5-3 115/230 VAC Power Supply-Installed

?00126

## SECTION 6

## THEORY OF OPERATION

### 6.1 TRANSMITTER

The transmitter circuitry is basically a Master-Oscillator Power-Amplifier configuration operating at a frequency of 208 kHz. Transistor Q102 operates as a pulsed oscillator normally in a cut-off state. When a positive-going signal is received at the base of Q102 from the TIDE and DRAFT ADJUST circuit, it oscillates at the frequency determined by the collector tuned circuit. The length of the pulse is determined by the build-up time of the RC network in the emitter of Q102; this is approximately 200 microseconds in both the X1 and X2 modes of operation. The secondary of the oscillator transformer is coupled to the base of Q103 which functions as a class "C" amplifier with the collector tuned to the oscillator frequency by the primary of T102 and the transducer capacity. Operating voltage for the transmitter amplifier is furnished by the built-in inverter. The inverter consists of a 150 kHz oscillator the output of which is rectified and filtered and clamped to 40 VDC by zener diode CR101. The inverter oscillator operates from the 12.6 VDC supply voltage and is tuned to 150 kHz by C101, C102 and L102.

### 6.2 RECEIVER

The transmitted pulse and the returning echo pulses are coupled to the receiver by the secondary of transformer T102. The receiver consists of two transformer-coupled stages, Q102 and Q103, tuned to 208 kHz. A factory set internal gain control, R112, determines the maximum sensitivity of the receiver. The front panel SENSITIVITY control permits the operator to vary the receiver to the desired gain level. The output of the receiver is rectified and filtered to remove the 208 kHz component. The resultant DC pulses supply the collector of Q106, the stylus oscillator, which is Colpitts configuration tuned to approximatley 22 kHz. The output from T105 is fed to Q107, an emitter follower, and in turn, to Q301 the power amplifier. The output of Q301 is fed to the stylus by the step up cupcore transformer T301.

### 6.3 MOTOR SPEED CONTROL

The stylus drive motor is a series wound DC motor; the speed is variable and is controlled electronically as follows: Speed sensing coil L305, which is wound on a small permanent magnet, is positioned such that a toothed disc, mounted on the motor shaft, is in the magnetic field of the coil. When the motor shaft and toothed disc rotate, a frequency directly proportional to the speed of the motor is generated in L305. The voltage developed is fed to the base of Q207 where it is amplified and fed to a one-shot multivibrator, Q208 and Q209. The multivibrator is triggered at a rate determined by the speed of the motor. Capacitor C217, in the base circuit of Q210, functions as an integrator; therefore the input to Q210 is a DC voltage which is inversely proportional to the speed of the motor (the voltage fed to the base of Q210 is maximum when the motor is stationary). Q210 compares the voltage on C217 with a zener voltage at CR207; when the output falls below the zener level Q210, Q211 and Q302 decrease conduction and maintain the motor at the proper speed. Zener diodes CR206 and CR208 limit the square wave signals from the multivibrator to the same amplitude irrespective of power supply variations. The voltage being compared is a result of frequency only, rather than of possible amplitude variations.

Transistor Q302 and the drive motor are supplied power from an unregulated source which will vary with the ship's power line variations. The drive motor circuitry is designed so that motor speed changes are slight regardless of large line voltage excursions. Diode CR301, connected across the motor, prevents the voltage on Q302 from rising too high when the transistor cuts off and opens the winding. The motor speed is governed in the same manner for both the X1 and X2 scales by merely changing the Rep Rate of the multivibrator with the Range X1, X2 control S302 and associated components. R305, the Speed of Sound control, permits the operator to vary the motor speed to compensate for variations of the speed of sound in water of various density and temperatures.

## 6.4 CHART DRIVE MOTOR CIRCUITRY

The chart drive mechanism is advanced by a stepping motor at the rate of 1, 2, 3 or 4 inches per minute; the speed is selected by the front panel control switch S304.

The electronics circuitry supplying power to the stepping motor consists of the following: A unijunction transistor Q212 with a repetition rate determined by C221 and a resistor selected by S304. Four different repetition rates are necessary to produce the 1, 2, 3, and 4 inch per minute paper feed. The repetition rates are factory set by adjustment of R241, R242, R243 and R244.

