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SCHILLER STATION QUALITY ASSURANCE PLAN AND STANDARD OPERATING PROCEDURES FOR ENTRAINMENT MONITORING

Revision 0

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1.0 INTRODUCTION

Public Service Company of New Hampshire ("PSNH") owns and operates Schiller Station in Portsmouth, New Hampshire. The Station, which has four generating units ("Unit 3", "Unit 4", "Unit 5", and "Unit 6"), is located on the southwestern (New Hampshire) bank of the Piscataqua River, which forms the boundary between coastal New Hampshire and Maine. PSNH is currently in the process of completing the Northern Wood Power Project at Schiller Station. The existing 50 MWe coal-burning Unit 5 boiler will be replaced with a high efficiency fluidized bed wood-fired boiler scheduled to be fully operational during the summer of 2006.

The primary activity of Schiller Station is the generation of electric power. The Station generates at a rated capacity of 150 MWe and withdraws once-through cooling water from two separate cooling water intake structures ("CWIS's"), which are located in separate bulkheads at the shoreline of the Piscataqua River. The Unit 3 and Unit 4 CWIS's are located in the north bulkhead (Screen House #1), and the Unit 5 and Unit 6 CWIS's are located in the south bulkhead (Screen House #2). The two CWIS's at the Schiller Station have a combined total design intake flow in excess of 50 million gallons per day ("MGD") and use at least 25% of the water withdrawn exclusively for cooling purposes. The current expected operating mode for Schiller Station over the next ten years is as a base-loaded facility at a capacity utilization rate in excess of 15%.

The final regulations implementing §316(b) of the Clean Water Act ("CWA") at existing electricity-generating stations (the "Phase II Regulations"), among other things, establish performance standards for the reduction of impingement mortality by 80 to 95 percent and, under certain circumstances, for the reduction of entrainment by 60 to 90 percent (See 69 Fed. Reg. 41576 (July 9, 2004)). The applicability of these performance standards is determined by several factors, including the type of water body from which a plant withdraws cooling water and the plant's capacity utilization factor. Under the Phase II Regulations, applicable performance standards can be met by design and construction technologies, operational measures, restoration measures, or some combination of these compliance alternatives.

The Phase II Regulations require submission of a Proposal for Information Collection ("PIC") in certain circumstances. The following Quality Assurance Plan (QAP) and Standard Operating Procedures (SOP) comprise Appendix 3 of the PIC that PSNH is submitting to the United States Environmental Protection Agency ("USEPA"). They detail the methods for completing the 2006 entrainment study at Schiller Station.

2.0 ENTRAINMENT STANDARD OPERATING PROCEDURES

PSNH proposes a one-year entrainment sampling program for Schiller Station beginning in August 2006 because the most recent and comprehensive annual entrainment data were obtained during the 1975-1976 study at the neighboring Newington Station as described in Section 6.1 of the PIC (Normandeau 2006), and because the present fish community in the Piscataqua River has most likely changed since then. The goal of the proposed entrainment program is to estimate the annual total ab-

undance of fish eggs and larvae, and macro-crustaceans that become entrained in the condenser cooling water withdrawn through the traveling screens of Schiller Station's two CWISs.

Entrainment sampling will be performed at Screen House # 2 (Unit 5 and Unit 6, Figure 2-1). Screen House # 1 (Unit 4, Figure 2-1) will not be sampled for entrainment at Schiller Station due to the absence of access for sampling. Entrainment data obtained from sampling at Screen House # 2 (Unit 5 and Unit 6, Figure 2-1) will be applied to Screen House # 1 (Unit 4) because the Phase II Regulations allow such use of data from a comparable facility for estimating the calculation baseline. See 69 Fed. Reg. 41684 ("The calculation baseline may be estimated using: ... historical impingement mortality and entrainment data from your facility or from another facility with comparable design, operational, and environmental conditions").

2.1 COOLING WATER INTAKE STRUCTURE DESCRIPTION

Schiller Station has two once-through CWIS's; Screen House #1 and Screen House #2 (Figure 2-1). Screen House #1 is located on the southwestern bank of the lower Piscataqua River in Portsmouth, New Hampshire at latitude 43°05'52" and longitude 70°46'59". Screen House # 2 is located approximately 150 ft south of Screen House #1 on the southwestern bank of the lower Piscataqua River in Portsmouth, New Hampshire at latitude 43°05'52" and longitude 70°46'58".

2.1.1 Schiller Station Screen House #1 CWIS

Schiller Station Screen House #1 contains the CWIS for Unit 3 and Unit 4. Screen House #1 withdraws non-contact cooling water from a submerged intake structure and intake tunnels located approximately 30 ft offshore from Screen House #1 (Figure 2-1). Screen House #1 contains one traveling screen servicing the circulating water pump (Pump 4) supplying the Unit 4 condenser cooling system. The Unit 4 traveling screen (Screen 4) is located on the south side of Screen House #1 the CWIS (Figure 2-1). The north side of Screen House #1 is occupied by Unit #3, which currently inactive. The two intake pumps for Unit 4 are not found in Screen House #1; they are located in the power plant in a separate building approximately 300 ft to the west of Screen House #1. The cooling water pumps for Unit 4 withdraws Piscataqua River water from the submerged, offshore intake protected by a set of coarse bar racks (12 in x 12 in) and by a 1.5 in mesh fiberglass screen.

The Screen House #1 CWIS at Schiller Station has one operable traveling screen (Screen 4) servicing the Unit 4 circulating water pump (Figure 2-1). The Unit 4 traveling screen is a Rex (Chain Belt Company) screen with standard 3/8-inch (0.375-inch) square opening mesh panels of woven stainless steel wire screen cloth. The screen is 5.5 feet wide and 28 feet high (measured from the center of the head shaft to the center of the tail shaft) and consists of 24 panels. Intake water passes through the submerged portion of the screen, where suspended fish and debris are deposited onto the screen cloth of the inclined trays and on the lower member of each tray which forms a shelf for lifting this solid material. The traveling screen is not rotated continuously, but is washed manually once every 6 hours or more frequently if a pressure differential develops between the front and back side of the screen. When the screen mechanism is operated, the screen trays ascend on the outboard (Piscataqua River) side and descend on the in-plant side at a speed of 10 feet per minute. Debris and fish are lifted from the water and removed from each tray just before it moves over the top sprockets and begins to de-

scend by a spray manifold that is located in the head (top) section of the screen. The spray manifold for each screen has 5 overlapping spray nozzles operating at a relatively low 40 pounds per square inch (psig) spray pressure, and the spray wash covers the entire width of each tray. The fish and debris are washed by the spray manifold from the traveling screen into a 18-inch wide by 12-inch deep trough built into the concrete deck of the CWIS and located in front (Piscataqua River side) of the traveling screen. This trough runs south along Screen 4 and out the south side of Screen House #1, and all washed material is carried in the wash water for discharge into the Piscataqua River through the side of the CWIS at an elevation of about 11 ft. above MLW elevation.

2.1.2 Schiller Station Unit 5 and Unit 6 CWIS

The Schiller Station Unit 5 and Unit 6 CWIS is located in Screen House #2, which is a concrete bulkhead with a brick superstructure that is flush with the shoreline (Figure 2-1). Screen House #2 also has a canvas awning on the east (river) side to provide a degree of protection for the traveling screens from the weather. The single intake pump providing the Unit 5 circulating water flow is located on the north side of the Screen House #2, and the single intake pump providing the Unit 6 circulating water flow is located on the south side of the Screen House #2 (Figure 2-1).

The Unit 5 and Unit 6 intake pumps each have two vertical single entry/exit traveling screens (described below) providing a basic debris and fish handling and return system. A partition wall below the deck inside Screen House #2 divides the CWIS into two discrete forebays, one associated with each unit's intake pump. This partition wall separates the flow to each pump so that the fish and debris collected from the two traveling screens in the north forebay represent the collection from the water withdrawn through intake pump 5, and the fish and debris collected from the two traveling screens in the south forebay represent the collection from the water withdrawn through intake pump 6. Each of the Screen House #2 two forebay openings to the Piscataqua River consists of a pair of 8.5 ft. wide by 32 ft deep stop log slots, and each stop log slot is covered with a coarse bar rack that is 9 ft. wide and 32 ft high with a 3.5-inch clear space (4 inch on-center spacing).

The Screen House #2 CWIS at Schiller Station is portioned so that traveling screens 6a and 6b service the north inlet forebay to circulating water pump 6, and screens 5a and 5b service the south inlet to circulating water pump 5 (Figure 2-1). Each of the four traveling screens is a Rex (Chain Belt Company) screen with standard 3/8-inch (0.375-inch) square opening mesh panels of woven stainless steel wire screen cloth. Each of the four screens is 5.5 feet wide and 29 feet high (measured from the center of the head shaft to the center of the tail shaft) and consists of 24 panels. Intake water passes through the submerged portion of each screen, where suspended fish and debris are deposited onto the screen cloth of the inclined trays and on the lower member of each tray which forms a shelf for lifting this solid material. The traveling screens are not rotated continuously, but are washed manually once every 6 hours or more frequently if a pressure differential develops between the front and back side of the screens. When the screen mechanism is operated, the screen trays ascend on the outboard (Piscataqua River) side and descend on the in-plant side at a speed of 10 feet per minute. Debris and fish are lifted from the water and removed from each tray just before it moves over the top sprockets and begins to descend by a spray manifold that is located in the head (top) section of each screen. The spray manifold for each screen has 5 overlapping spray nozzles operating at a relatively low 40 pounds per square inch (psig) spray pressure, and the spray wash covers the entire width of each tray.

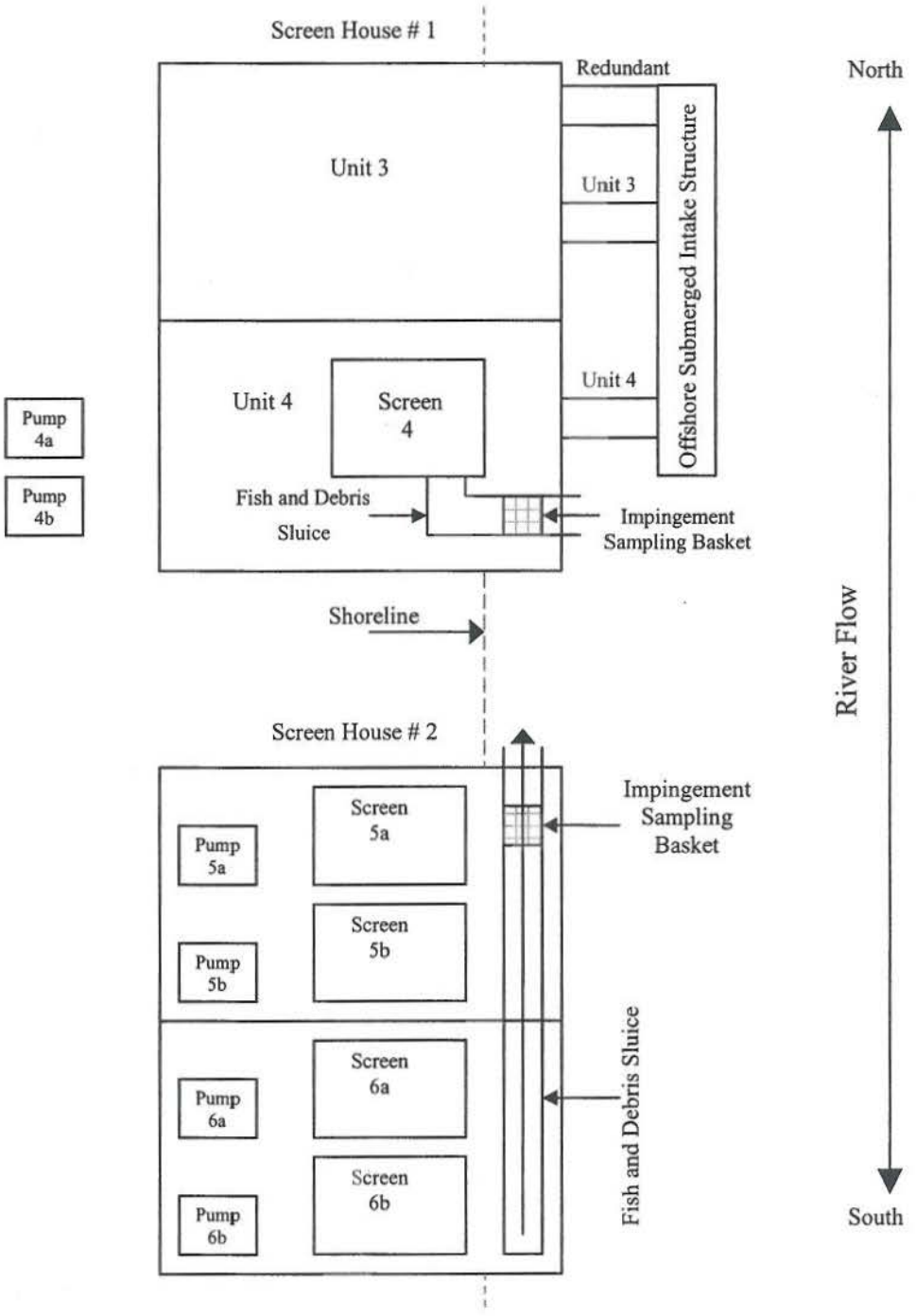


Figure 2-1. Schiller Station Screen House #1 (Unit 4) and Screen House #2 (Unit 5 and Unit 6) cooling water intake structures schematic showing the identification numbers for the circulating water pumps and traveling screens.

The fish and debris are washed by the spray manifold from each traveling screen into a 24-inch wide by 18-inch deep trough built into the concrete deck of the CWIS and located in front (Piscataqua River side) of each traveling screen. This trough runs along the entire length of the Screen House #2, and all washed material is carried in the wash water to the north end of the CWIS for discharge into the Piscataqua River through the side of the CWIS at an elevation of about 11 ft. above MLW elevation.

2.2 SAMPLING SCHEDULE AND LOCATION

The entrainment sampling protocol for Schiller Station is a seasonally-stratified fixed date design, that is consistent with numerous entrainment programs both completed or on-going at CWISs located in estuaries throughout the United States (EPRI 2005). Entrainment sampling will be conducted at the Schiller Station Screen House #2 CWIS. Entrainment sampling will not be performed at Schiller Station Screen House #1 (Unit 4) because there is no access for sampling. Condenser supply water representing each entrainment sample will be drawn from a common service water feed line that taps into the Unit 5 and Unit 6 circulating water pumps on the condenser side of the pumps and then supplies water at the same pressure as found in each condenser supply (about 15 psig) to a service water pump. Sampling the condenser feed in this manner will allow entrainment samples to be taken if either the Unit 5 circulating water pump or the Unit 6 circulating water pump are in operation, or if both are operating. No attempt will be made to separate entrainment abundance samples between Unit 5 and Unit 6, and the resulting abundance data will be applied to Unit 4 (Screen House #1), and to Unit 5 and Unit 6 (both in Screen House #2) of Schiller Station during data analysis and reporting.

The goal of the proposed entrainment program is to estimate the annual total abundance and mortality of fish eggs, fish larvae and post-yolk-sac larvae, and macro-crustacean larvae (crabs and lobster) that become entrained in the cooling water drawn through the traveling screens of each operating unit of Schiller Station. Entrainment sampling will be performed on one sampling day per week when the plant is operating during 13 consecutive weeks in a June through August seasonal period of peak ichthyoplankton abundance, and again for 13 consecutive weeks during January through March to coincide with the recently reported primary and secondary peaks in seasonal occurrence of fish eggs and larvae in the Piscataqua River nearfield area. Entrainment sampling will be conducted on one day every two weeks when the plant is operating during the 26 remaining weeks of lower seasonal abundance in April and May and from September through December. The resulting seasonally stratified entrainment sampling design will collect entrainment samples from 39 total weeks (26 weekly plus 13 biweekly samples) during 12 consecutive months. Operation is defined as having at least one circulating water pump at the Schiller Station Screen House #2 CWIS running for part or all of one collection interval.

Weekly or biweekly entrainment sampling will consist of collecting four separate 100 m^3 entrainment samples at six-hour intervals representing one consecutive 24-hour period. Entrainment sampling will be scheduled to occur from approximately 0900 on day 1 through 0859 on the next day (day 2). The same 24-hour period will be sampled during each scheduled week, and the four entrainment samples will be taken at approximately the same beginning and ending times ($\pm$ one hour) during each 24-hour period. This design will provide 156 entrainment samples for the year (4 samples per

day x 39 days) if the plant operates during all scheduled 6-hour sampling intervals throughout the year.

2.3 EQUIPMENT

Each entrainment sample will be collected in the Schiller Station Screen House #2 from a 4-inch raw-water tap drawing un-chlorinated ambient cooling water at low pressure (about 15 psi) from a common service water feed line that taps into both the Unit 5 and Unit 6 circulating water pumps on the condenser side of the pumps. Sampling the condenser feed in this manner will allow entrainment samples to be taken if either the Unit 5 circulating water pump or the Unit 6 circulating water pump are operation, or if both are operating. No attempt will be made to separate entrainment abundance samples between Unit 5 and Unit 6, and the resulting abundance data will be applied to Unit 4 (Screen House #1), and to Unit 5 and Unit 6 (both in Screen House #2) of Schiller Station during data analysis and reporting.

