DRAFT 6/16/91

# ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM
# NEAR COASTAL COMPONENT
# 1991 VIRGINIAN PROVINCE EFFORT

## FIELD OPERATIONS
## and
## SAFETY MANUAL

by

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Appendices

# APPENDIX A

# LIST OF STATION LOCATIONS AND TYPES

Following is a listing of station locations by system. Definitions of terms are as follows:

STA #
This is the station identification number. For the database management system, this number will be prefixed with VA91 to designate that samples were collected in the Virginian Province in 1991.

REF #
This denotes the EMAP station reference number. It should only be used to determine which BSS an Index Station is associated with. For example, Harlem River station 378 has a reference number of S31 (the "S" indicates small system). Station 376 has a reference number of S31I indicating that it is the Index station for station 378 (ref # S31).

ESTUARY
This column lists the specific system in which the station is located.

SIZE
This denotes the EMAP-NC size classification for the water body in which the station is located as follows:

L = Large estuarine system
TR = Tidal river
S = Small estuarine system

CLASS
This column lists the station class as follows:

BSS = These are Base Sampling Sites
ITE = These are Indicator Testing and Evaluation Stations
IND = These stations are Index Stations which are associated with Base Sampling Sites.
LTT = These are Long Term Trend Sites
LTS = These are Long Term Spatial Sites

Team 1 stations. Do not sample those stations that are struck-out.

| STA. # | REF. # | ESTUARY | SIZE | CLASS | LATITUDE (DDMMSS.s) | | | LONGITUDE (DDMMSS.s) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Buzzards Bay** | | | | | | | | |
| 406 | L018 | BUZZARDS BAY | L | BSS | 41 | 26 | 30.0 | 70 | 54 | 0.0 |
| 414 | L019 | BUZZARDS BAY | L | ITE | 41 | 35 | 2.4 | 70 | 47 | 48.0 |
| | | **Block Island Sound** | | | | | | | | |
| 390 | L022 | BLOCK ISLAND SOUND | L | BSS | 41 | 7 | 53.4 | 71 | 59 | 7.8 |
| 391 | L023 | BLOCK ISLAND SOUND | L | BSS | 41 | 8 | 18.0 | 71 | 45 | 55.8 |
| 398 | L024 | BLOCK ISLAND SOUND | L | BSS | 41 | 16 | 30.6 | 71 | 53 | 7.8 |
| 399 | L025 | BLOCK ISLAND SOUND | L | BSS | 41 | 16 | 54.6 | 71 | 39 | 54.0 |
| | | **Eastern Long Island** | | | | | | | | |
| ~~374~~ | ~~L021~~ | ~~GREAT SOUTH BAY~~ | ~~L~~ | ~~BSS~~ | ~~40~~ | ~~39~~ | ~~54.6~~ | ~~73~~ | ~~9~~ | ~~17.4~~ |
| | | **Hudson River** | | | | | | | | |
| 370 | S25I | JAMAICA BAY | S | IND | 40 | 34 | 9.6 | 73 | 55 | 27.0 |
| 371 | S25 | JAMAICA BAY | S | ITE | 40 | 36 | 57.0 | 73 | 53 | 15.0 |
| 376 | S31I | HARLEM RIVER | S | IND | 40 | 47 | 0.0 | 73 | 56 | 18.6 |
| 378 | S31 | HARLEM RIVER | S | BSS | 40 | 47 | 30.6 | 73 | 55 | 54.0 |
| 384 | R41 | HUDSON RIVER | R | BSS | 41 | 1 | 6.6 | 73 | 53 | 34.2 |
| 397 | R42 | HUDSON RIVER | R | BSS | 41 | 16 | 27.0 | 73 | 58 | 0.0 |
| 411 | R43 | HUDSON RIVER | R | BSS | 41 | 30 | 57.6 | 73 | 59 | 30.0 |
| 422 | R44 | HUDSON RIVER | R | BSS | 41 | 52 | 19.2 | 73 | 56 | 6.6 |
| 424 | R45 | HUDSON RIVER | R | BSS | 42 | 8 | 0.0 | 73 | 54 | 25.8 |
| 215 | LT88 | HUDSON RIVER | R | LTT | 41 | 44 | 0.0 | 73 | 56 | 42.6 |

## Long Island Sound

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 025 | LT15 | LONG ISLAND SOUND | L | LTT | 41 | 0 | 43.2 | 73 | 14 | 32.4 |
| 079 | LT02 | LONG ISLAND SOUND | L | LTT | 41 | 10 | 29.4 | 72 | 42 | 21.6 |
| 375 | S30 | FLUSHING BAY | S | BSS | 40 | 46 | 36.6 | 73 | 51 | 19.2 |
| 377 | S30I | FLUSHING BAY | S | IND | 40 | 47 | 30.6 | 73 | 51 | 41.4 |
| 379 | L001 | LONG ISLAND SOUND | L | BSS | 40 | 55 | 32.4 | 73 | 37 | 7.2 |
| 380 | L002 | LONG ISLAND SOUND | L | BSS | 40 | 56 | 44.4 | 73 | 10 | 51.6 |
| 381 | S9I | LITTLE PECONIC BAY | S | IND | 40 | 59 | 6.6 | 72 | 25 | 7.2 |
| 382 | S9 | LITTLE PECONIC BAY | S | BSS | 41 | 0 | 0.0 | 72 | 23 | 0.0 |
| 385 | L003 | LONG ISLAND SOUND | L | BSS | 41 | 4 | 52.2 | 73 | 18 | 13.2 |
| 386 | L004 | LONG ISLAND SOUND | L | BSS | 41 | 5 | 26.4 | 73 | 5 | 3.6 |
| 387 | L005 | LONG ISLAND SOUND | L | BSS | 41 | 5 | 58.8 | 72 | 51 | 53.4 |
| 388 | L006 | LONG ISLAND SOUND | L | BSS | 41 | 6 | 30.0 | 72 | 38 | 42.6 |
| 389 | L007 | LONG ISLAND SOUND | L | BSS | 41 | 6 | 59.4 | 72 | 25 | 31.2 |
| 392 | L008 | LONG ISLAND SOUND | L | BSS | 41 | 14 | 39.6 | 72 | 46 | 1.2 |
| ~~393~~ | ~~L010~~ | ~~LONG ISLAND SOUND~~ | ~~L~~ | ~~BSS~~ | ~~41~~ | ~~15~~ | ~~38.4~~ | ~~72~~ | ~~19~~ | ~~35.4~~ |
| 394 | L011 | LONG ISLAND SOUND | L | BSS | 41 | 16 | 5.4 | 72 | 6 | 21.6 |
| 395 | S7I | CONNECTICUT RIVER | S | IND | 41 | 16 | 12.6 | 72 | 20 | 0.0 |
| 401 | S8I | NIANTIC RIVER | S | IND | 41 | 17 | 52.8 | 72 | 11 | 0.0 |
| 403 | S7 | CONNECTICUT RIVER | S | BSS | 41 | 19 | 41.4 | 72 | 21 | 10.2 |
| 405 | S8 | NIANTIC RIVER | S | BSS | 41 | 20 | 34.8 | 72 | 10 | 45.0 |

## Narragansett Bay

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 417 | S18I | MOUNT HOPE BAY | S | IND | 41 | 38 | 27.0 | 71 | 12 | 55.8 |
| 418 | S18 | MOUNT HOPE BAY | S | BSS | 41 | 41 | 53.4 | 71 | 12 | 20.4 |
| 419 | S19I | TAUNTON RIVER | S | IND | 41 | 42 | 38.4 | 71 | 9 | 49.2 |
| ~~420~~ | ~~L020~~ | ~~NARRAGANSETT BAY~~ | ~~L~~ | ~~BSS~~ | ~~41~~ | ~~42~~ | ~~40.8~~ | ~~71~~ | ~~21~~ | ~~36.0~~ |
| 421 | S19 | TAUNTON RIVER | S | BSS | 41 | 46 | 0.0 | 71 | 7 | 23.4 |

## Nantucket Sound

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 400 | S32I | NANTUCKET HARBOR | S | IND | 41 | 17 | 50.4 | 70 | 5 | 55.8 |
| 402 | L012 | NANTUCKET SOUND | L | BSS | 41 | 18 | 56.4 | 70 | 7 | 5.4 |

Nantucket Sound (continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 404 | S32 | NANTUCKET HARBOR | S | BSS | 41 | 20 | 0.0 | 70 | 1 | 0.0 |
| 407 | L017 | VINEYARD SOUND | L | BSS | 41 | 26 | 46.2 | 70 | 40 | 42.6 |
| 408 | L013 | NANTUCKET SOUND | L | BSS | 41 | 27 | 1.2 | 70 | 27 | 24.6 |
| 409 | L014 | NANTUCKET SOUND | L | BSS | 41 | 27 | 14.4 | 70 | 14 | 6.6 |
| 410 | S29I | WESTPORT RIVER | S | IND | 41 | 30 | 42.6 | 71 | 3 | 11.4 |
| 413 | S29 | WESTPORT RIVER | S | BSS | 41 | 31 | 49.2 | 71 | 5 | 39.6 |
| 415 | L015 | NANTUCKET SOUND | L | BSS | 41 | 35 | 31.8 | 70 | 21 | 9.0 |
| 416 | L016 | NANTUCKET SOUND | L | BSS | 41 | 35 | 44.4 | 70 | 7 | 49.2 |

Team 2 stations. Do not sample those stations that are struck-out.

| STA. # | REF. # | ESTUARY | SIZE | CLASS | LATITUDE (DDMMSS.s) | | | LONGITUDE (DDMMSS.s) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Chesapeake Bay - Maryland | | | | | | |
| 090 | | BACK RIVER | S | ITE | 39 | 16 | 12.0 | 76 | 26 | 36.0 |
| 303 | L050 | CHESAPEAKE BAY | L | BSS | 38 | 12 | 43.2 | 76 | 17 | 50.4 |
| 307 | L051 | CHESAPEAKE BAY | L | BSS | 38 | 13 | 41.4 | 76 | 5 | 18.0 |
| 308 | S11I | FISHING BAY | S | IND | 38 | 14 | 2.4 | 75 | 59 | 31.8 |
| 311 | S10I | HONGA RIVER | S | IND | 38 | 14 | 57.0 | 76 | 6 | 48.6 |
| 316 | S10 | HONGA RIVER | S | BSS | 38 | 18 | 12.6 | 76 | 11 | 1.2 |
| 317 | S11 | FISHING BAY | S | BSS | 38 | 18 | 55.2 | 76 | 1 | 11.4 |
| ~~321~~ | ~~L052~~ | ~~CHESAPEAKE BAY~~ | ~~L~~ | ~~BSS~~ | ~~38~~ | ~~29~~ | ~~34.2~~ | ~~76~~ | ~~20~~ | ~~19.2~~ |
| 322 | S15 | LITTLE CHOPTANK RIVER | S | BSS | 38 | 31 | 9.6 | 76 | 16 | 6.6 |
| 323 | S15I | LITTLE CHOPTANK RIVER | S | IND | 38 | 32 | 57.0 | 76 | 18 | 45.0 |
| 325 | L053 | CHESAPEAKE BAY | L | BSS | 38 | 37 | 29.4 | 76 | 27 | 51.6 |
| ~~329~~ | ~~L054~~ | ~~CHESAPEAKE BAY~~ | ~~L~~ | ~~BSS~~ | ~~38~~ | ~~46~~ | ~~24.6~~ | ~~76~~ | ~~22~~ | ~~47.4~~ |
| 330 | S16 | MILES RIVER | S | BSS | 38 | 46 | 25.2 | 76 | 11 | 6.6 |
| 331 | S16I | MILES RIVER | S | IND | 38 | 49 | 23.4 | 76 | 13 | 4.2 |
| 332 | S17I | WYE RIVER | S | IND | 38 | 50 | 54.0 | 76 | 12 | 10.2 |
| 336 | S17 | WYE RIVER | S | BSS | 38 | 54 | 21.6 | 76 | 10 | 15.0 |
| 339 | L055 | CHESAPEAKE BAY | L | ITE | 39 | 3 | 14.4 | 76 | 25 | 15.6 |
| 343 | L056 | CHESAPEAKE BAY | L | BSS | 39 | 12 | 9.0 | 76 | 20 | 8.4 |
| ~~345~~ | ~~L057~~ | ~~CHESAPEAKE BAY~~ | ~~L~~ | ~~BSS~~ | ~~39~~ | ~~21~~ | ~~3.0~~ | ~~76~~ | ~~14~~ | ~~59.4~~ |
| 346 | S21 | SASSAFRAS RIVER | S | ITE | 39 | 22 | 10.8 | 75 | 55 | 30.0 |
| 347 | S21I | SASSAFRAS RIVER | S | IND | 39 | 22 | 47.4 | 76 | 3 | 42.6 |
| 351 | S20I | SUSQUEHANNA RIVER | S | IND | 39 | 32 | 59.4 | 76 | 4 | 46.2 |
| 353 | S20 | SUSQUEHANNA RIVER | S | BSS | 39 | 35 | 16.8 | 76 | 6 | 32.4 |
| 136 | LT13 | CHESAPEAKE BAY | L | LTT | 39 | 18 | 18.0 | 76 | 24 | 36.0 |
| | | | | Delaware Bay | | | | | | |
| 335 | L026 | DELAWARE BAY | L | BSS | 38 | 51 | 50.4 | 75 | 6 | 49.8 |
| 337 | L027 | DELAWARE BAY | L | BSS | 38 | 59 | 50.4 | 75 | 14 | 16.2 |
| 338 | L028 | DELAWARE BAY | L | BSS | 39 | 0 | 40.2 | 75 | 1 | 33.6 |
| 340 | L029 | DELAWARE BAY | L | BSS | 39 | 7 | 50.4 | 75 | 21 | 43.8 |
| 341 | L030 | DELAWARE BAY | L | BSS | 39 | 8 | 40.8 | 75 | 9 | 0.0 |

Delaware Bay (continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 342 | L031 | DELAWARE BAY | L | BSS | 39 | 9 | 30.0 | 74 | 56 | 15.6 |
| 344 | L032 | DELAWARE BAY | L | BSS | 39 | 16 | 41.4 | 75 | 16 | 27.6 |
| 350 | S3I | C & D CANAL | S | IND | 39 | 32 | 0.0 | 75 | 47 | 27.0 |
| 352 | S3 | C & D CANAL | S | BSS | 39 | 33 | 16.8 | 75 | 38 | 30.0 |
| 355 | R11 | DELAWARE RIVER | R | BSS | 39 | 40 | 0.0 | 75 | 32 | 42.6 |
| 356 | S27I | CHRISTINA RIVER | S | IND | 39 | 43 | 1.2 | 75 | 30 | 51.0 |
| 357 | S27 | CHRISTINA RIVER | S | BSS | 39 | 43 | 2.4 | 75 | 34 | 17.4 |
| 358 | R12 | DELAWARE RIVER | R | BSS | 39 | 50 | 5.4 | 75 | 21 | 3.0 |
| 360 | R13 | DELAWARE RIVER | R | BSS | 39 | 58 | 19.8 | 75 | 6 | 0.6 |
| 365 | R14 | DELAWARE RIVER | R | BSS | 40 | 6 | 4.2 | 74 | 50 | 10.8 |
| 367 | R15 | DELAWARE RIVER | R | BSS | 40 | 11 | 54.6 | 74 | 45 | 35.4 |

Delaware Coast

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 327 | S4I | REHOBETH BAY | S | IND | 38 | 39 | 30.6 | 75 | 5 | 47.4 |
| 328 | S4 | REHOBETH BAY | S | BSS | 38 | 40 | 28.8 | 75 | 7 | 5.4 |
| 150 | LT12 | INDIAN RIVER | S | LTT | 38 | 35 | 36.0 | 75 | 6 | 42.0 |

Hudson River

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 368 | S5I | RARITAN RIVER | S | IND | 40 | 29 | 25.2 | 74 | 15 | 49.8 |
| 369 | S5 | RARITAN RIVER | S | BSS | 40 | 30 | 40.2 | 74 | 18 | 0.0 |
| 372 | S6 | KILL VAN KULL | S | BSS | 40 | 38 | 31.8 | 74 | 7 | 59.4 |
| 373 | S6I | KILL VAN KULL | S | IND | 40 | 38 | 52.2 | 74 | 4 | 28.8 |
| 173 | LT11 | NEW YORK HARBOR | S | LTT | 40 | 38 | 48.0 | 74 | 3 | 30.0 |

Maryland Coast

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 305 | S12 | SINEPUXENT BAY | S | BSS | 38 | 13 | 24.0 | 75 | 13 | 1.8 |
| 318 | S12I | SINEPUXENT BAY | S | IND | 38 | 19 | 28.2 | 75 | 5 | 58.8 |

New Jersey Coast

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 348 | S24I | GREAT BAY | S | IND | 39 | 30 | 4.8 | 74 | 18 | 55.2 |
| 349 | S24 | GREAT BAY | S | BSS | 39 | 30 | 13.2 | 74 | 23 | 4.8 |
| 362 | S28 | METEDECONK RIVER | S | BSS | 40 | 3 | 6.0 | 74 | 6 | 39.0 |
| 363 | S28I | METEDECONK RIVER | S | IND | 40 | 3 | 11.4 | 74 | 4 | 0.0 |

Team 3 stations. Do not sample those stations that are struck-out.

