SOP-3

Field Procedures

Chlorophyll Sampling **Profiling**

DCP/ Buoy Maintenance **Sonde Swap**

Field Notes **Toolbox & Field box Setup**

****Field procedures may vary from site to site. It is up to the technicians. These steps are to be used as a guide for field sampling & field maintenance.**

<u>**DCP & Buoy Field Procedures**</u>

Prior to Field Maintenance:

1. Back up text and dat files from each site on disc. Back-up all configuration files on to A:/drive. Put configuration file disc in field laptop case.
2. Check battery power on field laptop and marine field battery.
3. Make sure direct connect cable, battery power adapter cable, DCP manual, and antenna-testing cable are in field laptop case.

Field Maintenance Prior to Departure:

1. Double checks to make sure the latest files were transmitted to the receiving computer.
2. Check data for any malfunctions
3. Double check weather (winds < 15kt for sonde swap only. If direct connection to DCP is required for troubleshooting problems or data download then winds should be < 10kt) Must have no precipitation to direct connect to DCP or break DCP seal for troubleshooting problems.
4. Double check field laptop case for direct connect cable, battery power adapter cable, and antenna testing cable.
5. Be sure to grab back up marine field battery to power laptop &/ or boat.
6. Bring a towel or cloth to cover screen of laptop. Plastic bags are also handy to keep connections dry.
7. Pack new desiccant, rubbing alcohol, and vacuum grease in field gear. Just in case seal of DCP canister needs to be broken and resealed in the field (troubleshooting problems only).

Field Maintenance at Buoy Site:

1. Tie up to site using eyebolts. Tie up on the down current side it makes it easier to work and causes less potential damage to the buoy.
2. Document tie up time in field notebook. Notes on GPS location weather tides, technicians, etc.
3. Check buoy for any visible damage or vandalism. Check for excessive rust around connectors. Beacon must be flashing. Inspect solar panels for any damage. Make sure all connectors are free of ice and snow. If water is on the surface of buoy, make sure no bubbles are coming from DCP canister seal.
4. Check connection. Make sure all connections are tight and free of debris. Document and clean any corrosion.

   ****If no damage is visible and no direct connection or troubleshooting is necessary then move on to sonde field procedures**.

Direct Connect for downloading files:

1. Make sure DCP cover is dry. Use towels to keep direct connect port on DCP dry from splashing and mist.
2. Setup laptop with direct connect cable to computer and DCP. Make sure appropriate COM port is chosen. (Generally just COM Port 1 on laptops). Cover connections in plastic if possible. Use dry towel to cover laptop screen to protect it from sun damage.
3. Open *Ecowatch DCP-6200* program and insert configuration file disc into the A:/ drive.
4. From the 6200 pop-down menu choose open file.
5. Choose the A:/ drive and then choose appropriate configuration file.
6. From the 6200 pop down menu choose restore configuration.
7. After restoration is complete, choose interrogate now from the 6200 pop-down menu.
8. Data will appear on the screen. Check each window to make sure data is being logged.
9. At the bottom of the window it will say interrogating until data retrieval is complete.
10. Make sure settings are set for appropriate unattended sampling (cell, radio, direct connect, etc). Then close window and disconnect cable and shut down laptop.

***Tip- keep direct connect and integration window open until after sonde swap. This allows for potential data problems or communication problems to be identified.*

Chlorophyll Field Samples

Prior to Field Maintenance:

1. Assemble all equipment to take in the field. A hand held cooler that can fit ice & a *Rubbermaid* watertight container for supplies is ideal. Desiccant can be placed in rubber maid container to keep filter dry. Be sure to include back ups.
2. Assemble 3 filters per site & be sure to include at least 3 back ups. Prepare clean & dry *Millipore/ Swinnex – 25* (Pat # 3.3863585) by properly install (grid side down) *Whatman* 25mm glass microfibre filters (# 1825 025). Filter should be placed on male end of filter casing using spatula tweezers, then white flat o-ring, and then hand tighten female end to seal for use.
3. Pack filters in a separate *Rubbermaid* watertight container. In a large container, pack clean spatula tweezers, aluminum foil pieces with labels, marker, zip-lock for samples, and a 60 ml syringe for each site.
4. In cooler, include a de-ionized water squirt bottle for cleaning, ice,. 1g $MgCO_3$ + 3g NaCl + 100ml of purified water in a squirt bottle to be used for a preservative.

Field Sampling at Buoy Site:

1. Clean sampling bucket with seawater. Rinse three times after cleaning. Be sure boat engine is off and cleaning away from engine area. Best to clean on the side of the boat opposite buoy & sonde cleaning area.
2. Cast clean bucket into water extending to the end of rope. Best if bucket is face down. Use rope to bring aboard water filled bucket to use for sampling. Be sure to have supplies ready and record time water sample was retrieved & weather conditions. Samples can be filtered in the field or in the lab. The holding time is 6 hours. Filtering my must be conducted within this time frame. Refer to MERL SOP-2 for more detail.

Filtering in the Field (optional based on holding time)-

3. Clean syringe 3 times before attaching filter casing. Fill syringe to 60 ml by over filling & measuring to 60 ml to be sure to rid syringe of air bubbles. Attach filter casing to syringe and steadily force water sample through syringe. Make sure filter casing is not leaking.
4. Detach filter casing. Repeat filling process until at least 60 ml has been filtered. Be sure to filter water away from sample bucket. Between filling swirl syringe in water to mix up sample. Do not put hands or anything else other than syringe in the water sample.
5. After a minimum of 60 ml of water sample has been filtered detach and fill syringe with air. Force air through syringe after reattaching filter casing. Repeat this process 3 times.
6. Store filter casing in cooler. Repeat sampling method 3 times (make sure filter casings are numbered). Record filter sample numbers, amount filtered, and any comments.
7. After all 3 filtered samples have been collected, add 3-5 drops of preservative (*1g $MgCO_3$ + 3g NaCl + 100ml of de-ionized water)* and repeat step 5 for each filter casing.
8. Then loosen casing and tap on deck to release o-ring and filter. Label a piece of aluminum foil for each filter sample. Include date, time, technician initials, filter #, and amount filtered. Make sure spatula is handy and placed in a clean dry area.
9. Use your body as a shield from the wind. Once labeling is completed, take cap (female end) of filter casing and carefully fold over filter using spatula tweezers on male end of casing. DO NOT TOUCH SAMPLE WITH TWEEZERS OR HANDS. If holding of the filter is unavoidable be sure to only touch outer edge (where the o-ring was). Once folded, place filter in aluminum foil using tweezers. Seal aluminum foil and place in zip-lock and store in cooler. Repeat process for all 3 samples.

Return from field maintenance:

1. Place samples in freezer for later analysis. Clean & dry supplies using the triple rinse method. Be sure to rinse in de-ionized water.
2. After triple rinsing of filter casings, store in deionized water for 7-10 days before using again. *Rubbermaid* 235 ml (1cup) container is ideal for 6 filter casings.

Field Profiling Procedures

Prior to Field Maintenance:

1. Check battery power on field handheld (YSI 650) and memory. Pack in waterproof & shockproof container for storage and transport.
2. Make sure direct connect cable, weight for profiling sonde, and cover for YSI 650 screen are packed in field supplies.
   *** YSI 100ft. Field cable (sonde connection & military clip connection for YSI 650) coiled in a round tote with hole cut in for YSI 650 end to pass through. This minimizes kinking of cable and maximizes cable life.*
3. Pack calibrated Profiling sonde and sonde guard.
   (*See Calibration section for calibrating sonde prior to use*)
4. Connect Profiling sonde to field profiling cable. Be sure to seal with silica grease and cable guard clip is attached to Sonde handle. Weight can be tied to guard clip at this point.

Field Maintenance in Route to Site:

1. Place sonde guard on sonde. BE SURE NOT TO HIT SENSORS!
2. Wrap sonde in wet white towels. The towels keeps sensors cool & wet for air saturation reading before deployment.
3. Turn on YSI 650. Connect to sonde by hitting enter key, ↵, when highlighted on Sonde Run option from the YSI 650 main menu. Screen will prompt with a connecting screen. The data will be displayed.
4. Check data to make sure Temperature (C), Specific Conductivity (mS/cm), Salinity (ppt), DO %, DO mg/L, Depth (m), pH, pH (mV), CHL, FS %, and Turbidity.
   *** These parameter are dependent on Sonde type (6600 for CHL & Turb, 6920 for CHL only, and 600XL no CHL or Turb)*
5. From the Top menu use the arrow, ∇, on the keypad to highlight **Start Logging** and hit the enter key, ↵.
6. FILENAME will be highlighted. Enter a filename using the keypad. Then hit the enter key, ↵. File name is only allowed 8characters.
   ***RECOMMENDED To use site Name (3 characters) & date (4charcters format of (mm/dd)) with p for profile at the end.*
7. Then arrow, ▷, over to OK to highlight box and hit enter, ↵. This will start the logging process and give Dissolved Oxygen time to stabilize (about 10 min.).
8. Wrap YSI 650 in protective cover. Over should protect against shock & weather conditions (hot sun, extreme cold, & precipitation). Plastic bag and ski masks work well.

Field Sampling at Site:

1. Record readings at air saturation (recording while sonde wrapped in wet towel).
2. Make sure cable and weight are secure. Then place sonde over board. Make sure sonde is at the surface (water level should be about half way up the sonde).
   ***Make sure sonde is away from engine & opposite from the buoy*
3. Wait 2 minutes and record readings at the surface. Wait longer if dissolved oxygen needs to stabilize.
4. Carefully lower sonde to bottom. Let weight hit the bottom. Pull up a little on cable. You want to position the sonde so that it is about 1 foot from the bottom. Let sonde stabilize for 2 minutes then record readings.
5. After readings recorded raise sonde 1 meter. Let stabilize for 2 minutes then record readings. Continue this process until the sonde is 2-2.5 meters from surface.
6. When sonde is about 2 meters from surface raise .5 meter between readings. Allowing for 2-minute stabilization between readings.
7. Before taking out of the water, record a reading at surface again. This allows determining if the sonde drifted during profiling.
8. Take sonde out of the water. Rinse with tap water. Put sonde cap over guard or wet towel. Let stabilize to record air saturation reading for QA/QC purposes. Then, highlight **stop logging** and hit **enter**. Then hit escape to disconnect from the sonde.

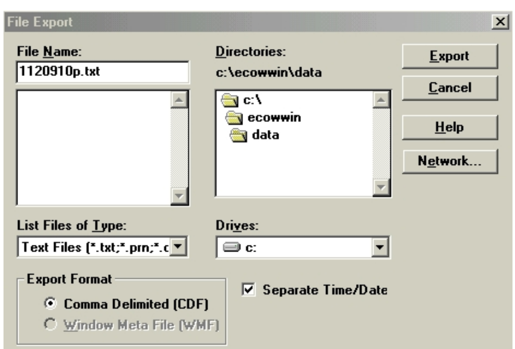
9. Disconnect YSI 650 and store in weatherproof/shock proof container. Make sure covers are over cable connector ends.

Return from field maintenance:

1. Disconnect sonde. Rinse and store sonde.
2. *2.* To download profiles to computer. Need computer cable that direct connects YSI 650 to COM port 1. Turn on YSI 650.
3. Turn on YSI 650 and open *Ecowatch* program. In the Ecowatch program, press the sonde icon, . Then choose COM port 1 option. A # will appear on a blank screen.
4. At this point, all transfers will be accomplished through the keypad on the YSI 650. Choose the FILE option from the MAIN menu. Then choose the UPLOAD TO PC option from the FILE menu. This will open to the directory.
5. Arrow down to the file you want to transfer. Highlight it and hit the enter key,↵.
6. On the PC in the Ecowatch program a File Transfer window will pop up. This window will display the bytes that are being transferred. When complete a smile face,☺, will pop up. The YSI 650 will say TRANSFER FINISHED.
7. To download another file just highlight the file name from the directory and hit enter again. Repeat steps until all files have been transferred.
   ***Always a good idea to transfer files to PC the same day to back up data.*
8. When finished, escape from menu on YSI 650 first and power down unit. Then close out of Ecowatch program. The transferred files can be used in *Ecowatch* or exported into EXCEL.