The circulating water flow from the 4-inch service line will be supplied from above into a 0.300 mm mesh plankton net that is suspended in a tank (barrel sampler). When sufficient volume of water has been filtered through the plankton net (flow measured and recorded continuously with an in-line flowmeter), each entrainment sample will be concentrated into the 0.300 mm cod-end cup of the plankton net, rinsed into a one-liter sample jar, preserved with 6 % buffered formalin, labeled with the date and time of collection and a unique sample number, and taken to the laboratory for analysis. Water temperature, DO concentration, and conductivity will be recorded in the barrel sampler outflow near the beginning of each entrainment sample collection. DO and conductivity measurements will be converted into percent saturation (D.O.) and salinity at 25°C (conductivity) during data analysis.

The following additional equipment is required for entrainment field sampling:

- copy of SOP and copy of Health & Safety Plan,
- 0.300 mm plankton net with 0.300 mm cod end cup,
- wash down pump or hose,
- data sheets, clipboard, and pencils,
- sample jars (one liter),
- labels and waterproof markers,
- 100% formalin preservative,
- flowmeter,
- stop watch,
- hand calculator,
- YSI Model 85 temperature/salinity/dissolved oxygen meter,
- hard hats,
- gloves,
- hand tools to aid sampler maintenance,
- flashlight,
- first aid kit,
- quality control log,

- appropriate clothing, footwear, and personal protective equipment as specified in the Health & Safety Plan.

2.4 ENTRAINMENT FIELD SAMPLING PROCEDURES

2.4.1 Sample Collection

1. Check to be sure that at least one circulating water pump in Screen House #2 of Schiller Station is operating (Pump 5 or Pump 6).
2. Inspect the entire entrainment sampling system shortly before the scheduled start of the 6-hour sampling period to be sure that all plumbing is connected, the inner tank is clean, and the mesh panels are free from debris and the previous sample has been removed.
3. Install the 0.300 mm plankton net with clean 0.300 mm cod end collection cup into the tank (barrel) after inspecting it to be sure it is clean, and that no debris or organisms are carried over from previous collections.
4. Install the stand pipe and close the drain valves in the bottom of the tank.
5. Turn the ball valve controlling the water supply to the tank to the open position (valve handle parallel to the supply pipe) and record the time that water begins to enter the sampling tank through the net as the start of the 6-hour sample.
6. Simultaneously start the stopwatch when the water begins to enter the tank and record the flowmeter totalizer reading to initiate the start of the entrainment sampling and observe the seconds required to fill the sampler to the drain ports.
7. Stop the stopwatch when the tank is full and begins overflowing, and calculate the sampling time required to collect a $100m^3$ sample and calibrate the in-line flowmeter (Section 2.4.2 below).
8. Fill out the sample identification and flow rate data at the top of the Entrainment Field Data Sheet (Section 2.5.1 below).
9. Record the required water quality data from the water in the barrel sampler overflow (Section 2.6.3).
10. At times, clogging of the net mesh may make it necessary to collect multiple jar samples and clean the mesh between samples by using a wash down hose to prevent the inner tank from overflowing (possibly as frequently as every 20 minutes). The wash water is drawn from the outer tank using a low pressure submersible pump and represents filtered (through 0.300 mm mesh netting) water. If subsamples are collected in this way to manage mesh clogging, adjust the sampling time so that the required sampling time calculated in Section 2.4.2 represents the time supply water is actually flowing through the mesh of the sampler by adding the wash down time(s) to the sampling time.

11. Wait until the flowmeter totalizer indicates 27,000 gallons to make sure that at least 100 cubic meters of water has been sampled before closing the ball valve to end the sample. After the volume has reached at least 27,000 gallons, turn off the pump, and record the time and totalizer reading. At a flow rate of of 250 gpm, a sample will take a little over 1 hour and 45 minutes to complete.

12. The sides and mesh of the net should be gently rinsed with a wash down hose to remove any clinging organisms or debris and washed contents will be allowed to drain into the cod end cup. The outer surface of the net will be sprayed with the wash down hose to prevent the introduction of any additional organisms into the sample.

13. More than one subsample may be preserved in the same jar, but if multiple jars are used, label each one with the same sample number and indicate that multiple jars were used (e.g. "1 of __").

14. Collect the sample material from the cod end cup and place it in a labeled sample container. A 0.300-mm or finer sieve may be used to remove excess water from the sample before transferring it to the sample jar. Take care that none of the sample is spilled, and that the contents of the collection tank and cod end bucket are completely rinsed into the sample container or sieve. Pouring the sample into the jar should always be done over a larger container in case some sample is spilled. Sample containers and cod end cups that are open should be set down only in a container or bucket, just in case the sample is spilled.

15. Preserve the sample by adding sufficient formalin to make the final concentration 6% (60 ml of full-strength formalin per liter of sample).

16. Repeat the above procedures for three additional diel samples within the 24-hr collection period. The starting times of the four diel samples should be six hours apart.

17. Before leaving the site, clean the net and cod end cup, and then disconnect and drain the barrel sampler to prevent biofouling or freezing during colder months.

2.4.2 Sampling Flow Rate and Duration Determination

At the start of each sampling day (i.e. the first of four consecutive 6-hour entrainment samples), measure the flow rate delivered from the supply line by opening the 4-inch ball valve and filling to the overflow ports a calibration vessel of known volume (the outer barrel sampler tank holds 210 gallons to the overflow). Simultaneously observe and record the in-line flowmeter readings. Record the time required from the start of filling the tank until it begins to overflow to the nearest 0.1 second. Calculate the observed flow rate (calibration gpm) and record the results on the field data sheet as follows:

calibration gpm = volume of calibration tank in gallons / (calibration seconds/60)

Also estimate the sampling time required to obtain a 100 m^3 entrainment sample as follows:

Sampling time in decimal minutes = 26,420 gallons / calibration gpm.

For example, if it takes 80.0 seconds to fill the 210 gallon sampling tank to the overflow, then the calibration gpm = 210/(80/60) = 210/1.33 = 157.9 gpm, and the sampling time is 26420/157.9 = 167 minutes or 2 hours and 47 minutes.

Then calculate the percent error indicated by the calibration trial as follows:

percent error = 100 x (gauge gpm – calibration gpm) / calibration gpm

The percent error can be positive or negative depending on whether the gauge gpm was larger or smaller than the calibration gpm. Record the results on the Entrainment Field Data Sheet (Appendix A), *including the minus sign* if the percent error was negative. If the absolute value of the percent error is less than 3% then no further action is necessary.

If the absolute value of the percent error is more than 3% then repeat the calibration trial two more times and average the three results, recording the results on the Entrainment Field Data Sheet. Keep the minus signs, if any, in calculating the average (if there are both positive and negative percent errors, they will partially cancel each other out). If the absolute value of the average percent error is less than 10% then no further action is necessary.

If the absolute value of the average percent error is more than 10% then replace the flowmeter and return it to the manufacturer for servicing. If there is no replacement flowmeter available immediately, continue to collect samples with the one that failed calibration, but enter the code for "flowmeter problem" in the sample status box on the Entrainment Field Data Sheet. (It may be feasible to estimate the sample volume by comparing the duration to durations of samples with known volumes collected during similar tidal conditions.)

2.4.3 Sample Handling

Fill entrainment sample jars completely by addition of 6% formalin. Each sample jar should be no more than 25% full of organisms and debris for adequate preservation. Label the jars externally with the sample number and the number of jars (e.g., 1 of 4, 2 of 4, etc.). Place an internal label in each jar giving the sample number. All entrainment samples will be transferred from the field site to the Bedford, NH laboratory for processing.

2.4.4 Use Code

Each entrainment sample collected will be assigned a Use Code (1, 2, or 5) that defines its use in analytical tasks. Use Code 1 samples will be entrainment collections from which valid data were collected and no sampling problems were encountered. This means that each entrainment sample collected is representative of the 6-hour (diel) collection period in that the sample represents the entire contents of ichthyoplankton eggs and larvae and any macro-crustacean larvae collected in the circulating water flow supplied to the sample collection device during the 6-hour collection period. A use code 1 entrainment sample indicates no loss of any ichthyoplankton or macro-crustacean larvae in the sample, and no interruption of circulating water flow during the collection interval. Use Code 1 entrainment samples can be used for all analytical tasks. Use Code 2 samples will be collections in which there are sampling problems encountered relating to either the accurate measurement of sample duration or volume, but ichthyoplankton or macro-crustacean larvae are caught. For example, if an

unknown part of the sample was spilled when transferring it from the collection cup into a sample jar, or the sample volume is unknown, this sample would be classified as Use Code = 2. Use Code 2 samples will be excluded from calculations involving density estimates (number per unit volume), but may be used to describe diel or seasonal occurrence and length-frequency distributions. Use Code 5 samples will be void samples where the entire contents of the sample is lost. Use Code 5 samples will be excluded from all analysis.

2.5 ENVIRONMENTAL PARAMETERS

2.5.1 Specifications

The following environmental parameters will be observed and recorded at the Schiller Station Screen House #2 CWIS at both the start of each 6-hour collection: water temperature, dissolved oxygen concentration, salinity, and river surface conditions (wind direction and velocity, water level, cloud cover, and precipitation). Water quality measurements will be taken in the outer sampling tank in the overflow.

2.5.2 Deployment

Water quality measurements will be taken at both the start and end of each 24-hour collection. Temperature, salinity (nearest 0.1 ppt), and dissolved oxygen (nearest 0.1 mg/L) will be measured with a YSI model 85 dissolved oxygen meter. Air temperature (nearest 1.0°C) will be measured with an armored alcohol-filled thermometer. In general, Piscataqua River water temperatures should range between -2.0°C and +30.0°C during the course of this study, salinity should range between 4.0 ppt and 35.0 ppt, and dissolved oxygen concentrations should read between 5.0 mg/l and 14.0 mg/l. Any temperature, salinity or dissolved oxygen (DO) readings outside of this range should be noted on the field data sheet and the instrument should be inspected and recalibrated.

Table 2-1 presents the saturation concentrations of DO in water at various water temperatures and salinities. DO concentrations that are greater than the saturation levels at a given temperature and salinity are suspect. If DO readings are above saturation, all connections on the meter should be checked, the membrane checked for contamination and bubbles, and the reading retaken. If the reading is still above saturation note any pertinent environmental conditions that may cause supersaturation such as excessive water turbulence below a dam and record these observations in the COMMENTS section.

2.5.3 YSI Model 85 Temperature, Conductivity, and Dissolved Oxygen Meter

Batteries will be recharged or replaced every six months or when the **LO BATT** appears on the LCD display. The instrument batteries are six "AA" size cells located inside the instrument. The probe's electrolyte fluid and membrane will be replaced at two-week intervals or when a bubble appears in the electrolyte.

Perform calibration checks at the beginning of each day's use of the instrument, following the procedures recommended by the manufacturer (Appendix C).

Table 2-1. 100% saturation level of oxygen in water of different salinities exposed to water saturated air at 1.0 atmospheric pressure (modified from APHA 1985).

Water Temperature in °C	100% Oxygen Saturation (mg/l) at Salinity (ppt)				
	0.0	**9.0**	**18.0**	**27.1**	**36.1**
0.0	14.6	13.7	12.9	12.1	11.4
2.0	13.8	13.0	12.2	11.5	10.8
4.0	13.1	12.3	11.6	10.9	10.3
6.0	12.4	11.7	11.0	10.4	9.8
8.0	11.8	11.2	10.5	9.9	9.4
10.0	11.3	10.7	10.1	9.5	9.0
12.0	10.8	10.2	9.6	9.1	8.6
14.0	10.3	9.7	9.2	8.7	8.2
16.0	9.9	9.3	8.8	8.4	7.9
18.0	9.5	9.0	8.5	8.0	7.6
20.0	9.1	8.6	8.2	7.7	7.3
22.0	8.7	8.3	7.9	7.5	7.1
24.0	8.4	8.0	7.6	7.2	6.8
26.0	8.1	7.7	7.3	7.0	6.6
28.0	7.8	7.4	7.1	6.7	6.4
30.0	7.6	7.2	6.8	6.5	6.2
32.0	7.3	7.0	6.6	6.3	6.0
34.0	7.1	6.7	6.4	6.1	5.8
36.0	6.8	6.5	6.2	5.9	5.6
38.0	6.6	6.3	6.0	5.7	5.5
40.0	6.4	6.1	5.8	5.6	5.3

Two-point calibration checks of the YSI dissolved oxygen meter will be performed at the beginning of a sampling day to maintain a field check of instrument performance and data quality. Calibration checks of the dissolved oxygen measurement system will be performed using water-saturated air for the 100% saturation point and a saturated solution of sodium sulfite with a trace of cobalt chloride for the 0% saturation point. These checks will be performed in the following manner and documented in an instrument calibration log:

- Inspect the probe to ensure that there are no air bubbles under the membrane and that it is not fouled.
- If air bubbles or fouling are observed, replace the membrane following procedures in the owner's manual.
- Ensure that the sponge inside the instrument's calibration chamber is wet and the probe is blotted dry.

- Insert the probe into the calibration chamber.
- Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument.
- Press the **MODE** button until the dissolved oxygen is displayed in mg/L or %.
- Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required).
- Use two fingers to press and release the **UP ARROW** and **DOWN ARROW** buttons at the same time once.
- The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** button once. EXAMPLE: Entering the number 12 indicates 1200 feet.
- The Model 85 should now display **CAL** in the lower left of the display, the calibration should be displayed in the lower right of the display and the actual % should be on the main display.
- Press the **ENTER** button and the display should read **SAVE** then should return to the Normal Operation Mode.

All calibrations should be completed at a temperature that is as close as possible to the sample temperature.

2.6 ENTRAINMENT FIELD DATA HANDLING

2.6.1 Entrainment Field Data Sheets and Coding Instructions

A unique sample number is assigned to each 6-hour entrainment abundance collection. The sample number is a four-digit number that is a composite of sample task code (1 for entrainment abundance sample), week number (two digits), and diel period (one digit). Record the sample identification and status, collection times, flow rate, and flow calibration data on the Entrainment Field Data Sheet (Appendix A) according to the instructions below. Use the space for comments at the bottom of the data sheet to explain any problems or unusual circumstances. Use a separate data sheet for each 6-hour diel period entrainment sample.

VARIABLE	INSTRUCTIONS
TASK CODE	Pre-coded 1 for entrainment abundance sample
Week	Enter week number within year (01-52).
Diel	Enter the code for diel period: 1=0800-1400 2=1400-2000 3=2000-0200 4=0200-0800

VARIABLE	INSTRUCTIONS
Use Code	Enter use code for status of sample: 1 = valid sample 2 = sample is provisional due to problem with flow 5 = void (no sample)
Comments	If comments are written at the bottom of the data sheet, enter 1; if not, leave it blank
Start Month	Record the month that the **24-hr** sampling event began (should be the same for all samples collected in the 24-hr period)
Start Day	Record the day that the **24-hr** sampling event began (should be the same for all samples collected in the 24-hr period)
Start Hour	Record the hour that the 100-cubic-meter diel sample began, using 24-hr clock (0000-2359 hrs)
Start Minute	Record the minute that the 100-cubic-meter diel sample began, using 24-hr clock (0000-2359 hrs)
End Hour	Record the hour that a 100-cubic-meter diel sample (or a subsample) ended, using 24-hr clock (0000-2359 hrs)
End Minute	Record the minute that a 100-cubic-meter diel sample (or a subsample) ended, using 24-hr clock (0000-2359 hrs)
Gallons, end	Record the flowmeter totalizer reading for total gallons at the end of the sample
Gallons, start	Record the flowmeter totalizer reading for total gallons at the beginning of the sample
Gallons, difference	Subtract the starting flowmeter totalizer volume reading from the ending flowmeter totalizer volume reading
Gauge gpm	Record the pumping rate indicated by the flowmeter gauge to the nearest gallon per minute
Calibration seconds	Record the time to the nearest 0.1 seconds needed for the sampling pump to fill the calibration tank
Calibration gallons	Enter the calibration tank volume (210 gallons)
Calibration gpm	Calculate the observed pumping rate by dividing the calibration time by 60 then dividing that number into the calibration volume (record the result to the nearest gallon per minute)
Sampling time	Calculate the sampling time required to collect a $100m^3$ sample given the flow rate and record the results of this calculation in decimal minutes to the nearest 0.1 minute as described in Section 2.4.2
Percent error	Calculate % error as described in Section 2.4.2 and record the result to the nearest 0.1% (keep the minus sign if it is negative)
Average % error	Calculate average % error as described in Section 3.3.2 and record the result to the nearest 0.1% (keep the minus sign if it is negative)

VARIABLE	INSTRUCTIONS
Start Temp.	Record the temperature to the nearest 0.1°C, at the start of each 6-hour entrainment sample
End Temp.	Record the temperature to the nearest 0.1°C, at the end of each 6-hour entrainment sample
Start Salinity	Record the salinity to the nearest 0.1 parts per thousand (ppt) at the start of each 6-hour entrainment sample
End Salinity	Record the salinity to the nearest 0.1 parts per thousand (ppt) at the end of each 6-hour entrainment sample
Start D.O.	Record the dissolved oxygen concentration to the nearest 0.1 mg/l (ppm) at the start of each 6-hour entrainment sample
End D.O.	Record the dissolved oxygen concentration to the nearest 0.1 mg/l (ppm), at the end of each 6-hour entrainment sample
Start Air Temp	Record air temperature (°C) at start of each 6-hour entrainment sample
End Air Temp	Record air temperature (°C) at end of each 6-hour entrainment sample
Start Cloud Cover	Record the cloud cover at the start of each 6-hour entrainment sample 0 = 0-9% 1 = 10-19% 2 = 20-29% 3 = 30-39% 4 = 40-49% 5 = 50-59% 6 = 60-69% 7 = 70-79% 8 = 80-89% 9 = 90-100%
End Cloud Cover	Record the cloud cover at the end of each 6-hour entrainment sample 0 = 0-9% 1 = 10-19% 2 = 20-29% 3 = 30-39% 4 = 40-49% 5 = 50-59% 6 = 60-69% 7 = 70-79% 8 = 80-89%

VARIABLE	INSTRUCTIONS
	9 = 90-100%
Start Precip.	Record the precipitation at the start of each 6-hour entrainment sample 0 = None 1 = Light Rain 2 = Heavy Rain 3 = Snow
End Precip.	Record the precipitation at the end of each 6-hour entrainment sample 0 = None 1 = Light Rain 2 = Heavy Rain 3 = Snow
Start Wind Dir.	Record the wind direction at the start of each 6-hour entrainment sample 0 = No Wind 1 = North 2 = South 3 = East 4 = West
End Wind Dir.	Record the wind direction at the end of each 6-hour entrainment sample 0 = No Wind 1 = North 2 = South 3 = East 4 = West
Start Wind Speed	Record the estimated wind speed (MPH) at the start of each 6-hour entrainment sample 1 = Leaves rustle, wind on face 2 = leaves and twigs in constant motion, flag waving 3 = raises dust and loose paper, small branches moving 4 = small trees begin to sway 5 = whole trees in motion
End Wind Speed	Record the wind speed (MPH) at the end of each 6-hour entrainment sample 1 = Leaves rustle, wind on face 2 = leaves and twigs in constant motion, flag waving

VARIABLE	INSTRUCTIONS
	3 = raises dust and loose paper, small branches moving
	4 = small trees begin to sway
	5 = whole trees in motion

2.6.2 Storage and Chain of Custody of Data Sheets

Check over all data sheets, to make sure they are completely and correctly filled out, and to be alert to any unusual or unexpected data values. Transport the original data sheets to the Bedford, NH office where they will be submitted to the technical data processing (TDP) center for keypunching and error checking. Document the transfer of each data packet using a data submittal chain of custody form supplied by the TDP. Retain a photocopy of TDP chain of custody form.