| STA. # | REF. # | ESTUARY | SIZE | CLASS | LATITUDE (DDMMSS.s) | | | LONGITUDE (DDMMSS.s) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Chesapeake Bay - Maryland** | | | | | | | | |
| 295 | L048 | CHESAPEAKE BAY | L | BSS | 38 | 4 | 47.4 | 76 | 10 | 20.4 |
| 296 | L049 | TANGIER SOUND | L | BSS | 38 | 5 | 44.4 | 75 | 57 | 49.2 |
| 282 | L041 | CHESAPEAKE BAY | L | BSS | 37 | 39 | 1.8 | 76 | 12 | 52.2 |
| 283 | L042 | CHESAPEAKE BAY | L | BSS | 37 | 39 | 59.4 | 76 | 0 | 25.8 |
| 284 | L043 | CHESAPEAKE BAY | L | BSS | 37 | 47 | 56.4 | 76 | 7 | 52.8 |
| 285 | L044 | TANGIER SOUND | L | BSS | 37 | 48 | 53.4 | 75 | 55 | 25.2 |
| ~~287~~ | ~~L045~~ | ~~POCOMOKE SOUND~~ | ~~L~~ | ~~BSS~~ | ~~37~~ | ~~49~~ | ~~49.2~~ | ~~75~~ | ~~42~~ | ~~56.4~~ |
| 291 | L046 | CHESAPEAKE BAY | L | BSS | 37 | 55 | 52.8 | 76 | 15 | 21.6 |
| 292 | L047 | CHESAPEAKE BAY | L | BSS | 37 | 56 | 50.4 | 76 | 2 | 52.2 |
| 302 | R21 | POTOMAC RIVER | R | BSS | 38 | 12 | 25.8 | 76 | 35 | 56.4 |
| 306 | S1I | BRETON BAY | S | IND | 38 | 13 | 40.8 | 76 | 41 | 48.0 |
| 312 | S1 | BRETON BAY | S | BSS | 38 | 15 | 22.2 | 76 | 39 | 39.0 |
| 304 | S2I | ST. CLEMENTS BAY | S | IND | 38 | 13 | 19.2 | 76 | 43 | 48.0 |
| 314 | S2 | ST. CLEMENTS BAY | S | BSS | 38 | 16 | 52.8 | 76 | 42 | 39.0 |
| 315 | R22 | POTOMAC RIVER | R | BSS | 38 | 17 | 5.4 | 76 | 55 | 39.6 |
| 319 | R23 | POTOMAC RIVER | R | BSS | 38 | 20 | 10.8 | 77 | 14 | 19.8 |
| 326 | R24 | POTOMAC RIVER | R | BSS | 38 | 37 | 30.0 | 77 | 9 | 42.6 |
| 333 | R25 | POTOMAC RIVER | R | BSS | 38 | 51 | 31.8 | 77 | 2 | 3.0 |
| 188 | LT09 | POTOMAC RIVER | R | LTT | 38 | 44 | 12.0 | 77 | 2 | 0.0 |
| | | **Chesapeake Bay - Virginia** | | | | | | | | |
| 261 | L033 | CHESAPEAKE BAY | L | BSS | 36 | 56 | 24.6 | 76 | 12 | 48.6 |
| 262 | L034 | CHESAPEAKE BAY | L | BSS | 36 | 57 | 22.8 | 76 | 0 | 29.4 |
| 263 | R51 | JAMES RIVER | R | BSS | 36 | 58 | 36.0 | 76 | 29 | 0.0 |
| 265 | L035 | CHESAPEAKE BAY | L | BSS | 37 | 5 | 19.8 | 76 | 7 | 54.0 |
| 266 | S14 | BACK RIVER, VA | S | BSS | 37 | 5 | 52.8 | 76 | 20 | 0.0 |
| 267 | S14I | BACK RIVER, VA | S | IND | 37 | 6 | 40.2 | 76 | 17 | 47.4 |
| 269 | R52 | JAMES RIVER | R | BSS | 37 | 9 | 48.0 | 76 | 37 | 43.2 |
| 270 | L036 | CHESAPEAKE BAY | L | BSS | 37 | 13 | 15.6 | 76 | 15 | 18.6 |
| 271 | L037 | CHESAPEAKE BAY | L | BSS | 37 | 14 | 14.4 | 76 | 2 | 57.6 |

Chesapeake Bay Virginia (continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 273 | R53 | JAMES RIVER | R | BSS | 37 | 14 | 26.4 | 76 | 57 | 18.0 |
| 275 | R54 | JAMES RIVER | R | BSS | 37 | 19 | 10.8 | 77 | 11 | 30.6 |
| 276 | L038 | CHESAPEAKE BAY | L | BSS | 37 | 22 | 10.8 | 76 | 10 | 23.4 |
| 278 | R55 | JAMES RIVER | R | BSS | 37 | 22 | 43.2 | 77 | 18 | 58.8 |
| 279 | L040 | CHESAPEAKE BAY | L | BSS | 37 | 31 | 5.4 | 76 | 5 | 25.2 |
| 280 | S22I | PIANKATANK RIVER | S | IND | 37 | 31 | 59.4 | 76 | 18 | 36.0 |
| 281 | S22 | PIANKATANK RIVER | S | BSS | 37 | 32 | 22.8 | 76 | 24 | 17.4 |
| 286 | S23I | GREAT WICOMICO RIVER | S | IND | 37 | 49 | 13.2 | 76 | 17 | 54.0 |
| 288 | R31 | RAPPAHANNOCK RIVER | R | BSS | 37 | 49 | 52.8 | 76 | 44 | 49.2 |
| 290 | S23 | GREAT WICOMICO RIVER | S | BSS | 37 | 51 | 0.0 | 76 | 21 | 38.4 |
| 294 | R32 | RAPPAHANNOCK RIVER | R | BSS | 38 | 2 | 19.2 | 76 | 55 | 0.0 |
| 298 | R33 | RAPPAHANNOCK RIVER | R | BSS | 38 | 8 | 22.2 | 77 | 3 | 14.4 |
| 300 | R34 | RAPPAHANNOCK RIVER | R | BSS | 38 | 10 | 52.2 | 77 | 11 | 34.8 |
| 309 | R35 | RAPPAHANNOCK RIVER | R | BSS | 38 | 14 | 4.8 | 77 | 13 | 46.8 |

THE FOLLOWING STATIONS WILL BE SAMPLED BY TEAM 3 DURING DRY RUNS

LTS sites are located along a transect radiating out at the specificied heading from the LTT site. Distances from the LTT site are given in miles.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 045 | LTO4 | TANGEIR SOUND | L | LTT | 38 | 9 | 37.8 | 76 | 1 | 33.6 |
| 433 | LS4A | | | LTS | HEADING 145 | | | 0.25 MILES | | |
| 432 | LS4B | | | LTS | | | | 0.50 MILES | | |
| 434 | LS4C | | | LTS | | | | 1.0 MILES | | |
| 050 | LT05 | CHES. BAY MD | L | LTT | 38 | 0 | 43.8 | 76 | 6 | 36.0 |
| 430 | LS5A | | | LTS | HEADING 225 | | | 0.25 MILES | | |
| 429 | LS5B | | | LTS | | | | 0.50 MILES | | |
| 431 | LS5C | | | LTS | | | | 1.0 MILES | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 058 | LT06 | CHES. BAY MD | | L | LTT | 39 | 7 | 45.0 | 76 | 16 | 52.8 |
| 436 | LS6A | | | | LTS | HEADING 225 | | | 0.25 MILES | | |
| 435 | LS6B | | | | LTS | | | | 0.50 MILES | | |
| 434 | LS6C | | | | LTS | | | | 1.0 MILES | | |
| | | | | | | | | | | | |
| 060 | LT07 | CHES. BAY VA | | L | LTT | 37 | 42 | 55.2 | 76 | 16 | 36.6 |
| 426 | LS7A | | | | LTS | HEADING 145 | | | 0.25 MILES | | |
| 427 | LS7B | | | | LTS | | | | 0.50 MILES | | |
| 428 | LS7C | | | | LTS | | | | 1.0 MILES | | |

# APPENDIX B

# EQUIPMENT LIST AND CHECK LISTS

# Equipment List

Each team is provided with the following equipment and supplies. This list can serve as a daily checklist to assure the crew is properly equipped.

Four wheel drive pickup truck (1)
- camper shell (1)
- bed liner (1)
- front bumper winch (1)
- CB radio (1)

Mobile laboratory (1)
- work bench (1)
- shelves for storing supplies
- marine band VHF radio (1)
- cellular telephone (1)
- GRiD computer with printer, power cables, phone cord and keyboard skin (1)
- bar code reader (1)
- first aid kit (1)
- jumper cables (1)
- tool box (1)
- Hach DO test kit with spare BOD bottles (2)
- flashlight (1)
- 10 pound fire extinguisher (1)
- CB radio (1)

24 foot Chesapeake-style boat
- 155 hp commercial Johnson engines (2)
- trailer with power winch, spare tire and spare rollers (1)
- mast and boom assembly (1)
- hydraulic winch & capstan (1)
- self-contained power supply for winch (1)
- windshield wipers
- marine band VHF radios (2)
- Loran navigation instrument (1)
- GPS navigation instrument (1)
- compass (1)
- hand-held compass (1)
- Radar unit (1)

depth finder (1)
spare propellers (2)
GRiD computer with printer, power cables, phone cable and keyboard skin (1)
bar code reader (2)
anchor with chain and line (2)
first aid kit (1)
fire extinguishers (2)
oar (1)
personal flotation devices with lights (1 per person)
survival suits (1 per person)
ring buoy (1)
life sling (1)
Emergency Position and Information Radio Beacon (1)
boat hook (1)
tool box including cable cutter and Nicopress tool (1)
garbage pail (1)
emergency eye wash (1)
jumper cables (1)
binoculars (1)
hardhats
spotlight (1)
flashlight (1)
flares (1kit)
fish totes
nautical charts
spare oil
spare shackles
siezing wire
spare Nicopress sleeves
spare cable for winch
fenders
spare line

Sampling gear

trawl net with doors (2)
Young-modified Van Veen grab sampler (2)
grab stand (1)
Sea-Bird CTD with data cable (1)
Hydrolab DataSonde 3 units (8)
moorings for the DataSondes
*Go-Flo* water sampling bottles (2)
spare parts for the *Go-Flo* bottles

0.5 mm stainless steel sieve (2)
sieve box (2)
Teflon mixing beaker for sediments (3)
Teflon spatula for sediments (3)
fish cutting and measuring board (2)
refractometers (2)
field thermometers (4)
Hach DO test kit with spare BOD bottles (1)
YSI DO meter
dissecting kits
pingers for all deployed gear
filet knives
coolers
fish scales (2)
Petersons fish guide (2)
Petersons guide to shells (2)
other fish keys

Supplies

sediment chemistry sampling bottles
sediment AVS bottles
sediment toxicity sampling bottles
bottles for benthic species composition and biomass
cubitainers - 1 and 5 gallon
zip lock bags - multiple sizes
cheesecloth for wrapping preserved fish
cores for grain size samples
625 ml containers for suspended solids samples
spare parts for CTD and DataSonde 3
spare DataSonde 3 low flow membranes
aluminum foil
Dietrich's fixative
formalin
long forceps for fish preserved in Dietrich's
wide mouth funnels (3)
centimeter ruler (3)
Alconox detergent
gloves
paper towels
Kimwipes®
alkaline batteries - AA and D
pH 7 and 10 buffers
salinity standard

Federal Express shipping labels
3.5" high density diskettes with mailers
data sheets (packs including bar code labels)
field notebooks (log)
plastic clipboards (2)
number 2 pencils
pens and waterproof markers
waterproof tags for fish
shipping boxes - multiple sizes
strapping tape
"blue ice bottles"
dry ice
insulated gloves
buckets for fish preserved in Dietrichs (2)
buckets for sorting fish (10)
boating yellow pages (depends on the team)
tap water
DI water
squirt bottles
brushes for cleaning gear
scissors
hole punches
whirlpacks - multiple sizes
tubing for *Go-Flo* bottles
dessicant packages for DataSonde 3
sodium sulfite for zeroing DO
protective glasses
Viton gloves
particle masks
Mercury clean-up kits
gear lube
outboard engine oil
grease guns
computer-generated maps
this manual (2)

# LAUNCHING CHECKLIST

1. Remove trailer tie-down strap.
2. Install scupper plugs
3. Check brass boat plug and the two plugs on the bottom of the outboard bracket.
4. Drop the engine trailering brackets.
5. Lower the speedometer pick-up unit.
6. Rotate battery switch to 1 for odd days and 2 for even days.
7. Make sure the keys are in the ignition.
8. Raise all antennas.
9. Raise the mast and boom assembly and secure all stays.
10. Make sure hydraulic hoses are not pinched.
11. Install all electronics.
12. Load all gear and supplies.
13. Remove the Briggs and Stratton exhaust cover.
14. Disconnect trailer wiring.
15. Check the ramp for obstacles.
16. Have wheel chocks and winch handle available.
17. Attach bowline.
18. Check oil and gasoline levels.
19. Launch boat.

# RETRIEVAL CHECKLIST

1. Engage the front hubs on the truck, place in 4WD LOW, back down the ramp, and chock the wheels.
2. Raise engines and haul boat onto trailer.
3. Disconnect winch power cable.
4. Attach safety chain.
5. Drive up the ramp, removing wheel chocks.
6. Lower engine trailering bar.
7. Remove the scupper plugs.
8. Check gas level. Fill before next launching.
9. Lower and secure mast and boom assembly.
10. Lower and secure antennas.
11. Turn off batteries.
12. Install trailering strap.
13. Close forward hatch.
14. Remove gear and electronics as appropriate. (Electronics are ALWAYS removed at night).
15. Secure all gear not removed.
16. Install Briggs and Stratton exhaust cover.
17. Check lock on the trailer tongue.
18. Reconnect trailer lighting and check lights.
20. Check all safety chains.

21. Take out of 4WD.

# APPENDIX C

# HAZARDOUS MATERIALS SAFETY AND HANDLING INFORMATION

This appendix consists of Materials Safety Data Sheets for all hazardous materials carried by the lab or boat crews. The permit issued to the Environmental Research Laboratory, Narragansett for handling and generating hazardous wastes covers EMAP field operations.

**The EPA Generator ID # is RID075721639**

# APPENDIX D

# PERMIT FOR OPERATING MARINE-BAND VHF RADIO

**ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM**
**BOAT RADIO FREQUENCY ASSIGNMENTS**

**CALL SIGNS**

| | |
|---|---|
| *R/V CYPRINODON* | **WRH 4387** |
| *R/V ARBACIA* | **WRW 8803** |
| *R/V MYSIDOPSIS* | **WRM 8373** |
| *R/V CHAMPIA* | **WRG 3330** |

**MOBILE LABS** **KB 2053**

FREQUENCY ASSIGNMENTS

| CHANNEL | TRANSMIT FREQ. (MHz) | TYPE OF OPERATION |
|---|---|---|
| 6 | 156.300 | Intership safety |
| 12 | 156.600 | Port operations |
| 13 | 156.650 | Bridge to bridge communications |
| 14 | 156.700 | Port operations |
| 16 | 156.800 | Calling, safety and DISTRESS |
| 20 | 157.000 | Port operations |
| 22A | 157.100 | Communications with Coast Guard |
| 67 | 156.375 | Bridge to bridge - Louisiana |
| **82A** | **157.125** | **Working channel US govt. only** |

In addition, all public correspondence channels (marine operator) can be used: 24, 25, 26, 27, 28, 84, 85, 86, and 87

# APPENDIX E

# INSTRUCTIONS FOR FISH PATHOLOGY EXAMINATION

# FIELD EXAMINATION OF FISH

The field examination of finfish for gross pathology abnormalities is conducted using two somewhat different field procedures corresponding to the two types of field sampling conducted during the Near Coastal EMAP Virginian Province Project. These two types of samples are Base Sampling and Indicator Testing and Evaluation sampling. The two corresponding gross pathology methods are described below.

## Base Sampling
## (Base Sampling Sites and Long Term Trend Sites)

I. Gross examination of fishes:

At each of the Base Sampling and Long Term Trends Sites visited at which fish trawls are taken, a gross examination of the contents of the trawl (target species only) is completed for pathological abnormalities. The examination is intended to be a rapid scan of the target individuals to be completed while other fish measures are being completed (i.e., identifying, enumerating, measuring). This scan should take no longer than 10-15 seconds per fish.

At each station, all TARGET species greater than 75 mm in fork length taken in the trawl, are examined to assess gross pathological problems. While each fish is still alive or fresh dead, a thorough external inspection of the body surfaces, fins, eyes, buccal cavity, and branchial chamber is performed. All observations are recorded on data sheets and then entered into the computer on the following day. Systematically check all body parts for all conditions using the data sheet as a guide. Record multiple anomalies as they occur.

A. Body surfaces and fins: Note any discolorations of body surfaces (i.e., darkening, hemorrhaging, cloudiness), raised scales, white spots, or parasites visible to the naked eye. Also look for any lumps, bumps, growths, ulcerations, fin erosion, deformities of the vertebral column and/or mandibles, swelling of the anus, or any other abnormal conditions.

B. Eyes: Check the eyes for cloudiness, hemorrhage, pop eye, and/or depression into the orbits. Note any of these abnormalities.

C. Branchial chamber: Examine operculea for any perforations or deformities. Lift the operculum (LEFT operculum on round fish, and the dark-side operculum on flat fish) and examine gills. Note color, look for erosion of gills, clubbing or other deformities, and parasitic infestations. Record the presence of parasites only if they occur in excessive numbers and cause

gill damage. Examine internal surfaces of the chamber for lumps, bumps, growths, ulcerations, or any other abnormal conditions. Note any of these abnormalities.