Importing Profile Files in EXCEL:

1. Open *Ecowatch* program. Choose the Open file icon, . Select the file name and open file.
2. Make sure the file is in chart format by clicking on the chart icon, . From this point make sure appropriate parameters are chosen. If they need to be adjusted, go in though the SETUP option in the taskbar. Choose PARAMETERS and then ADD/REMOVE. Designate the order and what parameters will be transferred into EXCEL. You can also adjust the parameter units if need. This is done by going into SETUP, then PARAMETERS, and then choose UNITS from the pop down menu.
3. Then from the FILE option in the taskbar, choose the EXPORT ▸ to the CDF/WMF… option. This will prompt a File Export Window. Here you want to make sure the file name has a txt extension, is comma delaminated, and is being saved in the proper location on the hard drive.



***Make sure the Date and time are set up the way you want it. They can be put in one column or in separate columns by checking this option on this screen.*

Figure 5-1. Profiling File Export

4. Hit export and the file is ready for use in EXCEL and other comparable programs.

Field Notes Procedures

Day Prior to Field Maintenance:

1. Be sure to use a weatherproof notebook. Preferably 11 ¾ " x 9 ¼ " quad sheets.
2. Make sure to pack back up writing utensils (pens, permanent markers, & pencils).
3. Prep field note book by setting it up with the following headings:

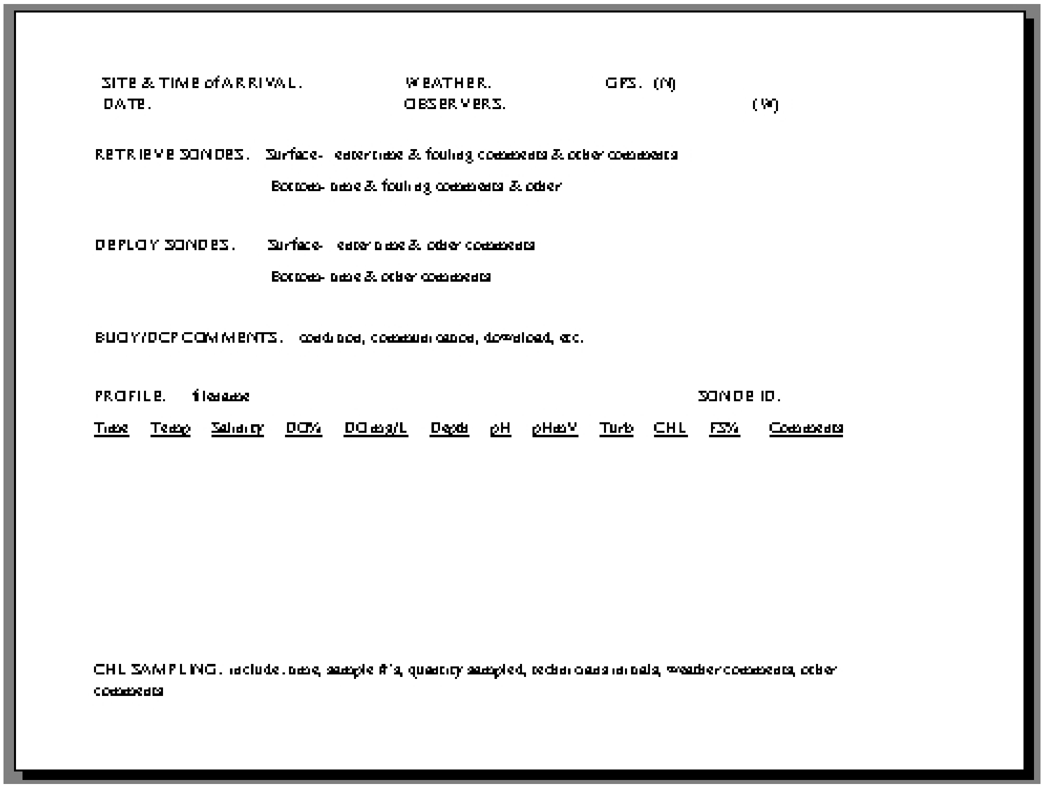


Figure 5-2. Field Notes.

Field Sampling At Buoy Site:

1. Fill in every section by following all field procedures.
2. If for some reason a field procedure is skipped be sure to note why.
3. Always a good idea to have one person to record field notes.
4. In Buoy comment section, if nothing is to report be sure to note: *everything is operational.*
5. **REMEMBER MORE INFO IS ALWAYS BETTER THAN NOT ENOUGH!! GOOD FIELD NOTES ARE FUNDIMENTAL TO GOOD DATA!!**

Sonde Swap Field Procedures

Prior to Field Maintenance:

1. Pack calibrated sondes with guard (including freshly rinsed with tap water sponge) in a carrying bucket. Make sure large enough for all to fit upright & sturdy enough to handle the weight.
2. Label all sondes to prevent confusion in field. Example: S=Surface, B=Bottom, Site name, SDI address & date calibrate (S111, SDI=0, 5/10/03). If more than one technician is calibrating it might be a good idea to put their initials on the label. The best label is electrical tape.
   ***Recommended: different color electrical tape for surface & bottom sondes*
3. Pack towels, rags, soft cloth, toothbrushes, green scrubbies, *Kimwipes*, Q-tips (cosmetic ones are best), o-ring grease, extra sonde caps, 2 spare buckets, & other cleaning brushes.
4. Make sure your toolbox has all the tools to troubleshoot buoy problems and do the sonde swap.
5. Toolbox needs for sonde swap: zipties, sockets 7/16" depending on brackets holding sondes, spare brackets & nuts & bolts, snips, small adjustable wrench, large adjustable wrench/pliers, extra caps, spare shackles, spare bracket holder, electrical tape, ss hose claps, screwdrivers, and WD-40. (see toolbox setup for more info)

Sonde Swap At Buoy Site:

1. It is always a good idea to travel to the site with two technicians. You can divide up the field procedures to reduce time at each site. Weather should be < 15 knots to swap sondes safely.
2. First step is to record the time & weather conditions. Fill a bucket with water. Pull the surface cable. Clip zipties & release shackle to get surface sonde on board. Keep cables attached to instruments.
3. Clean brackets and cables first. The green scrubby is idea for cleaning cables.
4. Disconnect surface sonde (& fluorometer if used) from bracket, but leave connected to cable secure in clean bucket of water to make sure it doesn't go overboard or get damaged. Thoroughly clean bracket. Water may need to be changed if fouled.
5. Be sure to make notes of fouling and other conditions (i.e., wear & tare on cables, brackets, & sonde).
6. Finally, clean then dry cable connection area. Toothbrush & *Kimwipes* are ideal for this task. Release safety clip, then cable to sonde connector. IMMEDIATELY, dry with *Kimwipes* and place caps on both ends.
7. Have newly calibrated and labeled sonde handy. Remove cap. Clean, dry, and apply new o-ring grease to top of new sonde. Make notes of any cable damage. Then connect cable to new surface sonde. Fasten clip to sonde handle.
8. Put new sonde in cleaned bracket & re-secure to buoy. The surface sonde should be attached to the East Side on the buoy.
9. Put retrieve surface sonde in guard cup and place in transport bucket.
10. BE SURE TO NEVER PUT AN UNSECURED SONDE OVER THE SIDE OF THE BOAT!
11. Bottom sonde requires cleaning as rope and cable are being raised. Green scrubby is ideal for the task & insulated gloves. The cable should be ziptied to weighted rope that allows for slack on cable & tension on rope.
12. Be sure to bring cable & rope in boat. If left in the water, it can get tangled around counterweight of the buoy.
13. Follow same instructions for surface sonde cleaning. Slowly lower cleaned sonde, cable, and rope into water. Feel for the anchor hitting the bottom before releasing.
    ***Bottom sonde deployed on West Side. DONOT TANGLE with mooring ropes.*

Suggested Supplies: Toolbox & Field Box

Toolbox Contents:

- Snips, screwdrivers, WD-40, vacuum tester, sockets (7/16, ½), Allen wrench, Allen head bolts for DCP can/ss bucket, bolts for antenna, zipties, o-ring grease, caps, o-rings, DO changing supplies (membranes, KCL solution, utility knife), adjustable wrenches (2 sizes), pliers (2 sizes), seizing wire, bracket fixtures, shackles, electrical tape, duct tape, and lock de-icier.

Field Box Contents:

- GPS, charts, Kimwipes, Q-tips, field notebook, pens, back-up batteries (AA & C), battery tester, back-up configuration discs, *Ziplock* bags, YSI 650, flashlight, back-up beacon flasher, operation manuals, field checklist, cell phone, and float plan w/ contact info.

QA/QC Procedures

YSI data review and editing protocol[1]

1. Introduction

The following document has been prepared to aid users of the YSI 6000/6600 in ascertaining the reliability of the data from their deployments. The primary purpose of the document is to provide guidelines for determining what portions of data records should be included in the overall NERR System-wide Monitoring Program's (SWMP) data logger database, and which should be rejected. The document is designed as a supplement to the recently submitted "Quality Assurance Protocol for YSI 6000 Field Studies" at NERR sites. Our recommendations, which follow, will be dependent on the performance of post deployment sensor performance and drift checks as outlined in the previous document.

This document is clearly not designed to be the final word on the data review and editing issue, but instead to simply be a starting point for consideration, rejection, and modification by the NERR System-wide Monitoring Program as more experience is acquired and more data are generated and processed.

The general philosophy for data acceptance or rejection will be based on absolute and discretionary factors.

*(1) **absolute:** In the first phase of data review and editing, values sometimes can be rejected on the basis of absolute factors via software statements with no detailed analysis of the study by the NERR Research Coordinator (RC) or Data Logger Manager at each site.*

*(2) **discretionary:** These are other instances in which the data must be examined before absolute rejection. In the second phase we are recommending that each deployment study be evaluated at the site for anomalies prior to submission of data for inclusion in the NERR SWMP's water quality data logger database.*

2. Absolute data rejection (1)

The value recorded in the sonde memory is outside the listed range specifications of the instrument.

[1] Produced by Mike Lizotte and John McDonald of YSI Inc. and Ginger Ogburn-Matthews former NERR CDMO data manager. Revised by Tammy D. Small, NERR CDMO manager and Mike Lizotte in 2003.

The following criteria are based on the latest YSI 6-Series Environmental Monitoring Systems Operating Manual sensor specifications in Appendix J and are what the NERR CDMO error checking criteria are based on.

Temperature: -5 to 45 ^{o}C
Specific Conductivity: 0 to 100 mS/cm
Salinity: 0 to 70 ppt
Dissolved Oxygen (% Saturation): 0 to 200 and 200 to 500 % air saturation
Dissolved Oxygen (mg/L): 0 to 20 and 20 to 50 mg/L
Shallow Depth: 0 to 9.1m
pH: 2 to 14 units
Turbidity: 0 to 1000 NTU

Always reject data that are outside of the range of the probes; the only exceptions to the absolute data rejection for out-of-range values are for the Shallow depth and Turbidity probes. These exceptions are explained under their respective headings in this document.

3. Absolute data rejection (2)

Examination of the data record indicates that some or all of the sensors were out of the water due to:

(1) An unexpected tidal fluctuation,
(2) An improperly deployed sonde, or
(3) Times of pre- and post-deployment when transporting the sonde.

An unexpected tidal fluctuation or an improperly deployed sonde: *Usually these situations will be indicated by a* ***very low (near zero) or a very sharp decline in conductivity*** *readings even when the unit is known to be at a site characterized by brackish water. This effect is demonstrated in Figure 1A where it is evident that the water level has dropped below the conductivity sensor on several occasions. In the study associated with Figure 1B, the sonde seemingly came out of the water midway through the study and remained there.*

Reject all of the data in these areas of the data record, not just conductivity/salinity because it is impossible to tell whether the other sensors were in the water at the time of measurement.

