BEST GUIDE AND PRINCIPLES MANUAL FOR THE SHIPS OF OPPORTUNITY PROGRAM (SOOP) AND EXPENDABLE BATHYTHERMOGRAPH (XBT) OPERATIONS

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by

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1. Introduction

The international scientific community has been utilizing ships of opportunity since the days of Benjamin Franklin as a mechanism to economically collect marine information. These programs have gone by many different names such as Ships of Opportunity Program (SOOP), Voluntary Observing Ships (VOS), Platforms of Opportunity (POOP), and Cooperative Oceanographic Platforms (COOP).

In the early days of the SOOP it was usually the interested scientist who would visit a vessel that they knew traveled a route in which the scientist was interested and then they would establish a working rapport with the Captain to accomplish the sampling. This was done to convince the Captain of the importance of the project and establish a working relationship with that ship to collect the required information. This worked quite well on small projects with a very personal interest between the scientist and participating vessels. In fact, the early successes of these first SOOP relationships caught the eye of marine scientists world wide and highlighted the potential of using a SOOP network as a "tool" to efficiently collect marine observations over vast areas of the world's oceans that could not reasonably be covered with traditional research vessel efforts.

2. Recruiting a Ship of Opportunity (SOO)

Today's SOO fleet is a much more dynamic entity than what it was in the past. There are still a few, and we want to emphasize few, vessels that cover the same route over and over again never deviating from their schedules, almost like a ferry boat. If such a vessel traversed an area of scientific interest then this would be a prime vessel to recruit. However, today's SOO fleet, more often than not, is a very fluid network with ships coming and going off line or being rerouted or merged with other shipping lines or even sold. As SOOP managers we find ourselves having to be very pro active and aggressive in keeping track of these vessels, their owners and ship managers in order to keep our lines or routes of interest properly maintained so as not to lose previously established time-series data.

More often than not we will now visit a ship and speak with the Captain to get a "feel" for the anticipated length of time the ship will be on charter, learn of other vessels on the same route, determine the ship's owners and/or manager and then start the process of recruiting from the corporate level.

When we board a ship for recruiting or riding ourselves for special measurements we must be careful to remember that we are entering into the mariners "home" and should treat it as such. We must strive to make ourselves and our programs as unobtrusive as possible. Commercial vessels are busy places and are staffed by fewer and fewer mariners. As such, we can't expect a lot of ship support for the successful culmination of our scientific programs. We can insure success by preparing the hardware carefully, simplifying the training, and the use of our equipment, as much as possible. The KISS (Keep It Simple Stupid) principle works the best. Malfunctioning equipment, less than courteous or professional ship visitors or unreasonable demands on the part of the program, program managers or ship riders can easily spoil a good working relationship. These are not research vessels, but rather professional businesses that navigate the worlds oceans. They are providing us with valuable ship's space, electric power, cooperation and, hopefully, an interest in the success of our programs.

Now arises a more serious concern, that in this environment of reduced scientific funding we find many of our scientific colleagues, both government and university, competing for the same vessels to collect different types of observations. It is a bit embarrassing when scientists within the same government agency don't know the other is also on the same vessel collecting a different set of observations. This is further complicated when university projects also approach the same vessel to accommodate their work. We have seen more than one vessel that was recruited by the National Weather Service to collect sea surface whether observations, then recruited by the National Ocean Service to collect Expendable Bathythermograph (XBT) data, then recruited by the Office of Ocean and Atmospheric Research to collect air samples, then recruited by National Marine Fisheries Service to collect plankton samples by "towing" a continuous plankton recorder, then recruited by the Defense Mapping Agency to collect bathymetry, then recruited by a university to allow a ship rider to collect different observations or deploy drifters or floats. One can imagine what the captains must feel like when they finally dock at a port for sometimes less than 24 hours and having to deal with immigration, customs, drug enforcement agents, surly port agents, late ship chandlers delivering the wrong stores, striking longshoremen, as well as possibly five different scientists or program managers attempting to remove data, load expendables, repair their equipment, train new bridge officers and debrief the captain and/or 1st officer. One of the goals of the SOOPIP members and the reason for this "Best Guide and Principles Manual" is to simplify and coordinate these programs so every program benefits without sacrificing the

"golden geese" of the VOS. In conclusion, if at all possible, there should be only one single (or as few as possible) point of operational contact for participating vessels and this person should have exceptional "people" skills.

The ability to effectively communicate with maritime personnel from company marine superintendents to ship's agents are critical for any successful vessel recruitment. One must be knowledgeable enough, pragmatic enough and professional enough, tinged with a bit of humility and a sense of humor, to sell your request. You have to know when to stop talking and start listening. Too much science or too many jokes can put you over the edge and impede your quest to recruit that ship.

Points to remember:

1- **It is difficult to keep track of ships and equipment because ships frequently change routes, captains, and ownership.**
2- **Try to anticipate changes.**
3- **A ship is the mariners "home." Make yourself unobtrusive, courteous, and professional.**
4- **Operations onboard must be smooth. Keep It Simple Stupid (KISS).**
5- **Coordinate as much as possible with other National agencies so that the ship's captain has only one contact person.**

3. Initial Installation of Equipment

During the recruiting discussions, you probably had a tour of the ship with the captain and/or chief engineer to determine the best location for installing your equipment; in this case, the computer, transmitter and XBT equipment. New installations almost always require the ship to provide power and access outside the ship for antenna runs. Ship's power can be quite variable and the most effective piece of equipment that we use to provide the best power is the use an