D. Buccal cavity: Open the mouth and examine for any deformities, ulcerations, lumps, bumps, or growths. Record any abnormalities.

II. Selection, killing and fixation for transfer:

Proper fixation of specimens is critical to the ultimate quality of the data obtained. Fish should be examined and fixed while still alive or shortly after death (within one hour of collection). Specimens should not be frozen or kept on ice at any time.

A. All specimens with gross lesions or other suspect conditions, as identified in Section I above, will be processed and coded individually. All these fish will be transferred as indicated below (Section III) to ERL-N for subsequent examination.

1. Carefully cut the entire length of the abdominal cavity open using scissors or a sharp knife. Gently insert the instrument into the abdomen near the anus and make an incision to the operculum. Cut with a lifting motion so that the incision is made from the inside outward, taking care not to injure the visceral organs. Remove the lateral musculature from one side of the animal's visceral cavity to facilitate the fixation of the internal organs. Make one or two cuts through the livers of fishes larger than 15 cm, remove the opercula, and immerse in fixative (see step 5).

2. If the total length of the fish exceeds 15 cm, only a portion of the fish will be saved for laboratory analysis. Carefully cut, through the entire thickness of the fish, from the top of the operculum back along the spine and down to the anus. The head and visceral cavity are then saved. Any abnormalities found on the remaining portion of the fish (which is to be discarded) are excised along with the surrounding tissue, and saved with the head and visceral cavity (i.e., fins suspected to have fin rot and/or net damage).

3. For fishes smaller than 15 cm, the entire fish is saved.

4. If an external growth is present, measure it and slice through the lesion with one clean cut using a sharp razor blade. Note texture and color of masses and lesions (both external and internal).

5. Place the sample (whole fish or head, visceral cavity and abnormalities excised) in a plastic "onion bag". Assign an appropriate sample number to each fish, affix the bar code to a fish tag, and attach the tag to the fish. Record this number on the datasheet, along with all other pertinent information on that fish. Place the bag in a tight sealing plastic container with sufficient fixative to completely cover the specimen. Specimens should be fixed in Dietrich's fixative.

- Dietrich's Fixative (to make ~5 gals.)
  37-40% Formalin ..... 1500 ml
  Glacial Acetic Acid ..... 300 ml
  95% Ethanol ..... 4500 ml
  Distilled water ..... 9000 ml

6. Carefully record pertinent information relating to each individual sample on the data sheet.

III. Shipping of preserved specimens:

Wrap each specimen in cotton or cheese-cloth and saturate with Dietrich's fixative. Clearly label individual specimens with code tags wrapped up with the fish. Place wrapped fish in zip-lock plastic bags and assure that they are completely saturated with fixative. Pack wrapped and bagged specimen in coolers or other suitable containers and ship via appropriate carrier.

## Indicator Testing and Evaluation Sampling

IV. Gross examination of fishes:

At each station, all target species greater than 75 mm taken in each trawl are examined to assess gross pathological problems. While each fish is still alive or fresh dead, a thorough external inspection of the body surfaces, fins, eyes, branchial chamber, and buccal cavity is performed. Record all observations and measurements on the data sheet, and transcribe into the computer on the following day.

A. Body surfaces and fins: Note any discolorations of body surfaces (i.e., darkening, hemorrhaging, cloudiness), raised scales, white spots, or

parasites visible to the naked eye. Also look for any lumps, bumps, growths, ulcerations, fin erosion, deformities of the vertebral column and/or mandibles, swelling of the anus, or any other abnormal conditions.

B. Eyes: Check the eyes for cloudiness, hemorrhage, pop eye, and/or depression into the orbits. Note any of these abnormalities.

C. Branchial chamber: Examine operculea for any perforations or deformities. Lift the operculum (LEFT operculum on round fish, and the dark-side operculum on flat fish) and examine gills. Note color, look for erosion of gills, clubbing or other deformities, and parasitic infestations. Record the presence of parasites only if they occur in excessive numbers and cause gill damage. Examine internal surfaces of the chamber for lumps, bumps, growths, ulcerations, or any other abnormal conditions. Note any of these abnormalities.

D. Buccal cavity: Open the mouth and examine for any deformities, ulcerations, lumps, bumps, or growths. Record any abnormalities.

V. Selection, killing and fixation for transfer:

Proper fixation of specimens is critical to the ultimate quality of the data obtained. Fish should be examined and fixed while still alive or shortly after death (within one hour). Specimens should not be frozen or kept on ice at any time.

A. All specimens with gross lesions or other suspect conditions, as identified in section I above, are processed and coded individually. All these fish will be transferred as indicated below (Section VI) to ERL-N for subsequent examination.

1. Carefully cut the entire length of the abdominal cavity open using scissors or a sharp knife. Gently insert the instrument into the abdomen near the anus and make an incision to the operculum. Cut with a lifting motion so that the incision is made from the inside outward, taking care not to injure the visceral organs. Remove the lateral musculature from one side of the animal's visceral cavity to facilitate the fixation of the internal organs. Make one or two cuts through the livers of fishes larger than 15 cm, remove the opercula, and immerse in fixative (see step 5).

2. If the total length of the fish exceeds 15 cm, only a portion of the fish will be saved for laboratory analysis. Carefully cut, through the entire thickness of the fish, from the top of the operculum back along the spine and down to the anus. The head and visceral cavity are then saved. Any abnormalities found on the remaining portion of the fish (which is to be discarded) are excised along with the surrounding tissue, and saved with the head and visceral cavity (i.e., fins suspected to have fin rot and/or net damage).

3. For fishes smaller than 15 cm, the entire fish is saved.

4. If an external growth is present, measure it and slice through the lesion with one clean cut using a sharp razor blade. Note texture and color of masses and lesions (both external and internal).

5. Place the sample (whole fish or head, visceral cavity and abnormalities excised) in a plastic "onion bag". Assign an appropriate sample number to each fish, affix the bar code to a fish tag, and attach the tag to the fish. Record this number on the datasheet, along with all other pertinent information on that fish. Place the bag in a tight sealing plastic container with sufficient fixative to completely cover the specimen. Specimens should be fixed in Dietrich's fixative.

- Dietrich's Fixative (to make ~5 gals.)
  37-40% Formalin ..... 1500 ml
  Glacial Acetic Acid ..... 300 ml
  95% Ethanol ..... 4500 ml
  Distilled water ..... 9000 ml

6. Carefully record pertinent information relating to each individual sample on the data sheet.

B. In addition to those specimens collected with visual abnormalities, a random, representative subset of specimens are collected from those fish that do not have visual abnormalities. All specimens of target fish species (Table 13.4) that "pass" the gross pathological inspection, up to a maximum of 25 individual fish, are forwarded to ERL-N as described in Section VI. Process and code as sample sets from each collection site. The number of "non-diseased" fishes collected at these sites is limited by the amount of fixative that can be carried on-board the boats. Each boat will carry two 6-gallon pails of fixative.

1. Open visceral cavity as described above (section II, A, 1).

2. Fix specimens in Dietrich's fixative as described above (section II, A, 3).

3. Carefully code samples and/or sample subsets with pertinent information, providing labels on and in containers.

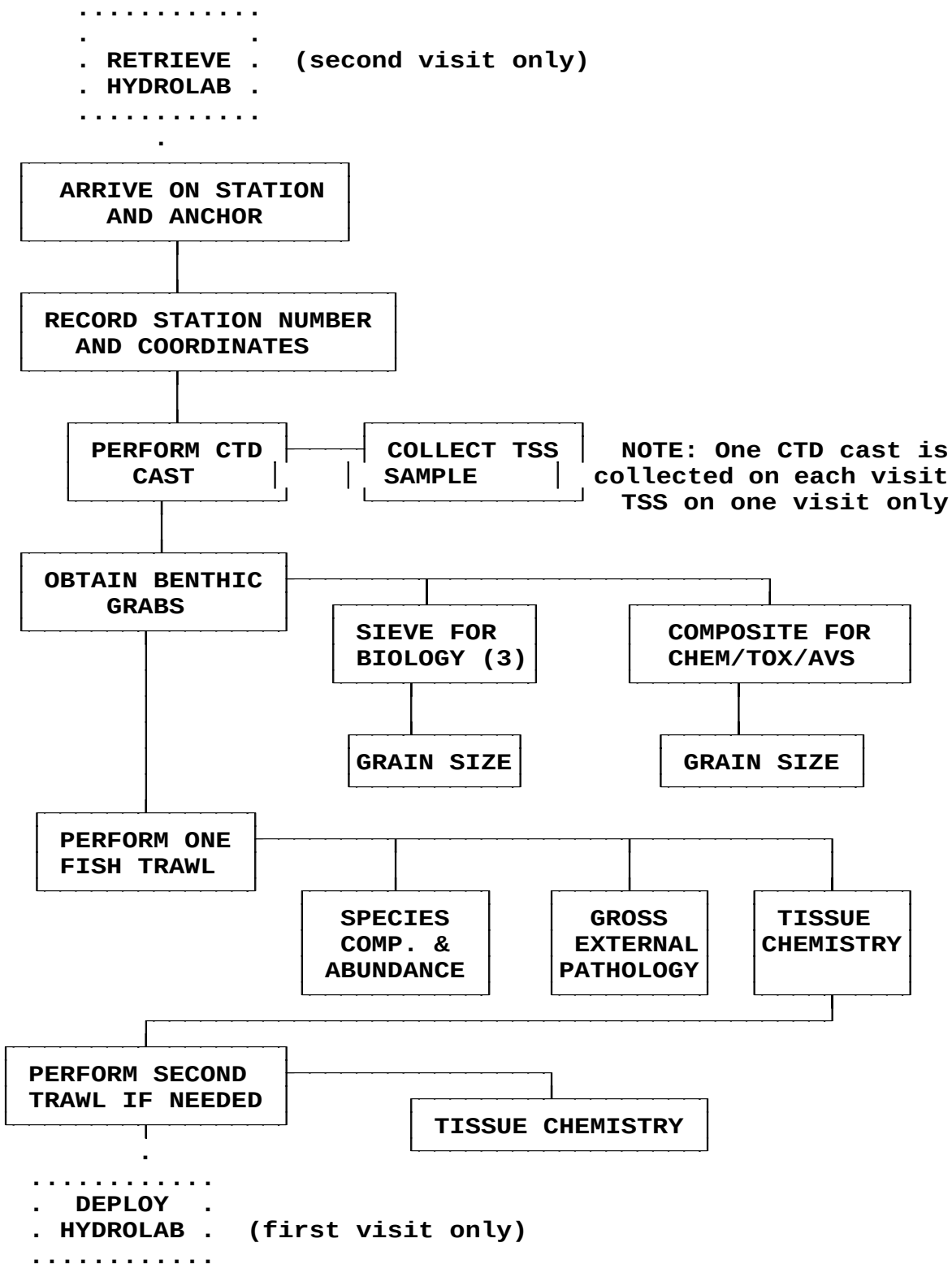
VI. Shipping of preserved specimens:

Wrap each specimen in cotton or cheese-cloth and saturate with Dietrich's fixative. Place wrapped fish in zip lock bags and assure that they are completely saturated with fixative. Pack wrapped and bagged specimen in coolers or other suitable containers and ship via appropriate carrier.

# APPENDIX F

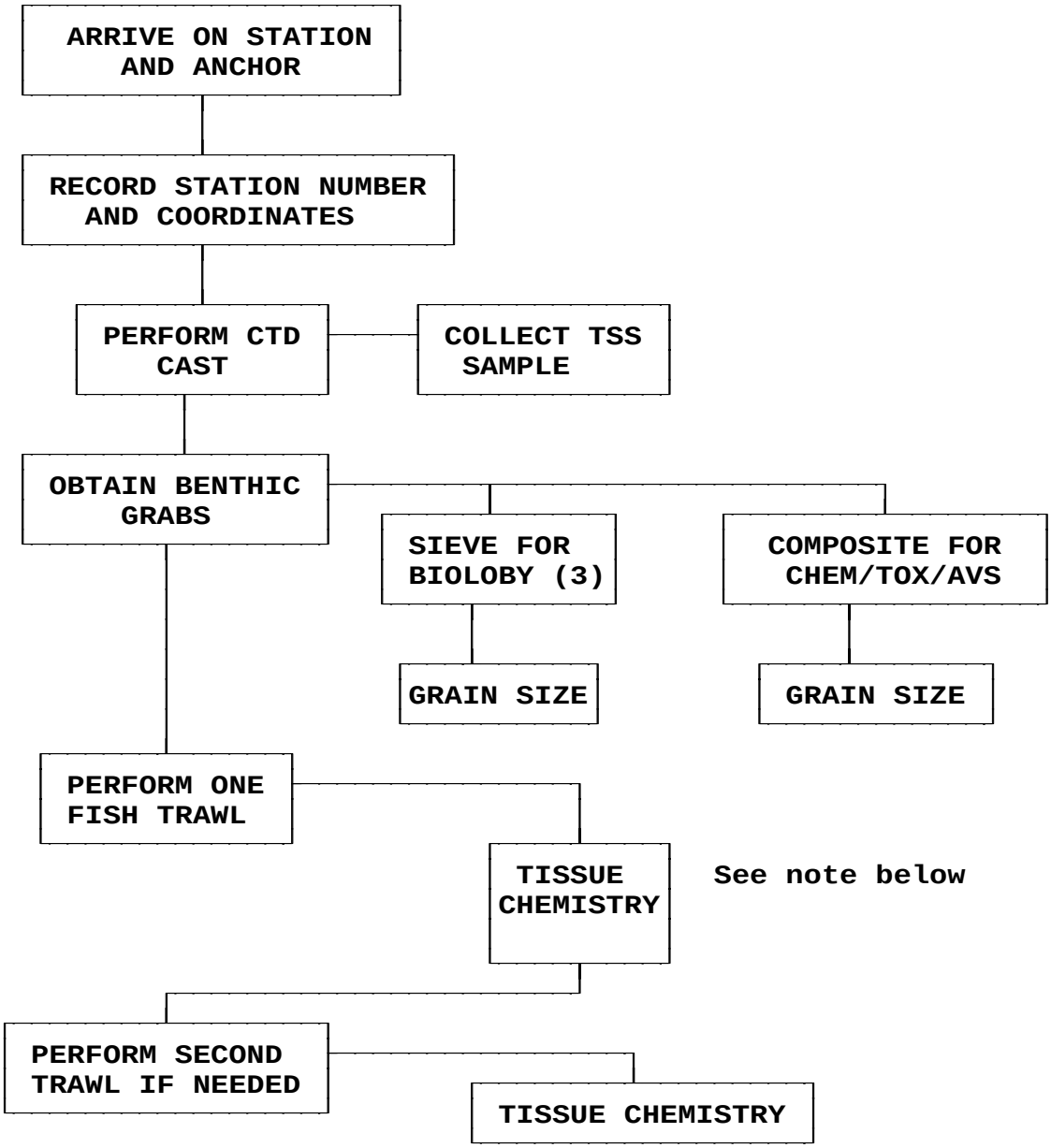
# FLOW CHARTS DESCRIBING THE ACTIVITIES PERFORMED AT EACH STATION TYPE AND THE PROCEDURES FOR COLLECTING SAMPLES

# FIELD SAMPLING ACTIVITIES
# BASE SAMPLING and LONG TERM TREND SITES



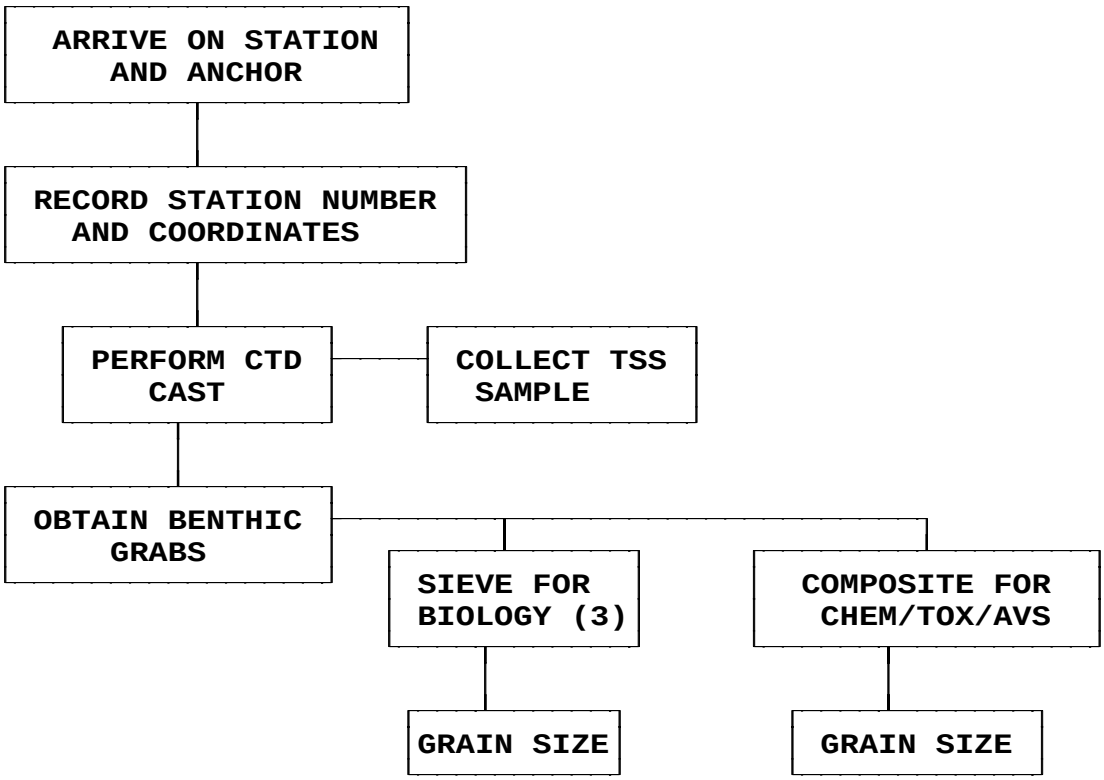

NOTE: With the exception of the CTD cast, samples are only obtained on one of the two visits.