Times of pre- and post-deployment when transporting the sonde*: Figure 2 and the beginning of Figure 4 show that the beginning and end (tails) of data (pre- and post-deployment) are not in range of the other readings. Note that the time on the sonde is not always the same as what is on your watch, especially during daylight savings. Remember that any data collection including that of the datasondes should be recorded in standard time only NOT daylight savings time.*

All data should be examined for these types of data, and the tails should be rejected and deleted from the deployment record.

4. Absolute data rejection (3)

All probes will register a value even if there is no sensor installed on the sonde!

This is a situation that cannot be replicated (for example, the motherboard does not always register the same values when the sensors are missing)!

Always delete data for sensors that have not been installed. Always document when you are missing a sensor for each deployment.

5. Other absolute data rejection (4)

In time, experience may indicate other absolute data rejection criteria.

6. Discretionary data rejection

In this part of the procedure, data analysis of all recorded parameters should be carried out by or under the supervision of the site Research Coordinator. If anomalies are observed that data may be marked as an anomaly, left in the data set and documented, or rejected at the discretion of the Research Coordinator and removed from the data file to be submitted to the CDMO ODIS.

Data review and editing should take place as soon as possible after sonde recovery so that the details of the deployment will be fresh in the minds of the site personnel and if anomalies are found, corrective action can be attempted prior to the next deployment. Immediately after recovery of the sonde, both YSI and the CDMO recommend an upload of the data file in the PC6000 format followed by cursory analysis of the data using the plotting function of the YSI-supplied PC6000 software or EcoWatch. This action will provide insight into whether problems occurred with any of the sensors during deployment, which might be grounds for rejection of portions of the data.

All PC6000 files should be archived at the individual sites. These files are basically inviolate since it is unlikely that the average user will have the knowledge to delete any entries from the PC6000 format. Therefore all data records (good and suspect) will be present. Also PC6000 (.dat) files can always be used to export comma-delimited files using EcoWatch or PC6000 software.

In the discretionary evaluation of the data, each sensor should be evaluated individually. Usually the evaluator should be looking for a discontinuity (sudden jumps high or low - to out of range values or other anomalies) in the data, which indicates a sensor has failed catastrophically during the deployment. This type of failure can be either reversible (torn membrane on the dissolved oxygen probe, for example) or irreversible (broken pH probe, for example).

In general, all data resulting from a known failure of a sensor within a particular deployment should be rejected. However, an exception to this general rule may apply in some turbidity studies as discussed below. A listing of possible failure mechanisms for each sensor is provided below. In some cases a figure documenting a data discontinuity, which appears to be associated with the failure mechanism, is also provided.

7. Time

On occasion, time jumps (from seconds to minutes) can occur in the data logger file for no apparent reason. There are two explanations for this. First, the data logger could have been interrupted by an uploading session while the sensors were trying to record water quality data or the contacts between the batteries and the sonde (the metal coil) had gotten damp and needed cleaning.

It is important to document in the metadata when the time was off. The CDMO pre-processing Excel macro will correct all times for you to the nearest half or quarter hour.

Time Gaps in the data file & Internal Device Error statement

If time gaps are observed in the uploaded data file or if a time gap is suspected, then you may have an Internal Device Error problem with the sonde. This is an indication of a handshaking problem between the internal boards of the instrument. When the board that runs the sensors transfers the sensors' signal to another internal board, there occasionally can be a communication problem. When a communication problem does occur, an Internal Device Error statement appears and there is a statement on a time line that the error has occurred INSTEAD of the data. Thus, when an Internal Device Error occurs there are no data at all at for that particular time. The message indicates that a sample is missing. It does not mean that the data before or after the error message is bad. In the file report, the only evidence of an internal device error is a time gap in the data.

***Note**: An internal device error statement is only visible in the "viewed data" and not in an "uploaded data" PC6000 formatted file. View the data on the screen using the View command from the sonde and look for the internal device error log.*

Any data that is recorded in the memory is probably okay since internal device errors do not affect sensor performance, only internal communication. Contact YSI to determine how to recover your data.

8. Temperature

The temperature sensor on the YSI 6030 probe rarely fails. If it does fail, the malfunction is inevitably irreversible and due to leakage of environmental water into the thermistor container. Although we have only very limited experience, the failure of the temperature sensor is usually signaled by jumpy and/or clearly incorrect readings. If a problem is suspected, the accuracy of the thermistor can be checked on return vs. another Model 6000 or a mercury-in-glass thermometer.

If a clear point of temperature discontinuity is present in a data record, all temperature readings from that point on should be eliminated from the official SWMP data logger data record. This point might be signaled by a sharp jump in temperature to an unexpected value or an overall drift that seems unreasonable.

*Since the data from most all other sensors (salinity, specific conductivity, depth, dissolved oxygen mg/L, pH, turbidity and chlorophyll-a) is temperature compensated using the values from the thermistor, all values for all logged parameters (**EXCEPT percent saturation and conductivity**) after a temperature probe failure should be viewed as suspect and eliminated from the official record. Thus, because of the ubiquity of temperature compensation, failure of the temperature sensor is particularly serious for the overall data record. This is demonstrated in Figure 3 where the temperature sensor failed during the study. However, remember that temperature probe failure is extremely rare.*

9. Conductivity

The conductivity sensor of the YSI 6030 probe seldom shows catastrophic failure. If an error occurs, the symptom is usually a drift of the overall conductivity output due to a changing of the cell constant during deployment. This cell constant change is, in turn, usually due to the presence of fouling in the cell compartment that causes a change in the effective volume. If the perturbation only involves the coating of the cell and electrodes with a layer of fouling, the change in cell constant is usually not significant. However, the formation of barnacles in the cell constant will result in readings that are in error.

A post deployment check of the sensor in a solution of known conductivity (not necessarily a primary standard) will allow the Research Coordinator to assess the extent of the drift. Cleaning of the sensor as described in the manual almost always reverses the drift caused by significant change in the cell volume. If a reversible drift is suspected, a linear compensation based on quality assurance data (pre-, mid-, and post-deployment) is possible using PC6000 software. YSI recommends that the decision as to whether to employ this (or any) compensation be left in the hands of the Research Coordinator.

In the unlikely event of a total sensor failure, a sharp discontinuity will usually appear in the output. All readings (salinity, specific conductivity, dissolved oxygen mg/L and depth) after this type of failure should be eliminated from the SWMP data logger database.

Remember though that sharp discontinuities in Conductivity can also be due to the sonde being out of the water, as is described in the Absolute Data Rejection (2) section above or as a result of a incorrect calibration. The BEST indicator of determining whether a sonde was out of the water is to use the Conductivity data. (See Figure 1A and 1B). Use the conductivity data in conjunction with depth values to help with decision-making.

If the sonde was deteremined to be out of the water, reject ALL YSI data in these areas of the data record because it is impossible to tell whether the other sensors were in the water at the time of measurement.

10. pH

Like the conductivity sensor, the pH probe of the YSI 6000 seldom shows catastrophic failure. If an error does occur, the symptom is usually a drift of the overall pH output due to a perturbation of the reference electrode during deployment. A post deployment check of the sensor in a solution of known pH (usually pH 7 buffer) will allow the Research Coordinator to assess the extent of the drift. The drift is usually confined to the sensor offset, not the sensitivity, and while not reversible per se*, can normally be "calibrated out" prior to the next deployment. If a reversible drift is suspected, a linear compensation based on quality assurance data (pre-, mid-, and post deployment) is possible. A decision to employ this (or any) compensation should be left in the hands of the Research Coordinator.*

In the event of a complete sensor failure (most likely due to breakage of the glass bulb),

(1) a sharp discontinuity may appear in the output,
(2) the readings may either be totally unreasonable,
(3) the ISE1 mV output in the Diagnostics submenu may be exactly 0 mV no matter what solution the sensor is immersed in, and/or
(4) the readings will show a great deal of noise.

The last failure symptom is demonstrated in Figure 4. All readings after this type of failure should be eliminated from the SWMP data logger database.

A more subtle clue to a near sensor failure (due to probe age or due to the gel drying up) was provided from NOC NERR's experience and indicates that the sensor will read from 5 to 6 units no matter what calibration solution it is in. The probe will not calibrate to any calibration standard. All readings from this type of failure should be eliminated from the SWMP data logger database. From DEL NERR's experience, another clue to a near sensor failure due to probe age is that the pH sensor appears to be working fine when the probe is submerged in a particular pH standard (for example, if the standard is a pH of 9, the probe's readings will be near 9), and it appears to track changes in pH; but when you try to calibrate the probe, the calibration is not accepted. After soaking the probe to restore it, it may appear to work properly and accept calibration. However, within a few weeks the message "calibration not accepted" may again be generated during calibration.

YSI technical support stated that this problem might also indicate that the internal coefficients for the pH calculations are incorrect (which will be the case for a newly installed pH probe). Corrective action in this case includes clearing the internal coefficient values and recalibrating with a 2-point calibration. Contact YSI for specific procedures to check, clear, and reset the sonde internal coefficients. Whether or not resetting the internal coefficients would have rescued the DEL NERR site's failing probe, it is not known. All readings from this type of failure should be examined carefully before being submitted to the NERR SWMP data logger database.

11. Dissolved Oxygen

The oxygen sensor of the YSI 6030 probe is susceptible to both drift and catastrophic failure during deployment. Drift is usually caused by deposition of a layer of biological fouling on the sensor membrane. The puncturing of this membrane by biological fouling usually causes catastrophic failure. A post-deployment check of the sensor in a medium of known DO content (usually water-saturated air or air-saturated water) will allow the Research Coordinator to assess the extent of the drift. If a reversible drift is suspected, a linear compensation based on quality assurance data (pre-, mid-, and/or post deployment) is possible. YSI recommends that the decision as to whether to employ this (or any) compensation be left in the hands of the Research Coordinator.

If the membrane is improperly installed or is punctured during the deployment, the sensor output is generally characterized by a large discontinuity. Figures 5 and 6A-C demonstrate this effect that is suspected to be due to membrane holes. Figure 5 shows DO failure at the beginning of the deployment and could well be due to improper membrane installation. Figures 6A-C shows failures during the deployment that are likely due to a membrane puncture from debris or animal activity. In most cases, the DO readings become unreasonably high very quickly and then drift off to varying extents. In Figure 6C however, the readings simply rise precipitously at the suspected point of puncture and then become noisy. For both symptoms, YSI suspects that the cause of the error is "cross talk" through the membrane hole between the DO and conductivity sensors in the conductive brackish water medium.

In all cases, all percent saturation and dissolved oxygen mg/L readings after the discontinuity should be eliminated from the SWMP data logger database for that deployment record. Note, however, that sensor malfunctions from membrane punctures usually affect only the DO data of the deployment in question -- reconditioning and re-membraning the probe correctly prior to the next deployment will likely return the sensor to its proper operating condition.

The dissolved oxygen sensor can occasionally fail during a deployment due to electrochemical or materials failure (fouling of the anode, internal short in the probe, etc.). These problems are usually characterized by a discontinuity in the data record and can usually be confirmed by the presence of high DO charge and/or noisy or negative readings during the post deployment check of the DO sensor. As for membrane punctures, the sensor is not likely to recover function during a deployment once these events have occurred and therefore, all DO readings associated with this deployment after the discontinuity should probably be eliminated. Some of the latter symptoms (internal shorts, material breakdown from age) are irreversible and will require probe replacement. For fouling of the electrodes, however, probe function can usually be restored by reconditioning the probe face with the fine sandpaper found in the 6035 kit.

12. Depth[2]

*The shallow depth sensor is a non-vented probe that is very susceptible to changes in barometric pressure. Negative depth values are a possibility when the sondes are deployed in shallow estuaries, as shown in Figure 7. Do not reject the depth values or the data for the other probes based on **negative** depth readings alone. Examine the other probe's readings (primarily specific conductivity) to determine whether or not the sonde was actually out of the water. (See the information about how the specific conductivity can be used as an indicator of the instrument being out of the water).*

Make sure that the probe was out of the water before rejecting and deleting the negative depth and other sensor values! If the depth probe was out of the water, the depth reading(s) will be negative and the other probe reading(s) (especially specific conductivity and salinity) will also be bad (Figure 1A and 1B). Reject, delete, and document all data after it has been determined that the sonde was out of the water.