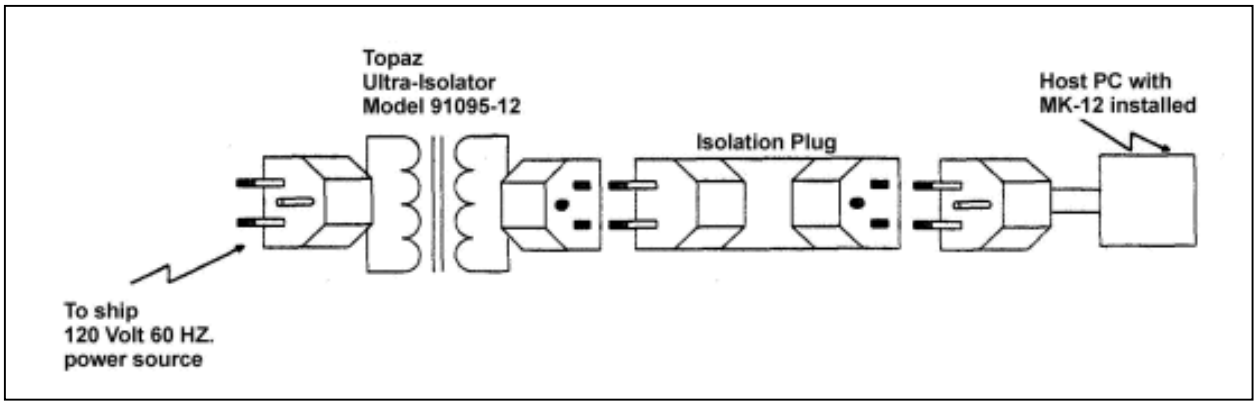

Figure 1. Isolation transformer with double prong cheater plug.

"isolation"transformer with a double prong "cheater" plug to completely isolate the power to the computer and XBT system. This will allow the necessary ground to be used at the XBT ground lug and not via the ships electrical system, and should prevent the dreaded "ground loop fault." A common mistake is to "over ground" by grounding via the ground lug on a three-prong power plug or grounding the computer independently, and the XBT recorder or launcher box which can cause the "ground loop fault." When using a Hand Launcher, isolate the ship's power and ground only at the XBT launcher box ground lug or Mk-9 converter lug. When using a Deck Launcher, ground at the launcher. A successful XBT probe launch requires that the XBT system be properly grounded to the ship's hull in order to complete the circuit to the probe when it enters
the water. If an uninterrupted power supply (UPS) is used, it is best used when installed after or downstream from the isolation transformer. This helps protect the XBT equipment.

Note on grounding: The grounding approach for the hand-held launcher differs from the approach for the deck mounted and thru-hull launchers. For the hand-held launcher, the ground is made at the connector box, while for the others it is made right at the launcher. In either case

only a single ground point should exist on the launcher and its cabling to the PC. (See figure 2 below)
Please refer to Sippican's Web Site "http://www.sippican.com/xbt_userguide.html" for more details regarding grounding, probe storage, launching hints, and system troubleshooting.

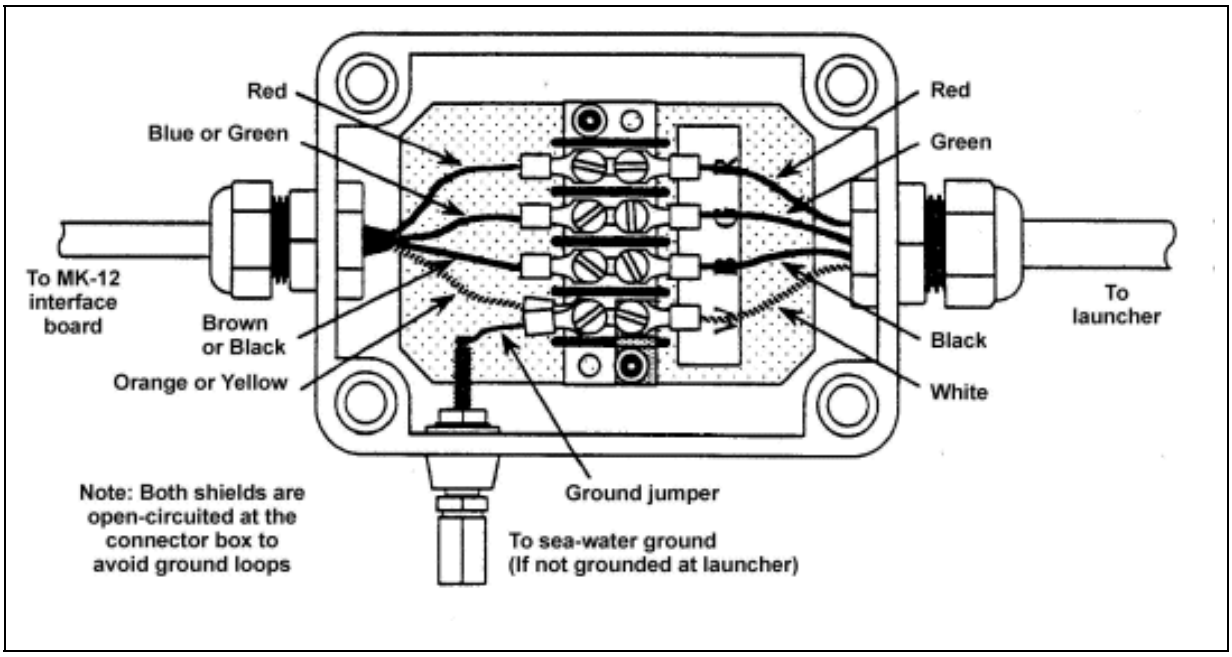

Figure 2. XBT connector box.