# FIELD SAMPLING ACTIVITIES
# INDEX STATIONS

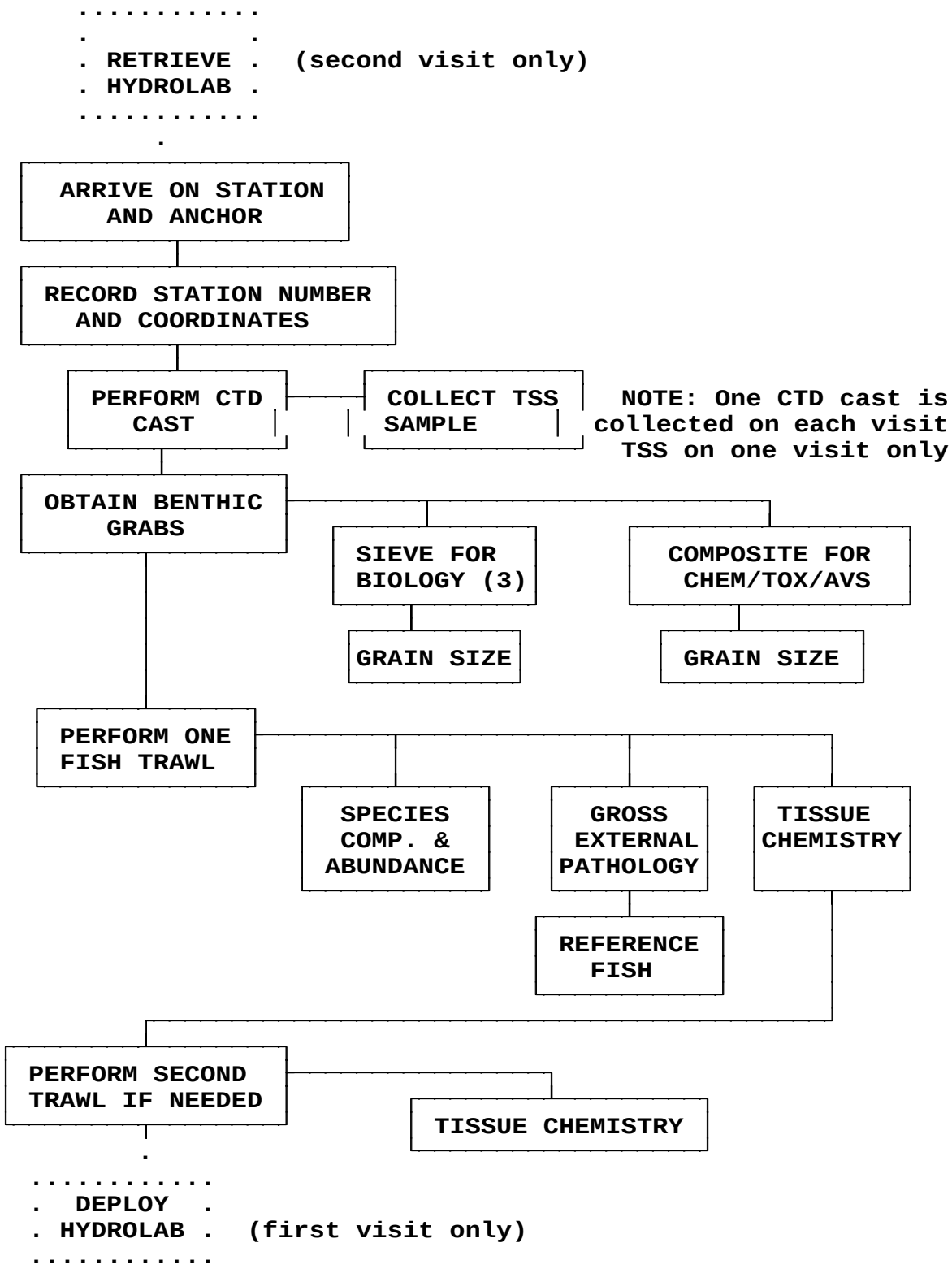



NOTE: Trawling should continue until at least one individual fish of one of the target species for which five individuals were collected at the associated BSS has been collected for chemistry.

# FIELD SAMPLING ACTIVITIES
# LONG TERM SPATIAL STATIONS

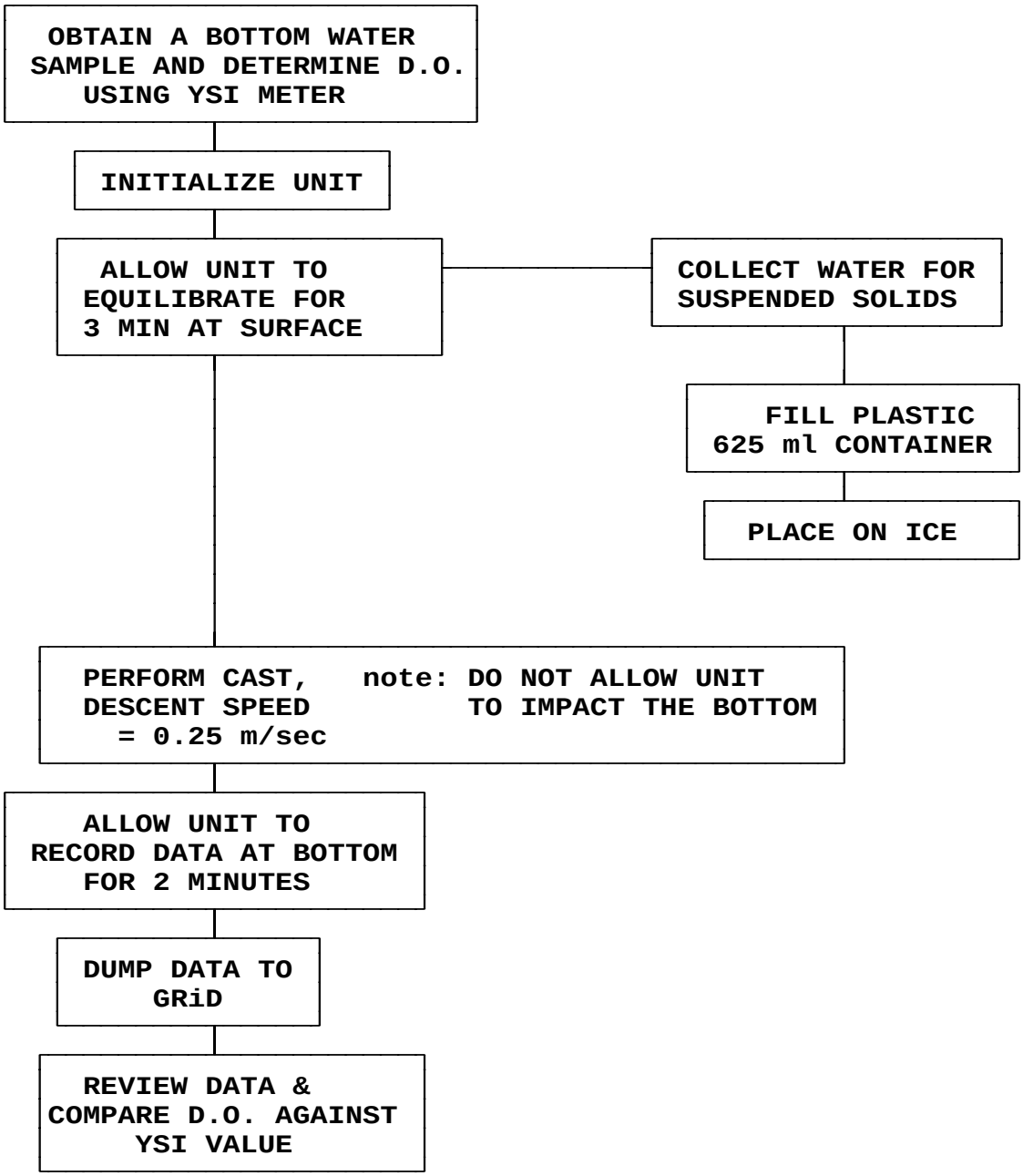


# FIELD SAMPLING ACTIVITIES
# INDICATOR TESTING & EVALUATION SITES

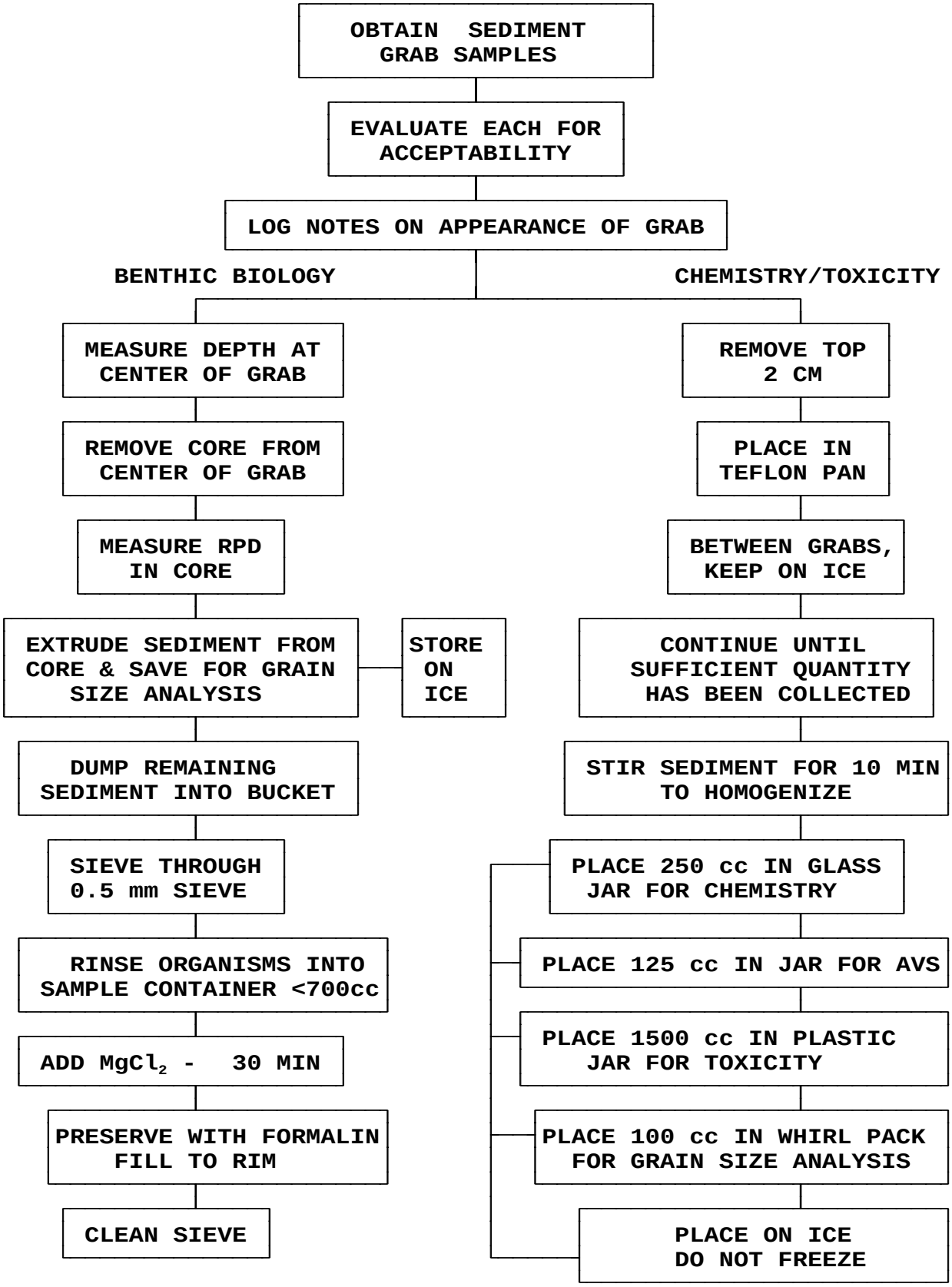



NOTE: With the exception of the CTD cast, samples are only obtained on one of the two visits.

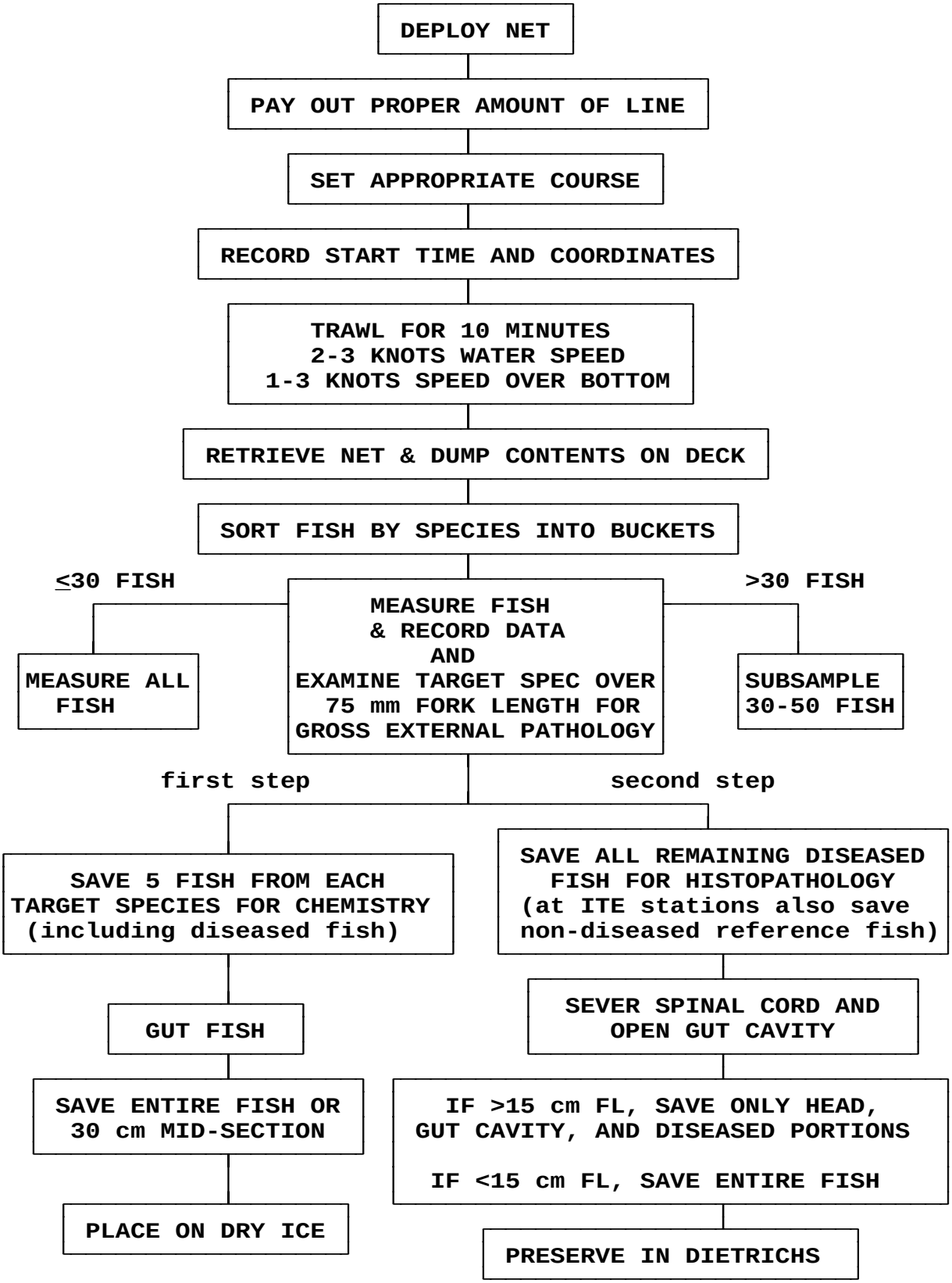
# PERFORMING A CTD CAST



# SEDIMENT COLLECTIONS



# FISH COLLECTIONS




Repeat for chem. only up to 1½ hours to obtain at least 5 individuals of one target species saved for chemistry.

# APPENDIX G

# OPERATION OF THE SEA-BIRD

# SBE 25 SEALOGGER

This appendix details the setup, deployment, dockside QC checks, and maintenance of the SBE 25 SeaLogger CTD.

## 1.0 SETUP PROFILE AND DOWNLOAD DATA

**1.** Select **"First"** or **"Second Visit Menu"**. At the prompts, enter the correct station information, etc.

**2.** Plug one end of the data cable into the CTD and the other into the serial port of the GRiD computer (COM2). Be certain that the fat pin on the CTD matches the raised bump on the cable, and be careful NOT to bend the CTD pins. Check that the magnetic switch on the CTD is in the OFF position.

**3.** Select **"CTD Cast"** from the menu. The computer will attempt to communicate with the CTD. If successful, computer will display **"CTD Menu"**. If communication is not established, you will be asked if you want to retry. Answer <Y>. If communication still cannot be established, check your connections and try again.