If the depth probe was not out of the water and the depth readings are negative, the other probe readings will be in line with the previous data (Figure 7). Do not reject the data but mark the negative depth data as anomalous and document it in the metadata.

From discussions with YSI's John McDonald (January 1997), it was determined that with the non-vented level probe, measurements could be as much as 0.39m (1.3 feet) off with an intense low pressure hurricane event. Keep this in mind when evaluating these data.

***Note**: The outlier program will still flag negative depth values (anything < zero), but this is done on purpose to warn you that the data may be erroneous and that the data need to be examined and evaluated.*

[2] Even though the depth probe is not supposed to measure below zero, it was agreed at the NERRS meeting at St. Simons Island, GA (November 1996) that negative depth would be allowed (and categorized as anomalous) due to the way the sensor could be influenced by low pressure weather systems.

13. Turbidity

The 6026 turbidity sensor associated with the YSI 6000 is usually not susceptible to drift per se. *This means that there will generally be little need for manual compensation of readings during a deployment due to the fouling or sensor drift that may affect the conductivity, pH, and dissolved oxygen sensors. The turbidity sensor can, however, produce erroneous readings for reasons other than drift such as mechanical failures. Examples of these are leakage of water into the sensor housing and scratches on the optics caused by an improperly installed wiper. The sensor can fail completely during deployment as shown in Figure 8 where the flat readings are almost certainly due to complete loss of probe sensitivity. Clearly, turbidity readings after this type of discontinuity should be rejected (Figure 8).*

High Positive (>1000) and Large Negative Values

Sometimes turbidity readings can be erroneously high (>1000 NTU) and then erroneously large negative readings. Or sometimes turbidity readings will be in the normal range of the instrument (0 to 1000 NTU) and then become large negative values. The most common problems associated with turbidity data like what is described above are likely due to one of the following:

(1) the presence of a large quantity of debris such as algae or Spartina,
(2) animals in the probe compartment,
(3) the wiper parking over the optics, or
(4) when there are actual turbidity values that the sensor is experiencing that are > 1000 NTU (greater than the range the probe can measure). This is a real event that the probe is experiencing and is not an error! Figure 9 shows that after a failure of a water control structure (see water level values before 14/07/96 0:00) which released a huge volume of water into the system that Delaware NERR was measuring, turbidity was increased beyond 1000 NTU which caused the turbidity sensor to "roll over" (see next paragraph).

In 1-3 above, the sensor is affected by a direct interference from a foreign body or the wiper. Sometimes the wiper can be jammed over the optics by debris or the wiper will park over the optics due to a dirty wiper blade. Note, in some cases you will need to replace the wiper and recalibrate the probe. All scenarios listed above can cause very high and large negative readings. Before the release of Version 3.10 sonde software for the YSI 6000UPG in January 1997, there was a "rollover" problem with the turbidity probe. When the A/D converter of the turbidity probe senses a very high reading, it "rolls over" and the output of the system becomes large and then negative. Thus, wiper malfunctions, direct interference in the optics, or turbidity values >1000 during a reading are usually characterized by very large, negative NTU data points as shown in Figures 10 and 11. The distribution of new sonde software (Version 3.10 and higher) from YSI corrected this problem.
The turbidity probe is an optical probe, which causes it to behave very differently that the rest of the probes. However, as opposed to the other sensors, if there is a malfunction it can be completely reversed within a given deployment. Thus, if the impediment is removed from the optics via natural causes in subsequent readings, there is no reason to suspect their validity.

If it is determined that there was an animal living in the YSI instrument, or debris was seen attached to the wiper area, or the wiper was stuck in the middle of the turbidity window, then reject and delete the data. This is where deployment notes are important to note any unusual circumstances regarding the instrument deployment. Make sure to review the turbidity data from each deployment and make a judgment as to the possible reliability of the data if large negative spikes occur and whether this data should be included in the SWMP data logger database.

However, since, in most cases, it cannot be determined whether or not the anomalous value is due to animal, debris, wiper, or natural causes, it is recommended that all anomalous data remain in the database. The values should be documented as anomalous in the metadata and left in the data file.

***TIP**: Small meshed netting over the sensor guard secured with cable tires can protect the probes from debris and animals taking up residence in the probe area. Contact YSI for the suggested mesh size and type.*

Small Negative Values

Just a small amount of water left on the probes (from the cup that the probes are stored in) can contaminate the zero turbidity standard when calibrating the turbidity probe. Contamination can cause the zero calibration to be off by +5 to +8 NTUs. So when the probe really experiences zero turbidity, the values are -5 to -8 NTU. Therefore, shake or dry off the instrument and probes thoroughly before continuing with calibration.

Due to this small calibration error possibility, small negative turbidity values should be kept in the data file and documented as anomalous due to this small calibration error.

Occasional High Positive Turbidity Spikes

Occasional high positive spikes that are not consistent with the overall data record may be real (Figure 12). Reject or accept spikes in turbidity values at the site's discretion.

However, do not reject or delete the data, unless you are absolutely sure that they are erroneous data. If you do not reject the data, leave the data in the file and document them as anomalous in the metadata. If you do reject them, delete and document them in the metadata.

FIGURE 1A

Sonde suspected to be out of water periodically during study. Reject all WQ data during periods of low conductivity.

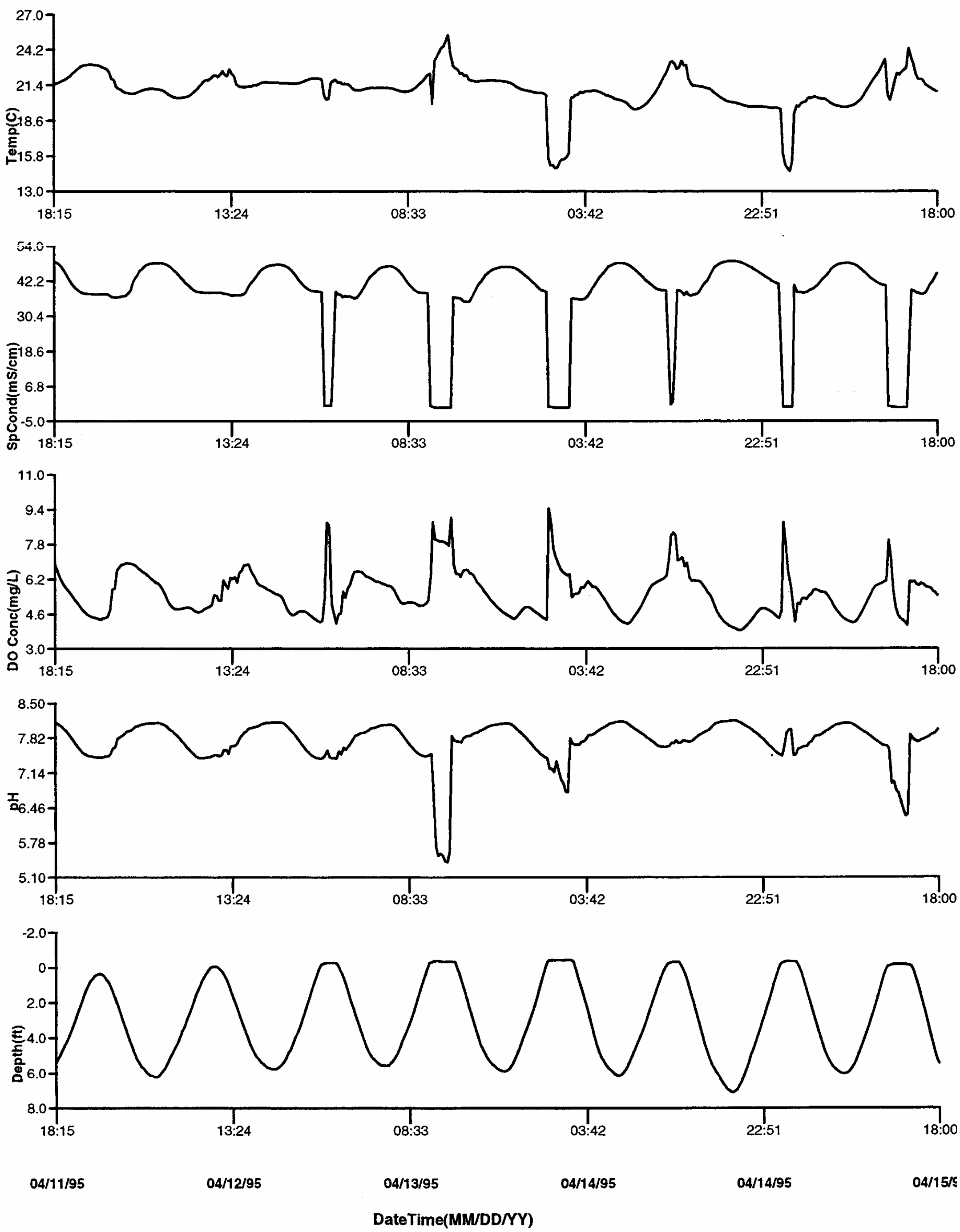


FIGURE 1B

Sonde suspected to be out of water during last 1/3 of study. Reject all WQ data after discontinuity.