Running any antenna wires such as Inmarsat Standard C, GOES or GPS should be completed as neatly as possible with the antennas usually installed on the railing above the bridge, in a central position and not in the shadow of the ship's stack or near other transmitting or receiving antennas. Assistance and guidance from a responsible nautical officer or engineer are critical so that they are aware of exactly what hardware is being installed and the impact of any electromagnetic fields can be determined. Be prepared to provide an official licence for transmitter operation. Make certain that the captain and chief engineer are aware and approve of any hole that may have to be drilled somewhere and a thru hull fitting installed to run any necessary antenna wires. Waterproofing the thru hull fitting as well as the external antenna connector is critical to assure good performance and reduce potential future failure points. We try to use self vulcanizing type tape finished off with electrical tape to insure a watertight connection.

Counter or table space is usually critical on most ship's bridges and consideration should be given to mounting equipment accordingly. For example, we only need access to the computer's keyboard and monitor on the table whereas the computer, isolation transformer and transmitter can be mounted under the counter or on the wall out of the way of normal ship's operations. By reducing our space impact on the ship whenever possible, we reduce potential conflicts, maintain a "low profile," and increase ease of operations.

Most importantly and prior to any installation, make sure to take the time to properly **PREPARE.**

1- **Configure the entire system.**
2- **Test the entire system.**
3- **Clean all components.**
4- **Don't recycle manuals or instruction sheets. Prepare new ones.**
5- **Don't begin training until ready.**
6- **Begin training from a "cold boot."**
7- **Take your time and resist "helping" too much. Have the trainees do a complete observation on their own.**
8- **Create "bootable-backup" disks.**
9- **Resist using "gimmick" software.**
10- **Take your time and pre-prepare.**

4. Ship Greeting

The three most important things for any successful ship greeting or recruitment are:

1- **Personal contact.**
2- **Personal contact.**
3- **Personal contact.**

Anyone visiting a SOOP participant should know well before that ship makes port, just how well the ship performed in collecting the required observations, if there are any hardware problems and how long it will be in port. Communication with the vessel while at sea is a good way to establish a sense of "participation" for the SOOP participant. Forgetting about a ship as soon as it tosses off its lines and not thinking about it again until just before it returns will not go unnoticed by the vessel's bridge officers. Monitoring the ship company web site via the Internet is a good tool for keeping informed about ship operations and schedules. Monitoring the flow of real-time data from your vessel always improves communication and co-operation.

Plan to visit the ship about 1½ to 2 hours after it has arrived. That way the captain and officers have had time to deal with immigration, customs, and the ship's agent. If normal port call activities are too hectic, try to establish a better time to return. If necessary, make an appointment and return later. Plan to spend some time when you visit. As mentioned earlier, the ship is the mariner's home, don't just rush onboard and grab your data and say thanks as you run down the gangway. Always, make your presence known to the captain if possible, and if not possible, the 1st, 2nd, 3rd mates or radio officer before you attend to your equipment. Under no circumstances should a ship greeter enter the bridge without permission. Whomever you speak with, please take some time to get to know them, have a cup of coffee, offer to take their mail ashore or provide a ride to the front gate. Be helpful in a general way. This will pay many dividends in the future. Not only will it help you remember who and what ship you were dealing with, it will imprint you in the mind of the ship's officer with whom you were dealing.

Use this debriefing time to talk about your program. Ask about any problems that may have occurred and solicit the officer's input on how best to solve these problems. If there are problems that the bridge officer can show you or recreate for you, that would be a good time to do so. Make sure you have "hot" spares and the necessary tools with you in case you have to make equipment changes, and that you have the latest versions of the software and manuals. If possible, take the time to produce products showing just how the data they collected for your program is being used and bring them to the ship for handouts and display. This is fairly easy for meteorological, XBT and drifter observations. This type of interaction and personal contact allows the overall program to operate more efficiently and helps the ship operators feel that they are contributing significantly to a successful mission.

Gifts of appreciation such as hats, T-shirts or coffee mugs go a long way in making our presence on board a bit less obtrusive and serves the additional purpose of advertising our program. Acquiring these "gifts" can sometimes be difficult especially when public tax funds are used to support the SOOP projects. Many times just providing a ride into town for lunch, dinner or shopping is our only recourse.

Points to remember:

1- **Be aware of performance before ship makes port.**
2- **Communicate with vessel at sea if possible.**
3- **Plan visit 1½ to 2 hours after it has arrived.**
4- **Ask permission and inform Captain for a ship visit.**
5- **Spend sufficient time when visiting and socialize if possible.**
6- **Talk about the program and show products.**
7- **Ask about problems and solicit input from the officers.**
8- **Bring necessary tools and software with you.**

4.1. Re-Supplying the vessel

Whenever possible, you should try to use the ship's dockside chandlers or agents as the mechanism for delivering XBT probes or drifters to the ship. There will always be a time when you will have to hand deliver, but if you have done a good job in your initial ship greeting and training, the ships personnel will usually assist in carrying the gear aboard the ship.

Probes can be damaged (i.e., wire insulation leaks) from mishandling or long term storage. Probes should always be carefully stored and transported in an upright position and in a cool place. You should always use the oldest probes first to avoid undue aging. This can be monitored by checking the date of manufacture stamped on the outside of the XBT probe case. The usual shelf life of an XBT probe is two years, but probes properly handled and stored can still be used after several years of storage.

In ports where you can drive up to the ship, you should always endeavor to remove the old XBT boxes so the ship doesn't have to deal with it. Today's pollution laws are such that individual ships have to pay for specialized trash removal, especially when plastics are involved. By relieving the captain or bridge officers from having to deal with "our" trash we simplify their job and not complicate it. Because the work they perform for us is voluntary, we should always strive to reduce the overall impact of our program on the ship.