2.6.3 Hazardous Substances Log

Maintain a log of the amounts of formalin preservative brought on site. Include in each log entry the date, the name of person making the log entry, and the volume in gallons of 100% formalin brought on site on that date. Make the log available for inspection as requested by PSNH's on-site Environmental Coordinator. Provide the log to PSNH's Environmental Coordinator at the end of the project.

2.7 Instrument Calibration and Maintenance

Field instruments will be calibrated prior to each day of use, and service laboratory scales and balances will be calibrated once each year. Daily calibration checks will be performed with each use of a laboratory scale or balance; field scales will be calibrated every six months. Calibration logs will be maintained for all instruments and include the following information:

- instrument number and identification
- date of calibration
- initials of the person(s) calibrating the instrument
- standards used
- results, including instrument accuracy at receipt for calibration, adjustments made, instrument accuracy after calibration.

3.0 Entrainment Survival

Entrainment survival studies will be performed monthly at Schiller Station Screen House #2 to determine the survival of entrained ichthyoplankton and macro-crustacean larvae (lobsters and cancer crabs) that have passed into the condenser cooling system through the CWIS. Entrainment survival collections at Schiller Station will be scheduled for one randomly selected day per month on a day already selected for entrainment abundance sampling. The regularly-scheduled entrainment abundance sample will be collected and preserved for each six-hour collection interval, and then one or more 10-minute samples will be collected in a collection tray and observed for entrainment survival. The entrainment survival studies will be staffed continuously during the collection and observation

periods, and sufficient volume of water will be filtered through the entrainment collection device to insure that at least 100 fish larvae are available for initial (0-hour) latent (24-hour) survival observations or eight hours of sampling has occurred. The environmental parameters observed during collection of the corresponding 6-hour entrainment abundance sample will be used to represent environmental conditions at the time of collection of the survival samples, so that a duplicate set of these data is not required.

A barrel-type entrainment sampler (modified from EA 1982) will be set up near the north side of the screen house for entrainment survival sampling. Unlike the plankton net suspended in the barrel, the entrainment survival sampler consists of two nested cylindrical tanks (Figure 2-2). The inner tank is 24 inches in diameter and 36 inches tall and is fitted at the bottom with a funnel that tapers from 24 inches down to 3 inches and protrudes 12 inches through the floor of the outer tank. The outlet of the funnel is fitted with a 3-inch ball valve and either a collection cup (for entrainment abundance samples) or a flexible section of clear vinyl tubing leading to a collection tray (for entrainment survival samples). The walls of the inner tank are covered with 0.300 mm mesh Nitex plankton netting. The outer tank (barrel) is 36 inches in diameter and 48 inches tall. Circulating water flow into the entrainment sampler will be supplied from the north circulating water pump (1B), controlled by a ball valve on the feed side, and the outlet of the 4-inch supply line will enter standing water near the bottom of the inner tank. The supply water outlet will be oriented at a tangential angle to the inner tank so that the incoming water will swirl slowly to disperse the incoming energy throughout the tank. In addition, the swirling motion will cause solids (i.e. fish eggs and larvae) to concentrate towards the center of the tank so that they are not subjected to abrasion against the netting covering the walls of the inner tank. The water level in the barrel will be maintained by an overflow system so that the water velocity of the supply line (at 11 psi) is dispersed over the entire inner tank, minimizing the possibility of net abrasion of ichthyoplankton.

The entrainment survival studies will be staffed continuously during the collection and observation periods, and sufficient volume of water will be filtered through the entrainment collection device to insure that at least 200 fish eggs, fish larvae, and macro-crustacean larvae (in aggregate) are collected and available for the initial (0-hour) survival observations, and at least 100 of these are available for latent (24-hour) survival observations, or 8 hours of sampling has occurred. These entrainment survival samples will be sorted in the field into six categories (initial alive, initial stunned, initial dead, latent alive, latent stunned and latent dead) and observed in the field for entrainment survival.

3.1 ENTRAINMENT SURVIVAL SAMPLE COLLECTION

Samples of ichthyoplankton and macro-crustacean larvae will be collected as specified in Section 2.4 (above), with the following exceptions to insure the viability of the collected organisms.

1. It is important to collect entrained ichthyoplankton and macro-crustacean larvae with minimum damage due to the collection and handling methods.

2. It is not important to know the volume of water represented by the entrainment survival sample.

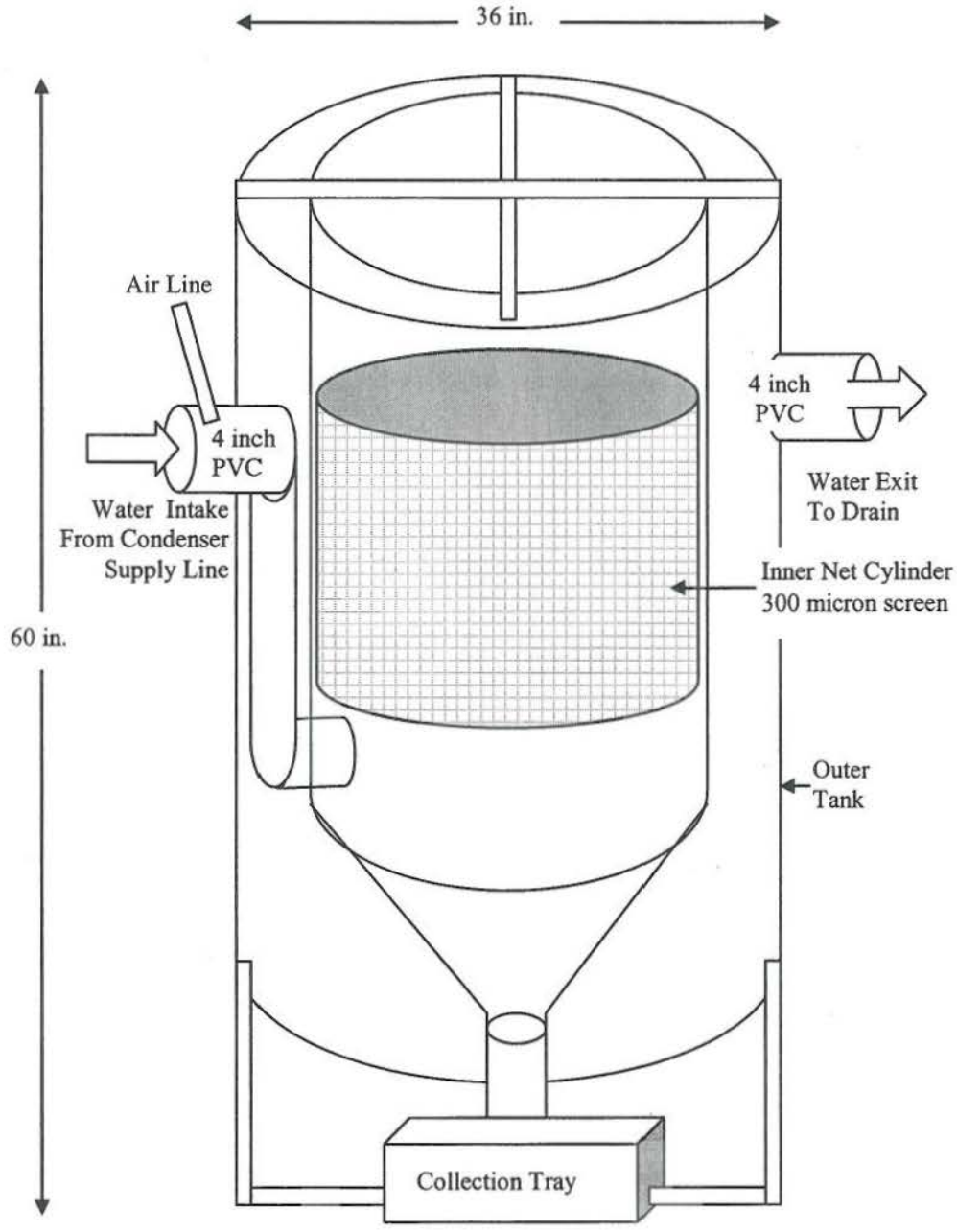


Figure 2-2. Schematic diagram of the entrainment sampling device (Barrel sampler).

3. Each entrainment survival sample will be collected in a clear glass processing tray which replaces the cod end cup.
4. No preservative of any kind will be used.
5. Be sure the survival study is performed when the biofouling control system is not operating.
6. Be sure any wash water comes from a raw water, un-chlorinated source at ambient temperature and salinity.
7. The sample duration will be determined based on field observations of entrained organisms. Start by supplying flow to the barrel sampler for no longer than ten minutes, and then sort and enumerate the contents as described below in Section 3.2 to determine the sample duration required to obtain at least 100 ichthyoplankton larvae and whatever additional number of fish eggs and macro-crustacean larvae are collected along with these fish larvae. It is better to collect ten 10-minute samples than one 100-minute sample.
8. It is important to identify each 10-minute entrainment survival collection with a unique sample number, and retain the distinction throughout the initial and latent observation periods.

3.2 Initial Survival Status of Entrained Organisms

Entrained organisms collected and observed for survival will be classified (sorted) in the field into two taxonomic categories (fish or macro-crustaceans), into two life stages (eggs or larvae), and into three survival status categories (live, stunned, dead). Species and life stage identifications will not be performed in the field to minimize handling mortality. Instead, specific identification, life stage classification, enumeration and length measurements will be performed in the laboratory on preserved specimens. The purpose of field sorting and classification is to observe and record the survival status of fish eggs, larvae and macro-crustacean larvae collected and place each organism in an appropriately labeled container designating the survival status for subsequent laboratory processing of the preserved samples.

Following collection of an entrainment survival sample, the initial (0-hour) survival status of live and dead ichthyoplankton eggs and larvae and any macro-crustacean larvae will be determined by immediately sorting the contents of the glass collection tray on site with the aid of a light table to classify each entrained organism in the initial observation period as live, stunned or dead according to the following criteria:

- Live (AD = 1)
  - Larvae swimming vigorously, no apparent difficulty in swimming orientation.
  - Eggs are translucent, chorion intact, and not cloudy in any internal portion.
- Dead (AD = 2)
  - Larvae showing no vital signs, no body or operculum movement; no movement when gently prodded.
  - Eggs are opaque, chorion ruptured, or cloudy in any internal portion.

- Stunned (AD = 3)
  - Larvae (only) swimming abnormally, struggling to maintain swimming position, or swimming sideways or upside down; or non-motile except when gently prodded.

Dead eggs and larvae will be removed from the initial (0-hour) sample after processing, placed in a labeled sample vial, designated as representing the "initial dead" class of organisms, and preserved in 6% buffered formalin. A color-coded labeling system will be used to differentiate the three categories of sample containers (alive = blue, stunned=green, dead=red), and a fourth label will designate each jar as representing the initial (0-hour) survival observation (initial = yellow).

3.3 LATENT (24-HOUR) SURVIVAL STATUS

After initial survival status is determined, live eggs will be carefully transferred from the collection tray into one-liter glass holding containers that have been filled with ambient, filtered (300 microns) un-chlorinated river water using a wide mouth pipette.

After initial survival status is determined, live and stunned larvae will be carefully transferred from the collection tray into separate glass one-liter holding containers that have been filled with ambient, filtered (300 microns) un-chlorinated river water. Stunned larvae will be placed in one or more separate holding containers from live larvae. A maximum of ten eggs or five larvae will be held in each one-liter container. Small larvae will be held separately from large larvae and juveniles to reduce the possibility of predation or cannibalism. Try to minimize the handling of larvae during transfer into holding containers by decanting or pouring from the collection tray, and only use wide mouth pipettes or plastic spoons to transfer organisms if necessary.

These holding containers will be covered with fine screening and held in a continuous flow water bath of ambient water until they are processed again at the latent (24-hour) observation time. A continuous temperature recording device (e.g. Onset StowAway® Tidbit® 32k temperature logger or the equivalent with an operating accuracy of $\pm$0.4°C) will be used to record the water bath temperature during the 24-hour holding period.

After a 24-hour holding period, the latent survival status of the fish eggs and larvae will be determined using the same criteria and procedures described above for the initial survival observations. All eggs and larvae will be removed from the latent observation samples after processing, placed in a labeled sample vial using a separate container for each latent survival category (live, stunned, dead), and preserved in 6% buffered formalin. A color-coded labeling system will be used to differentiate the three categories of sample containers (alive = blue, stunned=green, dead=red), and a fourth label will designate each jar as representing the latent (24-hour) survival observation (latent = white).

Preserved entrainment survival samples will be transported to the laboratory for identification, life stage determination, and enumeration. Total length of all ichthyoplankton larvae collected in the entrainment survival samples will be measured to the nearest 0.1 mm and recorded. The same data sheets used for processing entrainment abundance samples (Section 4.0 below) will be used for processing entrainment survival samples, but a TASK CODE = 4 is assigned to each entrainment survival sample.

3.4 ENTRAINMENT SURVIVAL FIELD OBSERVATION SHEET

Field observations of the initial and latent classification and survival of entrained organisms will be recorded on the Entrainment Survival Field Observation Sheet (Appendix A) according to the following instructions. A new data sheet will be used for each 10-minute survival sample collected and processed in the field. The last three digits of the sample number (task code, week and diel period) must correspond to the 6-hour entrainment abundance sample number on the Entrainment Abundance Field Data Sheet (Section 2.6.1). The first digit (pre-coded as 4) will differentiate each survival sample from each entrainment abundance sample (pre-coded as 1).

VARIABLE	INSTRUCTIONS
TASK CODE	Pre-coded 4 for entrainment survival sample
Week	Enter the two-digit week number within year (01-52).
Diel	Enter the one digit code for diel period: 1=1000-1600 2=1600-2200 3=2200-0400 4=0400-1000
Collection Time	Record the hour and minute from the start of the 10-minute survival collection (HHMM) using 24-hr clock (0000-2359 hrs)
Unit	Enter the code indicating the Unit from which the data was collected 4 = N/A 5 = Unit 5 6 = Unit 6 9 = Units 5 and 6 combined (continuous wash)
Holding Container ID #	Enter the unique holding container number
Observation Time	Record the hour and minute the survival observations were made (HHMM) using 24-hr clock (0000-2359 hrs)
Survival Period	Enter the code indicating the survival period when status was observed 1 = initial observation at the time of first collection (0-hours) 2 = survival status after 24 hour (latent) time period
Organism	Enter the code indicating the organism class for survival observations 1 = fish 2 = macro-crustacean
Life Stage	Enter the code indicating the organism life stage for survival observations 1 = egg 2 = larvae

VARIABLE	INSTRUCTIONS
AD	Enter the Alive or Dead survival status of the organism and life stage at the time of observation 1 = alive 2 = dead 3 = stunned
Count	Record a tally of the number of organisms observed in each category
Comments	Enter a 1 and write any comments at the bottom of the data sheet

3.5 CHAIN OF CUSTODY OF ENTRAINMENT SURVIVAL SAMPLES AND FIELD DATA SHEETS

Check over all data sheets, to make sure they are completely and correctly filled out, and to be alert to any unusual or unexpected data values. Transport the original data sheets to the Bedford, NH office where they will be submitted to the technical data processing (TDP) center for keypunching and error checking. Document the transfer of each data packet using a data submittal chain of custody form supplied by the TDP. Retain a photocopy of TDP chain of custody form. Preserved entrainment survival samples will be transported to the laboratory for identification, life stage determination, and enumeration.