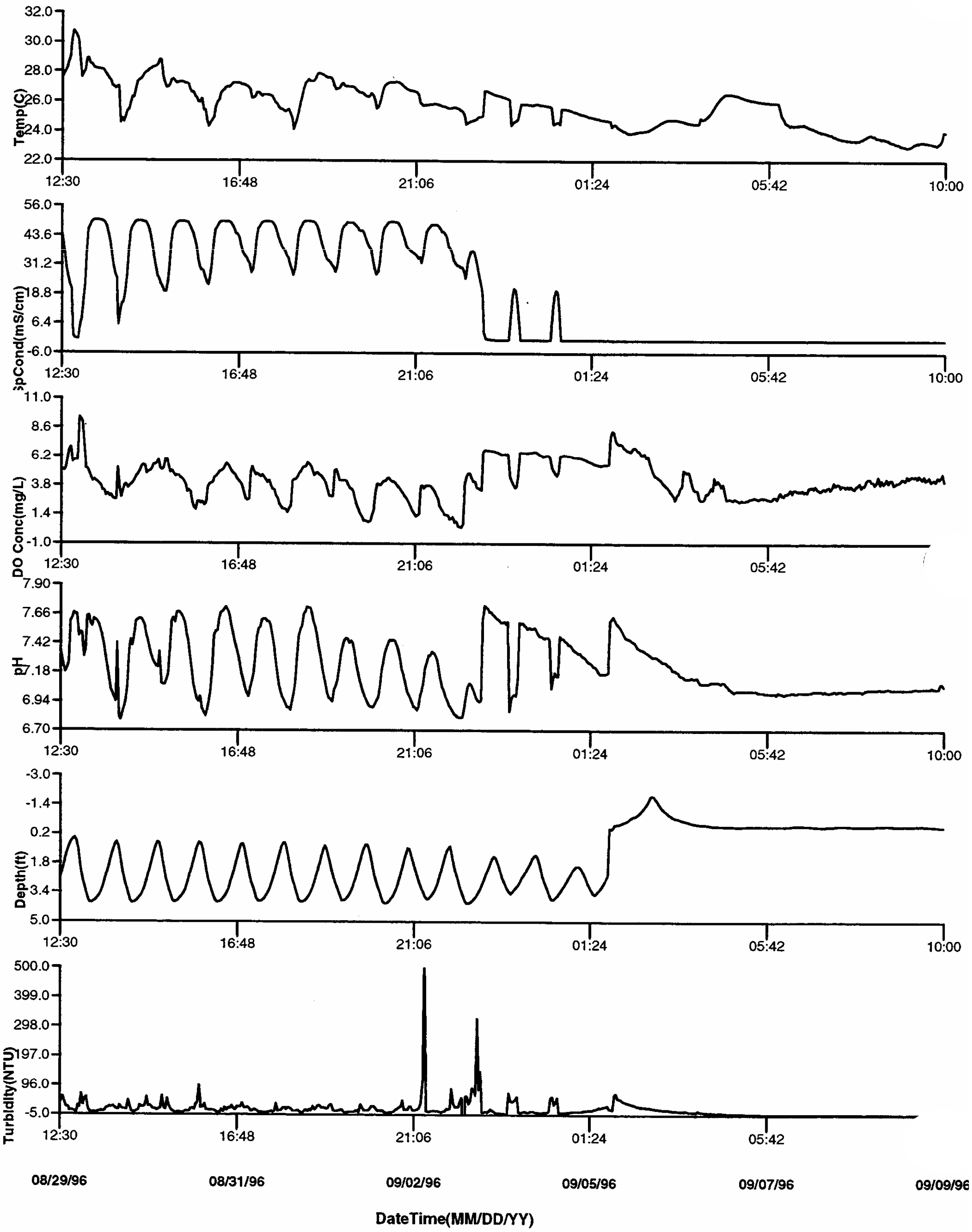


FIGURE 2

Reject and delete both the beginning and end ("tails") of the data record

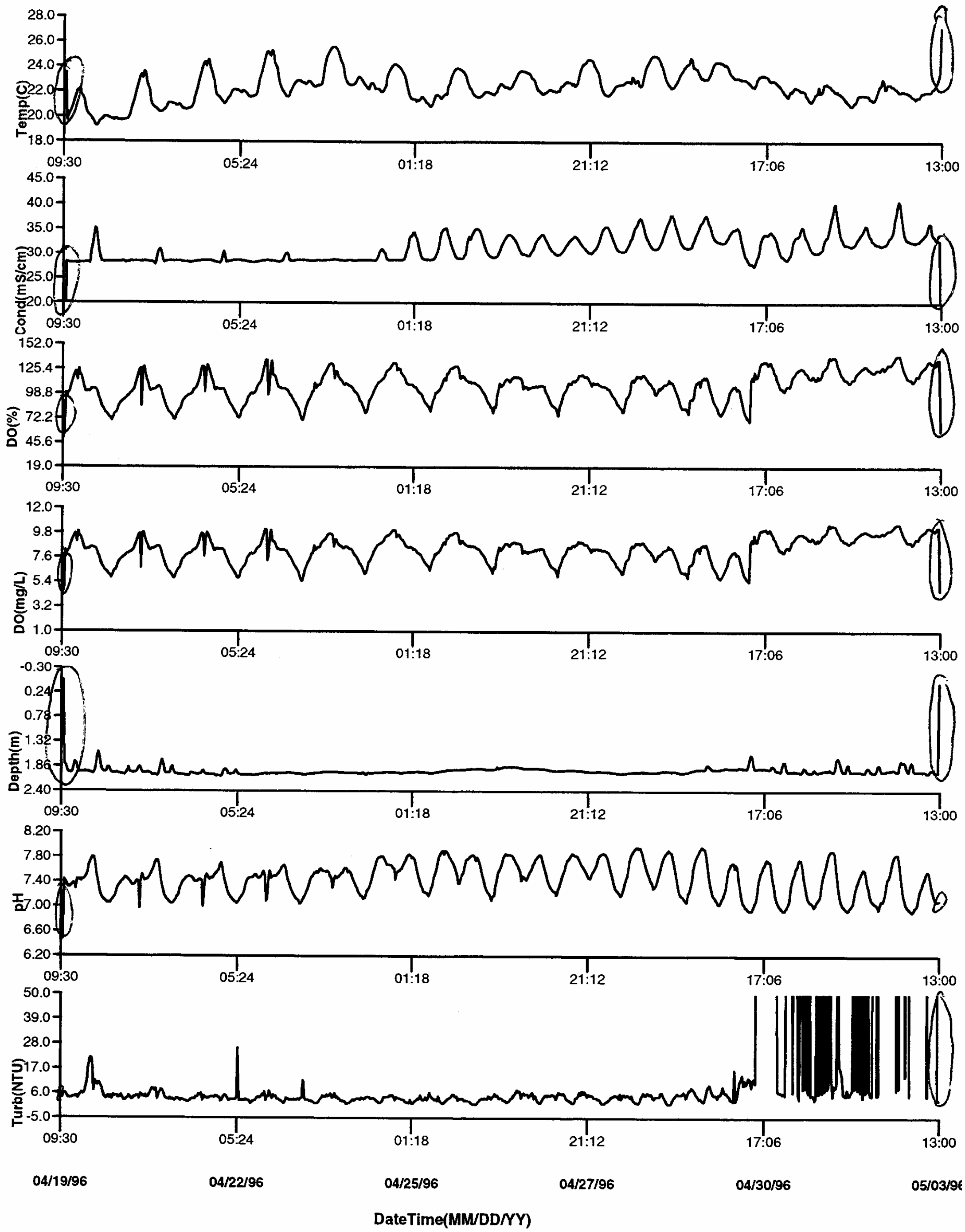


FIGURE 3

Temperture probe failure during deployment. Reject all WQ readings after discontinuity.

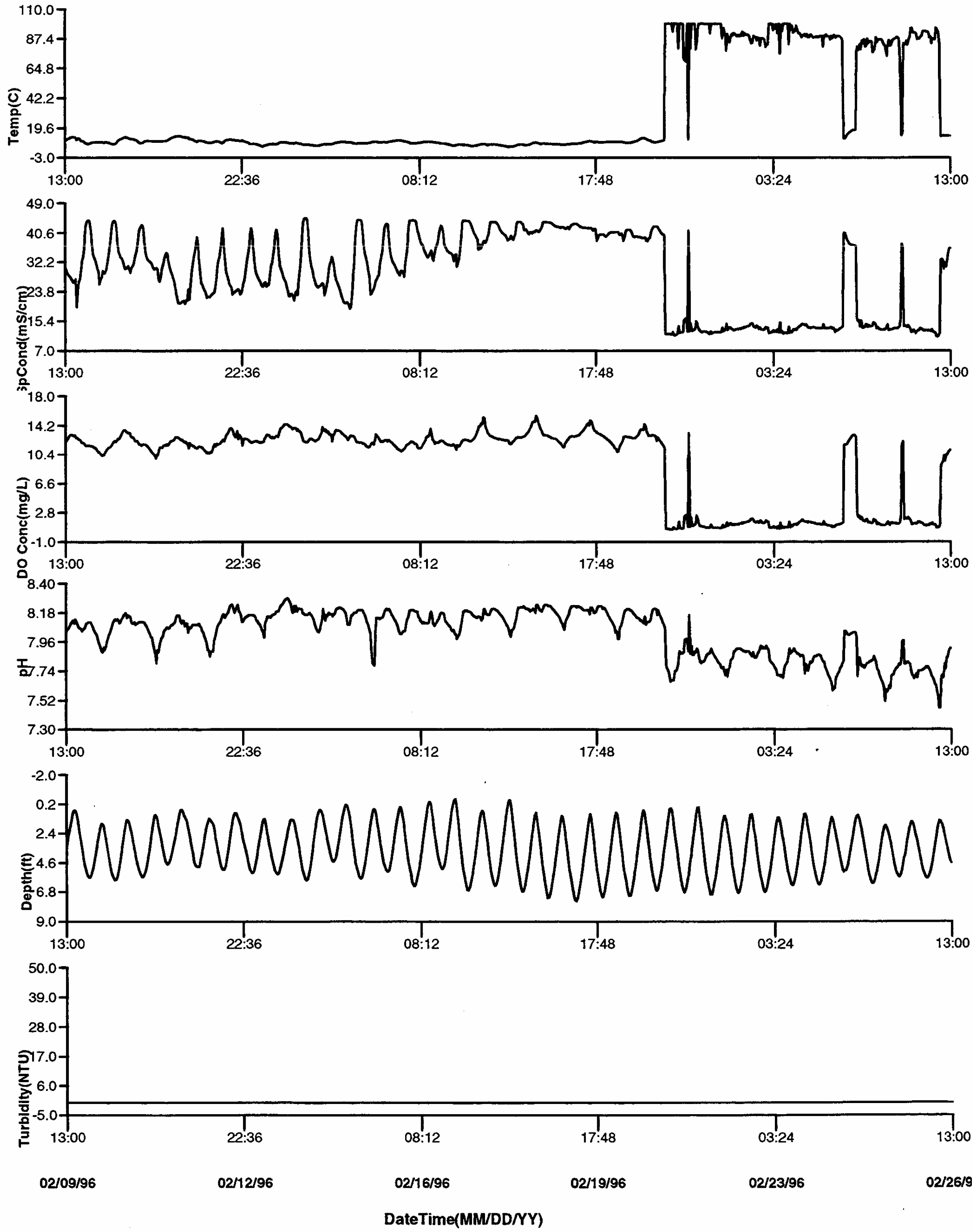


FIGURE 4

Malfunctioning pH probe evident from noise. Reject all pH data.

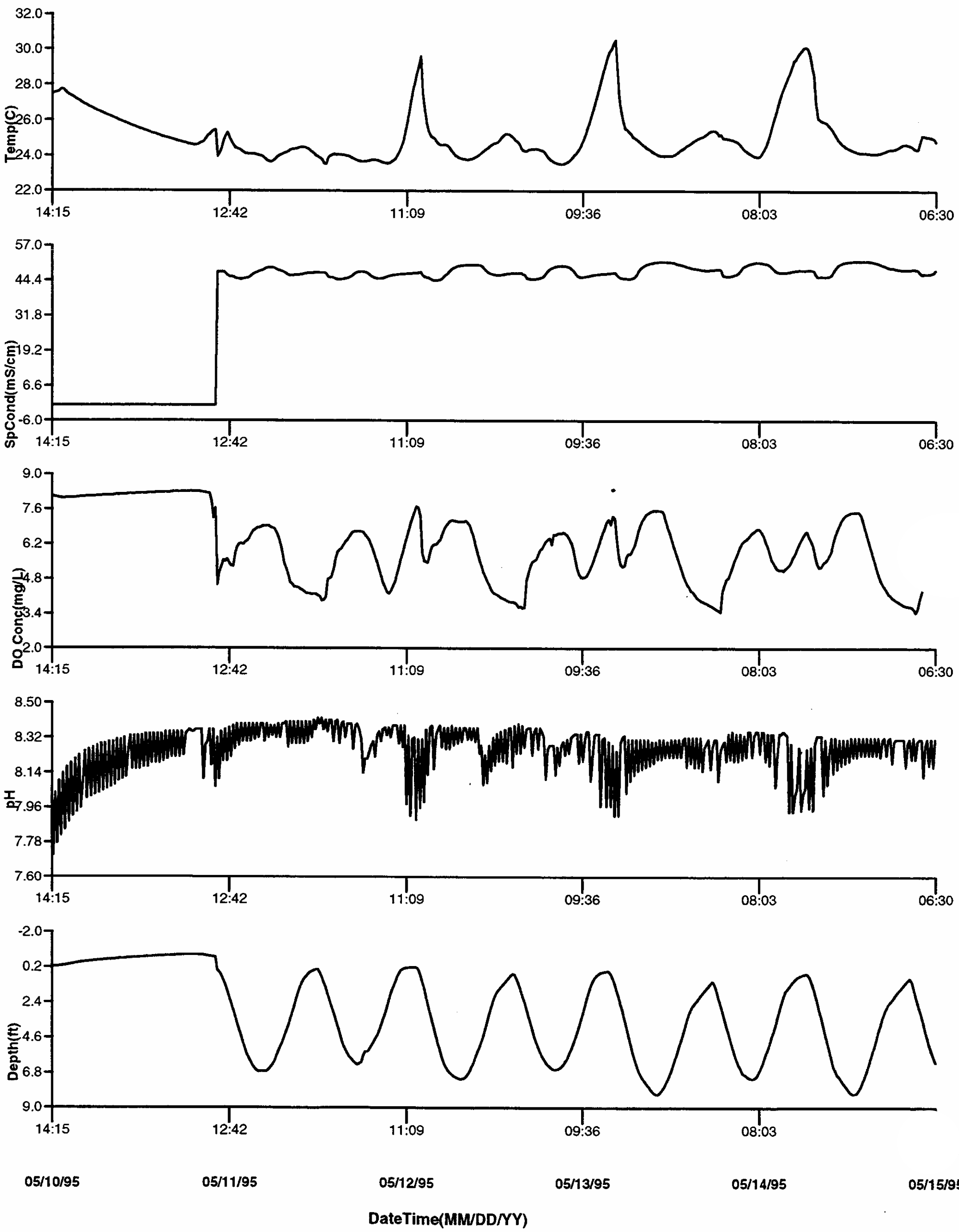


FIGURE 5

Immediate problem with DO membrane integrity. Suspect improperly installed membrane. Reject all DO data.