The theory of operation of the drive motor circuitry is as follows: each time the unijunction Q212 fires, a positive pulse is developed across R247 which controls a flip-flop circuit consisting of transistors Q213 and Q214. The pulse cuts off whichever transistor is on and in turn biases the other transistor on. The positive square wave outputs from the collectors of the flip-flop transistors are coupled via emitter followers Q215 and Q216 to the base of the stepping motor transistors Q217 and Q218. This causes Q217 and Q218 to alternately turn on and supply power to the stepping motor. From the above explanation it can be readily seen that with a faster unijunction rep. rate the stepping motor will turn faster.

6.5 TIDE AND DRAFT ADJUSTMENT CIRCUITRY

The positive-going pulse from the keying pick-up coil (L301-L304, depending on which phase is in use) is coupled to Q108, amplified and fed to the base of Q109 which is the first transistor of a single-shot multivibrator. This pulse is negative and cuts off Q109. The length of time Q109 is off and Q110 is on is determined by the RC discharge time of C127, R135 and the setting of potnetiometer R303 (Tide and Draft adjustment). The output of the transistor Q110 is differentiated and coupled to the base of Q102, the 208 kHz transmitter oscillator, turning it on.

6.6 SPEED CHECK MARKER

The Speed Check Marker circuitry, which operates only on the X1 mode, causes two fixed marks, 20.833 milliseconds apart, to appear constantly on the chart paper. The first of these two marks is adjusted by the CAL ZERO control, R307, to appear on the zero line of the chart paper at all times; the second mark automatically appears on the CALIBRATE line near the bottom of the chart. The second mark (calibrated) will be interrupted periodically to indicate the phase on which the recording was made. For example, two interruptions with one solid mark indicates operation on phase 1 (0-55 feet); three interruptions with 2 solid marks indicates operation on phase 2; etc. The primary purpose of the Speed Check Marker is to indicate the speed of the stylus drive motor. Should the motor speed vary the operator will be alerted; for example, should the motor run too fast the second mark will be below the calibrate line, and conversely if the motor is running too slow the second mark will be above the calibrate line. The "Speed of Sound" control allows the operator to vary the motor speed in accordance with local operating conditions.

The electronics circuitry for the Speed Check Marker operates as follows: Pickup coil L301 is connected through a coupling capacitor C201 to the base of Q201 which amplifies the positive going pulse impressed across the pickup coil. The amplifier pulse (now negative) is coupled to the base of Q202, the first transistor of a single-shot multivibrator, turning it off. The length of time this stage remains off is determined by the RC discharge time of C205, R207 and R307. The output of Q203, the second transistor of the multivibrator, is differentiated and its positive going pulse is fed to the base of Q204 which in turn conducts and turns on the unijunction Q205. This disrupts the normal repetition rate of the unijunction circuitry, the normal rate being determined by C208, R211 and the Rep. Rate adjust potentiometer R210. It is this trigger pulse that appears on the zero line of the chart paper. The purpose of this multivibrator is to permit the operator to either advance or delay this trigger pulse with the front panel control until it coincides with the zero line on the chart paper. After Q204 restarts the unijunction, it reverts back to its normal Rep. Rate. The initial pulse of this Rep. Rate, which is factory set by R210, shows on the "calibrate" mark on the chart paper. Both the "zero" and "calibrate" marks are coupled to the Colpitts Oscillator in the receiver via Q206 the pulse amplifier.

The interruptions in the "calibrate" mark (to indicate Phases 1, 2, 3 and 4) are obtained by mechanically grounding the base of Q206 through C225 and S303 to obtain the proper number of dashes which corresponds with the particular phase in use.

SECTION 7

MAINTENANCE

## 7.1 GENERAL

A routine maintenance schedule should be initiated to assure that your DE-719B equipment is kept in peak condition and ready for instant use. A program of regular maintenance can go far toward preventing major breakdowns and unnecssary downtime.

The recorder interior should be protected from excessive moisture. The recorder is designed to withstand dampness, but severe drenchings could render it inoperative and lead to costly repairs. Condensation of water vapor (due to lowering temperature when humidity is high) could cause malfunction; therefore, the equipment should be stored in a dry, well-ventilated location.

The unit should be checked periodically to be sure that all hardware is tight and the cabinet (inside and outside) should be kept clean. Carbon dust will collect inside the recorder case as a result of the recording process. The recorder interior should be cleaned with a soft brush and rag; the frequency of the cleaning operation will be largely determined by the amount of usage.