4.0 ENTRAINMENT LABORATORY SOP

The ichthyoplankton and macro-crustaceans in each entrainment abundance sample (Section 2.0 above) and each initial and latent survival sample (Section 3.0 above) will be processed to identify individuals to species (lowest distinguishable taxon, generally species) and enumerate them by life stage. Ichthyoplankton (except winter flounder) will be enumerated into the following life stages: eggs, yolk-sac larvae, post-yolk-sac larvae, and juveniles. Winter flounder will be identified and enumerated into five life stages (1-5) using the criteria developed for Millstone Station in Long Island Sound (Dominion Resources Services, Inc. 2005). Lobster larvae will be identified and enumerated into four life stages (1-4) according to the criteria of Herrick (1895). Crab larvae will be identified and enumerated into three life stages (zoea, megalops, and juvenile). The total length to the nearest 0.1 mm will be measured for up to 30 individuals of each ichthyoplankton life stage (except eggs) per sample. If more than 30 ichthyoplankton larvae are present in a sample, a random selection of 30 specimens will be measured. The sorted contents of all entrainment samples will be retained in storage until the Comprehensive Demonstration Study is accepted by the regulatory agencies.

4.1 SAMPLES TO BE ANALYZED

Entrainment samples will be collected during a year-long period from the Schiller Station Screen House #2 CWIS. Entrainment sampling will be scheduled to occur on one sampling day per week when the plant is operating during 13 consecutive weeks in the June through August seasonal period of peak ichthyoplankton abundance, and again for 13 consecutive weeks during the January through March seasonal period to coincide with the recently reported primary and secondary peaks in seasonal

occurrence of fish eggs and larvae in the Piscataqua River nearfield area. Entrainment sampling will be conducted on one day every two weeks when the plant is operating during the 26 remaining weeks of lower seasonal abundance in April and May and from September through December. The resulting seasonally stratified entrainment sampling design will collect 156 entrainment samples from 39 total weeks (26 weekly plus 13 biweekly samples) during 12 consecutive months if the CWIS is operated on all scheduled sampling dates.

Weekly or biweekly entrainment sampling will consist of collecting four separate 100 m^3 entrainment samples at six-hour intervals representing one consecutive 24-hour period. Each entrainment sample will be collected using a 0.300 mm mesh net. Entrainment sampling will be scheduled to occur from 1000 on day 1 through 0959 on the next day (day 2). The same 24-hour period will be sampled during each scheduled week, and the four entrainment samples will be taken at approximately the same beginning and ending times (± one hour) during each 24-hour period. This design will provide 156 entrainment samples for the year (4 samples per day x 39 days) if the plant operates during all scheduled 6-hour sampling intervals throughout the year.

Entrainment survival studies will be performed monthly at Schiller Station to determine the survival of entrained ichthyoplankton and macro-crustacean larvae that have passed into the condenser cooling system through the CWIS (Section 3.0 above). Entrainment survival collections at Schiller Station will be scheduled for one randomly selected day per month on a day already selected for entrainment abundance sampling. The regularly-scheduled entrainment abundance sample will be collected and preserved for each six-hour collection interval, and then a series of 10-minute collections will be made to obtain sufficient eggs and larvae for initial (0-hour) and latent (24-hour) survival observations. Entrainment survival samples will be sorted in the field into six categories (initial alive, initial stunned, initial dead, latent alive, latent stunned, latent dead) and observed in the field for entrainment survival. Following field survival observations, all survival samples will be delivered to the Bedford, NH laboratory for identification, life stage classification, enumeration, and length measurements.

4.2 EQUIPMENT

The following items are required for laboratory analysis of ichthyoplankton and macro-crustacean larvae in entrainment samples:

- Sorting pans
- Lights
- Magnifiers
- Dissecting microscopes
- Motoda plankton splitter
- Sieves
- Rose bengal
- Gridded Petri dishes
- Divided Petri dishes
- Jars, with lids
- Forceps
- Pipettes

- Multitally counters
- Squirt bottles
- Lab data sheets
- Pens
- Vials, with caps
- Vial labels
- Taxonomic literature
- Copy of SOP
- Ocular micrometers
- Millimeter rulers
- Masking tape
- Rubber bands
- Random number table
- Hensen Stempel Pipette
- Folsom Splitter

4.3 LABORATORY PROCEDURES

4.3.1 Subsampling

4.3.1.1 Restrictions and Quotas

Samples with high abundances may be subsampled in the laboratory, with a minimum of 200 fish eggs and larvae to be analyzed. This quota applies to the total count of all species combined, not to individual species.

For each sample with a low ichthyoplankton concentration and a high total volume of detritus and other plankton (more than 400 ml settled volume), sort a maximum of one-half of the sample for eggs and larvae.

Entrainment survival samples will not be subsampled.

4.3.1.2 Sequence

Use the following sequence of procedures in processing a sample that is subsampled by splitting. To eliminate any chance of bias, some steps in the procedure are to be performed by an assistant, as indicated below, so that the sorter has no prior knowledge of which samples are to be subjected to quality control inspection.

This procedure also applies when a previously split sample is further subsampled, such as an "id. split" performed because the fraction sorted was larger than necessary to meet the quota. In this situation the term "sample" in the following procedure refers to the part of the original sample that is to be further subsampled, and the selected fraction(s) are "analyzed" rather than "sorted."

1. Examine the sample to estimate the smallest size fraction that is likely to contain at least 200 fish eggs and larvae.

2. Divide the sample material into two equal parts using the techniques in Section 4.3.1.3.
3. Randomly select one of the two divisions for processing (or for further subsampling, if a smaller fraction is needed). Selection should be done using a random number table or a coin toss, so that each of the two divisions has an equal chance of being selected. The person performing the division must not know which of the two divisions will be analyzed before the division is completed (it is not acceptable to always select the division from the same chamber of the splitter).
4. Set aside the fraction not selected for further processing and label it to identify the sample number and fractional size.
5. If the fraction that was selected for further processing needs to be subsampled further, repeat steps 2-4 as many times as necessary to produce the desired fraction for analysis. When the desired fraction is obtained, label it to show the sample number and fractional size.
6. Sort the subsample by the procedures in Section 4.3.2. Organisms must be sorted from the entire subsample even if the quota is reached before finishing the subsample.

4.3.1.3 Splitting Technique

Perform all sample splitting using a Motoda splitter. The presence of filamentous algae or large items (including large juvenile fish, or older age classes) can interfere with the even distribution of material and organisms between the two chambers of the splitter. Therefore, to insure successful results, observe the following techniques: (1) Adjust sample dilution to be great enough to allow free mixing of the sample but not so great as to promote clumping due to over dilution. (2) Remove large fish and excessive amounts of filamentous algae before splitting, returning any adhering ichthyoplankton to the sample. (3) Pull apart remaining clumps of algae before splitting. (4) Scrutinize detritus and organisms during the splitting process to see that they appear equally distributed before making the final division. (5) Remix and split again if the two resulting portions of a division do not appear equal. If a sample has so much algae that it cannot be satisfactorily split, sort the entire sample, and if numbers of ichthyoplankton are high splitting may be performed after sorting. Large juveniles that are removed from the whole sample before splitting must be kept separate from ichthyoplankton sorted from the sample after splitting, and they must be labeled to show they represent the whole sample.

4.3.2 Sorting (Fish)

Remove fish eggs, larvae and juveniles, from the samples according to the following procedures:

- Samples may be stained with rose bengal to facilitate sorting.
- Pour the sample contents into a sieve with a mesh equivalent to, or finer than, 300 μm and rinse with water to remove the preservative.
- If the sample contains large numbers of fish eggs and larvae, prepare a subsample following the procedures in Section 4.3.1.

- Carefully wash the sample contents into a container making certain that nothing remains in the sieve. Pour portions of the sample from the container into a pan and examine them under magnification.
- Remove fish eggs, larvae, and juveniles from the sample using forceps, pipettes, and probes. Remove only those fragments that include the head.
- Maintain a combined total count for eggs and larvae that are removed from the sample (i.e., the combined total of eggs, yolk-sac larvae, post yolk-sac larvae, and juveniles).
- When sorting is completed, recheck the sample for organisms. After the sample has been rechecked, label vials containing the sorted organisms and place them in a box designated for sorted samples. Record the sorting results and date completed in a log.
- Carefully wash back the remaining sample contents into the original sample container, appropriately preserved, and return it to the storage area.
- If a sample is not completed by the end of the work day, it may be left unpreserved overnight if adequate precautions are taken to prevent it from drying out. No sample or part of a sample, however, should remain unpreserved for more than 24 hours.

4.3.3 Identification (Fish)

Identify, stage, count, and measure the sorted ichthyoplankton according to the following procedures:

- Obtain the sample vials containing the sorted organisms from the storage area and sign them out by initialing a status log.
- Rinse specimens free of preservative and submerge them in water in a Petri dish. Use a binocular microscope with an ocular micrometer to examine the specimens, and identify them to the lowest practical taxon (usually species) by referring to the literature, the reference collections, and by consulting with fellow identifiers.
- Determine the life stage of each specimen. Pertinent life stages for all except winter flounder larvae are defined and identified as follows:

  Egg: the embryonic developmental stage, from spawning until hatching. Eggs frequently become damaged during collection and sample processing. Damaged eggs are counted as the number of embryos (without regard to how many egg capsules are present). Do not count non-fertilized eggs if they are present.

  Yolk-sac larva: the transition stage from hatching through the development of a complete, functional digestive system (regardless of the degree of yolk and/or oil globule retention)

  Post yolk-sac larva: the transition stage from development of a complete, functional digestive system to transformation to juvenile form (regardless of the degree of yolk and/or oil globule retention), including the leptocephalus stage of eels

Young-of-the year: the stage from completed transformation to Age 1 (i.e., 12 months after hatching). A young-of-the-year has a full complement of fin rays identical to that of an adult. Eels are classified in this stage until Age 2.

Yearling or older: a fish at least one year old

- Determine the life stage for winter flounder larvae as follows:

  Stage 1: yolk-sac present or eyes not pigmented

  Stage 2: no yolk-sac present and eyes pigmented, but either no fin ray development or no flexion of the notochord

  Stage 3: fin rays present and notochord flexion has begun, but the left eye has not migrated to the midline of the head

  Stage 4: left eye has reached the midline of the head, but full fin ray complement has not yet been attained

- Count the specimens of each life stage. Record the counts by species and stage on the lab data sheet (refer to Section 4.5.1 for coding instructions).

- From each entrainment abundance sample, measure a maximum of 30 larvae of each fish taxon and larval life stage to the nearest 0.1 mm (total length) and record the measurements on the lab data sheet. Record total length of juvenile life stages to the nearest 1.0 mm. If more than 30 larvae of a given taxon and life stage are present, randomize the selection of specimens for measuring by the following procedure. Spread them uniformly in a gridded container, select a starting point in the grid by means of a random number table, and then measure the first 30 measurable specimens encountered in a predetermined pattern commencing at the starting point. Every grid space must have an equal probability of being selected as the starting point, so that every specimen will have an equal probability of being included in the subsample.

- All larvae from entrainment survival samples will be measured without subsampling.

- For each larva measured, record its life stage or developmental stage (stage 1-stage 4 as defined above for winter flounder).

- Place identified organisms in vials with an adequate amount of preservative for storage. Specimens may be removed for inclusion in the reference collection. For those removed, list the species, life stage, and numbers on the comments section of the form and note their removal on a tag retained inside the appropriate vial. Label all vials for a single sample, initial them and band them together. Record the number of vials for the sample on the data form. For reference collection procedures refer to Section 4.7.

Larvae are usually identified to the species level except for occasional badly damaged specimens. The primary exception is among hakes of the genus *Urophycis* sp. In the New Hampshire coastal region it is possible to collect red hake (*U. chuss*), white hake (*U. tenuis*), and spotted hake (*U. regia*), but there is insufficient published information available for reliably distinguishing the larvae of the

three species. In estuaries and inshore waters along the NH coast red hake is probably the most abundant and spotted hake is probably relatively rare, although all three species have been identified in adult fish collections off Seabrook, NH. Northern searobin (*Prionotus carolinus*) and striped searobin (*P. evolans*) occur occasionally in the area and are not distinguishable in the egg and early larval stages, so they are identified only to genus.

Some groups of larvae are often identified only to the generic level by others but are usually identified to species at Normandeau. These include grubby (*Myoxocephalus aenaeus*), longhorn sculpin (*M. octodecemspinosus*), shorthorn sculpin (*M. scorpius*), Atlantic seasnail (*Liparis atlanticus*), and Gulf snailfish (*L. coheni*). The abundant sand lance larvae are categorized by the Normandeau lab as American sand lance (*Ammodytes americanus*), although the possibility of some of them being northern sand lance (*A. dubius*) cannot be ruled out. The much less common redfish larvae are coded as *Sebastes* sp., although it most likely that they are all Acadian redfish (*S. fasciatus*). Golden redfish (*S. norvegicus*) and deepwater redfish (*S. mentella*) are distributed more offshore and they are difficult to distinguish from Acadian redfish even as adults.

Although most larvae are identified to species, there are some relatively abundant species that cannot routinely be identified to the species level in the egg stage. The very abundant cunner (*Tautogolabrus adspersus*, family Labridae) cannot usually be distinguished from the occasional yellowtail flounder (*Limanda ferruginea*, family Pleuronectidae) and the locally uncommon tautog (*Tautoga onitis*, family Labridae), except for occasional specimens that are close enough to hatching that the embryo within the egg capsule is well developed. These are routinely identified as "Labridae/*Limanda*" eggs and are believed to be mostly cunner, based on the relative abundance of the larvae of the three species. A second commonly used category used for eggs is "*Enchelyopus/Urophycis*," which includes fourbeard rockling (*E. cimbrius*) and phycid hakes (*Urophycis* sp.). A third grouping of species that are not usually distinguishable from each other at the egg stage includes the commonly occurring Atlantic cod (*Gadus morhua*) and witch flounder (*Glyptocephalus cynoglossus*), plus the much less common haddock (*Melanogrammus aeglefinus*), recorded as "Gadidae/*Glyptocephalus*." Those three categories account for by far the most instances of not identifying eggs to the species level, but there are occasionally others.

4.3.4 Lobster and Macro-Crustacean (Crab) Larvae

In addition to ichthyoplankton, process the planktonic stages of the American lobster and macrocrustaceans (crabs) listed in the table below. The spider crab *Libinia sp.* is quite rare in coastal NH waters. The common spider crabs are *Hyas coarctatus* and *H. aranea*. *Cancer* sp. are difficult to distinguish in Stage 1 zoea and impossible to distinguish in later zoeal stages, so we use *Cancer* sp. for zoea, and identify megalopa and juveniles to the species level of taxonomy.

Family	Family Common Name	Scientific Name	Common Name	Taxon Code
Portunidae	swimming crab	*Carcinus maenus*	green crab	762
Cancridae	rock crab	*Cancer irroratus*	Atlantic rock crab	764
Cancridae	rock crab	*Cancer borealis*	Jonah crab	765
Cancridae	rock crab	*Cancer sp.*	unidentified cancer crab	766
Nephropidae	lobster	*Homarus americanus*	American lobster	770
Majidae	spider crab	*Libinia sp.*	unidentified spider crab	821
Majidae	spider crab	*Hyas araneus*	Atlantic lyre crab	854
Majidae	spider crab	*Hyas coarctacus*	Arctic lyre crab	855
Grapsidae	shore, marsh, talon crab	*Hemigrapsus sanguineus*	Japanese shore crab	835

4.3.4.1 Lobster Larvae

Lobster larvae will only be processed from samples collected during their known period of seasonal occurrence from the May-August samples (16 weeks x 4 diel periods = 64 samples scheduled). These consist of stages 1-4, which range from about 8 to 15 mm in total length. The first three stages are zoeae that are characterized by a long rostral spine and prominent abdominal spines. The fourth stage is a megalops that resembles a small adult.

Sort samples for lobster larvae by the same procedures as for ichthyoplankton (Section 4.3.2), except that no subsampling is performed for lobster larvae. Remove all stage 1-4 lobster larvae from the entire samples.

Refer to the following technical reference for identifying and staging lobster larvae:

> Herrick, F.H. 1895. The American lobster: a study of its habits and development. Bulletin of the U.S. Fisheries Commission. 15:1-252.

Count the number of lobster larvae in the sample by stage. Stage 1 larvae lack pleopods (swimmerets) on the abdomen. Stage 2 larvae have pleopods, but they lack uropods beside the telson. Stage 3 larvae have uropods. Stage 4 larvae have enlarged claws and they resemble small adult lobsters. Record the counts on the same data sheet as the ichthyoplankton (Section 4.5.1), using the code 770 for the variable TAXON and the codes 1, 2, 3, or 4 for the variable STAGE. No measurement data are required for lobster larvae.

Place lobster larvae in a separate vial for each sample, with an adequate amount of preservative for storage. Specimens may be removed for inclusion in the reference collection (Section 4.7). Document the removal of reference specimens on the data sheet and on an internal label in the vial for the sample.