4.2. Things to pay attention to

1- **Check the PC for date, time, software version and extra data and archive disks.**
2- **Check the entire system using a test box or precision test box to evaluate the functioning of the system and calibration stability.**
3- **Check the launcher system for salt deposits and contamination of probe contacts. Salt should be removed with fresh water and a cloth swab. Other contaminations should be removed with a cloth swab dipped in alcohol.**
4- **Use virus scanning software to check for viruses on the PC.**
5- **Be sure to remove, archive and label any data you collect.**
6- **Clean the floppy drives on the PC.**
7- **Use window cleaner to clean the monitor, PC and keyboard.**
8- **Tidy up around the area and remove any old or outdated versions of your software and manuals.**
9- **Make reminder notes for future use or any missing items required.**
10- **If necessary, leave written notes to the bridge officers.**
11- **It also is a good idea to prepare a short "How to/quick reference guide" set of instructions on how to drop an XBT probe. These instructions could be laminated and left attached to or close by the computer keyboard or monitor.**
12- **Similar sets of sampling instructions (just where to start and stop the XBT probe sampling) is also a good idea and makes the bridge officers job a little easier.**
13- **Allow the electronics to warm up before the first XBT measurement and keep the electronics powered up during the whole cruise to help prevent condensation.**
14- **To protect Deck Launcher's, one should leave the expended XBT probe canister in the breech of the launcher until the next observation to help protect the launcher contacts and the breech. If possible, the launcher should be covered/protected from weather and spray when not in use. To protect Hand Launchers, one should store the hand launcher inside being careful not to kink the wire or damage it by leaving it exposed to potential hatch closings. If possible, it is a good idea to**

hang the launcher on a hook by a cord tied to the handle. This allows for easier looping of the launcher wire that prevents kinking.

15- **Note that the XBT probe wire may act as a receiving antenna. Not only strong electromagnetic fields of nearby lightening strokes may cause measurement errors, but also radio communication can be a primary source of electronic noise.**

16- **Due to the thermal mass of the zinc nose of the XBT probe, the difference between the XBT probe's storage temperature and the sea surface temperature should be minimized. Storing a day's use of XBT probes outside of the wheelhouse will help "climatize" them. Avoid launching XBT probes that have been stored in an air-conditioned wheelhouse into tropical waters and vice versa, avoid launching XBT probes stored in a heated wheelhouse into arctic waters.**

17- **When you leave the ship, if at all practical, inform the captain or bridge officers that you are finished, thank them for a job well done, and wish them a safe voyage.**

4.3. Pitfalls to avoid

1- **Don't visit the ship late at night. (You may only find the night watch mate on duty, who will know nothing of the previous cruise, and is not the one who will require training and may not even pass along information that you visited the ship)**

2- **Don't visit the ship just prior to sailing. (Things are just too hectic then with ships stores coming aboard, last minute visits from the ships agents or managers, stress on the Captain because he wants to sail on the "tide" etc.)**

3- **Don't just rush on board and grab your data and leave assuming all was working before so everything must still be all right. (This is a sure path for failure and won't ingratiate you with the ship's officers)**

4- **Don't walk on board with an attitude like this is "your" ship even though you may have visited this ship a hundred times and know everyone who has ever worked the ship. (This ship is their home and you should always be respectful of that)**

5- **Don't "promise" something and then not deliver. If you tell the Captain that you will "find out" about something, then do so and get back to him with that information as soon as practical. (Do this in a timely manner even if you have to call, fax or email the ship at sea)**

4.4. Training

The training of bridge officers in how to launch XBT probes usually requires about ½ an hour of their time. (The same for how to deploy drifters or floats). Depending on how much time and how effective you were in the debriefing when you first came aboard can have a large effect on how much time you now spend training a new bridge officer. Keep in mind that there are usually three bridge officers that stand a watch and sometimes a radio or electronics officer. These officers are always coming and going so your training never stops. You have to do training each time you visit a ship to guarantee that all officers know what to do. You can't always depend on one mate passing the knowledge along to the next, even though many do. Most vessels have overlapping replacement officers, but not always. There are many examples of entire crews and bridge officers being changed at the same time. This really makes your training job tough because at those times the officers being exchanged are really busy trying to come up to speed with their "new" vessel.

If the ship owners give you permission to ride their vessel to the next port you can use that time to enhance any training required. These activities are frequently referred to as "familiarization" or "fam" floats. On certain routes where high density sampling is required we often use ship riders to collect the data. When those ship riders depart and the bridge officers again commence their normal low density sampling, the quality of the data collected remains very high. Ship riders also convey the message of "program importance" to the ship's officers which adds credence to your program.

1- **Slowly step the bridge officer or officers through the software program. Begin from a "cold boot" and take your time.**
2- **Have them do it once by themselves (resist helping too much) and go so far as to have them drop an XBT probe or two while dockside to be sure they are comfortable. Better to sacrifice a couple of XBT probes dockside than to loose a complete transect because of some problem or confusion. A test box is also a very useful tool for training purposes. Another very good alternative is a demonstration by dropping an XBT probe into a grounded bucket filled with water.**
3- **Answer any questions they may have.**
4- **Assure them there is nothing that they can "break" in the software.**
5- **Explain how to recover from a system corruption of some sort by reinstalling the configuration files. Create "bootable-backup" disks. Resist using "gimmick" software.**
6- **Explain how they can reach you if they have any questions or concerns.**
7- **Monitor the ship's reporting the first couple of days after sailing, and if you see no observations being transmitted, then contact the ship right away and ascertain the reason. Take corrective action as required.**
8- **Additionally, monitor the ship's reporting throughout their voyage and when a few days out of the port in which you will visit the ship, contact them again to inform them you will be visiting the ship upon arrival. This provides them with a "heads up" and notice that you "care" about the observations they are collecting for the program.**
9- **Provide a laminated "quick start" type simplified instruction sheet to be placed near the PC for reference.**
10- **Reassure the officers that any problems they may have are "your" problems and not "theirs." If problems persist, have them shut down the system and wait until the next in port visit. If possible, email communications can be used to attempt solving any "at sea" difficulties.**

4.5. Ship Visit Reports

A ship visit report should be created for each visit and added to a data base or at least a filing system. These ship visit reports provide a record of ship and equipment problems as well as provide a mechanism for the tracking of delayed mode data. Additionally, it will allow for the tracking of expendables delivered to each ship and also provide information to others in the program who may visit ships in different ports or, on occasion, different countries. (In this case a copy should be left on board).