## 7.2 LUBRICATION

The DE-719B is constructed with oilite and ball-type bearings which are designed to provide many hours of trouble-free operation. The bearings are pre-lubricated at the factory and will not require further lubrication for the life of the bearing. The drive gears are nylon, therefore do not require lubrication. All hinges and hasps should be periodically lubricated with a light oil to prevent seizure, especially when the equipment is used around salt water.

## 7.3 INTERNAL CONTROLS (FACTORY SET)

The following controls are preset at the factory and should not be readjusted without the proper test equipment.

| Control | Function |
|---|---|
| R112, Internal gain | Sets receiver gain to 40-microvolt maximum |
| R210, Marker circuit | Sets rep. rate of unijunction Q205 |
| R227, Scale X2 speed adj. | Trim potentiometer, sets stylus motor speed on scale X1 |

| Control | Function |
|---|---|
| R241, Paper feed adj. | Sets rep. rate of unijunction Q212 to feed chart paper at 1" per minute |
| R242, Paper feed adj. | Sets rep. rate of unijunction Q212 to feed chart paper at 2" per minute |
| R243, Paper feed adj. | Sets rep. rate of unijunction Q212 to feed chart paper at 3" per minute |
| R244, Paper feed adj. | Sets rep. rate of unijunction Q212 to feed chart paper at 4" per minute |

## 7.4 ALIGNMENT PROCEDURE

### 7.4.1 Equipment Required

1. Calibrated oscilloscope
2. Signal generator capable of covering from 190 to 220 kHz with 10 ohms output impedance.
3. Accurate Strobotac
4. 200T5HAD transducer (to be the same transducer which will be used with the DE-719B).

### 7.4.2 Stylus Drive Motor Speed Adjustment

The recording mechanism is designed for operation with a drive motor speed of 3350 RPM to coincide with the calibration for the speed of sound in water of 4800 feet per second when operating in the X1 (normal) mode. In the X2 mode the motor speed is reduced to 1675 RPM. The exact motor speed can be determined by an accurate Strobotac or an electronic frequency counter connected to measure the frequency generated by the "tone wheel" mounted on the motor shaft. (The number of teeth has been selected to provide a direct RPM count.)

To adjust:

1. Set the RANGE X1, X2 switch (S302) to the X1 mode.
2. Set the SPEED OF SOUND control (R305) to midposition.

3. Using an accurate Strobotac set the stylus drive motor speed to 3350 RPM (±15) by carefully adjusting R229.

4. Set the RANGE X1, X2 switch to the X2 mode and adjust R227 until the motor speed is 1675 RPM ±15. Return RANGE switch to the X1 position.

NOTE

*An accurate strobe reading can be obtained by triggering a frequency counter from the Strobotac.*

7.4.3 Calibration Marker Adjustment

1. Be sure that the stylus drive motor speed has been adjusted to 3350 RPM.

2. Adjust the CAL ZERO control (R307) until the calibrate zero line falls directly on the chart paper zero line.

NOTE

*The direct transmission pulse can be moved off the zero line by the TIDE and DRAFT control while making the calibrate zero adjustment.*

3. Adjust R210 until the second calibrate pulse falls exactly on the 50-foot line on the chart paper.

NOTE

*Adjustment of the SPEED OF SOUND control, R305, will vary the position of the 50-foot calibrate line by plus and minus three feet.*

4. The calibrate lines (at zero and 50 feet) will not be present when operating on the X2 range.

7.4.4 Tide and Draft Adjustment

1. While operating on the X1 range, adjust the TIDE and DRAFT control until the mark inscribed by the direct transmission falls on zero.

2. Switch to the RANGE X2 mode and adjust R304 until the direct transmission mark is on the zero line on the chart paper. (Do not alter position of TIDE and DRAFT control while making the above adjustment.

7.4.5 Chart Paper Advance Adjustments

The chart paper drive mechanism is driven by a stepping motor whose armature advances $15^{\circ}$ each time a pulse is alternately applied to the two field coils. A gear reduction of 45:1 is built into the motor and an external gear reduction of 3.11:1 is incorporated between the drive motor and the chart paper drive roller. The square wave pulses which drive the stepping motor are generated by controlling a flip-flop circuit (Q218 and Q214) from a unijunction (Q212) time base circuit. The time constant of the unijunction is controlled by the four position CHART SPEED switch (S304). A separate trim-pot for each of the four speeds is provided for close adjustment. The output of the flip-flop is followed by two stages of push-pull amplification to drive the stepping motor.