**4.** For the FIRST cast of the day select **"Initialize CTD"**. Answer <Y> to clear the CTD memory. At this point logging will be initialized, and the CTD time and date will be reset to match the computer time and date.

**5.** If this is NOT the first cast of the day, OR if you have completed "Initialize CTD", select **"Prepare For Next Cast"**.

**6.** Confirm that the magnetic switch is in the OFF position and press <ESC>. At this point the computer will check and display the CTD main battery voltage and availability of free memory, then place the CTD in quiet state. If the voltage or memory capacity are low a warning message will be displayed. You can still elect to continue the cast, or take action to correct the problems.

- To correct a low voltage problem, change the batteries (See 4.0 CTD MAINTAINENCE AND CLEANING).

- To correct a full memory problem, initialize the CTD (See step 4, above).

**7.** Disconnect the CTD, and prepare for deployment (See 2.0 DEPLOYMENT).

**8.** Following a profile, turn off the magnetic switch and reconnect the data cable between the computer and CTD.

**9.** Select **"Download CTD"** from the CTD Menu. The computer will establish communication with the CTD, display the cast headers in the scroll window, and request the cast number to be downloaded. Enter the appropriate cast number. This will normally be the highest number (i.e. the latest cast).

**10.** The computer will list 3 steps that must be preformed by the operator:

Step 1: Press <ENTER>.
Step 2: Press <D> to start download.
Step 3: Press <ESC> when done.

Begin by pressing <ENTER>. After you see the message "Sea-Bird Electronics, Inc. SEASOFT Version 3.4e" press <D>. WAIT until the download is finished, then when you see the "S>" prompt, press <ESC>. At this point WAIT while the system processes the data and builds the graphical displays.

**11.** The computer will present a series of graphical displays of each sampled parameter plotted against depth. At present, YOU MUST RECORD ON THE "CTD CAST DATASHEET" A CTD BOTTOM D.O., A CTD BOTTOM SALINITY, AND A CTD BOTTOM DEPTH. These numbers can be read from the graphical displays.

- To change parameter displays, press <ENTER>. Currently, you can only move forward through the displays, and not backwards.

- To scroll through the data in a parameter display, use the arrow and page keys. Page keys work by holding the <Fn> key down, and pressing <PgUp> or <PgDn>.

- To dump a screen display to the printer, make sure the printer is on-line, then hold the <Fn> key down and press <PrtSc>.

**12.** After you have viewed all the profiles, the computer will ask if you want to accept this cast. Answer <Y> or <N>.

- "NO" will return you to the "First" or "Second Visit Menu".

- "YES" will bring up the "Field Crew's Station Info. screen".

**13.** Enter the station visited and the event number. The system will back up the data on the A: drive, then bring up the "CTD Cast Information" screen.

**14.** Enter ALL the appropriate information, including the CTD bottom DO, CTD bottom salinity, and CTD bottom depth as recorded on the data sheet. Press <F5> to save and record the data. Answer <Y> if the page is correct. At this point more log files will be copied to the

A: drive, and the computer will return to the "First" or "Second Visit Menu".

## 2.0 DEPLOYMENT

**1.** Disconnect the data cable, and replace the dummy plug (be careful NOT to bend the CTD pins). Finger tighten the locking sleeve on the dummy plug. Confirm that the magnetic switch on the CTD is in the OFF position.

**2.** Prior to actually putting the CTD in the water, run through the following checklist:

**A.** Remove the distilled water loop from the conductivity cell, and connect the tube from the oxygen probe. Remove all rubber stoppers.

**B.** Check the transmissometer and fluorometer lens to make sure they are clean. Use only Kim-wipes or lens paper to clean them.

**C.** Carefully unscrew the bottom of the bottle covering the pH probe, and slide it straight down off the probe. If you can't reach the plastic bottle, first remove the sensor guard cage by unscrewing it.

**D.** Remove the black plastic cap covering the PAR light sensor.

**E.** Attach the downweight and floatation if they are to be used. Secure the winch shackle to the metal ring at the top of the frame, and raise the CTD to the rail.

**F.** Slide the magnetic switch DOWN into the ON position, and <u>immediately</u> lower the CTD into the water.

**3.** Hold the CTD just under the water surface for a minimum of 3-5 minutes to allow the probes to equilibrate and the pump to stabilize. The CTD should be kept sufficiently deep for the water surface to reach the bottom of the shackle ring on the frame.

**4.** Attempt to position the boat so that the PAR sensor (the small white sphere) is NOT shaded. This may involve holding the CTD away from the boat with a boat hook.

**5.** Lower the CTD at a slow, steady rate through the water column. Optimum lowering rates are between 0.5 to 1.5 m/s (1.6 to 5 ft/s). Since most of our stations are shallow, the slower rates are preferred.

**6.** When you feel the CTD bottom weight touch, stop lowering and hold the CTD at the bottom for 1 minute. Pay careful attention to the wire, and make sure the CTD isn't bounced or dragged across the bottom. The bottom weight should ensure that the CTD sensors never actually touch the bottom, and therefore won't become plugged with mud.

**7.** Raise the CTD. As the CTD comes out of the water, slide the magnetic switch UP to the OFF position. Check the conductivity and temperature probes for damage and/or obstructing mud or stones. Reconnect the distilled water loops to the oxygen and conductivity sensors, and carefully cap the pH and PAR probes. Remove the dummy plug from the data port, re-connect the cable, and download the data (see 1.0 SETUP PROFILE AND DOWNLOAD DATA).

**8.** After sampling is finished for the day, the CTD should be throughly rinsed down with freshwater.

## 3.0 CTD DOCKSIDE QC CHECKS

A QC check of the CTD (and the YSI) will preformed once each sampling cycle, from a convenient dock or sheltered location. The **CTD/YSI QC DATA SHEET** should be used to record all values taken during the CTD QC check.

**1.** If not already done, do the YSI QC check (see appendix X, section 5.0) and calibrate the YSI (see appendix X, section 3.0).

**2.** Set up the CTD in realtime mode. To do this, connect the data cable to the CTD, select **"Mobile Lab"** from the main menu, select **"CTD"**, and select **"Realtime CTD/YSI QC Check"**. Answer <N> when asked about changing the aquisition or display parameters. You will be prompted to turn on the CTD switch. NOTE: DO NOT turn on the CTD until just before you are ready to lower it into the water. (As with a real deployment, this will allow air to bleed out of the tubing system before the pump kicks in.)

**3.** Once the CTD is on, the computer screen should change to a fixed display of numbers. Allow the CTD to equilibrate in the water - this may take up to 10 minutes, depending on the temperature difference between the deck and the water. Watch the "Oxygen Temp" and "Temperature" numbers. When they are within 0.5 C, the unit is equilibrated.

**4.** Put the calibrated YSI over the side next to the bottom of the CTD. Adjust the YSI salinity to the CTD salinity, then record the YSI temperature and oxygen (as the AMBIENT values) and the CTD temperature, oxygen and salinity.

**5.** Take a bucket water sample from next to the CTD, check the salinity with a refractometer and record this value.

**6.** Bring the CTD back on deck, but leave the magnetic switch ON, and leave the computer in real time mode. Rinse off the pH probe with distilled water and some pH 10 buffer, then insert the probe in the pH 10 buffer. Confirm that an electrical connection exists between the top of the pH probe and the buffer solution. Record the CTD pH reading.

**7.** The CTD may now be turned OFF, the sensors rinsed with freshwater, and all probe covers replaced. Exit from the real time mode with <Ctrl F1>, then answer <N> to the restart question.

**8.** At this point the computer will display the **"CTD/YSI QC Information"** menu. Fill in ALL pertinent data and copy all the CTD QC check values to the computer data sheet, including the differences between the CTD and the AMBIENT readings. At this point you should also enter the YSI QC check data (see appendix X, section 5.0).

**9.** The tolerances for passing the CTD QC check are as follows:

- Salinity: +/- 2 ppt
- Temperature: +/- 2 C
- Oxygen: +/- 1 ppm (mg/l)
- pH: +/- 0.5 pH units

If a CTD fails to pass any of the QC checks, repeat the above procedures one time. If the CTD still fails, contact Sue Cielenski at the FOC immediately.

## 4.0 CTD MAINTAINENCE AND CLEANING

**1.** As often as possible, flush the entire CTD with fresh water.

**2.** Keep the distilled water loop on the conductivity cell, and keep the oxygen sensor moist (it does not need to be full of water, just in a humid environment.

**3.** To clean the conductivity cell and the oxygen probe, put a few drops of the Triton X-100 cleaner into their respective tubes, and allow to soak over night. The tubes should be flushed with water before deployment. NEVER use a brush or tool to clean the inside of the conductivity cell.

**4.** When the data cable is not in use, keep it coiled.

**5.** Handle the CTD with care - some of the sensors are more delicate than others, and can be damaged by bouncing the unit on deck, or by letting the unit fall over, etc.

# APPENDIX H

# PERFORMING WINKLER TITRATIONS USING THE HACH DO KIT

# DETERMINATION OF DISSOLVED OXYGEN BY THE HACH KIT PROCEDURE

The method described here follows a modification of the classical Winkler procedure. A divalent manganese solution, followed by strong alkali, is added to the sample. The precipitated manganous hydroxide is dispersed evenly throughout the seawater sample which completely fills a stoppered glass bottle. Any dissolved oxygen rapidly oxidizes an equivalent amount of divalent manganese to basic hydroxides of higher valency states. When the solution is acidified in the presence of iodide, the oxidized manganese again reverts to the divalent state and iodine, equivalent to the original dissolved oxygen content of the water, is liberated. The amount of iodine is measured by titration with sodium thiosulfate.

Once a week, a QC check on the performance of the YSI dissolved oxygen probe is required. This includes evaluating the calibration of the DO probe and will determine whether a membrane change is necessary. The Hach company model OX-DT Dissolved Oxygen Test Kit has been selected for use in these QC checks.

## 1.0 SAMPLING PROCEDURE AND STORAGE

a. Insert the tube from the Go-Flo bottle approximately 3/4 of the way down into a clean 300-ml BOD bottle. Open the top valve on the Go-Flo bottle and allow the sample to slowly enter the BOD bottle, being careful to avoid the introduction of air bubbles. Allow at least two volumes (600 ml) to overflow, then crimp the hose and gently remove it, allowing just enough water to enter the bottle to displace the volume of the hose. Make sure there are no air bubbles trapped in the BOD bottle and stopper.

b. Add the contents of one manganous sulfate powder pillow and one alkaline iodide-azide reagent powder pillow.

c. Immediately insert the stopper so air is not trapped in the bottle. Firmly hold the stopper in place and invert several times to mix. **Note: A flocculent precipitate will form which will be orange-brown if oxygen is present. In salt water, the floc may not settle fully.**

d. Let the floc in the solution settle to about 1/3 of the way down the bottle. Again invert the bottle several times and wait until the floc has settled to about one-half to two thirds down. **Note: Waiting until the floc has settled twice assures complete reaction of the sample and reagents.** At this point, samples may be stored in the dark up to 8 hours before analysis. If the sample is not to be titrated

immediately, store upright and seal the top by pouring a small amount of water into the flared lip area.

## 2.0 ANALYSIS

a. When you are ready to perform the titration, remove the stopper and add the contents of one sulfamic acid powder pillow. (Do not re-mix the sample before adding the sulfamic acid). Replace the stopper without trapping air in the bottle and invert several times to mix. **Note: The floc will dissolve and leave a yellow color if oxygen is present.**

b. Attach the cartridge to the titrator body following the procedure described in the Hach manual. Insert a clean delivery tube into the titration cartridge. Turn the delivery knob to eject a few drops of titrant. Reset the counter and wipe the tip with a clean Kimwipe.

c. Use a clean graduated cylinder to measure 100 mls of sample and then transfer the sample into a 250-ml erlenmeyer flask. The erlenmeyer flask should be placed on the battery-powered mixing stand and a stir bar should be added to mix the sample.

d. Place the delivery tube into the solution so that the tip is submerged and swirl the flask while titrating with sodium thiosulfate to a pale yellow (straw) color.

e. Add four drops of starch indicator solution and swirl to mix. **Note: A blue color will develop due to the formation of a starch-iodine complex.**

f. Continue the titration to a colorless end point using the fine adjustment on the titrator. The titration is finished when the sample first turns completely colorless. Record the number of digits from the digital counter.

g. Calculate mg/l dissolved oxygen by multiplying the digits required x the digit multiplier (.02 for 2 - 10 mg/l dissolved oxygen). For example, a reading of 300 digits x .02 equals a DO concentration of 6.00 mg/l. Depending on the accuracy of the strength of the sodium thiosulfate solution in the cartridge, a correction factor may need to be applied (see the instructions which follow this section).

h. Record this value on the appropriate data sheet.

i. Discard the remainder of the sample and rinse all glassware with deionized water.

## 3.0 INSTRUCTIONS FOR DETERMINING THE ACCURACY OF THE HACH WINKLER TITRATIONS USING THE IODATE-IODIDE STANDARD SOLUTION

The accuracy of the Hach Winkler titrations can be checked by using an iodate-iodide standard solution which has a constant dissolved oxygen concentration of 10 mg/l. The periodic use of this standard solution provides a check both on the strength of the sodium thiosulfate titrant and the accuracy of the digital titrator. One titration with the iodate-iodide standard should be performed every time a new titration cartridge is used. In addition, it is good practice to check the strength of the titrant at regular intervals (every two or three days) and apply the appropriate correction factors to the titration results for the actual field samples. The procedure for performing the titration of the iodate-iodide standard and calculating the correction factor is given below.

1. The titration of the iodate-iodide standard solution basically follows the same procedure as a normal Winkler titration. First, measure 100 ml of the iodate-iodide standard solution using the graduated cylinder and pour it into the erlenmeyer flask. Place the flask on the mixing stand and add a stir bar.

2. While the solution is mixing, add the contents one Sulfamic Acid powder pillow (Hach kit reagent 3). The solution will turn clear yellow. Wait a few minutes for all the sulfamic acid crystals to dissolve.

3. Titrate the solution following the instructions for the Winkler titration given in the previous section (begin at step 12, after you have prepared the digital titrator).

4. When the titration is complete, record the number on the digital titrator. Ideally, this number should be 500, which is equivalent to a dissolved oxygen concentration of 10 mg/l (the expected value). If the reading is 500, there is no need to apply a correction factor. If the reading on the digital titrator is between 475 and 525 (i.e., between 9.50 to 10.50 mg/l), then the digital titrator readings for actual field samples must be corrected. The calculation for determining a corrected digital titrator reading involves using a simple proportion, as follows:

$$\frac{a}{b} = \frac{c}{d}$$

Where:
a = digital titrator reading following titration of iodate-iodide standard
b = 500 (the expected value following the iodate-iodide solution titration)
c = digital titrator reading following titration of actual sample
d = "corrected" digital titrator reading following titration of actual sample

The equation is solved for "d" (the corrected digital titrator reading following titration of a sample). The corrected reading is then multiplied by 0.02 to give the oxygen concentration in mg/l.

Example:

You titrate the iodate-iodide standard solution and get a reading of 480 on the digital titrator. You then titrate a normal field sample and get a reading of 350. You would correct this field sample reading as follows:

$$\frac{480}{500} = \frac{350}{d}$$

Rearranging the equation:

$$d = \frac{500 \times 350}{480}$$

$$d = 364.6$$

To get the dissolved oxygen concentration of the field sample in mg/l, multiply 364.6 by 0.02. This gives a final dissolved oxygen concentration in the sample of 7.29 mg/l.

5. If the reading on the digital titrator is less than 475 or greater than 525 following the titration of the iodate-iodide standard solution, the thiosulfate cartridge should be disgarded and a new one should be used. Readings less than 475 or greater 525 generally indicate that the titrant is too strong or too weak to give accurate results, even if you use corrected digital titrator readings. A second source of inaccuracy in the Hach Winkler kit is the digital titrator itself. If the digital titrator readings are still less than 475 or greater than 525 when the iodate-iodide titration is performed with a new cartridge, the digital titrator is suspect and a backup one should be used.

6. Whenever the digital titrator readings are "corrected" using the above equation, the calculations should be recorded on the back of the data sheet in the field, so that they can be checked when the data sheet is sent to the Field Operations Center.

## 4.0 DETERMINATION OF DISSOLVED OXYGEN

The following notes will hopefully enable everyone to do a dissolved oxygen titration efficiently and accurately.

- Be sure the sample bottle is clean and rinsed twice with the water to be tested. Check carefully for bubbles.

- Try to be as precise as possible when adding manganese sulfate and alkaline potassium iodide reagents; however, since these are added in excess there is some room for error. It is necessary to add the manganese sulfate first.

- You may add these two solutions to the sample in the field and then go back home to complete the test. **The test must be completed within the recommended number of hours for the procedure you are using. Keep samples in the dark until you are ready to analyze them.**

- The amount of sample to be titrated is critical. Measure carefully. The bottom of the meniscus should rest on top of the white line on the titration tube. (A miniscus is a curved upper surface of a liquid column that is concave when the containing walls are wetted by the liquid).

- The titration is also extremely critical. Once the starch has been added, titrate carefully so as not to overshoot the endpoint.

- Add a uniform number of drops of starch per sample if possible. Simply add titrant until the sample is light yellow; add starch solution and continue adding drops "very carefully" until solution just turns clear. The first complete disappearance of blue color is the endpoint. (If you see the solution turn blue again,, ignore it!)

- Record all values on the record sheet.

- Finally, if you have any further questions, please let us know. Testing for the amount of dissolved oxygen is very important and we want to know we are getting accurate numbers.