4.3.4.2 Macro-Crustacean (Crab) Larvae

Macro-crustacean larvae other than lobsters (i.e. crabs) will be sorted, identified, and enumerated into three life stages (zoea, megalops and juvenile). The zoeae are characterized by absent or non-setose pleopods and enlarged first and second maxillipeds and will be assigned STAGE = 1. The megalopae resemble small adults, but have an extended abdomen with setose pleopods and will be assigned

STAGE = 3. The juveniles resemble adults with the abdomen reflexed against the body, but which are sexually immature and will be assigned a STAGE = 4.

In general, subsampling will occur for numerically dominant species and life stages. The minimum count quota will be 100 individuals of a species life stage for subsampling to be permitted. Less common species and life stages will be enumerated in the entire sample. Samples containing more than 400 ml of settled plankton volume will be split in half and only one-half will be analyzed.

- Pour sample into 256 micron mesh sieve to separate sample from preservative and rinse sample.
- Place sample in large beaker and adjust volume using water to provide a 10-ml aliquot that will contain about 50-100 of the dominant crab larvae, if possible. Record adjusted volume (ml).
- Using a 10-ml Hensen Stempel pipette, homogenize the sample and remove an aliquot. Place the aliquot in a plankton counting tray. Identify and enumerate all target species and stages using a dissecting microscope at magnifications of 6X-50X. Continue subsampling by aliquots until a minimum of 100 of the dominant crab larvae are counted. Count all individuals in the final aliquot. Record subsample volume (number of aliquots x 10 ml) and number counted.
- Depending on the numerical distribution of species in the sample, the taxonomist may either continue subsampling using the Hensen Stempel pipette to enumerate sub-dominant taxa or discontinue subsampling and process the remainder of the sample in its entirety if all other species or stages are in relatively low abundance.
- To process sample in its entirety, mix and pour portions of the sample into the plankton counting tray and identify and enumerate using the dissecting microscope. Continue process until entire sample has been examined. Record counts and portion of sample examined.
- A Folsom splitter may be used to serially split the sample if moderate numbers of larvae are present (requiring one-half to one-eighth of the total sample be examined) or in cases where subsampling with a Hensen Stempel pipette is not possible due to large amounts of debris or filamentous material in the sample. Record counts and fraction of sample examined.
- Consider the different lifestages of a species to be discrete taxa. For example, if a count quota of 100 zoea is attained for *Cancer* sp., continue counting the *Cancer* megalopa and juvenile stages in the remainder of the sample.
- After sample identification and enumeration is complete, return sample to jar, preserve and return to storage area. Fill out all logs and data sheets.
- Lengths of any crustacean stage will not be measured.
- Voucher specimens of each species and life stage will be removed and placed in vials. Specimens only need to be removed from one sample of the project. Record sample, date and species.

4.4 SAMPLE HANDLING

4.4.1 Sample Control

Each sample was given a unique sample number at the time of collection. Track each sample by that sample number throughout the laboratory and data processing functions.

4.4.2 Chain of Custody Records

The chain of custody documentation begins with the field staff providing a list with the following information for each sample in a shipment delivered to the laboratory facility in Bedford, New Hampshire: sample collection date, sample collection time, sample identification number, and number of jars. Upon receipt of the samples, a laboratory representative verifies that all jars of all samples on the list are present, then signs and dates the chain of custody document.

After samples have been received in the laboratory, track their location and status during all phases of storage and laboratory analysis by means of sample control logs. The function of this system is to provide a paper trail of who performed each step in the analysis of a sample from collection to storage, when each step occurred, what condition the samples were in and where each step took place.

4.4.3 Preservation and Storage

Retain the original preservative (formalin solution) for reuse in preserving the residue of sorted samples, adding 5% formalin as needed to fill the sample jars. Store processed samples (i.e., detritus and organisms not removed from split samples) until sorting quality control checks are completed. Keep sorted ichthyoplankton in vials in a heated storage area until disposal is authorized (when the Comprehensive Demonstration Study is submitted to USEPA, presently scheduled for January 2008). Tape the tops of jars and vials to prevent loss of preservative by evaporation.

4.4.4 Disposal

Disposal of sample residue remaining after sorting (detritus and organisms not removed from split samples) may proceed after sorting quality control has been completed. Disposal of vials of organisms from processed samples may proceed after receiving authorization from PSNH. Follow all applicable state and federal regulations for hazardous waste disposal.

4.5 DATA HANDLING

4.5.1 Data Sheets and Coding Instructions

Record ichthyoplankton counts and measurements on Entrainment Lab Count Data Sheets and Entrainment Lab Length Data Sheets (Appendix A). The Entrainment Lab Count Data Sheet is for species identifications, life stage determination, and count data for all taxa. The Entrainment Lab Length Data Sheet is for measurements of all fish larvae. Indicate in the upper right-hand corner of each data sheet how many pages there are for the sample (use "1 of 1" for a one-page sample, "1 of 2" and "2 of 2" for a two-page sample, etc.). Also record in the upper right-hand section of the first page the identifier's initials, the date the sample was identified, and the number of vials.

4.5.1.1 Count Data

Record count data in the top ("Card Type L1") section of the data sheet according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the 4-digit sample number. Sample numbers will be in the range 1011 to 1524 for entrainment abundance samples or 4011 through 4524 for entrainment survival samples (but not every number in that range is used).
CONTAINER #	If sample number begins with 4 (entrainment survival sample), record the holding container sample number Blank = not a survival sample (first sample number digit is 1)
SURVIVAL PERIOD	If sample number begins with 4 (entrainment survival sample), enter the code indicating the survival period from the label on the sample vial Blank = not a survival sample (first sample number digit is 1) 1 = initial observation (0-hours) with yellow label 2 = survival status after 24 hour (latent) time period with white label
AD	If sample number begins with 4 (entrainment survival sample), enter the Alive or Dead survival status of the sample from the label on the sample vial Blank = not a survival sample (first sample number digit is 1) 1 = alive (blue label) 2 = dead (red label) 3 = stunned (green label)
CATCH_CD	Enter 1 for valid non-empty sample or 2 for valid empty sample (data sheets are not required for void samples)
SPL_FACT	Enter 1.00 if the whole sample is analyzed; if the sample is subsampled record the ratio of the whole sample to the subsample (e.g., 8.00 for a 1/8 split)
TAXON	Enter the TAXON code from the list provided in Appendix C.
STAGE	Enter one of the following life stage codes: 0 = unknown 1 = eggs 2 = yolk-sac larvae (do not use for winter flounder) 3 = post yolk-sac larvae (do not use for winter flounder) 4 = young-of-the-year 5 = yearling or older 11 = winter flounder Stage 1 larvae 12 = winter flounder Stage 2 larvae 13 = winter flounder Stage 3 larvae 14 = winter flounder Stage 4 larvae

VARIABLE	INSTRUCTIONS
COUNT	Record the number of organisms of the indicated taxon and life stage in the sample (or subsample)
SPECIES NAME	Record the common name for the taxon

4.5.1.2 Measurement Data

Record measurement data for all fish larvae on one or more Entrainment Lab Length Data Sheets according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the sample number
Card Type	Preprinted: L2
SURVIVAL PERIOD	If sample number begins with 4 (entrainment survival sample), enter the code indicating the survival period from the label on the sample vial Blank = not a survival sample (first sample number digit is 1) 1 = initial observation at the time of first collection (0-hours) 2 = survival status after 24 hour (latent) time period
AD	If sample number begins with 4 (entrainment survival sample), enter the Alive or Dead survival status of the sample from the label on the sample vial Blank = not a survival sample (first sample number digit is 1) 1 = alive 2 = dead 3 = stunned
Conversion Factor	Record the number of millimeters per division for the optical micrometer used to measure larvae
TAXON	Enter the TAXON code from the list provided in Appendix C.
FISH_ID	Preprinted: 1-30 for each taxon of ichthyoplankton larvae.
STAGE (or "STG.")	Enter the life stage code for each larva measured (11, 12, 13, or 14 for winter flounder; or 2, 3, 4, or 5 for other species). Refer to the life stage code definitions used for count data (Section 4.3.3).
SCALE	Enter 6 if measurements are recorded in optical micrometer units; enter 7 if measurements are recorded directly in millimeters. (If optical micrometer units are recorded for a measurement, the actual length in millimeters will be obtained later by multiplying the measurement by the conversion factor.)
MEASUREMENT	Record the total length of fish larvae to the nearest 0.1 optical micrometer unit or to the nearest 0.1 mm. Measure juvenile fish to nearest 1.0 mm.

4.5.2 Storage and Chain of Custody of Data Sheets

Maintain all completed data sheets in duplicate. Keep photocopies at the site of origin and transfer the originals as needed from the laboratory to the data center, quality control, and a master project file. Track the custody of data sheets by means of data control logs.

4.6 QUALITY CONTROL

4.6.1 Tasks Subject to Quality Control

The following tasks are subjected to quality control checks consisting of reanalysis of randomly selected samples or measurements:

- sorting
- identification, life stage determination, and enumeration

4.6.2 Inspection Plans

Items are inspected using a quality control (QC) procedure derived from MIL-STD (military-standard) 1235B (single and multiple level continuous sampling procedures and tables for inspection by attributes) to achieve a 10 percent or better AOQL (Average Outgoing Quality Limit). The QC procedure used is the CSP-1 continuous sampling plan, which is conducted in two modes as follows:

- ***Mode 1.*** Reinspect one hundred percent of the samples until "i" consecutive samples pass.
- ***Mode 2.*** After "i" consecutive samples pass QC reinspection, randomly choose (using a random numbers table) the fraction "f" of the samples for reinspection. If any QC sample fails then return to Mode 1.

For this application of CSP-1, **i=8** and **f=1/7**, because the total number of samples analyzed by an individual is less than 500. It is important that QC inspections are performed as soon as possible after the original analysis; work-up of QC samples must not be postponed to be done in batches. Keeping the QC program as current as possible insures that problems are detected and remedied quickly, minimizing the additional number of samples that are analyzed before the problem is addressed.

Select items for reanalysis according to the plan using a random number table. The original analyzer should not know whether a sample is to be checked before the analysis of that sample has been completed. Perform all quality control checks "blindly" (i.e., the individual performing the QC inspection should have no knowledge of the original analyst's results).

Apply the QC plan on an individual processor basis, so that each person's work is subjected to the QC plan independently of others, starting at 100% inspection.

A resolution (third person) value may be determined for any sample found defective. All errors found during the QC check, whether the sample is found to be defective or not, are to be corrected on the data sheets. (A difference between original and QC counts that is within acceptable limits is not con-

sidered to be an error). Results of the quality control program are to be presented to all sorters and identifiers and help is to be made available to anyone failing a QC check.

In some cases a QC inspection may be able to determine the taxon or life stage of damaged specimens when the original identifier has recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by the original identifier includes the more specific category used by the QC inspector, and that is the only reason for a count discrepancy, then that sample does not fail the QC inspection on the basis of that taxon. For example, damaged specimens recorded as *Morone* sp. by the original identifier and as striped bass by the QC inspector are to be considered in agreement because the category *Morone* sp. includes striped bass. In contrast, an original determination of unidentified gobiid would not be acceptable if the QC determination was striped bass, because striped bass is not included in the family Gobiidae. If substantial differences occur between the original and QC counts as a result of identifying or staging to different levels, then the identifier should be provided with additional guidance or training to minimize such differences in future samples.

4.6.3 Acceptance/Rejection Criteria

4.6.3.1 Sorting

A sample is considered defective if the sorter failed to remove 10 percent of the total organisms in the sample (or subsample). Percent error is calculated as follows (where "QC count" denotes the number missed by the sorter):

$$\% \text{ error} = 100\% \times \text{QC count}/(\text{sorter's count} + \text{QC count})$$

When the total count (sorter's plus QC) is ≤20, then the sample is considered defective only if the sorter missed more than two organisms.

4.6.3.2 Identification

A sample is considered defective if an error of 10 percent or more is made in identifying, assigning a life stage, or counting any species. In determining whether a sample is defective, analyzer and QC results are compared within each taxon/life stage combination.

For each taxon (or for a life stage within a taxon) the percent error is calculated as follows (except where the QC count is ≤20, the percent error is considered to be zero if analyzer and QC counts differ by no more than two organisms):

$$\% \text{ error} = 100\% \times |\text{analyzer count} - \text{QC count}|/\text{QC count}$$

A sample with a percent error of greater than or equal to 10% for any life stage for any taxon is considered defective.

For each defective sample, a resolution may be determined in which a third person reanalyzes the sample (resolution value). The error for each species and life stage will then be calculated using the resolution counts as the divisor. This will be done for both identification and QC counts:

$$\% \text{ error} = 100\% \times |\text{identifier count} - \text{resolution count}|/\text{resolution count}$$

$$\% \text{ error} = 100\% \times | \text{QC count} - \text{resolution count} | / \text{resolution count}$$

If the resolution vs. identifier error is <10 percent, the sample passes. If they are not, the sample fails and identifier counts are replaced by QC counts for all cases, provided the QC vs. resolution error is <10 percent. If the resolution vs. identifier and the resolution vs. QC errors are both 10 percent or more, the sample will be thoroughly reviewed by all three people and the identifier's sample processing will not continue until agreement can be reached on the identification of the sample. Subsequent samples will be reanalyzed by the QC person until eight consecutive samples pass. Notify the Laboratory Manager of any identifier exceeding two failed samples.

4.6.4 Quality Control Records

Maintain quality control logs, documenting the samples analyzed, the samples selected for reanalysis according to the QC plan, the results of the QC analysis, and any corrective action performed. All QC logs will be 100% inspected monthly by the Laboratory Supervisors. A summary report of quality control results and follow-up corrective action will be submitted to the client upon request.

4.6.5 Quality Control Personnel

The QC of the sorting process is to be conducted under the direct supervision of the Sorting Supervisor. Only the Sorting Supervisor or individuals with a documented sorting QC record of superior performance may provide sort QC.

Regarding identification QC, only the Identification Supervisors will be performing the QC on ichthyoplankton identification.

4.7 Reference Collection

Make sure that each taxon and life stage identified in the entrainment program is represented in a project-specific reference collection at Normandeau's biology laboratory. Add to that reference collection as needed by removing specimens from PSNH entrainment samples and storing them in vials in a designated area. If available, include several (e.g., 10) specimens per taxon per stage, displaying a variety of sizes. Label the vials with the scientific name, date of capture, capture location, and a reference collection catalog number. The catalog number identifies a card containing more detailed sampling information, identifier, comments, etc. File the cards alphabetically by family, genus, and species.

4.8 Instrument Calibration

Calibrate each ocular micrometer periodically (at least weekly) using a stage micrometer. After calibration of ocular micrometers on zoom microscopes, place a calibration mark on the microscope so that measurement accuracy is maintained. Ocular micrometers on microscopes that have been adjusted or moved must be recalibrated before use. Document the calibrations in a log showing the dates and results of the calibrations.

5.0 DATA PROCESSING

5.1 DATA ENTRY VERIFICATION

A submittal form will be provided with each batch of data sheets submitted to the Technical Data Processing (TDP) department in the Bedford office for data entry. Information on the submittal form should include names of sender and recipient, date sent, and dates of impingement collections included in the batch.

All data will be keyed twice, resolving discrepancies between the two versions as they are flagged by the data verification program.

5.2 SYSTEMATIC ERROR CHECKS

Keyed data will be subjected to a series of systematic error checking programs developed specifically for this project. These consist of univariate, bivariate, and multivariate checks specified by project personnel. Univariate range checks identify records for which one or more variables have values outside their valid or expected ranges. Bivariate and multivariate checks compare values of related variables. Additional checks scan the data for duplicate or missing observations. All records flagged by these programs will be resolved, and corrections to both the data files and the data sheets will be made as necessary. After error checking is complete, data files will be subjected to quality control inspection (refer to Section 5.4).

5.3 DATA FILE FORMAT

Error checked data files will be assembled into a computerized database.

5.4 QUALITY CONTROL OF DATA FILES

Data files that have completed the systematic error checking process will undergo a QC inspection to assure a 1% AOQL (Average Outgoing Quality Limit) according to a lot sampling plan (American Society for Quality Control. 1993. Sampling procedures and tables for inspection by attributes. ANSI/ASQC Z1.4-1993). This procedure insures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are shown below. If more than the acceptable number of failures are found, then the data set must be inspected 100%.

Lot Sampling Plan for QC Inspection at Less Than 1% AOQL.

		Number of Failures	
Lot Size	**Sample Size**	**Accept If ≤**	**Reject If ≥**
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

6.0 TRAINING

In order to assure the standardization of field, laboratory, and data processing procedures, Normandeau has developed a two-level system for training technicians: the first level being documented standard operating procedures; the second level being a training program for all new project personnel. At a minimum, this training program consists of the following steps:

- A complete reading and explanation of the project SOP and QA manual. This is documented by a sign-off sheet which is filed in the program file.
- Observation by the Program Manager, Field Site Supervisor or Laboratory Manager of the first two or more times a new procedure is performed. This is documented with a signed checklist.
- Direct supervision by an experienced technician of personnel assigned to unfamiliar tasks for their first two or more attempts.
- 100% quality control checks for at least the first five samples analyzed.
- On tasks requiring identification of fish and ichthyoplankton, the Program Manager will have final approval as to who is qualified to make these identifications. In some cases special training will be required to participate in tasks, as set forth by the Program Manager.