To adjust the trim-pots proceed as follows:

1. Connect a calibrated scope to pins X and N of the motor control printed circuit board and observe square wave pulses of approximately 12 volts amplitude with transient leading edge reaching above 20 volts. Set the CHART SPEED switch (S304) to the one inch per minute position. Adjust R241 for a pulse length of 53.6 milliseconds ±3%.

2. Set the CHART SPEED switch to the 2 inches per minute position. Adjust R242 for a pulse length of 26.8 milliseconds ±3%.

3. Set the CHART SPEED switch to the 3 inches per minute position. Adjust R243 for a pulse length of 17.87 milliseconds ±3%.

4. Set the CHART SPEED switch to the 4 inches per minute position. Adjust R244 for a pulse length of 13.4 milliseconds ±?

*NOTE*

*The vertical timing lines on the chart paper are one inch apart.*

### 7.4.6 Transceiver PC Board Adjustments

The transceiver is tuned, at the factory, to match the particular 200T5HAD transducer furnished with the equipment. If the transducer or a transceiver component is replaced, a slight retuning of the transmitter and/or receiver section may be required. Proceed as follows:

1. Place the transducer in the water and plug it into the equipment. Connect the oscilloscope across the transducer terminals and turn the equipment on . Observe the direct transmission (transmitted pulse) and the first echo return.

2. The DC voltage across the transducer should be 40 volts ±10%.

3. Adjust the tuning slug in T101 for maximum first echo return. The transmission pulse should be at least 80 volts peak-to-peak and 100 to 200 microseconds in length.

4. To tune the receiver; suspend the transducer in air two feet from a hard flat surface. Connect the oscilloscope between the secondary of T104 and ground. Set the gain control to maximum and tune T103 and T104 for the maximum number of multiple echoes. If feed-through from the 40-volt inverter is present, tune L102 until minimum feed-through is seen.

5. Connect the signal generator in series with the cold transducer lead (generator hot lead to transducer and generator ground to DE-719B ground). Set the signal generator output level to 100 microvolts, 50% modulated, tune generator for maximum receiver response. Maximum should fall at 208 kHz ±7%.

6. Reduce the signal generator output to 40 microvolts, adjust the internal gain trim-pot, R112, until the receiver output level results in a medium gray recording on the chart with the CHART SPEED set at 1 inch per minute and the RANGE switch set on the X1 mode.

### 7.4.7 Notes

1. Actuating the FIX MARK switch should cause a straight, dark fix-mark line on the chart paper. The line should be straight within 1/32 inch. Note that when a new stylus is installed, it may take several minutes of "run-in" before a straight fix-mark line is obtained.

2. The life expectancy of a new stylus is approximately 40 hours when operated in the X1 mode. Double this life should be expected when operating in the X2 mode.