## *Oxygen Solubility in Seawater*

(values in mg/l)

| Temp. (°C) | *Salinity (ppt)* 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 14.62 | 14.12 | 13.64 | 13.17 | 12.71 | 12.28 | 11.85 | 11.45 | 11.05 |
| 1 | 14.22 | 13.73 | 13.27 | 12.82 | 12.38 | 11.96 | 11.55 | 11.15 | 10.77 |
| 2 | 13.83 | 13.36 | 12.91 | 12.48 | 12.06 | 11.65 | 11.26 | 10.88 | 10.51 |
| 3 | 13.46 | 13.01 | 12.58 | 12.16 | 11.75 | 11.36 | 10.98 | 10.61 | 10.25 |
| 4 | 13.11 | 12.67 | 12.26 | 11.85 | 11.46 | 11.08 | 10.71 | 10.35 | 10.01 |
| 5 | 12.77 | 12.35 | 11.95 | 11.55 | 11.18 | 10.81 | 10.45 | 10.11 | 9.77 |
| 6 | 12.45 | 12.04 | 11.65 | 11.27 | 10.91 | 10.55 | 10.21 | 9.87 | 9.55 |
| 7 | 12.14 | 11.75 | 11.37 | 11.00 | 10.65 | 10.30 | 9.97 | 9.65 | 9.34 |
| 8 | 11.84 | 11.47 | 11.10 | 10.74 | 10.40 | 10.07 | 9.74 | 9.43 | 9.13 |
| 9 | 11.56 | 11.19 | 10.84 | 10.50 | 10.16 | 9.84 | 9.53 | 9.22 | 8.93 |
| 10 | 11.29 | 10.93 | 10.59 | 10.26 | 9.93 | 9.62 | 9.32 | 9.02 | 8.74 |
| 11 | 11.03 | 10.68 | 10.35 | 10.03 | 9.72 | 9.41 | 9.12 | 8.83 | 8.56 |
| 12 | 10.78 | 10.44 | 10.12 | 9.81 | 9.51 | 9.21 | 8.93 | 8.65 | 8.38 |
| 13 | 10.54 | 10.21 | 9.90 | 9.60 | 9.30 | 9.02 | 8.74 | 8.47 | 8.21 |
| 14 | 10.31 | 9.99 | 9.69 | 9.39 | 9.11 | 8.83 | 8.56 | 8.30 | 8.05 |
| 15 | 10.08 | 9.78 | 9.49 | 9.20 | 8.92 | 8.65 | 8.39 | 8.14 | 7.89 |
| 16 | 9.87 | 9.58 | 9.29 | 9.01 | 8.74 | 8.48 | 8.22 | 7.98 | 7.74 |
| 17 | 9.67 | 9.38 | 9.10 | 8.83 | 8.57 | 8.31 | 8.06 | 7.82 | 7.59 |
| 18 | 9.47 | 9.19 | 8.92 | 8.65 | 8.40 | 8.15 | 7.91 | 7.68 | 7.45 |
| 19 | 9.28 | 9.01 | 8.74 | 8.48 | 8.24 | 8.00 | 7.76 | 7.53 | 7.31 |
| 20 | 9.09 | 8.83 | 8.57 | 8.32 | 8.08 | 7.85 | 7.62 | 7.40 | 7.18 |
| 21 | 8.92 | 8.66 | 8.41 | 8.17 | 7.93 | 7.70 | 7.48 | 7.26 | 7.05 |
| 22 | 8.74 | 8.49 | 8.25 | 8.01 | 7.79 | 7.56 | 7.35 | 7.13 | 6.93 |
| 23 | 8.58 | 8.34 | 8.10 | 7.87 | 7.64 | 7.43 | 7.22 | 7.01 | 6.81 |
| 24 | 8.42 | 8.18 | 7.95 | 7.73 | 7.51 | 7.30 | 7.09 | 6.89 | 6.69 |
| 25 | 8.26 | 8.03 | 7.81 | 7.59 | 7.38 | 7.17 | 6.97 | 6.77 | 6.58 |
| 26 | 8.11 | 7.89 | 7.67 | 7.46 | 7.25 | 7.05 | 6.85 | 6.66 | 6.47 |
| 27 | 7.97 | 7.75 | 7.54 | 7.33 | 7.12 | 6.93 | 6.74 | 6.55 | 6.37 |
| 28 | 7.83 | 7.61 | 7.40 | 7.20 | 7.00 | 6.81 | 6.62 | 6.44 | 6.26 |
| 29 | 7.69 | 7.48 | 7.28 | 7.08 | 6.89 | 6.70 | 6.52 | 6.34 | 6.16 |
| 30 | 7.56 | 7.35 | 7.16 | 6.96 | 6.77 | 6.59 | 6.41 | 6.24 | 6.07 |
| 31 | 7.43 | 7.23 | 7.04 | 6.85 | 6.66 | 6.48 | 6.31 | 6.14 | 5.97 |
| 32 | 7.31 | 7.11 | 6.92 | 6.74 | 6.56 | 6.38 | 6.21 | 6.04 | 5.88 |
| 33 | 7.18 | 6.99 | 6.81 | 6.63 | 6.45 | 6.28 | 6.11 | 5.95 | 5.79 |
| 34 | 7.07 | 6.88 | 6.70 | 6.52 | 6.35 | 6.18 | 6.02 | 5.86 | 5.70 |
| 35 | 6.95 | 6.77 | 6.59 | 6.42 | 6.25 | 6.09 | 5.93 | 5.77 | 5.62 |
| 36 | 6.84 | 6.66 | 6.49 | 6.32 | 6.15 | 5.99 | 5.83 | 5.68 | 5.53 |
| 37 | 6.73 | 6.55 | 6.38 | 6.22 | 6.06 | 5.90 | 5.75 | 5.60 | 5.45 |
| 38 | 6.62 | 6.45 | 6.28 | 6.12 | 5.96 | 5.81 | 5.66 | 5.51 | 5.37 |
| 39 | 6.52 | 6.35 | 6.19 | 6.03 | 5.87 | 5.72 | 5.58 | 5.43 | 5.29 |
| 40 | 6.41 | 6.25 | 6.09 | 5.94 | 5.78 | 5.64 | 5.49 | 5.35 | 5.22 |

Benson, B.B. and D. Krause Jr. 1984. The concentration and isotopic fractionation of oxygen dissolved in freshwater and seawater in equilibrium with the atmosphere. Limnol. Oceanogr., 29(3), 620-632.

# APPENDIX I
# OPERATION OF THE HYDROLAB DATASONDE 3 DATA LOGGER

## 1.0 INITIAL SETUP AND COMPUTER INSTRUCTIONS

**1.** Attach the 6-pin female end of the data cable to the DataSonde unit. Match the raised bump on the connector to the fat pin on the unit.

**2.** Plug the 9 pin female connector on the Y-cable into the 9 pin male port at the back of the GRiD computer (this is identified as port "3", RS232 Serial, on the GRiD case).

**3.** Plug the external power cable (the round four pin metal connector) into corresponding plug on the Y-cable.

**4.** If hydrolab data is still not visible on the computer screen, check all connections and the external power source.

**5.** From within the navigation system select "Hydrolab". The Hydrolab menu will present the following options:

"Download Hydrolab"
"Set-up Hydrolab Logging"
"QC Check / Calibrate Hydrolab"

Select the appropriate menu choice.

**6.** At the PROCOMM+ opening screen, hit any key to enter terminal mode.

**7.** See the following sections for the indicated activities:



**8.** To exit PROCOMM+ type <ALT X>, and answer <Y>es to the prompts.

## 2.0 12 HOURS PRIOR TO CALIBRATION

The following procedures should be done in the mobile laboratory on the afternoon or evening of the day before the unit is calibrated.

**1.** Install new batteries in the battery pack (see Section 8.0 BATTERY PACK INSTALLATION, below).

**2.** Invert and clamp the DataSonde in the ringstand, and establish communications using the "QC Check / Calibrate Hydrolab" menu choice (see Section 1.0). Be sure to use an external power supply, so the internal batteries are not drained. Remove the old oxygen membrane, shake out the electrolyte, and dry off the gold ring. While the membrane is off, confirm that the oxygen reading is nearly zero (>1 mg/l), and record this value on the Hydrolab calibration data sheet.

**3.** Remove the white conductivity block (attached with 2 phillips head screws), and dry off the six conductivity pins. (If they are darkly tarnished, remove the six little O-rings and buff the pins with emory cloth, then rinse with distilled water and dry.)

**4.** Re-attach the small O-rings (if the pins were buffed) and the conductivity block. Put on a new LoFlow oxygen membrane (see section 7.0 HYDROLAB'S LoFlow DO MEMBRANE, below, for details).

## 3.0 CALIBRATING WATER QUALITY PARAMETERS

### 3.1 pH CALIBRATION

**1.** Rinse the probes thoroughly with deionized water and then with the pH 7.0 buffer solution. This is done by filling the calibration cup with a small amount of solution, then covering with the black rubber cap and shaking vigorously. Discard the water and pH rinses when finished.

**2.** Invert the DataSonde and clamp it to the ringstand (probes will now be pointed upwards). Fill the calibration cup with pH 7.0 solution until the pH reference probe is completely covered. Note that pH 7.0 should always be the first buffer calibrated.

**3.** Wait 1-2 minutes until the pH sensor equilibrates and the pH readings stabilize, i.e. five consecutive readings are identical (note the pH has stabilized at 7.21 units in the following figure). Press <RETURN> to calibrate pH 7.

**4.** The calibration command gets sent down to the hydrolab while the calibration menu remains on the upper half of the screen. At this point the hydrolab pH readings should be stable at 7.0 (notice that the hydrolab pH is now stable at 7.00 units in the following figure).

If the readings are not stable, you may need to repeat the calibration procedure.

If the Hydrolab does not accept your calibration value, an error message "Out of tolerance, calibration is not saved" will scroll by the screen. Several things could be wrong:

**A.** You may have used the incorrect pH solution. Be sure you have entered the correct value for the solution in the calibration cup.

**B.** The reference electrode may need to be refilled or replaced. Refer to the Hydrolab manual, section 3-5, the first three paragraphs.

**C.** The mercury batteries for the DO probe may need to be replaced. These batteries also power the pH circuits so that no warm-up is required.

**5.** Repeat procedures for the pH 10.0 solution. Rinse the calibration cup and probes with deionized water between each pH solution. Rinse the probes thoroughly with the pH 10.0 buffer solution. This is done by filling the calibration cup with a small amount of solution, then covering with the black rubber cap and shaking vigorously. Discard the water and pH rinses when finished.

**6.** Invert the DataSonde and clamp it to the ringstand (probes will now be pointed upwards). Fill the calibration cup with pH 10.0 solution until the pH reference probe is completely covered. Note that pH 10.0 should always be calibrated after pH 7.0 has been calibrated.

**7.** Wait 1-2 minutes until the pH sensor equilibrates and the pH readings stabilize, i.e. five consecutive readings are identical (note the pH has stabilized at 9.91 units in the following figure). Press <RETURN> to calibrate pH 10.

**8.** The calibration command gets sent down to the hydrolab while the calibration menu remains on the upper half of the screen. At this point the hydrolab pH readings should be stable at 10.0 (notice that the hydrolab pH is now stable at 10.00 units in the following figure).

If the readings are not stable, you may need to repeat the calibration procedure.

If the Hydrolab does not accept your calibration value, an error message "Out of tolerance, calibration is not saved" will scroll by the screen. Several things could be wrong:

**A.** You may have used the incorrect pH solution. Be sure you have entered the correct value for the solution in the calibration cup.

**B.** The reference electrode may need to be refilled or replaced. Refer to the Hydrolab manual, section 3-5, the first three paragraphs.

**C.** The mercury batteries for the DO probe may need to be replaced. These batteries also power the pH circuits so that no warm-up is required.

## 3.2 SALINITY CALIBRATION

**1.** Rinse the calibration cup with deionized water, then with two rinses of the seawater standard. (Batches of standard seawater solution will be sent out periodically from the FOC). Fill the cup with seawater standard, to just below the level of the oxygen membrane. Make sure there are no air bubbles in the conductivity cell block.

**2.** Monitor the salinity readings for 1-2 minutes until they have stabilized (note salinity is stable at 28.9 ppt in the following figure).

**3.** Manually enter the correct salinity value (ppt) of the seawater standard (29.7 ppt in this example). Hit <RETURN> to calibrate salinity.

4. Once the salinity calibration command has been sent down to the hydrolab, the computer returns to the Calibration menu. Monitor the salinity readings, they should be stable at the value of the seawater standard (note the salinity is now stable at 29.7 ppt in the following figure). If the readings are not stable you may need to repeat the salinity calibration procedures.

5. If the hydrolab did not accept the calibration value, an error message "Out of tolerance, calibration is not saved" will scroll by the screen. Check that you have entered the proper salinity value of the standard seawater solution and repeat the calibration procedures.

### 3.3 DISSOLVED OXYGEN

**1.** Rinse the calibration cup and probes with deionized water.

**2.** Clamp the unit (in an inverted position) and fill the calibration cup with water until the level is just below the oxygen membrane. Wipe away any droplets on the membrane with the corner of a tissue.

**3.** Lay the white calibration cup cover upside down (concave upward) on calibration cup and let the sensor equilibrate for about 10 minutes. Equilibration may take some time; however, wait until condensation droplets are visible on the sides of the calibration cup. This ensures that that the calibration will be conducted in water-saturated air (100% humidity).

**4.** Once the readings stabilize, select <% Saturation> from the calibration menu to calibrate oxygen percent saturation.

5. Enter the correct barometric pressure (760 mmHg for sea level). Hit <RETURN> and DO will be calibrated.

6. The Percent Saturation value should read 102.5% (The values for the low-flow membrane are artificially increased 2.5% to compensate for the thickness of the membrane). If the Hydrolab does not accept the calibration, an error message "Out of tolerance, calibration is not saved" will scroll by the screen. Check the following:

**A.** The DO probe has had sufficient time to stabilize.

**B.** The Lo-flow membrane (not the standard membrane) is installed, and that it has had at least 12 hours to 'relax'.

**C.** The mercury batteries for polarizing the DO probe are installed.

## 4.0 LOGGING SET-UP AND DEPLOYMENT INSTRUCTIONS

**1.** Hook up the DataSonde to the computer (see Section 1.0 INITIAL SETUP AND COMPUTER INSTRUCTIONS, above). From the menu select "Setup Logging". As Procomm+ boots up, you will see the Hydrolab messages coming across the screen. Wait for these to stop scrolling.

**2**. Enter the file name of the logging file you are setting up. The correct name is LTDO.PRN. This should also be the default file name.

**3.** Enter the start date (MMDDYY), start time (HHMMSS), finish date (MMDDYY), and finish time (HHMMSS) for the logging file. The finish date should be set for 20 days ahead, and the finish time can be set to match the start time. These parameters should also be recorded on the Hydrolab deployment data sheet.

**4.** Set the time interval between readings (this should be 30 minutes, written as 003000, and should be the default value).

**5.** Type <N>o to disable warmup. This is not neccessary since the DO probe batteries will always keep the oxygen and pH sensors 'warm'.

**6.** Hit the <space bar> to go back to the Hydrolab menu. Disconnect the external power supply at this time.

**7.** Confirm your setup by typing <L>ogging and <T> (for status). There should be only 2 log files: the AUTOLOG and LTDO.PRN. If there are any others, they should be erased. Also note the amount of battery life remaining for the AA cells (this will only be correct if the external power was disconnected before asking for Status).

**8.** Disconnect the cable, and re-attach the dummy plug. Note: Once the unit has been programmed it will "sleep" after the data cable is disconnected until the entered start time.

**9.** Exit Procomm+ (see section 1.0), and <ESC>ape to the navigation system. Set up the Hydrolab mooring system at this time and prepare Hydrolab for deployment: remove the storage cup and replace it with the screw-on weight. Insert the entire unit into the mooring and secure.

**10.** When ready to deploy the Hydrolab, select the "Hydrolab deployment" option and follow the screen prompts for taking a fix at the moment the mooring is set on the bottom. This will also involve recording the Hydrolab serial number (or using the bar code reader). Position, time, and serial number information should also be recorded on the Hydrolab deployment data sheet.

## 5.0 RECOVERY AND DOWNLOAD INSTRUCTIONS

**1.** Before the Hydrolab is pulled from the water, recover the yellow float and excess

line, so that the boat is nearly over the unit itself. From within the Nav system select the menu option "Hydrolab Retrieval", and follow the screen prompts. This will involve taking a fix as the Hydrolab is recovered, and after it is on deck, recording the serial number. Postion, time of recovery, and serial number should also be recorded in the Hydrolab retrieval data sheet.

**2.** Hook up the DataSonde to the computer (see Section 1.0 INITIAL SETUP AND COMPUTER INSTRUCTIONS, above). Select the menu option "Hydrolab Set-up", then "Download Hydrolab". This will automatically work through some of the Hydrolab screen menus (wait for the menus to stop scrolling), until you are asked to select the number of the file to download. Normally you select <1>, which should be 'LTDO.PRN'.

**3.** Select <S>preadsheet ready, <F>ollow calibration changes, and <N>o power down probes. The screen will then display the message "XMODEM transfer initiated".

**4.** Hold the <Fn> key and press <PgDn>. PROCOMM+ will list a menu of data transfer options. Select <1> for "XMODEM" (this will normally be the default).

**5.** The computer will ask for a file name, and should display 'LTDO.PRN' as the default name. Type in the name if it is not displayed. A window will open and you will see numbers counting up as the file is transferred. If nothing happens after a minute, try <ESC>aping and start over again.