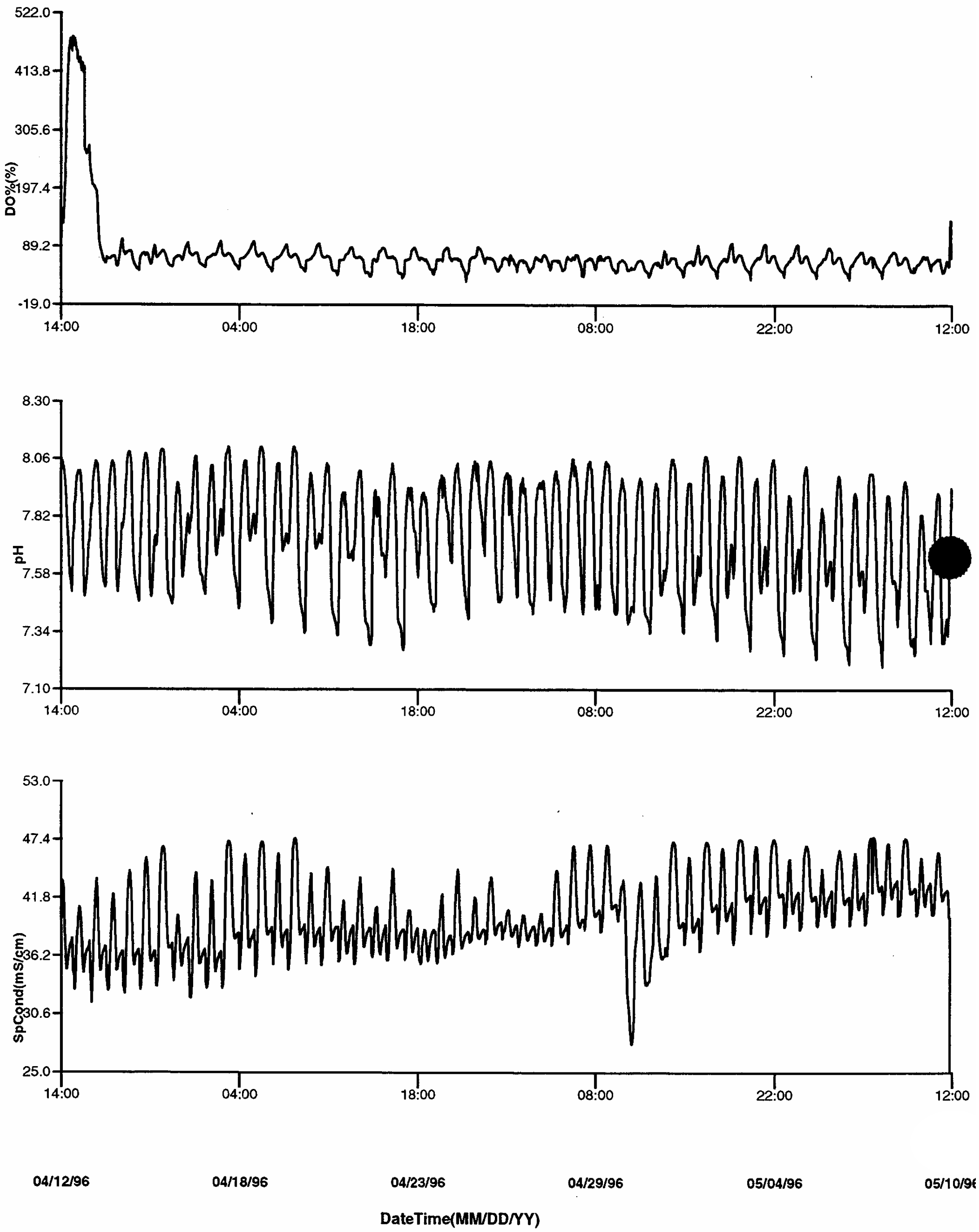


FIGURE 6A

Suspected DO membrane pucture late in study. Reject all DO readings after discontinuity.

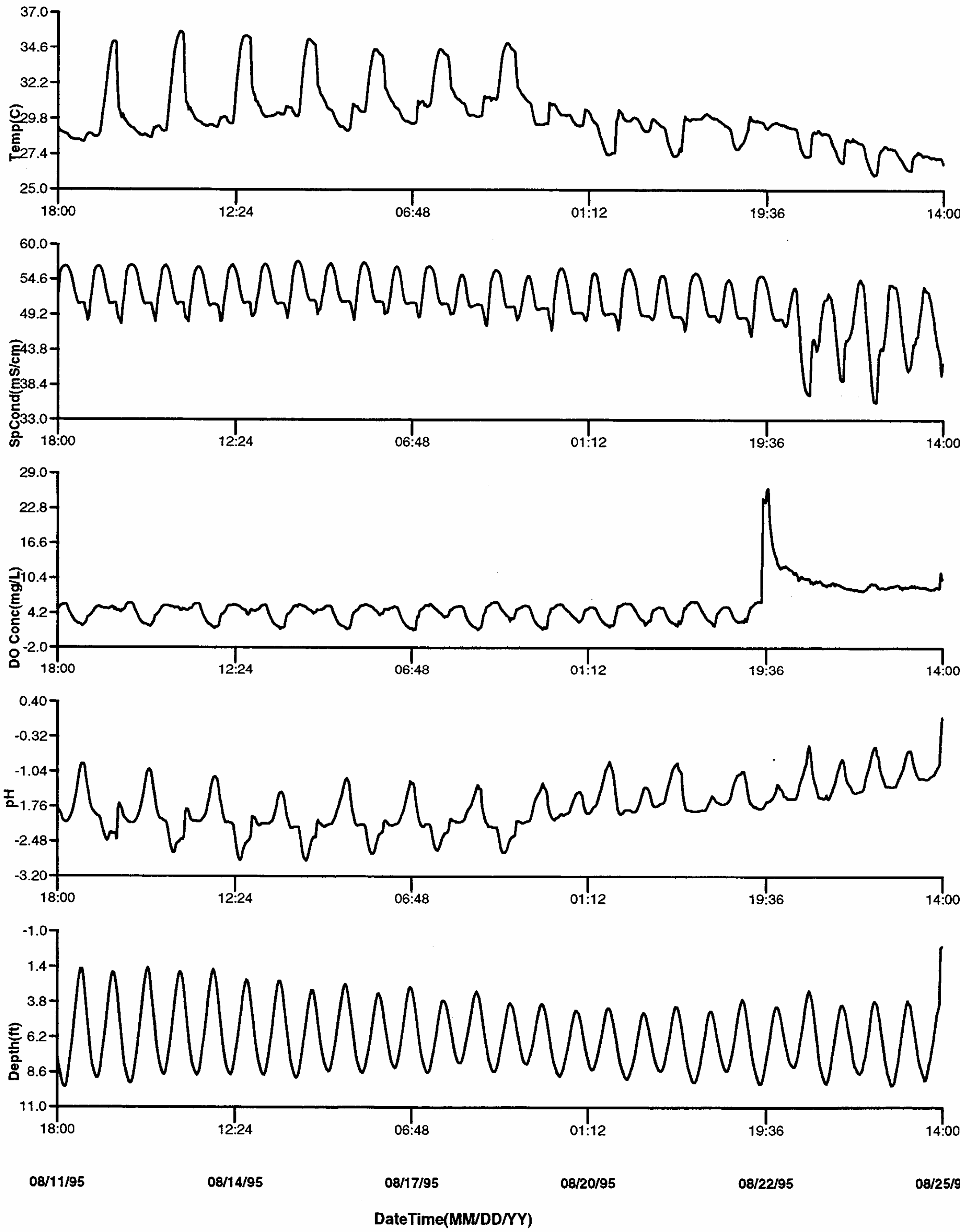


FIGURE 6B

Suspected DO membrane puncture early in study. Reject all DO data after discontinuity.

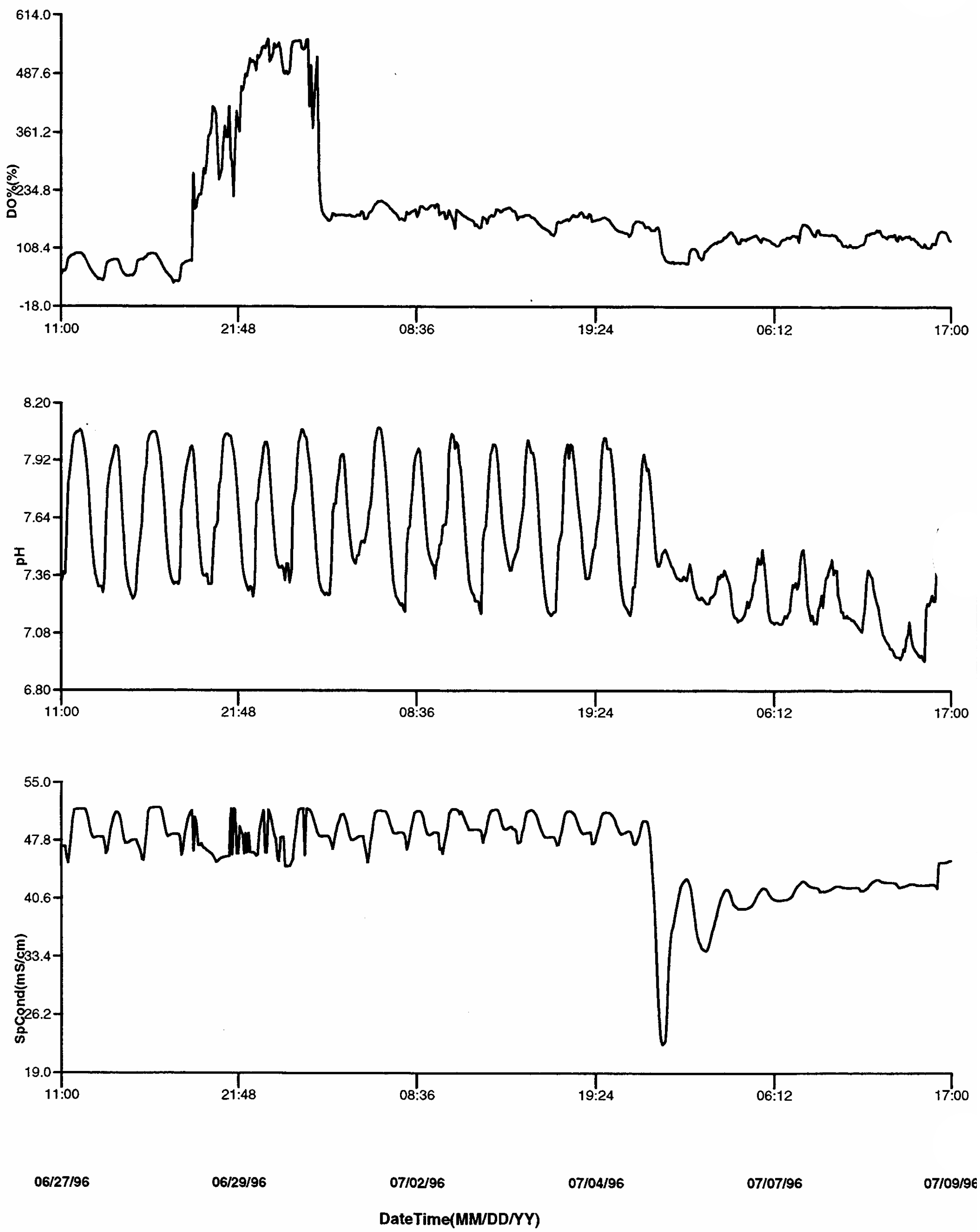


FIGURE 6C

Suspected DO membrane puncture 1/3 through study. Reject all DO data after discontinuity.