Depending on how large your SOOP is and how many different vessels you have to keep track of, you should take into account the probability of ships changing owners, names and radio call signs often. In the GOOS Center we use the vessels Lloyd's or IMO number as a common tracking mechanism, because ship's names and call signs may change but the IMO number remains the same.

A very simple Ship Visit Report should consist of at least the following:

1- **Ships name, call sign and cruise number.**
2- **Captain's name.**
3- **Date of a visit.**
4- **XBT probes and types remaining on board.**
5- **New XBT probes supplied (type, date of manufacture, serial numbers)**
6- **Data removed (number of observations).**
7- **Hardware changed out or repaired.**
8- **Remarks sections where you can record officers names, problems, information requests, communication links, routes covered, etc.**

SHIP NAME: M/V Alexander Sy

CALL SIGN: COOK

DATE OF VISIT: 7/16/00

NUMBER AND TYPE OF PROBES DELIVERED: 10 Cases
(s/n 992766 to 992886)

NUMBER AND SERIAL NUMBERS OF DRIFTERS DELIVERED:
None.

DATA FILES REMOVED:
PROBE.DIR
MET.DAT
.

DUTIES PERFORMED: Removed empties, trained new crew.

REMARKS: Monitor fades after a few days. Put a new one on - 1st one I tried didn't work (7 flights!)2nd one ok. Strange color, better picture.
Computer and monitor hit the deck in the Tasman sea. Doesn't seem to have done any harm.
Comsat news is now being received on all my ships.

Figure 3. Example of generic ship visit log

4.6. Data Retrieval

It is important to make a concerted effort to backup and archive all data collected by the vessel. There are several ways to accomplish this:

1- **Manual copying of the files to floppy disks.**
2- **Automatic archiving that is controlled by the operational collection software, either by date, time or volume.**
3- **Utilization of compression software to maintain copies of the data on the ships PC.**

Creating backup or compressed data files by the ship greeter provides the opportunity to review the data collected for errors, to display the data collected to the ship observers and, additionally, allows for the first quality control review. This review should pick up date, time and possible positional errors that can be corrected then and there with a little extra training**,** or at least noted for future correction. Ideally, one should leave a compressed copy of the data on the ship (identified by some cruise number), remove from the ship a similar compressed copy via floppy disk or some other copy medium and also the original "raw" data in a similar medium. This provides three levels of redundancy, which in most cases should protect the data from the most egregious mishandling.

5. Launching XBT probes

The launching process realistically takes about 5 minutes of the bridge officer's time. The pre-launch setup with the computer software, walking out to the leeward bridge wing with the hand launcher, the actual launch (Deep Blues take about 2 minutes to reach their maximum depth of 760 meters), returning to the bridge and coiling up the hand launcher wire, and the post-launch data processing and transmission with the computer.

Ideally XBT probes should be launched as far aft and as close to the water as possible, preferably with the use of a Thru Hull Launcher or Deck Launcher. The next best place is off the fan tail of the ship. However, in the SOOP environment, neither of those options is realistic (as bridge officers can't leave the bridge while on watch) and most XBT probe observations are collected via hand launchers from the ship's bridge wings. On some larger vessels the bridge wings can be as high as 80 feet above the surface of the water. XBT probe launches from this height can result in a higher than usual XBT probe failure rates (3 to 5 %).

The highest cause of XBT probe failure or partial failure results when the XBT probe wire touches or drags against the ships container's, railing or hull. This usually causes some "spiking" in the data due to wire insulation penetration which then has to be edited out and sometimes is so bad that the whole trace is unuseable. Wind is the greatest enemy of a successful XBT probe launch. Experiences show that a relative wind exceeding 50 knots (common in the higher latitudes) causes a significant increase of spikes due to "wire stretching". Wind gusts can stretch the wire which breaks up the thin insulation coating. Sometimes just the wind "whipping" the XBT wire on the sea surface may cause "spiking". Present day commercial vessels are so large and fast that they can "create" their own wind vortices that can take control of the very light XBT probe wire and send it all over a ship. There are several ways to avoid having the XBT probe wire touch the vessel.

1- **Always launch on the leeward side of the vessel.**
2- **Launch as far aft on the bridge wings as possible.**
3- **Point the hand launcher aft and hold it as far out from the ship as possible before pulling the pin.**
4- **Using a long plastic pipe: Sometimes using a 1 to 2 meter length of plastic pipe in which the hand launcher fits helps to get the wire farther outboard and, if properly anchored, also allows the mate on watch to "pull the pin" and then return to the bridge while the wire streams out and thereby avoids having to stand there holding the hand launcher in inclement weather. The opening of the tube should be well rounded to prevent damage or chafing to the insulating coating of the XBT probe wire as it streams out.**
5- **Raising launcher outboard and over head: Sometimes raising the hand launcher outboard and over your head will allow the XBT probe wire to be carried by the wind away from the ship.**
6- **Strong winds: If the wind is very strong or blowing from the stern you can gently pull the pin and carefully catch the probe in your hand and then throw (lob in a gentle smooth arch) the probe out and away from the ship while at the same time raising the hand launcher outboard and over your head like in number 4 above. However, using this launch technique you have to be careful not to cause the probe to tumble on its way to the ocean surface. Tumbling can cause the XBT wire to kink or allow the probe to hit the water in a less than perpendicular fashion thereby causing a failure.**

Usually, under strong wind or unusual oceanographic conditions we will try re-dropping two, sometimes three XBT probes to collect a satisfactory observation. If failure continues then cease operations until conditions improve. See Figures 8a through 8l for examples of wire stretch or leakage.