**6.** When the transfer is completed successfully, the computer will close the window, and the Hydrolab will go back into real-time sampling.

**7.** To view the file you just downloaded, type <ALT V> and the name of the file (LTDO.PRN). When finished viewing, return with <ESC>. If all was well, exit Procomm+ with <ALT X>. NOTE: it is important to exit correctly, since this will cause the file just downloaded to be moved into the appropriate subdirectory. This process may be slow, so be patient while the files are backed up and renamed.

## 6.0 HYDROLAB QC CHECKS

QC (Quality Control) checks need to be done on both the retrieval and deployment units. If the deployed unit does not pass, then the backup Hydrolab will be QC checked. If neither unit passes the QC check, one of the units will have to be re-calibrated prior to

deployment. Although the QC checks are identical, there are separate Hydrolab QC menus for the deployed and retrieved units.

**1.** Attach the data cable to the computer and the Hydrolab as described earlier.

**2.** Attach the open-ended calibration cup, and rinse with the pH 7.0 buffer twice. Fill the cup with buffer to below the oxygen membrane but above the reference electrode. Gently wipe the oxygen membrane dry, place the white cap over the end of the cup, and allow the pH readings to stabilize. Monitor the pH readings and enter the pH value that is being recorded by the hydrolab.

**3.** Grab a bucket of local seawater (or fresh water if up a tidal river). Put the hydrolab unit in the bucket and let it equilibrate. In order to ensure proper flow across the oxygen membrane, keep the hydrolab moving slowly in the bucket. Monitor the hydrolab readings for several minutes until temperature, salinity and dissolved oxygen have stabilized.

**4.** Determine the temperature, salinity and dissolved oxygen of the water in the bucket using a thermometer, refractometer and YSI meter, respectively. (Be sure the YSI probe has stablized and the meter is set to the proper salinity). Enter these values into the data sheet that appears in the upper half of the computer screen. At the same time, monitor the hydrolab readings and record these temperature, salinity and dissolved oxygen.

Acceptable differences are:

Dissolved Oxygen - 1 mg/l
Temperature - 2 degrees C
Salinity - 2 ppt
pH - 0.5 units

The computer calculates the differences and gives error messages if any of the above differences are exceeded.

## 7.0 HYDROLAB'S LoFlow DO MEMBRANE

Every time a DataSonde unit is serviced (every 10 days) the LoFlow DO membrane must be replaced. Calibration of the probe must not be performed for at least 12 hours after replacement of the membrane. During long-term storage of a Hydrolab, the oxygen electrolyte should be removed and a dry membrane put over the oxygen sensor.

**1.** Remove the white DO sensor guard and the O-ring securing the clear Teflon

membrane.

**2.** Remove the old membrane and gently shake out the old electrolyte fluid. Rinse sensor with deionized water then with fresh electrolyte. Shake out the old electrolyte and clamp the unit in the inverted position for easier handling. Refill the probe with fresh electrolyte (fill sensor until there is a perceptible meniscus of electrolyte rising above the entire electrode surface of the sensor). Rap the sonde housing firmly with a hard object (like a screw-driver handle) to release any bubbles trapped on the inner wall of the oxygen probe.

**3.** Cut a square piece of LoFlow membrane about 1.5" x 1.5" (big enough to cover the probe end and leave extra membrane). Place the membrane on top of the electrolyte meniscus, being careful not to trap any bubbles underneath.

**4.** Set the O-ring on the membrane above the probe, and using your thumb and index finger, roll the O-ring down over the probe until it is seated. Try not to touch the membrane surface while doing this. Gently tug at the exposed corners to remove any wrinkles, then trim away any excess membrane below the O-ring and replace the white DO sensor guard. Inspect the membrane to make sure there are no bubbles, wrinkles, or cuts.

**5.** Put the storage cup back on with fresh tap water, and allow the membrane at least 12 hours before calibration.

## 8.0 BATTERY PACK INSTALLATION AND REPLACEMENT

**1.** Clean the entire transmitter with soapy water and a soft brush.

**2.** Once cleaned and properly dried, remove the two hex head Allen screws that hold the battery pack on to the transmitter housing located at the top (6 prong end) of the unit.

**3.** Grasp the battery pack and, with a slight back-and-forth twisting motion, pull it from the transmitter tube.

**4.** Once the battery pack is free of the housing, gently pull the wiring loose from the connector inside the housing.

**5.** Turn over the battery pack and remove the two large hex head Allen screws that hold the battery pack together. Remove and properly discard the spent batteries.

**6.** Install 10 new AA alkaline batteries, paying close attention to the polarity of the batteries and the battery pack.

**7.** Reassemble the battery pack.

**8.** Carefully examine the O-rings sealing the top of the DataSonde. Replace these if any nicks or deterioration are noted. Make sure that the surfaces of the battery pack and the inside of the DataSonde walls are clean and free of debris.

**9.** LIGHTLY coat the O-rings with silicone grease, reconnect the wiring (being careful to note the orientation of the prongs) and re-install the battery pack.

**10.** Connect the DataSonde to the computer. Momentarily disconnect it from external power to make sure that the internal batteries are operating properly. Observe the battery voltage readings, they should be followed by an "&", indicating the unit is being powered by the internal battery pack.

## 9.0 FIELD REPLACEMENT OF PROBES / MERCURY BATTERIES

If the temperature, pH, DO, or conductivity probes become obviously damaged or fail completely, it will be neccessary to replace the entire probe unit. Replacing the probes is a last resort, to be done only after all other methods to fix the problem have been tried. If the DO probe fails to calibrate, or exhibits large changes in apparent oxygen concentration just after the DataSonde is turned on, it may be neccessary to replace the polarizing batteries. The general instructions for replacing the DataSonde probes and/or DO batteries are as follows:

**1.** Remove the two hex head screws at the bottom (probe end) of the unit, and gently pull the probe end from the housing with a back-and-forth twisting motion.

**2.** Disconnect the rectangular battery/data connector from one of the interior boards. This is the connector with the multicolored wires running all the way to the top of the housing. Release the two black latches over the connector by swinging them down, then pull the connector away from the board. You can now set the housing aside. [At this point if you are just replacing the DO batteries, remove the old batteries and install the new ones. Be careful to observe the correct polarity, and use only mercury 2.7 volt batteries. Reassemble the DataSonde using proper precautions with the O-rings.]

## A. TEMPERATURE / CONDUCTIVIITY / DO PROBE (T/C/DO)

**1.** To remove the T/C/DO probe, first pull out the white paper-like connection strip where it slides into the small rectangular blue jumper between the mercury batteries. NOTE that the strip has a half-twist in it; this is the correct orientation for re-attaching the strip when you are putting the unit together again.

**2.** Next, remove the T/C/DO probe cable from the board in the same manner that you released the Data/Battery cable (release the black latches and pull the connector out).

**3.** Release the retaining ring over the end of the T/C/DO. Use a pair of needle-nose pliers to pop this ring off.

**4.** Grasp the T/C/DO probe and pull it firmly down and out from the end cap. The data cable and connector will slide through the hole.

**5.** Reverse this procedure to replace the probe unit, first making sure that the O-rings on the new probe are lightly greased and free of dirt or cuts.

**6.** Reassemble the DataSonde with the new T/C/DO probe by reversing steps A-D.

## B. pH PROBE

**1.** Remove the phillips head retaining screw and washer on the inside of the endcap, just offset from the bottom of the pH probe.

**2.** Firmly pull the pH probe up into the housing.

**3.** With a small flathead screwdriver, release the two wires attaching the pH probe to the green screw-down strip on the board (the black cable attaches to the 'pH' connection, and the thin black-and-white cable goes into the 'shld' connection).

**4.** Reassemble the DataSonde with a new pH probe by reversing steps A-C. Make sure the three small O-rings are on the pH probe, and that they are lightly greased.

**5.** Before completely reassembling the DataSonde, reattach the data/battery cable, and make certain that you can establish communications with the computer. If you cannot, double check all your connections and battery voltages.

# APPENDIX J

# OPERATION OF THE YSI MODEL 58

# AND MODEL 57 DISSOLVED OXYGEN METERS

YSI Model 58 and Model 57 Dissolved Oxygen Meter and Probe

The YSI will be used to take oxygen measurements from surface water and from bottom water collected in a GO-FLO bottle. In addition, the YSI will be used for a bucket QC check of the HydroLab. The following sections detail the maintenance and operation of the YSI Model 58 and Model 57 Dissolved Oxygen Meter. The Model 58 will be the standard field unit for each crew, but will be replaced by a Model 57 if a field unit becomes disabled.

## 1.0 INITIAL SETUP OF THE YSI

1. The YSI Model 58 has two separate sets of batteries, one for the oxygen meter and the other for the stirrer. Both sets consist of 4 D-size Alkaline batteries. These are accessed by removing the four screws on the back panel then carefully pulling the meter back away. The upper battery holder is for the oxygen meter, the lower holder for the stirrer batteries. Note that the stirrer batteries will probably require more frequent replacement, whereas the meter batteries will most likely last throughout the entire field season. Observe correct polarity whenever changing batteries in either holder.

2. When the YSI meter batteries are low, the LOWBAT warning will show **continuously** on the display (the LOWBAT warning may flash momentarily as the meter knob is turned off, but this is normal). The initial appearance of LOWBAT indicates about 50 hours of meter battery life. The normal life for the meter batteries is about 1000 hours.

   To check the YSI stirrer batteries, turn and hold the STIRRER knob to the BATT CHK position. If the LOWBAT warning shows **continuously** on the display then the stirrer batteries should be changed. The initial appearance of the LOWBAT warning in the BATT CHK position indicates 5 hours or less of stirrer battery life. The normal life for the stirrer batteries is about 100 hours.

3. While the meter is still open, observe the position of the sliding switch in the upper right hand corner of the meter. This switch sets the meter sensitivity for the type of membrane on the oxygen probe. The switch should be in the middle position, set for a 1 mil ("standard") membrane.

4. Close the meter housing and gently tighten the corner screws. DO NOT OVER TIGHTEN these screws, as they are easily stripped. As you close the meter, work the rubber gasket so that the outer edge overlaps both halves of the housing.

## 2.0 CHANGING THE YSI PROBE MEMBRANE

The procedure for changing the YSI probe membrane is similar to that for the HydroLab membrane. However there are some differences, so it's important to be familiar with both procedures. The YSI membrane should be changed roughly every 2-4 weeks. Visual inspection is the best indication of when to change the membrane: if the membrane is fouled, wrinkled, cut, has bubbles underneath it, or the gold cathode is tarnished...then it's time. Try to schedule membrane replacement at the end of a field day, or the night before. This allows the membrane more time to "relax" and equilibrate.

**1.** Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.

**2.** Unscrew the sensor guard, and remove the O-ring and membrane. Rinse the sensor with distilled water and then with electrolyte. Gently wipe the gold cathode ring with a kim-wipe or paper towel.

**3.** Fill the sensor with electrolyte. If you're a "rightie", grasp the sensor in your left hand with the pressure compensating vent to the right. Successively fill the sensor body with electrolyte, then pump the diaphragm with the ERASER end of a pencil or with some similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. Tap the sensor with the pencil to free any bubbles trapped on the sides.

**4.** Remove a membrane from the "standard membrane" package (DO NOT use the HydroLab membranes - they are different). Secure the membrane under your left thumb. Add a few more drops of electrolyte to the sensor to form a meniscus over the gold cathode.

**5.** With the thumb and forefinger of your other hand, grasp the free end of the membrane.

**6.** Using a continuous motion, stretch the membrane UP, OVER, and DOWN the other side of the sensor. Stretching forms the membrane to the contour of the probe.

**7.** Secure the end of the membrane under the forefinger of the hand holding the probe.

**8.** Set the O-ring on the membrane above the probe, and using your thumb and index finger, roll the O-ring down over the probe until it is seated. Try not to touch the membrane surface while doing this. Gently tug at the exposed corners to remove all wrinkles, then trim away the excess membrane below the O-ring and

replace the sensor guard. Inspect the membrane to make sure there are no bubbles, wrinkles, or cuts.

**9.** The probe should be stored in the open-ended plastic bottle provided for that purpose. Moisten the sponge or paper towel in the end of the storage bottle to prevent the membrane from drying out.

## 3.0 CALIBRATION OF THE YSI OXYGEN METER

The YSI should be calibrated before sampling at EACH station, and the meter and attached probe should be turned on for **at least 15 minutes** prior to calibration or sampling. In practice this means turning the meter on at the beginning of the day and leaving it on (with the possible exception of very long transit periods between stations). On field days when the probe is not being used leave the meter in the % switch positions (or, in the case of the model 57, in the 0-10 MG/L position).

The digital YSI model 58 will be the standard oxygen meter on the EMAP boats. In the event of a disabled model 58, the field replacement will be the analog model 57. For this reason, differences in the calibration procedures of both units are noted here.

CALIBRATION OF YSI MODEL 58 (DIGITAL)

**1.** Calibration will be done in the probe storage bottle. Confirm that a moist piece of towel or sponge is present in the bottle. Remove any water droplets from the membrane surface by drying with the corner of a paper towel. Insert the probe in the storage bottle and set aside away from direct sunlight. (This is to ensure that the probe is in thermal equilibrium with the surrounding air.)

**2.** Set the function switch to ZERO, and when the display reading has stabilized, readjust display to read 0.00.

**3.** Reset the function switch to % mode. When the display reading has stabilized, unlock the O2 CALIB control locking ring and adjust the display to read 100%. Relock the locking ring to prevent inadvertent changes. Avoid exposing the calibrated probe to large thermal changes, such as from direct sunlight or lying on a hot deck.

CALIBRATION OF YSI MODEL 57 (ANALOG)

**1.** As above for the model 58, perform calibrations in the probe storage bottle.

**2.** Set the middle function switch to RED LINE, then adjust the red line knob so that the needle is lined up with the red line on the meter faceplate.

**3.** Set the middle function switch to ZERO, then adjust the zero knob so that the needle is lined up with the 0 reading on the meter faceplate.

**4.** Confirm that the SALINITY switch is set to 0. Set the middle function switch to TEMP, then record the probe temperature reading.

**5.** Find the oxygen saturation table on the back of the meter and look up the saturation value for the temperature you just recorded. Set the middle function switch to the 0-10 MG/L position, and adjust the CALIB knob to read the oxygen saturation value from the table. Be careful to use the correct scale when setting the calibration or reading the meter. The meter is now calibrated.

## 4.0 OPERATION OF THE YSI OXYGEN METER

In general the YSI will be used to confirm the proper operation of the HydroLab and CTD.

**1.** Calibrate the YSI (See above; section 3.0 CALIBRATION OF THE YSI OXYGEN METER).

**2.** Remove the storage bottle and the sensor guard, and CAREFULLY screw the probe into the stirrer. The probe membrane should NOT touch the stirrer blades. Membrane damage occurs most often when the probe is being inserted or removed from the stirrer. If a measurement isn't to be taken immediately, wrap the stirrer-probe unit in a moist towel and set it out of the sun.

**3.** Set the function switch to 0.01 MG/L mode (for the model 57 set to the 0-10 MG/L scale).

**4.** To preform the bottom dissolved oxygen check of the CTD do the following:

**A.** Collect a bottom water sample in the GO-FLO bottle.

**B.** Draw out a small sample from the bottle and measure the salinity using the refractometer. Set the SALINITY switch to this value, and record the salinity on the **"CTD CAST DATA SHEET"**.

**C.** Insert the stirrer-probe unit into the GO-FLO bottle and turn the stirrer ON.

**D.** When the meter reading has stabilized, record the oxygen value on the **"CTD CAST DATA SHEET"**.

**E.** Remove the probe, turn the stirrer OFF, rinse the probe with freshwater, replace the storage bottle, and store the unit out of sunlight.

**4.** In the mobil lab, preform the HydroLab pre- and post- deployment QC oxygen checks as follows:

**A.** If the bucket is freshwater, set the SALINITY switch to 0. If you are using seawater, take a refractometer reading and set the SALINITY switch to the appropriate value.

**B.** Place the stirrer-probe unit into the same bucket of water that the HydroLab is in, and turn the stirrer ON.

**C.** When the meter reading has stabilized, record the YSI oxygen values on the **"HYDROLAB DEPLOYMENT QC AND SET-UP LAB DATA SHEET"** or the **"HYDROLAB RETRIEVAL QC LAB DATA SHEET"**.

## 5.0 YSI MOBIL LAB QC CHECK

A QC check of the YSI will be preformed once each sampling cycle. This should be done before the CTD QC check, since the YSI is used to QC the CTD. YSI QC data should be recorded on the **CTD/YSI QC DATA SHEET**. This information MUST also be transfered to the computer, and should be done immediately following the CTD QC check (see appendix X, section 3.0).

**1.** Air calibrate the YSI as outlined above (see section 3.0 CALIBRATION OF THE YSI OXYGEN METER).

**2.** Bubble a bucket of freshwater for at least 15 minutes to allow it to become air saturated. Put the calibrated YSI stirrer-probe unit into the bucket and turn the stirrer ON. The SALINITY switch should be set to 0.

**3.** When the meter has stabilized, record the YSI oxygen and temperature readings.

**4.** Insert a thermometer into the bucket and record the ambient water temperature.

**5.** Siphon a water sample from the bucket into a BOD bottle, and do a Winkler titration on the sample (see appendix X.X, section X.X). (NOTE: As part of the

titration process, the thiosulfate should be calibrated.) Record the Winkler oxygen value.