7.0 QUALITY ASSURANCE PLAN

Normandeau's Program Manager is Mr. Richard Simmons. The program Technical Director is Dr. Mark Mattson, who will be the principle report reviewer and co-author. Normandeau's Quality Assurance Director is Mr. Robert Hasevlat, who is independent of the project and reports directly to the company's President, Ms. Pamela Hall. The Field Supervisor is Mr. Michael Jeanneau. Field crew members include Mr. Michael Jeanneau, Mr. Cory Francis, Mr. Donald Mason, Mr. Al Frizzell, Mr.

Chris Baker, Ms. Shayle Reed, and Mr. Randy Whistler. Normandeau's laboratory fish taxonomist is Mr. Joseph Strube. Normandeau's technical information processing services will be provided by Ms. Susan Ward or Mr. Chris Gushin. Report authors and data analysts will include Mr. Paul Lindsay, Mr. Drew Trested, or Mr. Jason Wyda.

7.1 IMPORTANCE OF QUALITY ASSURANCE

The analytical study will provide qualitative and quantitative data for use in decision making. To be valuable, the data must accurately describe the characteristics and concentrations of constituents in the sample analyzed. In many cases, because they lead to faulty interpretations, approximate or incorrect results are worse than no results at all. Decisions on process changes, plant modifications or the construction of new facilities may be based upon the results of field and laboratory analysis. The financial implications of such decisions make it imperative that extreme care be taken in analysis. The analyst should realize not only that he/she has considerable responsibility for providing reliable descriptions of the samples at issue, but also that his/her professional competence, the validity of the procedures used, and the resulting values reported may be challenged (perhaps in court). For the analyst to meet such challenges, he/she should support the data with an adequate documentation program that provides valid records of the control measures applied to all factors bearing on the final results of investigations. Although all analysts practice quality control (QC) in amounts depending upon their training, professional pride, and the importance of their particular projects, under actual working conditions sufficiently detailed QC may be neglected. An established, routine, quality assurance program applied to each analytical test will provide the detailed QC necessary to insure the validity and reliability of the data.

7.2 QUALITY ASSURANCE

A Quality Assurance (QA) Program will be implemented that will provide a 10% Average Outgoing Quality Limit (AOQL) (i.e., 10% or less non-conforming product) for all field or laboratory measurement parameters and a 1% AOQL (i.e., 1% or less non-conforming product) for all data calculations and data tables. This Quality Assurance Program is designed to meet or exceed the USEPA's guidance criteria and be consistent with the intent of Federal regulations (10 CFR 50) which require that quality assurance be separated from operational and budgetary concerns. Normandeau has a full time Quality Assurance Director who supervises the implementation and documentation of the QA Program and reports directly to the President of the Company.

Normandeau's Quality Assurance Program will comprise two systems: a quality control (QC) system and a quality assurance (QA) system. The principal strengths of the QA Program are the functional independence of the systems and the common collection and interpretation point for quality related information, the Quality Assurance Director. The QC system is managed by the Program Manager and conducted by operational personnel. The QA system is managed by Normandeau's Quality Assurance Director and utilizes project-independent technical personnel during performance and system audits.

7.3 QUALITY CONTROL

The function of the QC system is to continually monitor the reliability and validity (accuracy, precision, and completeness) of data produced on a daily basis. The QC system is approved by the QA Director and incorporated into the project Standard Operating Procedures (SOP); any changes to the SOP must be coordinated through Normandeau's QA Department and approved by a client representative. The project SOP will describe and document the following tasks:

- technical requirements, methods, and procedures,
- Quality Control program,
- instrument maintenance and calibration,
- document control and documentation of the resulting from sample analysis, instrument maintenance and calibration and data processing,
- sample control procedures, and
- training of technicians.

Tasks subject to 10% AOQL quality control inspection will be specified in the project SOP. Quality assurance audits of field and laboratory activities will be performed at least once per year to verify that procedures are carried out as specified in the SOP and to verify the effectiveness of the quality control system. Computer entry of data from data sheets will be subjected to double entry verification. Computer files will be subjected to a rigorous set of univariate, bivariate, and multivariate systematic error checks. Analytical files will then be subjected to a 1% AOQL quality control inspection to verify that values have correctly been correctly transferred from data sheets to the analytical files. Representative data values in tables and graphs will be verified by recalculating them from the original data.

7.4 NONCONFORMANCE REPORTS AND CORRECTIVE ACTION

Documentation of problems or unusual events occurring during a program will be accomplished using Extraordinary Event/Nonconformity (EENC) forms. The EENC form (Appendix A) is designed to dispense information to the Program Manager and Quality Assurance department and to obtain necessary action on items that are critical to technical operations and management of programs. The report results from observations such as these:

- deviations from standard operating procedures
- losing a sample
- finding an endangered species in a sample
- noting samples that are grossly different from expected (content, preservation, labels)
- noting a phenomenon that may deserve continued monitoring in the interest of the client and therefore may require a change in the scope of work

- quality control samples that exceed acceptable limits
- unusually high organism counts.

Items, samples, data, or information not in conformity with specifications or which do not meet pre-conditions for the next step in processing or use, will be set aside until the problem is resolved and documented via the EENC report procedure.

The EENC report is designed for use by any person who identifies a problem or discovers information that is germane to a program scope of work or the improvement or change of contract performance. The originator describes the problem and may make recommendations for its resolution. Two temporary copies are made, and the original is sent to the Program Manager. One of the copies is kept by the originator in a file for "open" EENC reports (corrective action in progress), and the other is sent to the Quality Assurance Supervisor, who periodically checks on the progress of corrective action.

The Program Manager confers with appropriate parties and decides what corrective action will be required. Instructions to the Action Addressee (the person responsible for carrying out the corrective action) are written on the original EENC report. The Program Manger retains the original and sends a copy to the Action Addressee.

The Action Addressee resolves the problem as directed and then signs the EENC copy and returns it to the Program Manager to signify that the corrective action has been completed.

The Program Manager files the signed copy from each Action Addressee (there may be more than one), and when all corrective action is complete signs the original EENC report, keeps a temporary copy, and forwards the original to the QA Supervisor.

The QA Supervisor reviews the EENC report, and signifies acceptance of the resolution by signing and dating the report to "close" it. A copy of the closed EENC report is retained in QA files, the temporary copy received earlier from the originator is discarded, and the original is returned to the Program Manager.

The Program Manager discards the temporary copy and keeps the original on file. A copy of the closed EENC report is sent to the originator, and additional copies are sent to any other affected parties. The originator discards the temporary copy in the file of open EENC reports and files the copy of the closed EENC report.

7.5 QA AUDITS

It is the responsibility of the Quality Assurance organization to verify the achievement of quality through all phases of the project. Once the proposal, program design, and work development phases are complete, these responsibilities will be accomplished primarily by audits, tests, and surveys which will provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the study QA manual are being implemented. All field, laboratory, and data processing tasks will be subject to at least one audit. These audits will be conducted by an audit team of technically qualified personnel familiar with, but independent of and not responsible for, the

work or activities under evaluation. The audit team will review the operations, specifications, QC systems, plans, and project objectives and examine the acquisition and transfer of data from field to report.

Observations of nonconformities and program deficiencies will be classified into three categories:

A. Deficiencies that affect the data adversely;

B. Deficiencies that might affect the data adversely; and

C. Deficiencies or procedural changes that cannot affect the data adversely.

Class A deficiencies will be resolved before that portion of the program can proceed. Class B deficiencies must have a determination as to whether they should be changed to Class A or C deficiencies and whether or not corrective action is necessary. If corrective action is necessary, it will be performed within a reasonable time frame agreed to by the program management, the Quality Assurance Department, and PSNH. Operations with Class A or B deficiencies will be subject to re-audit to determine the effectiveness of corrective action. Class C deficiencies must have corrective action accomplished before the next scheduled audit or end of the project, whichever comes first.

Audit results will be presented orally to the appropriate project or facility management by the audit team after the audit has been completed. At this time, specific findings will be presented and recommended courses of corrective action developed. Subsequently, the audit results will be documented in a written audit report and reviewed by management having responsibility in the areas audited. These reports will include a summary of audit results, observations made with a listing of nonconformities, recommendations and corrective action taken.

The quality assurance director will maintain a file of all project and facility audits. This file will include copies of the audit checklists, audit reports, written replies, the record of completion of corrective action and follow-up action. Further copies of the audit reports, written responses and records of completion of corrective actions will be sent to Ms. Pamela S. Hall, Normandeau's President.

APPENDIX A

Forms

SCHILLER STATION, 2006

Entrainment Field Data Sheet

Task Code	Week	Diel	Use Code	Comments	
1					Screen House #2

DATE & TIME

	month *	day *	hour	min
start				
end				

* Month and day refer to when the 24 hours sample began

CALIBRATION

	Gallons*
start	
end	
difference	

* flowmeter totalizer reading

Calibration seconds		time for sampling pump to fill calibration tank
Calibration gallons		calibration tank volume (210 gal.)
Calibration gpm		= cal. tank vol. / (cal. Seconds / 60)
Sampling time		= 26,420 gal / cal. Gpm

% Error		= 100 x (gauge gpm - calibration gpm) / calibration gpm
Average % Error		if % error greater than 3%, conduct 3 trials and average

WATER QUALITY

	Start	End
temp.		
salinity		
D.O.		

ENVIRONMENT

	Air Temp (°C)	Cloud Cover	Precip.	Wind Dir.	Wind Speed (Mph)
Start	.				
End	.				

COMMENTS

CODES

Week:	number within year (01-52)
Diel:	1 = 1000 - 1600
	2 = 1600 - 2200
	3 = 2200 - 0400
	4 = 0400 - 1000
Use Code:	1=valid sample
	2=fish collected, problems with flow
	3=void(no sample)
Comments:	1=yes
	2=no

Cloud Cover:	0=1-9%
	1=10-19%
	2=20-29%
	3=30-39%
	4=40-49%
	5=50-59%
	6=60-69%
	7=70-79%
	8=80-89%
	9=90-100%
Precip.	0=None
	1=Light Rain
	2=Heavy Rain
	3=Snow

Wind Dir.	0=No Wind
	1=North
	2=South
	3=East
	4=West
Wind Speed	1=Leaves rustle, wind on face
	2=leaves and twigs in constant mtn, flag waves
	3=raises dust/loose paper, flag in motion
	4=small trees begin to sway
	5=whole trees in motion

SCHILLER STATION, 2006

Entrainment Survival Field Observation Sheet Screen House #2

Task Code	Week	Diel	Comments	Unit	Period
4				1	

Collection Time: min* hour*

* Start time for 10 min. survival collection (0000-2359 hrs)

Container ID#	Observation Time	Organism	Life Stage	AD	Count

Comments

CODES

Week:	number within year (01-52)	Period:	1 = Initial observation (time=0hrs)	AD:	1 = alive
Diel:	1 = 1000 - 1600		2 = Latent observation (time=24hrs)		2 = dead
	2 = 1600 - 2200	Organism:	1 = fish		3 = stunned
	3 = 2200 - 0400		2 = macro-crustacean		
	4 = 0400 - 1000	Life Stage:	1 = egg		
Comments:	1 = yes		2 = larvae		
	2 = no				

SCHILLER STATION, 2006

Entrainment Lab Count Data Sheet

Sample | Card | Container # | Period | AD | Catch_CD | Analyzed By: _____

L1 | Date: _____

No. Vials: _____

SPL_FACT	TAXON	STAGE	COUNT	SPECIES NAME

Stage Codes

0 = unknown
1 =egg
2 = yolk-sac larvae
3 = post yolk sac larvae
4 = young of year
5 = yearling or older
6 = WF stage 1
7 = WF stage 2
8 = WF stage 3
9 = WF stage 4

Sample | Card Type L2 | Conversion Factor | Taxon

	Stg.	Scale	Msrmnt		Stg.	Scale	Msrmnt		Stg.	Scale	Msrmnt		Stg.	Scale	Msrmnt		Stg.	Scale	Msrmnt
1			.	11			.	21			.	31			.	41			.
2			.	12			.	22			.	32			.	42			.
3			.	13			.	23			.	33			.	43			.
4			.	14			.	24			.	34			.	44			.
5			.	15			.	25			.	35			.	45			.
6			.	16			.	26			.	36			.	46			.
7			.	17			.	27			.	37			.	47			.
8			.	18			.	28			.	38			.	48			.
9			.	19			.	29			.	39			.	49			.
10			.	20			.	30			.	40			.	50			.

PAGE ___ of ___

SCHILLER STATION, 2006

Entrainment Lab Length Data Sheet

Sample ____ Card L2

Stage Codes: 0 = unknown
2 = yolk sac larvae
3 = post yolk sac larvae
4 = post yolk sac larvae
5 = yearling or older

Page___ of ___

TAXON ____ STAGE ____ TAXON ____ STAGE ____ TAXON ____ STAGE ____

Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement
1	.	16	.	1	.	16	.	1	.	16	.
2	.	17	.	2	.	17	.	2	.	17	.
3	.	18	.	3	.	18	.	3	.	18	.
4	.	19	.	4	.	19	.	4	.	19	.
5	.	20	.	5	.	20	.	5	.	20	.
6	.	21	.	6	.	21	.	6	.	21	.
7	.	22	.	7	.	22	.	7	.	22	.
8	.	23	.	8	.	23	.	8	.	23	.
9	.	24	.	9	.	24	.	9	.	24	.
10	.	25	.	10	.	25	.	10	.	25	.
11	.	26	.	11	.	26	.	11	.	26	.
12	.	27	.	12	.	27	.	12	.	27	.
13	.	28	.	13	.	28	.	13	.	28	.
14	.	29	.	14	.	29	.	14	.	29	.
15	.	30	.	15	.	30	.	15	.	30	.

TAXON ____ STAGE ____ TAXON ____ STAGE ____ TAXON ____ STAGE ____

Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement	Scale	Measurement
1	.	16	.	1	.	16	.	1	.	16	.
2	.	17	.	2	.	17	.	2	.	17	.
3	.	18	.	3	.	18	.	3	.	18	.
4	.	19	.	4	.	19	.	4	.	19	.
5	.	20	.	5	.	20	.	5	.	20	.
6	.	21	.	6	.	21	.	6	.	21	.
7	.	22	.	7	.	22	.	7	.	22	.
8	.	23	.	8	.	23	.	8	.	23	.
9	.	24	.	9	.	24	.	9	.	24	.
10	.	25	.	10	.	25	.	10	.	25	.
11	.	26	.	11	.	26	.	11	.	26	.
12	.	27	.	12	.	27	.	12	.	27	.
13	.	28	.	13	.	28	.	13	.	28	.
14	.	29	.	14	.	29	.	14	.	29	.
15	.	30	.	15	.	30	.	15	.	30	.

EXTRAORDINARY EVENT/NONCONFORMITY REPORT

EE/NC Report Number: FIELD(number) Date:_____ From:_____

Respond by (date): _____ Project No.: _____ Title:_____

Date closed: _____

ADDRESSEES:
QA: _√_ Project Mgr.: _____ Field Mgr.: _____ Lab Mgr.: _____ Technical Mgr.: _____ Others: _____

PROBLEM DEFINITION (e.g.. Sample ID, Activity, Data, Standard, etc. Not in Conformity) :

RECOMMENDATIONS FOR or CORRECTIVE ACTION TAKEN:

Signed:

ACTION ADDRESSEE RESPONSE:

CORRECTIVE ACTION COMPLETED: Date: _____ Signed:_____

Distribution: ORIGINAL:QA, COPIES OF ORIGINAL: Originator, Addressees
RESPONSES: QA (responses are to be made on copies)

APPENDIX B

Taxon Identification Codes

Appendix Table B-1. Taxon codes for fish and macro-crustaceans commonly found in the Piscataqua River 1976-2003.