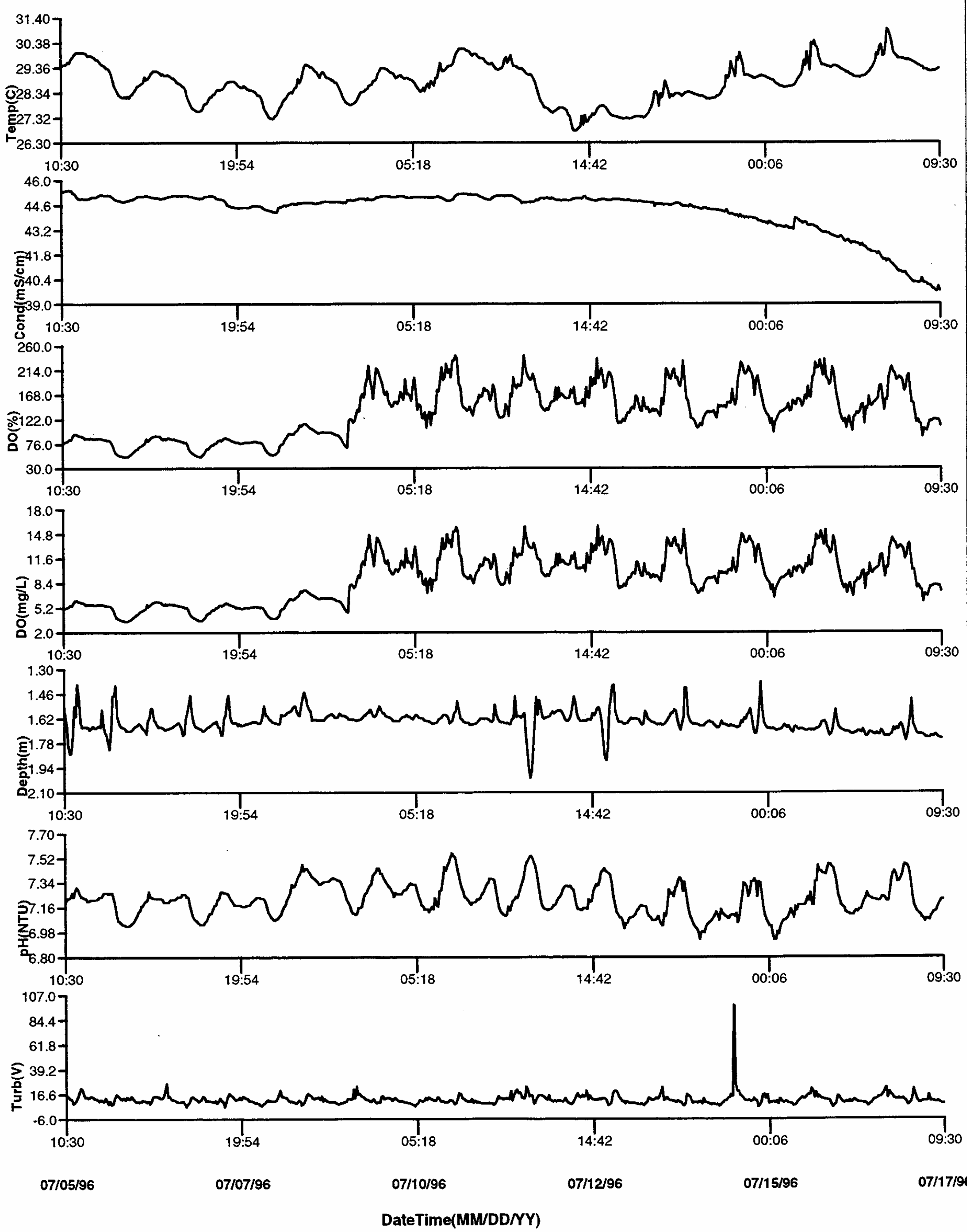


FIGURE 7

Do not reject negative depth when the other values are determined to be correct

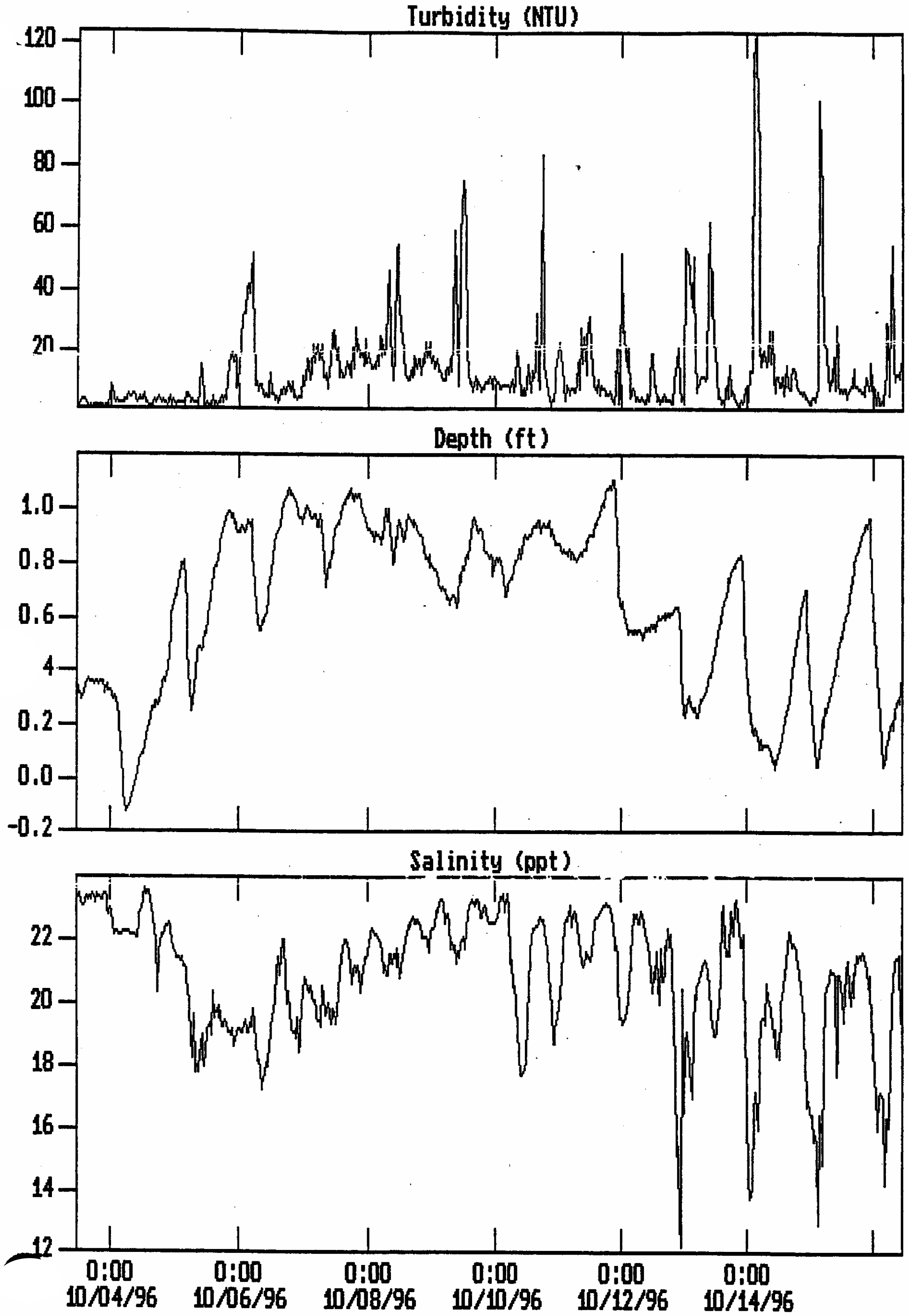


FIGURE 8

Turbidity probe failure during deployment. Reject all readings after failure.

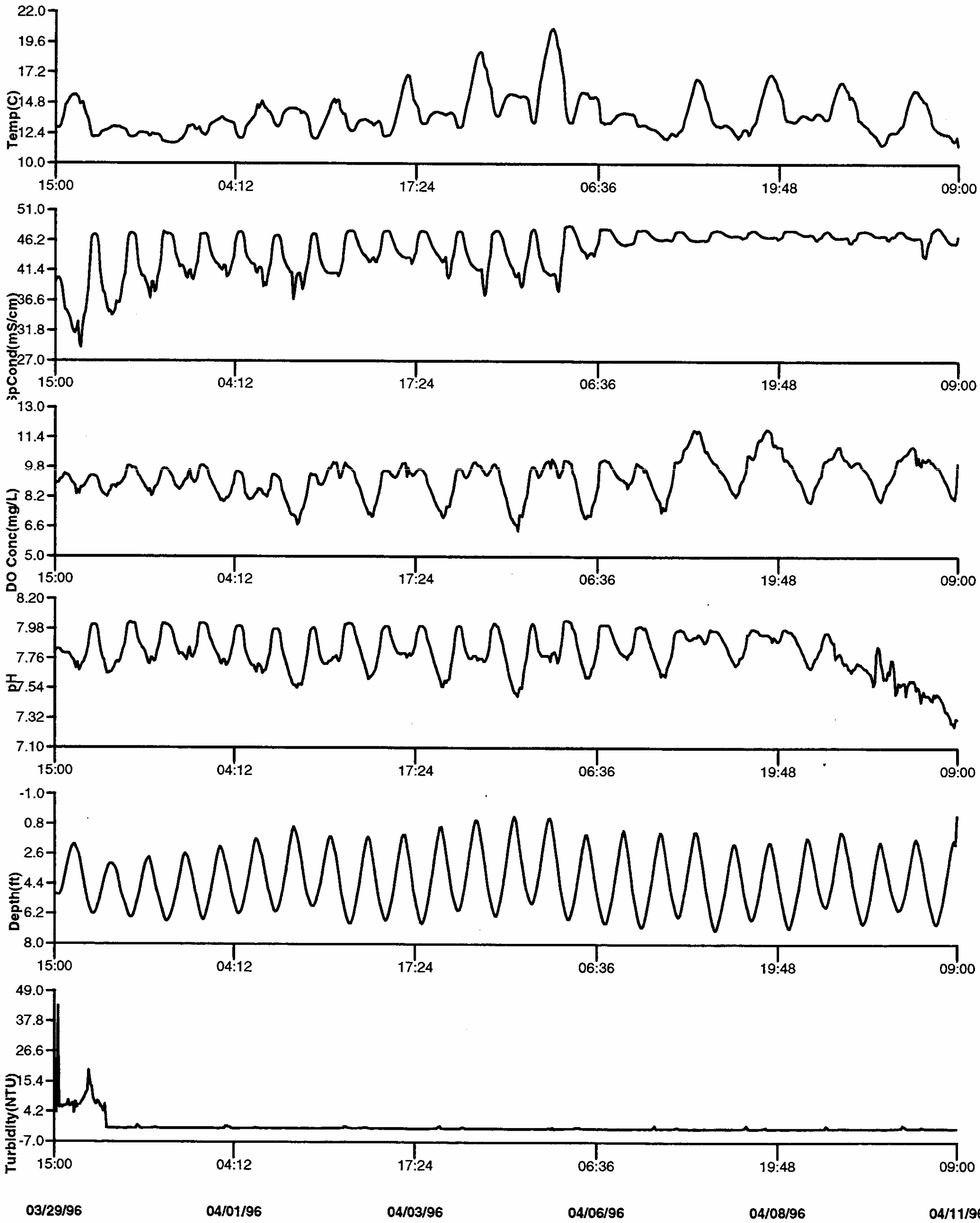


FIGURE 9

Do not reject high and large negative turbidity values when turbidity values > 1000