**6.** Tolerances for passing the YSI QC check are as follows:

- Temperature: +/- 2 C
- Oxygen: +/- 0.5 ppm

If a YSI fails to pass any of the QC checks, repeat the above procedures one time. If the YSI still fails, change the probe unit and try again. Repeated failure with a new probe unit may indicate that the YSI meter is bad. Contact Sue Cielenski at the FOC immediately.

## *Oxygen Solubility in Seawater*

(values in mg/l)

| Temp. (°C) | *Salinity (ppt)* 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 14.62 | 14.12 | 13.64 | 13.17 | 12.71 | 12.28 | 11.85 | 11.45 | 11.05 |
| 1 | 14.22 | 13.73 | 13.27 | 12.82 | 12.38 | 11.96 | 11.55 | 11.15 | 10.77 |
| 2 | 13.83 | 13.36 | 12.91 | 12.48 | 12.06 | 11.65 | 11.26 | 10.88 | 10.51 |
| 3 | 13.46 | 13.01 | 12.58 | 12.16 | 11.75 | 11.36 | 10.98 | 10.61 | 10.25 |
| 4 | 13.11 | 12.67 | 12.26 | 11.85 | 11.46 | 11.08 | 10.71 | 10.35 | 10.01 |
| 5 | 12.77 | 12.35 | 11.95 | 11.55 | 11.18 | 10.81 | 10.45 | 10.11 | 9.77 |
| 6 | 12.45 | 12.04 | 11.65 | 11.27 | 10.91 | 10.55 | 10.21 | 9.87 | 9.55 |
| 7 | 12.14 | 11.75 | 11.37 | 11.00 | 10.65 | 10.30 | 9.97 | 9.65 | 9.34 |
| 8 | 11.84 | 11.47 | 11.10 | 10.74 | 10.40 | 10.07 | 9.74 | 9.43 | 9.13 |
| 9 | 11.56 | 11.19 | 10.84 | 10.50 | 10.16 | 9.84 | 9.53 | 9.22 | 8.93 |
| 10 | 11.29 | 10.93 | 10.59 | 10.26 | 9.93 | 9.62 | 9.32 | 9.02 | 8.74 |
| 11 | 11.03 | 10.68 | 10.35 | 10.03 | 9.72 | 9.41 | 9.12 | 8.83 | 8.56 |
| 12 | 10.78 | 10.44 | 10.12 | 9.81 | 9.51 | 9.21 | 8.93 | 8.65 | 8.38 |
| 13 | 10.54 | 10.21 | 9.90 | 9.60 | 9.30 | 9.02 | 8.74 | 8.47 | 8.21 |
| 14 | 10.31 | 9.99 | 9.69 | 9.39 | 9.11 | 8.83 | 8.56 | 8.30 | 8.05 |
| 15 | 10.08 | 9.78 | 9.49 | 9.20 | 8.92 | 8.65 | 8.39 | 8.14 | 7.89 |
| 16 | 9.87 | 9.58 | 9.29 | 9.01 | 8.74 | 8.48 | 8.22 | 7.98 | 7.74 |
| 17 | 9.67 | 9.38 | 9.10 | 8.83 | 8.57 | 8.31 | 8.06 | 7.82 | 7.59 |
| 18 | 9.47 | 9.19 | 8.92 | 8.65 | 8.40 | 8.15 | 7.91 | 7.68 | 7.45 |
| 19 | 9.28 | 9.01 | 8.74 | 8.48 | 8.24 | 8.00 | 7.76 | 7.53 | 7.31 |
| 20 | 9.09 | 8.83 | 8.57 | 8.32 | 8.08 | 7.85 | 7.62 | 7.40 | 7.18 |
| 21 | 8.92 | 8.66 | 8.41 | 8.17 | 7.93 | 7.70 | 7.48 | 7.26 | 7.05 |
| 22 | 8.74 | 8.49 | 8.25 | 8.01 | 7.79 | 7.56 | 7.35 | 7.13 | 6.93 |
| 23 | 8.58 | 8.34 | 8.10 | 7.87 | 7.64 | 7.43 | 7.22 | 7.01 | 6.81 |
| 24 | 8.42 | 8.18 | 7.95 | 7.73 | 7.51 | 7.30 | 7.09 | 6.89 | 6.69 |
| 25 | 8.26 | 8.03 | 7.81 | 7.59 | 7.38 | 7.17 | 6.97 | 6.77 | 6.58 |
| 26 | 8.11 | 7.89 | 7.67 | 7.46 | 7.25 | 7.05 | 6.85 | 6.66 | 6.47 |
| 27 | 7.97 | 7.75 | 7.54 | 7.33 | 7.12 | 6.93 | 6.74 | 6.55 | 6.37 |
| 28 | 7.83 | 7.61 | 7.40 | 7.20 | 7.00 | 6.81 | 6.62 | 6.44 | 6.26 |
| 29 | 7.69 | 7.48 | 7.28 | 7.08 | 6.89 | 6.70 | 6.52 | 6.34 | 6.16 |
| 30 | 7.56 | 7.35 | 7.16 | 6.96 | 6.77 | 6.59 | 6.41 | 6.24 | 6.07 |
| 31 | 7.43 | 7.23 | 7.04 | 6.85 | 6.66 | 6.48 | 6.31 | 6.14 | 5.97 |
| 32 | 7.31 | 7.11 | 6.92 | 6.74 | 6.56 | 6.38 | 6.21 | 6.04 | 5.88 |
| 33 | 7.18 | 6.99 | 6.81 | 6.63 | 6.45 | 6.28 | 6.11 | 5.95 | 5.79 |
| 34 | 7.07 | 6.88 | 6.70 | 6.52 | 6.35 | 6.18 | 6.02 | 5.86 | 5.70 |
| 35 | 6.95 | 6.77 | 6.59 | 6.42 | 6.25 | 6.09 | 5.93 | 5.77 | 5.62 |
| 36 | 6.84 | 6.66 | 6.49 | 6.32 | 6.15 | 5.99 | 5.83 | 5.68 | 5.53 |
| 37 | 6.73 | 6.55 | 6.38 | 6.22 | 6.06 | 5.90 | 5.75 | 5.60 | 5.45 |
| 38 | 6.62 | 6.45 | 6.28 | 6.12 | 5.96 | 5.81 | 5.66 | 5.51 | 5.37 |
| 39 | 6.52 | 6.35 | 6.19 | 6.03 | 5.87 | 5.72 | 5.58 | 5.43 | 5.29 |
| 40 | 6.41 | 6.25 | 6.09 | 5.94 | 5.78 | 5.64 | 5.49 | 5.35 | 5.22 |

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# APPENDIX K

# DATA SHEETS

# APPENDIX L

# OPERATION OF THE SAIC EDAS

This appendix details the use of the SAIC EDAS (Environmental Data Acquisition System).

## 1.0 SET UP COMPUTER AND CONFIGURE GPS

**1.** The computer should be configured with the LORAN data cable in COM4 and the GPS data cable in COM3.

**2.** BEFORE starting the navigation system on the computer, the LORAN and GPS receivers should be powered up and operating correctly.

**3.** The following steps outline the initialization and use of the Raytheon GPS receiver. Initialization normally needs to be done only once, but it is a good idea to at least check the initialization parameters at the beginning of each sampling cycle.

**GPS INITIALIZATION**

**A.** Turn the GPS on and set the position switch to the INIT mode. To scroll through the parameters without resetting them, use the <ENTER> key. A flashing parameter can be set by hitting the appropriate numeric keys.

**B.** Set your approximate current position (within about 1 nm). Enter the values as DD MM.mm (degrees and decimal minutes). Make sure the Lat/Long values scroll all the way across the screen, and enter any terminating zeros in the values. While entering the Lat/Long, confirm that the correct hemisphere is displayed next to the number (should be W and N). If not, change the hemisphere with the <+> and <-> keys. Press <ENTER> when finished with each value.

**C.** Set the time. This is in GMT (Greenwich Mean Time) which is 4 hours ahead of our time (therefore if your current local time is 13:00 hours, GMT will be 17:00 hours). Set the date, using the format YYMMDD, and entering any zeros as needed. (Note the unusual format of the date value, and be careful to enter it correctly. Also be aware that if you are initializing the unit after 20:00 hours local time, the date will be the NEXT day in GMT.) Enter the local time offset from GMT, which in our case is -4.00 hours. Press <ENTER> when finished with each value.

**D.** Set the antenna height, using an approximate value of 3 meters. Press <ENTER> when finished.

**E.** Once the initialization parameters are set to your satisfaction, turn the position switch to the SAT mode. The GPS should remain in this mode throughout the day.

## GPS USE AND STATUS

**A.** Following initialization, the GPS receiver will acquire and download tracking information from all currently available satellites. The time it takes for this process to happen will vary, but should be no longer than about 15 minutes.

**B.** The status display of the GPS will provide you with a variety of information. See the GPS manual for the display format. Individual satellite information can be cycled through by pressing the <#> key.

The GPS display parameters are as follows:

- Satellite number: the number of the satellite for which information is displayed.

- Status: status of the satellite. 0 = searching, 1 = tracking, 2 = data download from satellite complete.

- Received Signal Level: the strength of the satellite signal. The higher the better.

- Azimuth Angle: angle on the horizon (0 = north) of the satellite.

- Elevation Angle: elevation above the horizon of the satellite. A satellite below 5 degrees will be tracked (but not accepted) by the GPS until its height is adequate.

- Normal Satellites: the number of normal satellites currently in operation.

- Dilution of Precision (DOP): this is a statistic representing the quality of the position information being output to the computer. It is most important to observe the DOP, since the higher the value the more degraded the position solution. For system calibration, DOP should be LESS THAN 5, for navigation with the LORAN and GPS on-line, DOP should be LESS THAN 10. If DOP is greater than 10, the GPS should be taken off-line from the navigation system.

- Visible Number of Satellites: the total number of satellites currently visible to the receiver.

- Satellite Numbers used for Position Fix: these start as two lines of

4 dashes. They are replaced by the satellite numbers being tracked, as the satellites are acquired. Note that these numbers will only be displayed if 3 or more satellites are being tracked.

**C.** If the satellite coverage is currently not sufficient to provide position information, the time window when coverage will be adequate can be checked. To do this press the <CHNG> key twice. The bottom of the display will show the time window when coverage will be available for a 2-dimensional solution. These times will be in your LOCAL time.

**D.** The EDAS system is configured to OUTPUT position information in the North American 1983 (NAD-83) datum. However, it expects that the INPUT from the GPS will be in the WGS-72 datum. Therefore the GPS datum must be set to WGS-72. Do this by turning the position switch to LAT/LONG. Press the <CHNG> key twice. Press the <#> then <5> to change the GPS datum to WGS-72. The datum need only be set once - it will be saved in memory, even after the GPS has been turned off.

## 2.0 EDAS CALIBRATION

The EDAS is capable of two types of calibration, SYSTEM and POINT. SYSTEM calibration uses the GPS position to generate calibration factors for the LORAN. POINT calibration also creates calibration factors for the LORAN, but requires the boat to be positioned at a fixed point with known coordinates (such as a buoy or lighthouse). Whenever GPS satellite coverage is available, SYSTEM calibration is the preferred method. POINT calibration should be used only when GPS position data is not available. For both types of calibration, the boat should be stationary and preferably tied to a dock.
The LORAN Cal Factors generated by either method are generally good for a radius of 20-30 nm, provided there is no strong interference with the LORAN signals.

For either calibration the LORAN receiver should be using the two slaves that provide the strongest signals and optimum LOPs. The receiver should also be set so that it DOES NOT automatically select chains (otherwise the unit might later switch over to a slave that did not have Cal Factors). See the LORAN manual for instructions on selecting chains.

### SYSTEM CALIBRATION

**1.** Confirm that the navigation system is getting LORAN and GPS data from the receivers. Do this by pressing <Ctrl F10>, then typing "DTCLDP" to display the LORAN telegram. Check the GPS telegram by pressing <Ctrl F10> and typing "DTCGDP". If

both the LORAN and GPS are outputting data, select **"Navigate to Station"** from the main menu.

**2.** Select **"Kalman Filter"**, and turn BOTH the GPS and the LORAN C **OFFLINE**. This is done by moving to each item and pressing <RETURN>. <ESC> back to the EDAS menu.

**3.** Select **"Positioning Systems"**. The GRI should be 9960. Select **"Calibrate"**, then select **"Reset"**, and answer <Y> to reset. <ESC> and answer <Y> to save the cal factors (this will save the zeroed out cal factors). <ESC> back to the EDAS menu.

**4.** Select **"Kalman Filter"** again, and turn the GPS **ONLINE**. Leave the LORAN OFFLINE. <ESC> back to the EDAS menu.

**5.** Select the **"Positioning System"** again, and select **"Calibrate"**. Press <F2> twice, to display the bias and TD's for each LORAN chain. These will update continuously. When the bias becomes stable then the system can be calibrated.

**6.** Select **"System Calibration"**. Answer <Y> to calibrate. Record the 2 Cal Factors for the LORAN chains being used. Press <ESC> and answer <Y> to save the Cal Factors. At this point the Cal Factors will be applied to the LORAN data. Press <ESC> to return to the EDAS menu.

**7.** Select **"Kalman Filter"**, and turn the LORAN C **ONLINE**. Leave the GPS ONLINE. <ESC> back to the EDAS menu. The system is now ready to navigate using both calibrated LORAN and GPS. (NOTE: Read the "IMPORTANT CALIBRATION NOTES" below.)

## POINT CALIBRATION

The point calibration should only be used when the GPS data is not available, or the DOP is above 5. The following discussion assumes that 1) the boat has been navigated to a known position (a buoy, lighthouse, etc.), and 2) the datum of this position is NAD-83 (or WGS-84) coordinates. To convert WGS-72 chart data to the NAD-83 datum, see Section 3.0 DATUM CONVERSION USING THE GEODETIC UTILITIES.

**1.** Confirm that the navigation system is getting LORAN data from the receiver. Do this by pressing <Ctrl F10>, then typing "DTCLDP" to display the LORAN telegram. If the LORAN is outputting data, select **"Navigate to Station"** from the main menu.

**2.** Select **"Kalman Filter"**, and turn BOTH the GPS and the LORAN C **OFFLINE**. This is done by moving to each item and pressing <RETURN>. <ESC> back to the EDAS menu.

**3.** Select **"Positioning Systems"**. The GRI should be 9960. Select **"Calibrate"**, then select **"Reset"**, and answer <Y> to reset. <ESC> and answer <Y> to save the cal factors (this will save the zeroed out cal factors). <ESC> back to the EDAS menu.

**4.** Select **"Kalman Filter"** again, and turn the LORAN **ONLINE**. Leave the GPS OFFLINE. <ESC> back to the EDAS menu.

**5.** Select the **"Positioning System"** again, and select **"Calibrate"**. Enter the Latitude and Longitude of your known position. Select **"Point Calibration"** and press <SPACE> to begin the averaging. When the average Cal Factors stabilize, press <SPACE> to stop the averaging. Record the 2 Cal Factors for the LORAN chains being used in the navigation log. Press <ESC> and answer <Y> to save the Cal Factors. At this point the Cal Factors will be applied to the LORAN data. Press <ESC> to return to the EDAS menu.

**6.** The system is now ready to navigate using only the calibrated LORAN. (NOTE: Read the "IMPORTANT CALIBRATION NOTES" below.)

**IMPORTANT CALIBRATION NOTES**

Be aware that the GPS will ALWAYS output navigation data to the EDAS, regardless of the quality of that data. Therefore if the DOP goes high, or satellites are lost, the position information coming into the EDAS will not be good.

** It is up to you, the operator, to determine the quality of the GPS reception. **

Some rules of thumb:

If the DOP is low-to-moderate (less than 10), and the time window for coverage spans the period you will be sampling, and the LORAN reception is good, then use both the GPS and calibrated LORAN to navigate. (Both GPS and LORAN **ONLINE** in the Kalman Filter.)

If the GPS coverage window is small (i.e. the satellite coverage will not be adequate the whole time you are on the water) or the DOP is high (greater than 10), then navigate with just the calibrated LORAN. (GPS **OFFLINE** and LORAN **ONLINE** in the Kalman Filter.)

If the GPS coverage is good but the LORAN reception is not, then navigate with the GPS alone. (GPS **ONLINE** and LORAN **OFFLINE** in the Kalman Filter).

## 3.0 DATUM CONVERSION USING THE GEODETIC UTILITIES

When doing a POINT calibration of the LORAN, it is necessary to read your position from a chart. If the chart coordinates are in WGS-72 or NAD-27 (North American 1927) they need to be converted to the NAD-83 (North American 1983) datum. To convert Lat/Longs between datums, use the Geodetic Utilities as follows:

**1.** From the EDAS menu select **"Geodetic Utilities"**, and then select **"Datum Conversion"**.

**2.** **"Datum 1"** is the datum you are converting FROM (i.e. the chart datum). Press <RETURN> to scroll through the available datums.

**3.** **"Datum 2"** is the datum you are converting TO. You should always select **"North American 1983"** (NAD-83). Press <RETURN> to scroll through the available datums.

**4.** **"Latitude 1"** is the latitude you are converting FROM. Press <RETURN>, enter the latitude, and press <RETURN> again. Repeat this process with **"Longitude 1"**. Each time a value is entered the screen will update.

**5.** The converted Lat/Longs are **"Latitude 2"** and **"Longitude 2"**. Record these values, and use them as the latitude and longitude entries for the POINT calibration.

# APPENDIX M

# USE AND MAINTENANCE OF

# BARCODE WANDS, LASER GUNS AND DECODERS