Family	Family Common Name	Scientific Name	Common Name	Taxon Code
Clupeidae	herrings	*Alosa pseudoharengus*	alewife	1
Clupeidae	herrings	*Alosa sapidissima*	American shad	3
Anguillidae	freshwater eels	*Anguilla rostrata*	American eel	10
Fundulidae	topminnows	*Fundulus heteroclitus*	mummichog	18
Clupeidae	herrings	*Brevoortia tyrannus*	Atlantic menhaden	19
Clupeidae	herrings	*Alosa aestivalis*	blueback herring	22
Atherinopsidae	New World silversides	*Menidia menidia*	Atlantic silverside	24
Osmeridae	smelts	*Osmerus mordax*	rainbow smelt	25
Gasterosteidae	sticklebacks	*Apeltes quadracus*	fourspine stickleback	31
Gadidae	cods	*Microgadus tomcod*	Atlantic tomcod	32
			to be identified	33
Syngnathidae	pipefishes	*Syngnathus fuscus*	northern pipefish	39
Labridae	wrasses	*Tautoga onitis*	tautog	62
Phycidae	phycid hakes	*Enchelyopus cimbrius*	fourbeard rockling	63
Pleuronectidae	righteye flounders	*Pseudopleuronectes americanus*	winter flounder	72
Merlucciidae	merluccid hakes	*Merluccius bilinearis*	silver hake	76
Gasterosteidae	sticklebacks	*Gasterosteus aculeatus*	threespine stickleback	78
Stromateidae	butterfishes	*Peprilus triacanthus*	butterfish	80
Phycidae	phycid hakes	*Urophycis chuss*	red hake	98
Cottidae	sculpins	*Myoxocephalus aenaeus*	grubby	101
Cottidae	sculpins	*Myoxocephalus octodecemspinosus*	longhorn sculpin	114
Clupeidae	herrings	*Clupea harengus*	Atlantic herring	117
Gadidae	cods	*Pollachius virens*	pollock	128
Pleuronectidae	righteye flounders	*Limanda ferruginea*	yellowtail flounder	131
Scophthalmidae	turbots	*Scophthalmus aquosus*	windowpane	132
Phycidae	phycid hakes	*Urophycis regia*	spotted hake	133
Ammodytidae	sand lances	*Ammodytes americanus*	American sand lance	137
Paralichthyidae	sand flounders	*Paralichthys oblongus*	fourspot flounder	139
Scombridae	mackerels	*Scomber scombrus*	Atlantic mackerel	140
Paralichthyidae	sand flounders	*Etropus microstomus*	smallmouth flounder	142
Pholidae	gunnels	*Pholis gunnellus*	rock gunnel	143
Labridae	wrasses	*Tautogolabrus adspersus*	cunner	164
Gadidae	cods	*Gadus morhua*	Atlantic cod	170
Hemitripteridae	sea ravens	*Hemitripterus americanus*	sea raven	171
Lophiidae	goosefishes	*Lophius americanus*	goosefish	203
Liparidae	snailfishes	*Liparis atlanticus*	Atlantic seasnail	218
Pleuronectidae	righteye flounders	*Glyptocephalus cynoglossus*	witch flounder	224
Stichaeidae	pricklebacks	*Ulvaria subbifurcata*	radiated shanny	227

(continued)

Appendix Table B-1. (Continued)

Family	Family Common Name	Scientific Name	Common Name	Taxon Code
Gadidae	cods	*Brosme brosme*	cusk	228
Pleuronectidae	righteye flounders	*Hippoglossoides platessoides*	American plaice	230
Gadidae	cods	*Melanogrammus aeglefinus*	haddock	237
Portunidae	swimming crab	*Carcinus maenus*	green crab	762
Cancridae	rock crab	*Cancer irroratus*	Atlantic rock crab	764
Cancridae	rock crab	*Cancer borealis*	Jonah crab	765
Cancridae	rock crab	*Cancer sp.*	unidentified cancer crab	766
Nephropsidae	lobster	*Homarus americanus*	American lobster	770
Majidae	spider crab	*Libinia sp.*	unidentified spider crab	821
Grapsidae	shore, marsh, talon crab	*Hemigrapsus sanguineus*	Japanese shore crab	835

Note: check Appendix Table B-2 for taxa not found on this list.

Appendix Table B-2. Taxon codes for fish species.

Taxon Code	Common Name
1	alewife
2	bay anchovy
3	American shad
4	bluefish
5	bluegill
6	brown bullhead
7	pumpkinseed
8	black crappie
9	common carp
10	American eel
11	goldfish
12	golden shiner
13	hogchoker
14	tessellated darter
15	banded killifish
16	emerald shiner
17	largemouth bass
18	mummichog
19	Atlantic menhaden
20	(use 59)
21	chain pickerel
22	blueback herring
23	white sucker
24	Atlantic silverside
25	rainbow smelt
26	smallmouth bass
27	shortnose sturgeon
28	spottail shiner
29	Atlantic sturgeon
30	striped bass
31	fourspine stickleback

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
32	Atlantic tomcod
33	to be identified
34	white catfish
35	white perch
36	yellow perch
37	satinfin shiner
38	rock bass
39	northern pipefish
40	redbreast sunfish
41	Atlantic needlefish
42	crevalle jack
43	eastern silvery minnow
44	fallfish
45	weakfish
46	comely shiner
47	common shiner
48	mimic shiner
49	lookdown
50	unidentified clupeid
51	(use 50)
52	(use 60)
53	grass pickerel
54	lined seahorse
55	logperch
56	trout-perch
57	northern hog sucker
58	fathead minnow
59	unidentified cyprinid
60	unidentified *Morone*
61	redfin pickerel
62	tautog
63	fourbeard rockling

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
64	striped cusk-eel
65	(use 96)
66	northern kingfish
67	spot
68	Atlantic moonfish
69	brook stickleback
70	unidentified sturgeon
71	scup
72	winter flounder
73	inland silverside
74	sea lamprey
75	gizzard shad
76	silver hake
77	striped mullet
78	threespine stickleback
79	brown trout
80	butterfish
81	white crappie
82	brook trout
83	northern pike
84	green sunfish
85	silver perch
86	northern puffer
87	eastern blacknose dace
88	bridle shiner
90	cutlip minnow
96	unidentified centrarchid
97	spotfin shiner
98	red hake
99	unidentifiable
100	central mudminnow
101	grubby

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
102	eastern mudminnow
103	white bass
104	rough silverside
105	longear sunfish
106	summer flounder
107	longnose dace
108	creek chub
109	black bullhead
110	striped searobin
111	northern searobin
113	Atlantic croaker
114	longhorn sculpin
115	round herring
116	hickory shad
117	Atlantic herring
118	reef silverside
119	striped anchovy
120	conger eel
121	striped killifish
122	warmouth
123	bluntnose minnow
124	walleye
125	white mullet
126	yellow bullhead
127	channel catfish
128	pollock
129	seaboard goby
130	naked goby
131	yellowtail flounder
132	windowpane
133	spotted hake
134	unidentified searobin

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
136	northern stargazer
137	American sand lance
138	fat sleeper
139	fourspot flounder
140	Atlantic mackerel
141	black sea bass
142	smallmouth flounder
143	rock gunnel
144	inshore lizardfish
145	unidentified mudminnow
146	silver lamprey
147	rainbow trout
148	rosyface shiner
149	unidentified *Esox*
150	unidentified gobiid
151	unidentified *Fundulus*
152	unidentified cyprinodontid
153	unidentified *Myoxocephalus*
154	unidentified cottid
155	unidentified pleuronectiform
156	unidentified pleuronectid
157	unidentified atherinid
158	unidentified *Menidia*
159	unidentified bothid
160	speckled wormeel
161	unidentified syngnathid
162	mackerel scad
163	unidentified *Ammodytes*
164	cunner
165	unidentified sciaenid
166	unidentified gadid

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
167	flying gurnard
168	shield darter
169	gray snapper
170	Atlantic cod
171	sea raven
172	bigeye scad
173	striped burrfish
174	sheepshead
175	unidentified percid
176	spotfin mojarra
177	spotfin butterflyfish
178	unidentified gasterosteid
179	planehead filefish
180	Atlantic cutlassfish
181	pigfish
182	short bigeye
183	guaguanche
184	freckled blenny
185	unidentified tetraodontid
186	orangespotted filefish
187	margined madtom
188	bluespotted cornetfish
189	black drum
190	northern sennet
191	scamp
192	cobia
193	least darter
194	unidentified percichthyid
195	scrawled cowfish
196	spotfin flyingfish
197	Gulf menhaden

(continued)

Appendix Table B-2 (Continued)

Taxon Code	Common Name
198	pugnose shiner
199	redfin shiner
200	sand shiner
201	swallowtail shiner
202	tiger muskellunge
203	goosefish
204	permit
205	freshwater drum
206	king mackerel
207	longnose gar
208	Spanish mackerel
209	highfin goby
210	unidentified sucker
211	unidentified labrid
212	blackcheek tonguefish
213	oyster toadfish
214	feather blenny
215	orange filefish
216	little skate
217	spiny dogfish
218	Atlantic seasnail
219	Gulf Stream flounder
220	spotted goatfish
221	brook silverside
222	harvestfish
223	pinfish
224	witch flounder
225	kokanee
226	ladyfish
227	radiated shanny
228	cusk
229	unidentified *Urophycis*

(continued)

Appendix Table B-2 (Continued)

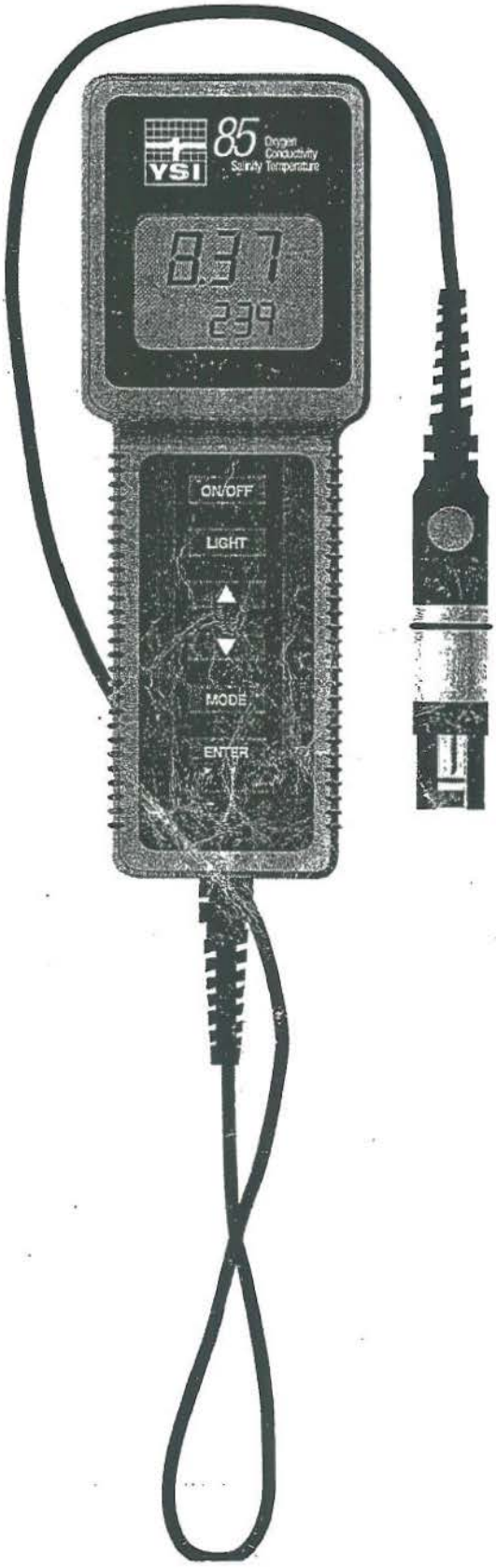
Taxon Code	Common Name
230	American plaice
231	slimy sculpin
232	sheepshead minnow
233	unidentified blenny
234	unidentified skate
235	clearnose skate
236	weakfish/scup
237	haddock
238	rudd

Note: Check with the project Technical Director if taxon is not found in this list

APPENDIX C

YSI Model 85 Temperature, Conductivity, and Dissolved Oxygen Meter

YSI *incorporated*



YSI Model 85

Handheld Oxygen, Conductivity, Salinity, and Temperature System

Operations Manual

CONTENTS

SECTION 1 INTRODUCTION

The YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System is a rugged, micro-processor based, digital meter with an attached YSI combination conductivity and dissolved oxygen probe.

The YSI Model 85 is designed for use in field, lab, and process control applications as well as for environmental, aquaculture, and industrial uses. The Model 85 is available with cable lengths of either 10, 25, 50 or 100 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The probe also utilizes our easy to install cap membranes for measuring dissolved oxygen.

The YSI Model 85 probe is a non-detachable, combination sensor designed specifically for the YSI Model 85 Handheld System. The conductivity portion is a four-electrode cell with a cell constant of 5.0/cm ±4%. The dissolved oxygen portion is a polargraphic Clark type sensor.

The Model 85's microprocessor allows the system to be easily calibrated for dissolved oxygen or conductivity with the press of a few buttons. Additionally, the microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the conductivity cell constant and function of the instrument circuitry.
The system simultaneously displays temperature (in °C), along with one of the following parameters: dissolved oxygen in either mg/L (milligrams per liter) or % air saturation; conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand {ppt}).

The system requires only a single calibration regardless of which dissolved oxygen display you use. The calibration of conductivity is not required but is available. A single calibration will adjust the instrument, regardless if you are reading conductivity or temperature compensated conductivity. You can switch between all of these parameters with the push of a single key.

A calibration\storage chamber is built into the instrument case. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration of the dissolved oxygen probe. This chamber also provides a convenient place to store the probe when the system is not in use, and provides protection for the electrodes within the conductivity probe. The Model 85 case is also waterproof (rated to IP65). You can operate your Model 85 in the rain without damage to the instrument.

Six AA-size alkaline batteries power the instrument. A new set of alkaline batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

SECTION 2 PREPARING THE METER

2.1 UNPACKING

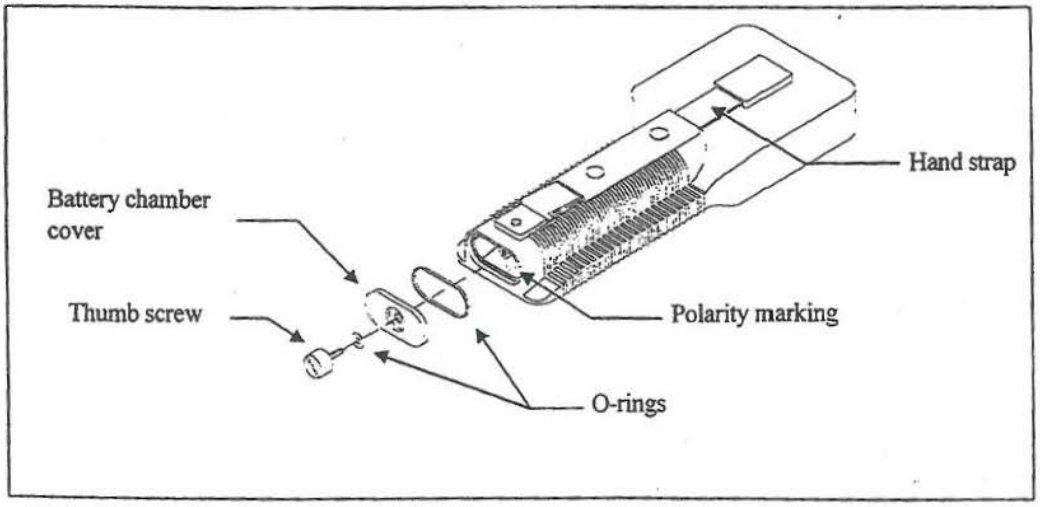
When you unpack your new YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System for the first time, check the packing list to make sure you have received everything you should have. If there is anything missing or damaged, call the dealer from whom you purchased the Model 85. If you do not know which of our authorized dealers sold the system to you, call YSI Customer Service at 800-765-4974 or 937-767-7241, and we'll be happy to help you.

2.2 WARRANTY CARD

Before you do anything else, please complete the Warranty Card and return it to YSI. This will record your purchase of this quality instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI Model 85 should ever need repair and we will be able to quickly verify the warranty period.

2.3 BATTERIES

There are a few things you must do to prepare your YSI Model 85 for use. First, locate the six AA-size alkaline batteries that were included in your purchase. Use a screwdriver or a small coin to remove the thumbscrew on the bottom of the instrument. This thumbscrew holds the battery-chamber cover in place. The battery-chamber cover is marked with the words "OPEN" and "CLOSE."



NOTE: On some models, the battery cover thumbscrew may be unscrewed by hand (a screwdriver may not be required).

There is a small label inside each of the two battery-chamber sleeves. These labels illustrate the correct way to install the batteries into each sleeve of the battery-chamber.

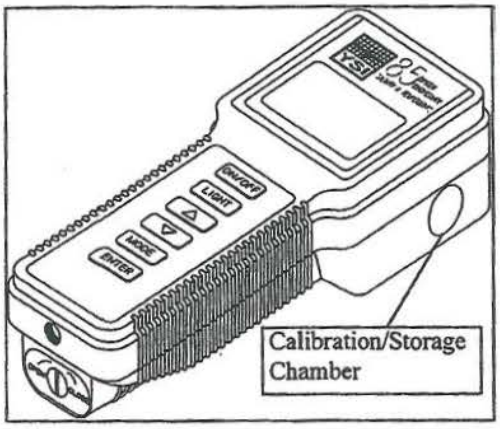
NOTE: It is very important that the batteries be installed ONLY as illustrated. The instrument will not function and may be damaged if the batteries are installed incorrectly.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument. The liquid crystal display (LCD) should come on. Allow a few seconds for the instrument to complete its diagnostic routine. Notice that the instrument will display the specific cell constant of the conductivity probe during this diagnostic routine. If the instrument does not operate, consult the section entitled Troubleshooting.

You may also want to take the instrument into a dark room and with the instrument ON, hold down the **LIGHT** button. The instrument backlight should illuminate the LCD so that the display can be easily read.

2.4 CALIBRATION/STORAGE CHAMBER

The Model 85 has a convenient calibration storage chamber built into the instruments' side. This chamber provides an ideal storage area for the probe during transport and extended non-use. If you look into the chamber you should notice a small round sponge in the bottom of the chamber. Carefully put 3 to 6 drops of clean water into the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe, which is ideal for dissolved oxygen calibration.



2.5 HAND STRAP

The hand strap is designed to allow comfortable operation of the Model 85 with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be easily dropped or bumped from your hand. See figure on previous page.

To adjust the hand strap on the back of the meter, unsnap the vinyl cover and pull the two Velcro strips apart. Place your hand between the meter and the strap and adjust the strap length so that your hand is snugly held in place. Press the two Velcro strips back together and snap the vinyl cover back into place.