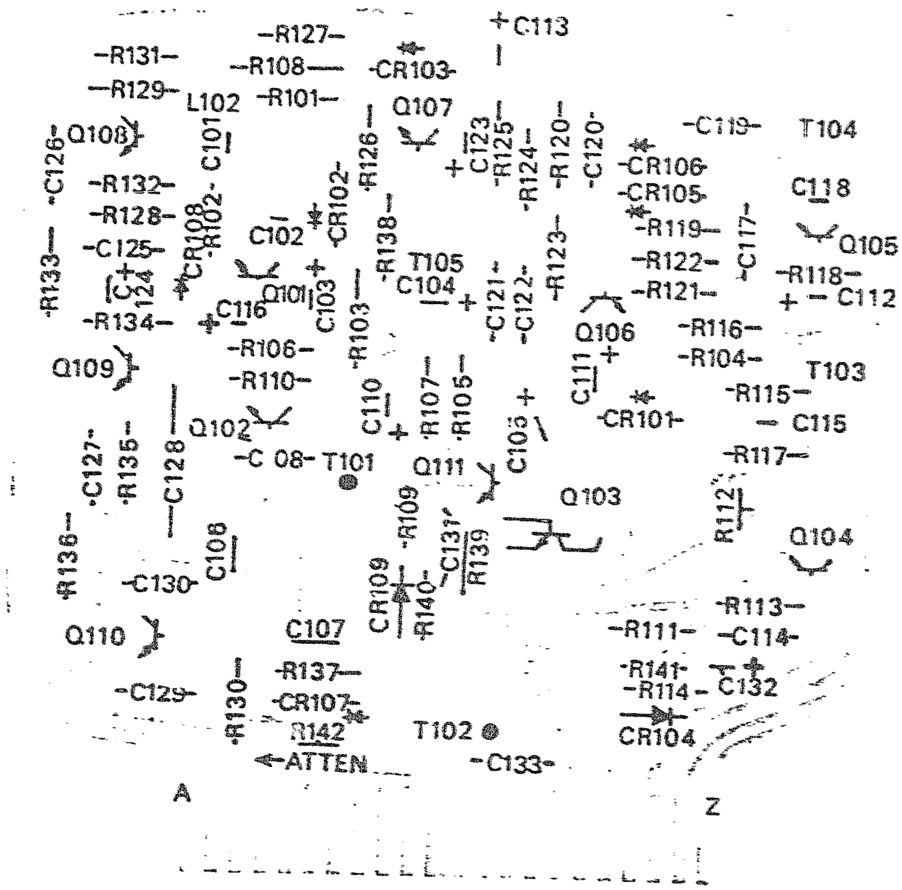


Figure 7-1. Transceiver PC Board

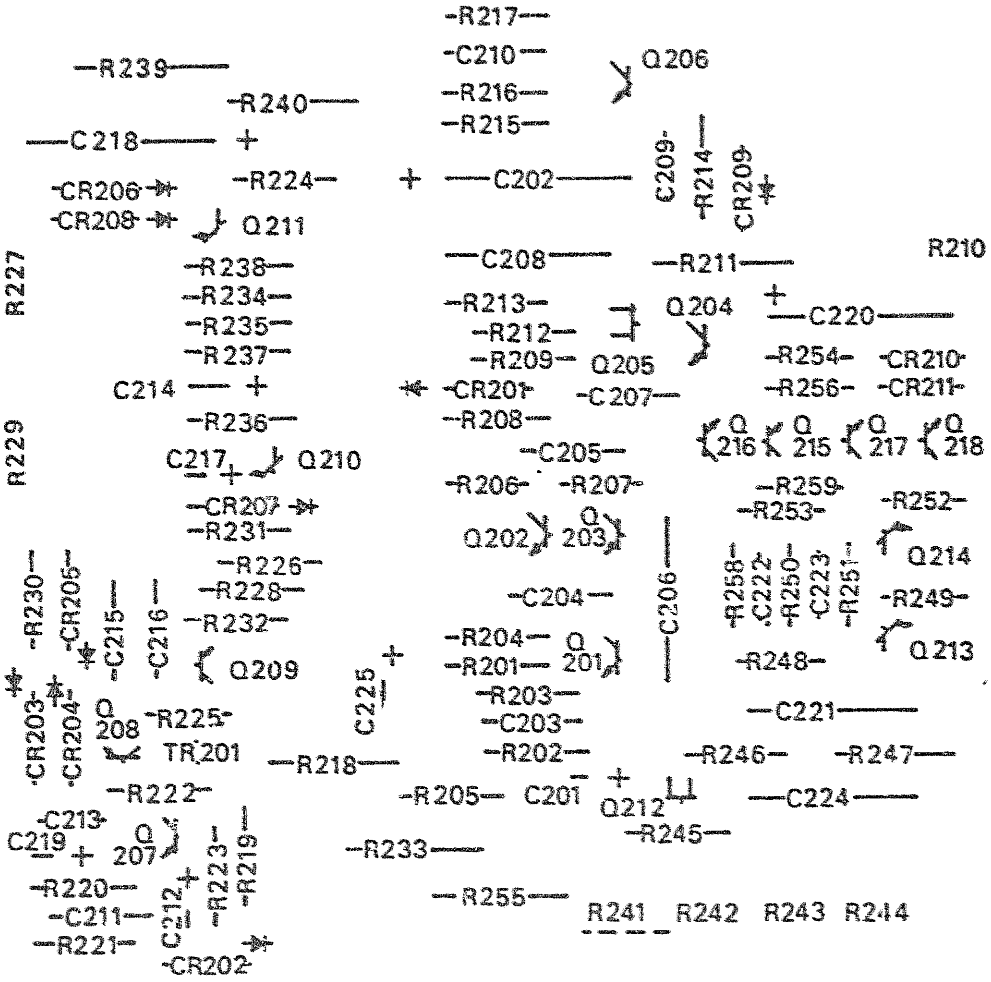