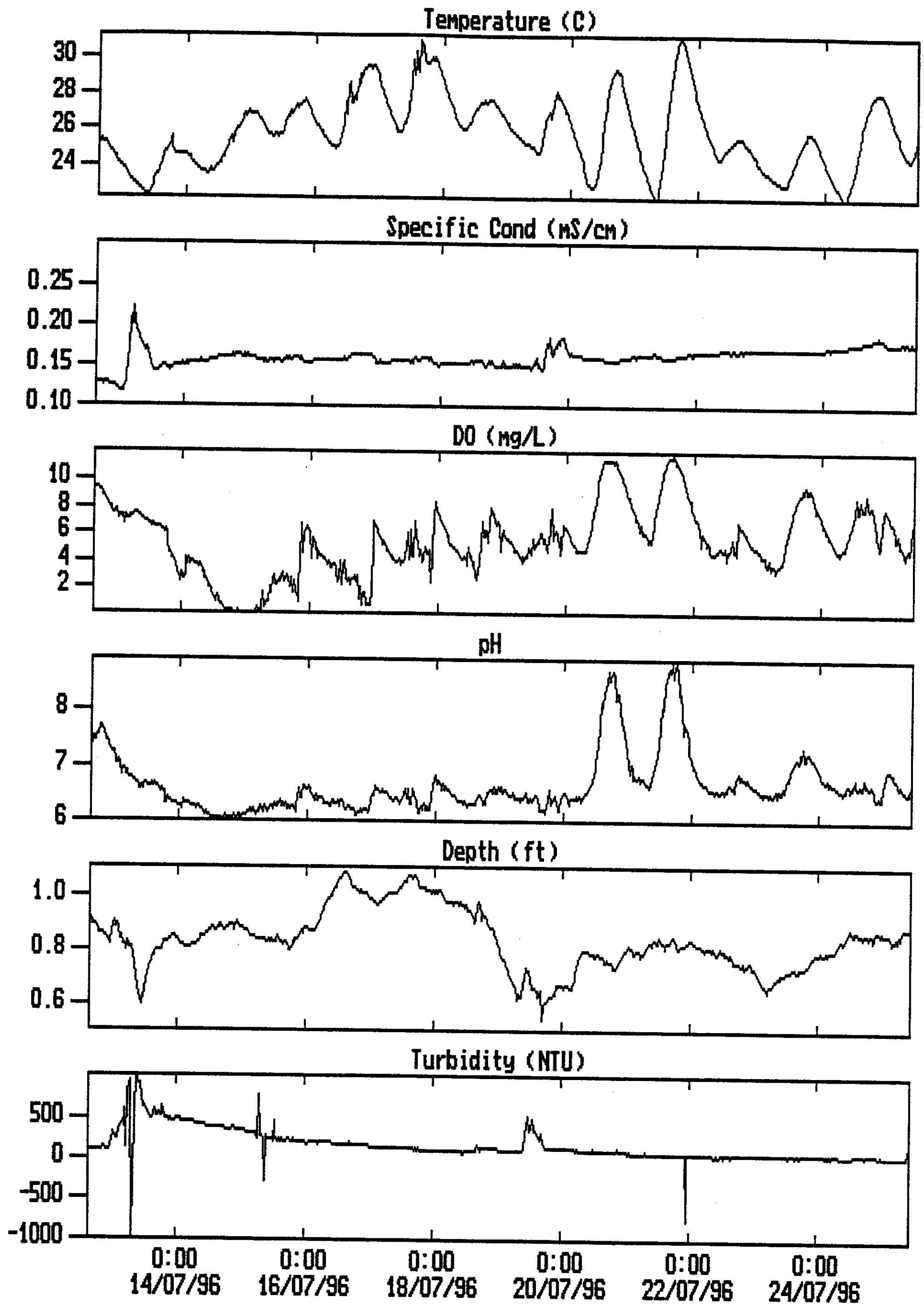


FIGURE 10

Reject and accept turbidity readings at site coordinator's discretion

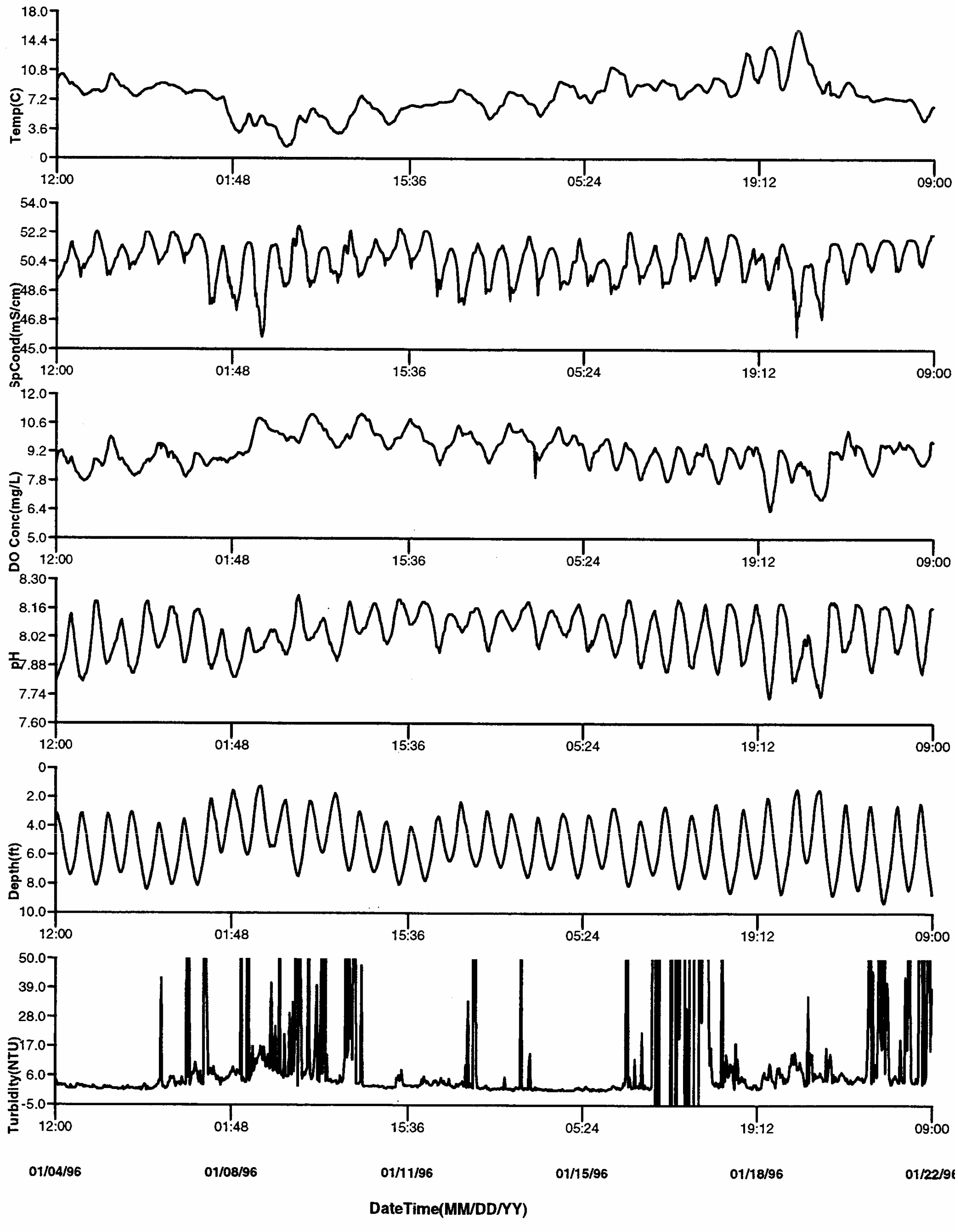


FIGURE 11

Reject or accept large negative turbidity values at site's discretion

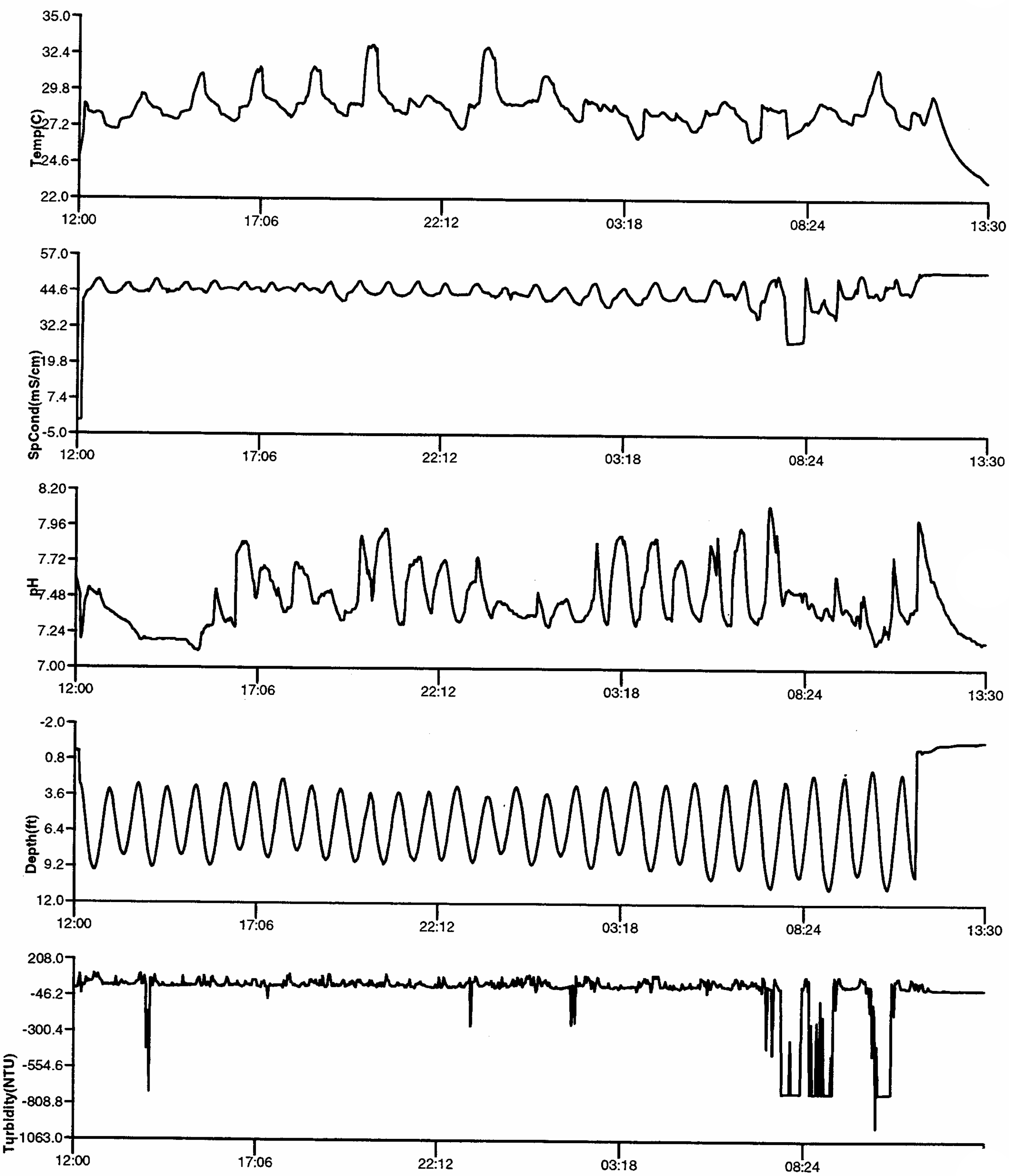


FIGURE 12

Reject or accept large negative turbidity values at site's discretion