6. Examples of bad XBT profiles

The following figures (8a through 8l) are examples of bad XBT observations taken from Daneshzadeh et all. (1994). They were determined to be bad from quality control procedures developed by our Australian colleagues at CSIRO. While these procedures are used in a scientific quality control atmosphere they may be a bit too subtle for most VOS operations and are included here for reference only.

Fig. 8a: The BOR flag is used if an unrealistic inversion (warming of >0.2 C in a region where inversions have not previously been observed) is detected in the mixed layer.

Fig. 8b: The CTA/CTR flag is used to reject data from the surface if the profile is isothermal and if the surface temperature is inconsistent (invalid) with that of neighboring profiles.

Fig. 8c: The CUR flag is used if large amplitude (>0.2 C) periodic cusping is embedded in a profile.

Fig. 8d: The HBR flag is used if a hit bottom event is indicated by the trace.

Fig. 8e: The HFR flag is used if there is severe interference or if filtering fails and the temperature records are considered to be corrupt.

Fig. 8f: The IPR flag is used if the profile is deemed not to have fully recovered from an insulation penetration spike.

Fig. 8g: The LER flag is used when leakage is observed as erratic, sharp and unrealistic structure over a range of depths or the entire profile.

Fig. 8h: The NGR flag is used if all or a portion of the profile is obviously erroneous.

Fig. 8i: The SPR flag is used if large amplitude step-like features are observed in a profile.

Fig. 8j: The TOR flag is used if an unrealistic temperature difference can not be confirmed by a neighboring drop.

Fig. 8k: The WBR flag is used if the bottom of the XBT profile exhibits a sudden deflection to the high or low temperature end of the scale.

Fig. 8l: The WSR flag is used if an unrealistic bulge to the high temperature end of the scale is present that does not fully recover.

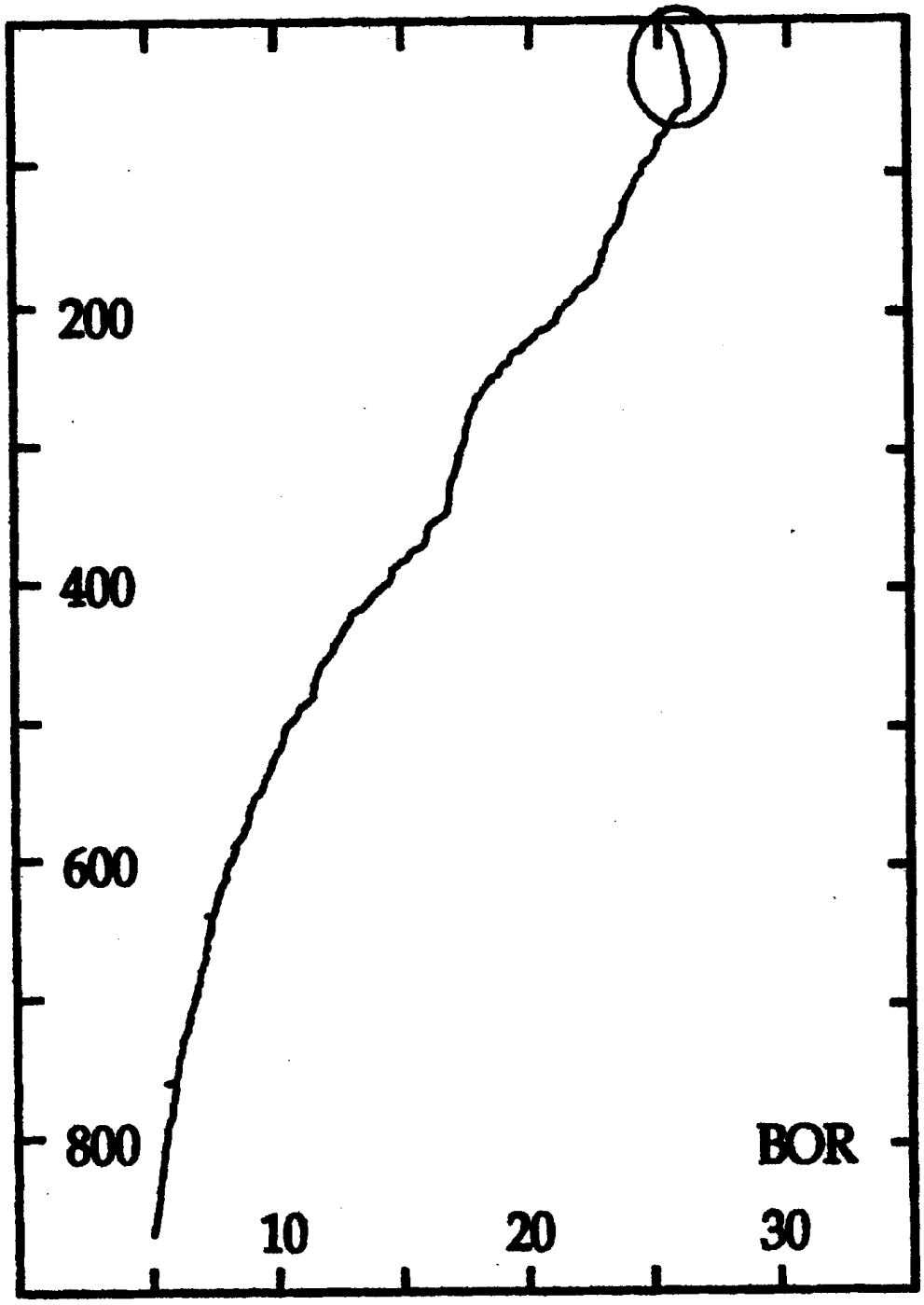

Figure 8a. Bowed Mixed Layer Reject (BOR)