Figure 7-2. Motor Control PC Board

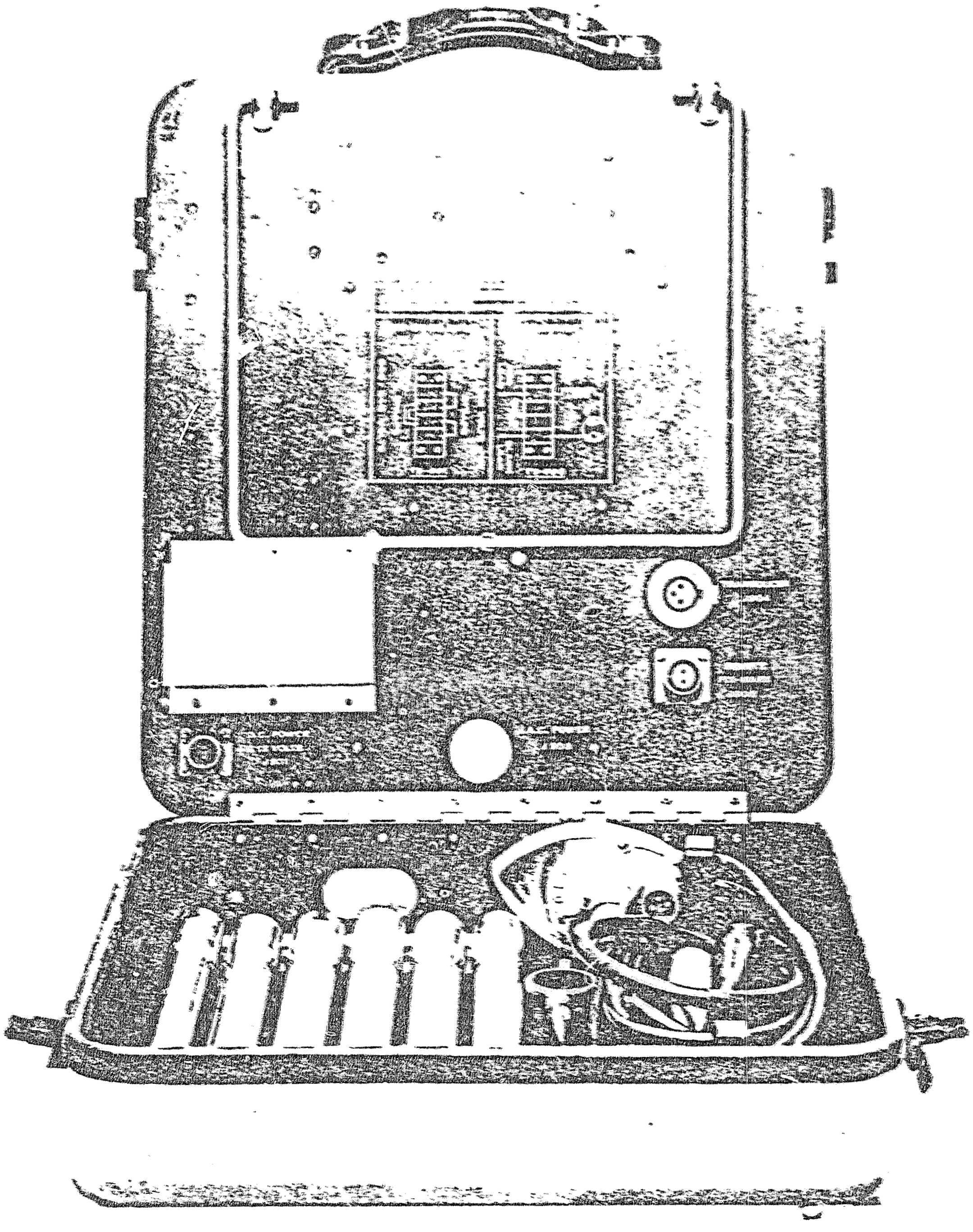

Figure 7-3. Chassis Plate - Rear View