2.6 THE METER CASE

The meter case is sealed at the factory and is not intended to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the meter case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

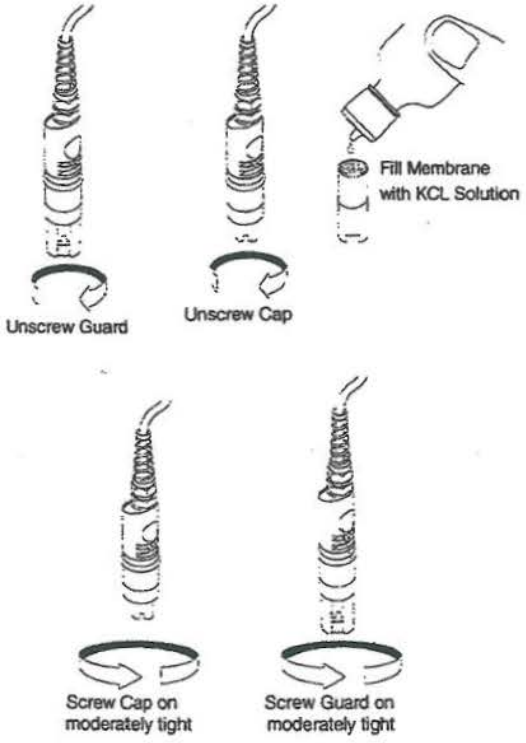
SECTION 3 PREPARING THE PROBE

The YSI Model 85 dissolved oxygen probe is shipped dry. The protective membrane cap on the probe tip must be removed and replaced with KCl solution and a new membrane cap before using the probe. Follow the instructions below to install KCl solution and the new membrane cap.

3.1 MEMBRANE CAP INSTALLATION

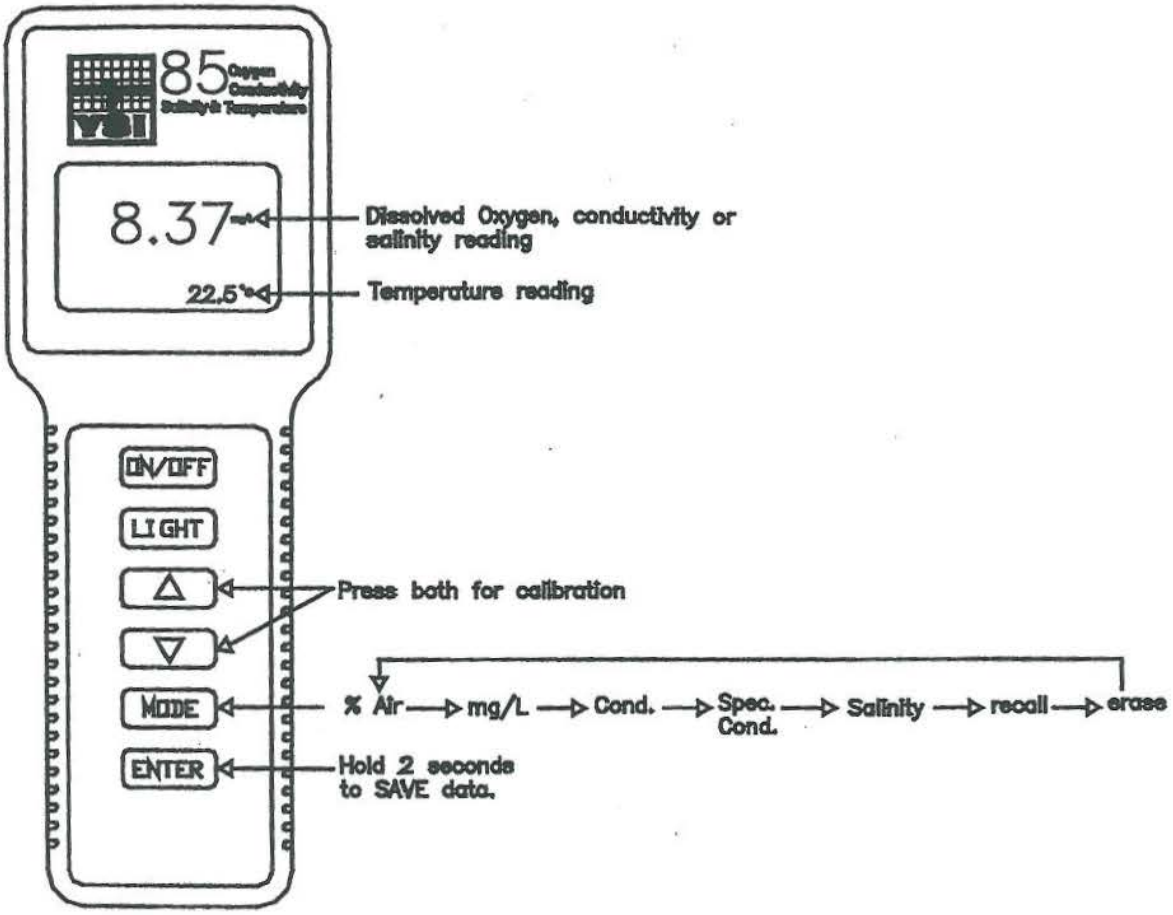
To install a new membrane on your YSI Model 85 dissolved oxygen probe:

1. Unscrew and remove the probe sensor guard.
2. Unscrew and remove the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the KCl solution bottle.
5. Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
7. Screw the probe sensor guard on moderately tight.



SECTION 4 OVERVIEW OF OPERATION

The following diagram is an overview of the operation of the Model 85. See the following sections for details of operation.



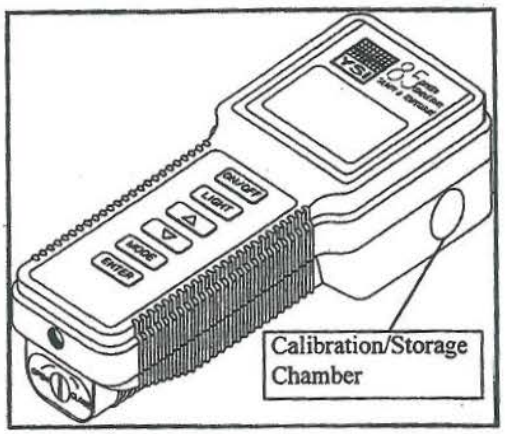
SECTION 5 CALIBRATION

5.1 CALIBRATION OF DISSOLVED OXYGEN

To accurately calibrate the YSI Model 85 you will need to know the approximate altitude of the region in which you are located.

1. Ensure that the sponge inside the instrument's calibration chamber is wet. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Press the **MODE** button until dissolved oxygen is displayed in mg/L or %. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required).



3. Use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** buttons at the same time.

4. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** button once.

EXAMPLE: Entering the number 12 here indicates 1200 feet.

5. The Model 85 should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable, then press the **ENTER** button. The display should read **SAVE** then should return to the Normal Operation Mode.

Each time the Model 85 is turned off, it may be necessary to re-calibrate before taking measurements. All calibrations should be completed at a temperature which is as close as possible to the sample temperature. Dissolved oxygen readings are only as good as the calibration.

5.2 CALIBRATION OF CONDUCTIVITY

IMPORTANT: System calibration is rarely required because of the factory calibration of the YSI Model 85. However, from time to time it is wise to check the system calibration and make adjustments when necessary.

Prior to calibration of the YSI Model 85, it is important to remember the following:

1. Always use clean, properly stored, NIST traceable calibration solutions (see Accessories and Replacement Parts). When filling a calibration container prior to performing the calibration procedures, make certain that the level of calibrant buffers is high enough in the container to cover the entire probe. Gently agitate the probe to remove any bubbles in the conductivity cell.
2. Rinse the probe with distilled water (and wipe dry) between changes of calibration solutions.
3. During calibration, allow the probe time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. The readings after calibration are only as good as the calibration itself.
4. Perform sensor calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

Follow these steps to perform an accurate calibration of the YSI Model 85:

1. Turn the instrument on and allow it to complete its self-test procedure.
2. Select a calibration solution that is most similar to the sample you will be measuring.
   - For sea water choose a 50 mS/cm conductivity standard (YSI Catalog# 3169)
   - For fresh water choose a 1 mS/cm conductivity standard (YSI Catalog# 3167)
   - For brackish water choose a 10 mS/cm conductivity standard (YSI Catalog # 3168)
3. Place at least 3 inches of solution in a clean glass beaker.
4. Use the **MODE** button to advance the instrument to display conductivity.
5. Insert the probe into the beaker deep enough so that the oval-shaped hole on the side of the probe is completely covered. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
6. Allow at least 60 seconds for the temperature reading to become stable.
7. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.
8. Press and release the **UP ARROW** and **DOWN ARROW** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.

9. Use the **UP ARROW** or **DOWN ARROW** button to adjust the reading on the display until it matches the value of the calibration solution you are using.
10. Once the display reads the exact value of the calibration solution being used (the instrument will make the appropriate compensation for temperature variation from 25°C), press the **ENTER** button once. The word **"SAVE"** will flash across the display for a second indicating that the calibration has been accepted.

The YSI Model 85 is designed to retain its last conductivity calibration permanently. Therefore, there is no need to calibrate the instrument after battery changes or power down.

SECTION 6 ADVANCED CONDUCTIVITY SETUP

The default settings of the YSI Model 85 are appropriate for the vast majority of measurement applications. However, some measurement applications require very specific measurement criteria. For that reason, we have made the YSI Model 85 flexible to accommodate these "advanced users."

If, for example, you are using the YSI Model 85 for a process control application that requires that the conductivity readings be compensated to 20 °C instead of 25 °C -- this is the section to read. Or, if your application for the YSI Model 85 involves the measurement of a very specific saline solution, the default temperature coefficient may need to be changed to get the very best measurement of that specific salt.

IMPORTANT: There is never a need to enter Advanced Setup Mode unless your special measurement application calls for a change in reference temperature and or temperature coefficient. Therefore, unless you are certain that your application requires a change to one or both of these criteria, do not modify the default reference temperature (25°C) or the default temperature coefficient (1.91%).

6.1 CHANGING THE TEMPERATURE COEFFICIENT

Follow these steps to modify the temperature coefficient of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new temperature coefficient.
5. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
6. Press the **MODE** button to return to normal operation; the CAL symbol will disappear from the display.

6.2 CHANGING THE REFERENCE TEMPERATURE

Follow these steps to modify the reference temperature of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Press and release the **MODE** button; the large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).
5. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new reference temperature (any value between 15 °C and 25 °C is acceptable).
6. Press the **ENTER** button. The word **"SAVE"** will flash across the display for a second to indicate that your change has been accepted.
7. The instrument will automatically return to normal operation mode.

6.3 CHANGING FROM AUTORANGING TO MANUAL RANGING

If your application is easier to perform using a manual range that you select, the YSI Model 85 allows you to turn off the default autoranging feature. While you are making conductivity or temperature compensated conductivity measurements, simply press and release the **UP ARROW** button. Each additional press of the **UP ARROW** button will cycle the Model 85 to a different manual range until you return again to autoranging. Five pushes of the **UP ARROW** button will cycle the Model 85 through the four manual ranges and return the instrument to autoranging.

NOTE: You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring. If this happens, simply press and release the **UP ARROW** button again until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. Also note that the conductivity units will flash while you are in manual range. The instrument will always default to autoranging when first turned on.

The four ranges of the YSI Model 85 are:

Range 1	Range 2	Range 3	Range 4
0 to 499.9 µS/cm	0 to 4999 µS/cm	0 to 49.99 mS/cm	0 to 200.0 mS/cm

SECTION 7 MAKING MEASUREMENTS

7.1 TURNING THE INSTRUMENT ON

Once the batteries are installed correctly, press the **ON/OFF** button. The instrument will activate all segments of the display for a few seconds, which will be followed by a self-test procedure that will last for several more seconds. During this power on self-test sequence, the instrument's microprocessor is verifying that the instrument is working properly. The Model 85 will display the cell constant of the conductivity probe when the self-test is complete. If the instrument were to detect an internal problem, the display would show a **continuous** error message. See the section entitled Troubleshooting for a list of these error messages.

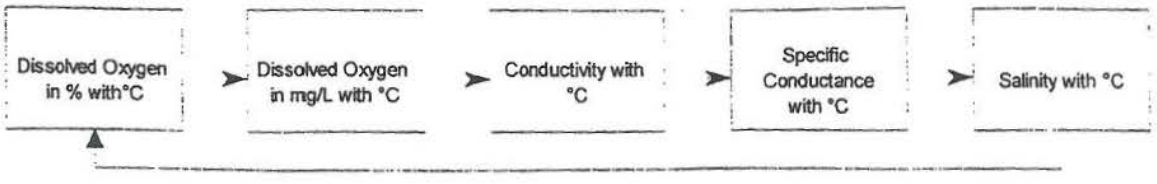
7.2 THE MEASUREMENT MODES OF THE MODEL 85

The Model 85 is designed to provide six distinct measurements:

- **Dissolved Oxygen %** -- A measurement of oxygen in percent of saturation.
- **Dissolved Oxygen mg/L** -- A measurement of oxygen in mg/L
- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Specific Conductance** -- Also known as temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25° C (or some other reference temperature which you choose). See Advanced Setup.
- **Temperature** -- which is always displayed.
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings.

NOTE: When you turn the Model 85 off, it will "remember" which mode you used last and will return to that mode the next time the instrument is turned on.

To choose one of the measurement modes above (temperature is always displayed) simply press and release the **MODE** button. Carefully observe the small legends at the far right side of the LCD.



If the instrument is reading **Specific Conductance** the large numbers on the display will be followed by either a µS or an **mS.** Additionally the small portion of the display will show the ° C flashing on and off.

If the instrument is reading **Conductivity** (not temperature compensated) the large numbers on the display will be followed by either a µS or an **mS.** Additionally the small portion of the display will show the ° C NOT flashing.

If the instrument is reading **Dissolved Oxygen** the large numbers on the display will be followed by either a mg/L or %. It is important to remember that the dissolved oxygen probe is stirring dependent. This is due to the consumption of oxygen at the sensor tip during measurement. When taking dissolved oxygen measurements the probe must be moved through the sample at a rate of 1 foot per second to provide adequate stirring.

If the instrument is reading **Salinity** the large numbers on the display will be followed by a **ppt.**

7.3 AUTORANGING & RANGE SEARCHING

The YSI Model 85 is an autoranging instrument. This means that regardless of the conductivity or salinity of the solution (within the specifications of the instrument) all you need to do to get the most accurate reading is to put the probe in the sample. This feature makes the Model 85 as simple as possible to operate.

When you first place the Model 85 probe into a sample or calibration solution, and again when you first remove the probe the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches the instrument display will flash **rANG** to indicate its movement from one range to another. The length of the range search depends on the number of ranges that must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

7.4 THE BACKLIGHT

At times it may be necessary to take measurements with the Model 85 in dark or poorly lit areas. To help in this situation, the Model 85 comes equipped with a backlight that will illuminate the display so that it can be easily read. To activate the backlight, press and hold the **LIGHT** button.

The display will remain lit as long as the button is depressed. When you release it, the light goes out to preserve battery life.

SECTION 12 TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	ACTION
1. Instrument will not turn on	A. Low battery voltage B. Batteries installed wrong C. Meter requires service	A. Replace batteries B. Check battery polarity. C. Return system for service
2. Instrument will not calibrate (Dissolved Oxygen)	A. Membrane is fouled or damaged B. Probe anode is fouled or dark C. Probe cathode is tarnished D. System requires service	A. Replace membrane & KCl B. Clean anode C. Clean cathode D. Return system for service
3. Instrument will not calibrate (Conductivity)	A. Cell is contaminated	A. See "Maintenance" Section
4. Instrument "locks up"	A. Instrument has rec'd a shock B. Batteries are low or damaged C. System requires service	A & B. Remove battery lid, wait 15 seconds for reset, replace lid. C. Return system for service
5. Instrument readings are inaccurate (Dissolved Oxygen)	A. Cal altitude is incorrect B. Probe not in 100% O_2 saturated air during Cal procedure C. Membrane fouled or damaged D. Probe anode is fouled or dark E. Probe cathode is tarnished F. System requires service	A. Recalibrate w/correct value B. Moisten sponge & place in Cal chamber w/ probe & Recal C. Replace membrane D. Clean anode E. Clean cathode F. Return system for service
6. Instrument readings are inaccurate (Conductivity)	A. Calibration is required B. Cell is contaminated C. Tempco is set incorrectly D. Reference temperature incorrect E. Readings are or are not temperature compensated.	A. See "Calibration" Section B. See "Maintenance" Section C. See "Advanced Setup" Section D. See "Advanced Setup" Section E. See "Making Measurements" Section
7..LCD displays "LO BAT" Main display flashes "off"	A. Batteries are low or damaged	A. Replace batteries
8. Main Display reads "OVEr" (Secondary display reads "ovr") (Secondary display reads "udr")	A. Conductivity reading is >200 mS B. Temperature reading is >65°C C. Temperature reading is <-5°C D. Salinity reading is >80 ppt E. User cell constant cal K is >5.25 F. DO temperature is >46°C G. DO % saturation is >200% H. DO concentration is >20 mg/L	In all cases, check calibration values and procedures; check advanced setup settings. If each of these are set correctly, return instrument for service.
9. Main display reads "Undr"	A. User cell constant cal K is <4.9 B. DO current too low to calibrate	A. Recalibrate instrument using known good conductivity standard. Follow cell cleaning procedure in the Maintenance section. B. Replace membrane, clean probe
10. Main display reads "rErr"	A. Reading exceeds user selected manual range.	A. Use the mode key to select a higher or lower manual range, or set system to autoranging.
11. Main display reads "PErr"	A. User cell constant cal K is 0.0 B. Incorrect sequence of keystrokes.	A. See "Advanced Setup" section. B. Refer to manual section for step by step instruction for the function you are