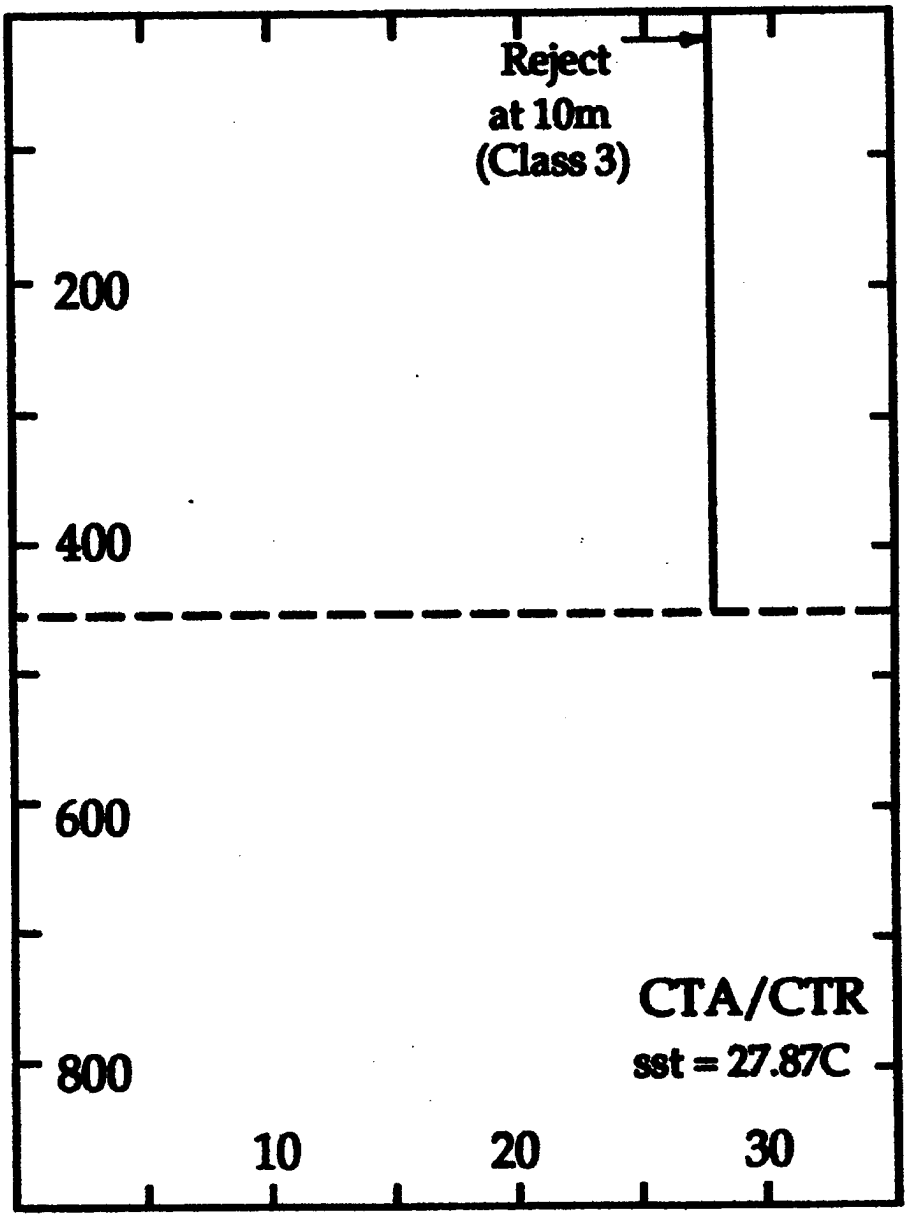

Figure 8b. Constant Temperature Profile Reject (CTR)

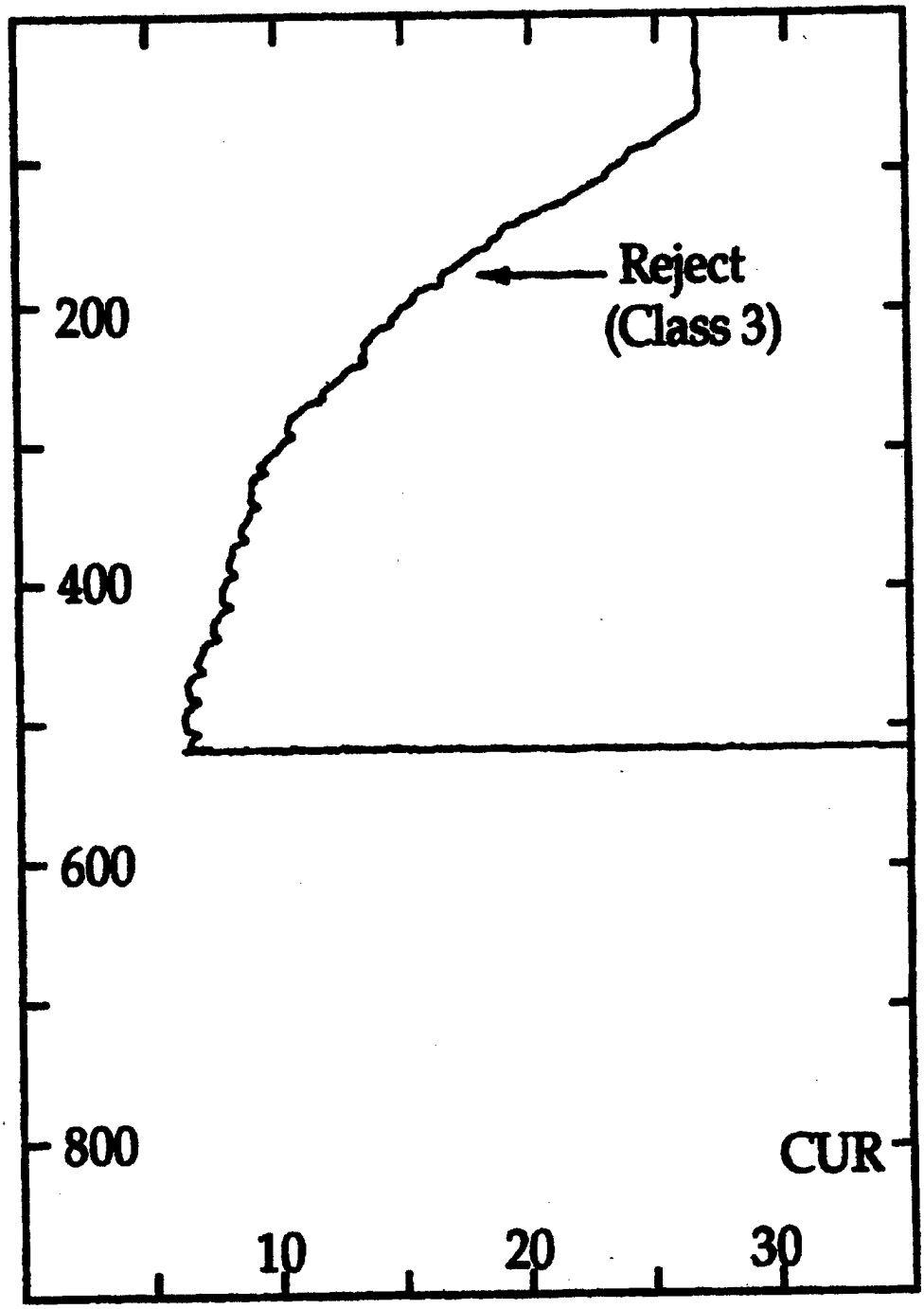

Figure 8c. Cusping Error Reject (CUR)

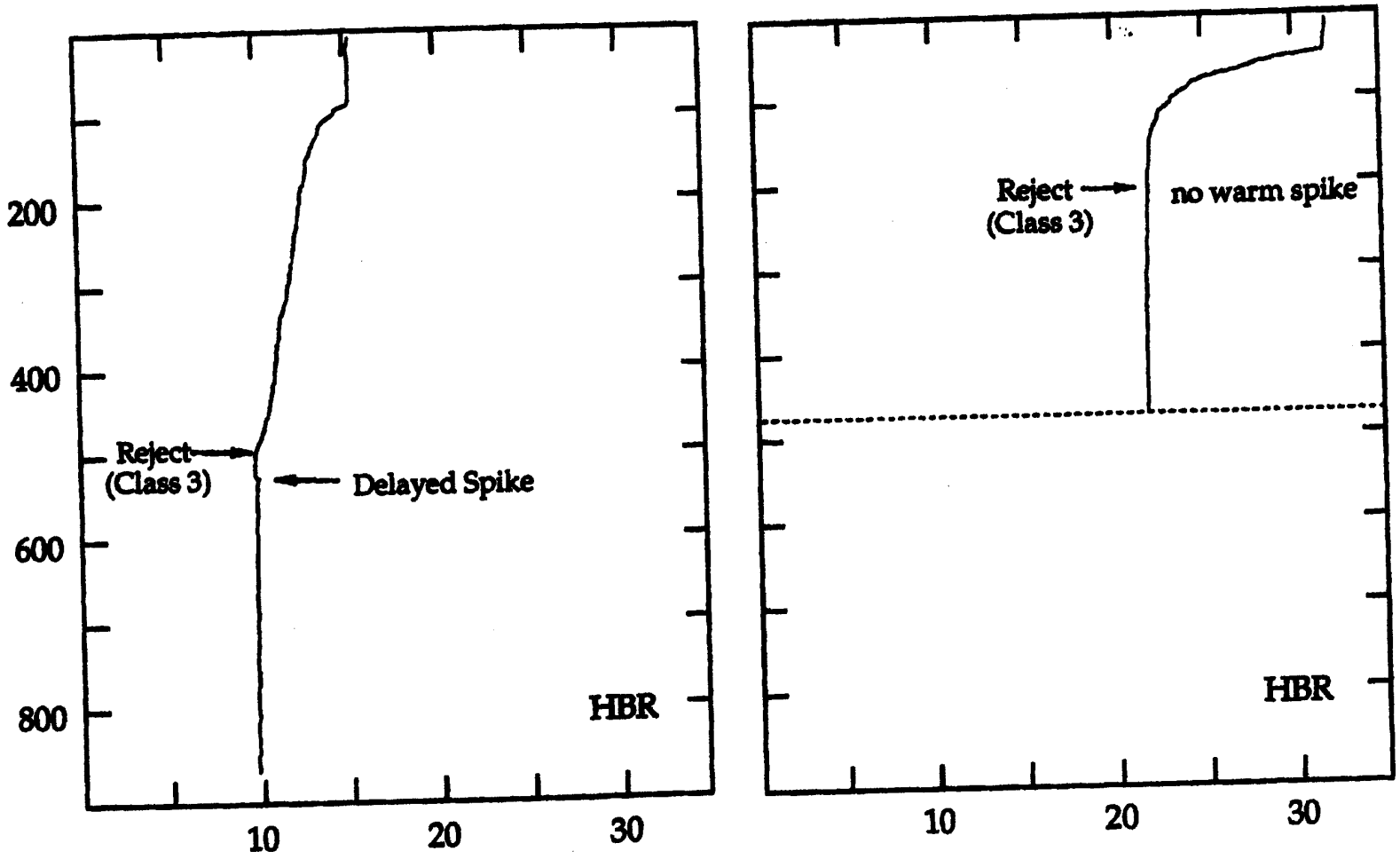

Figure 8d. Hit Bottom Reject (HBR)

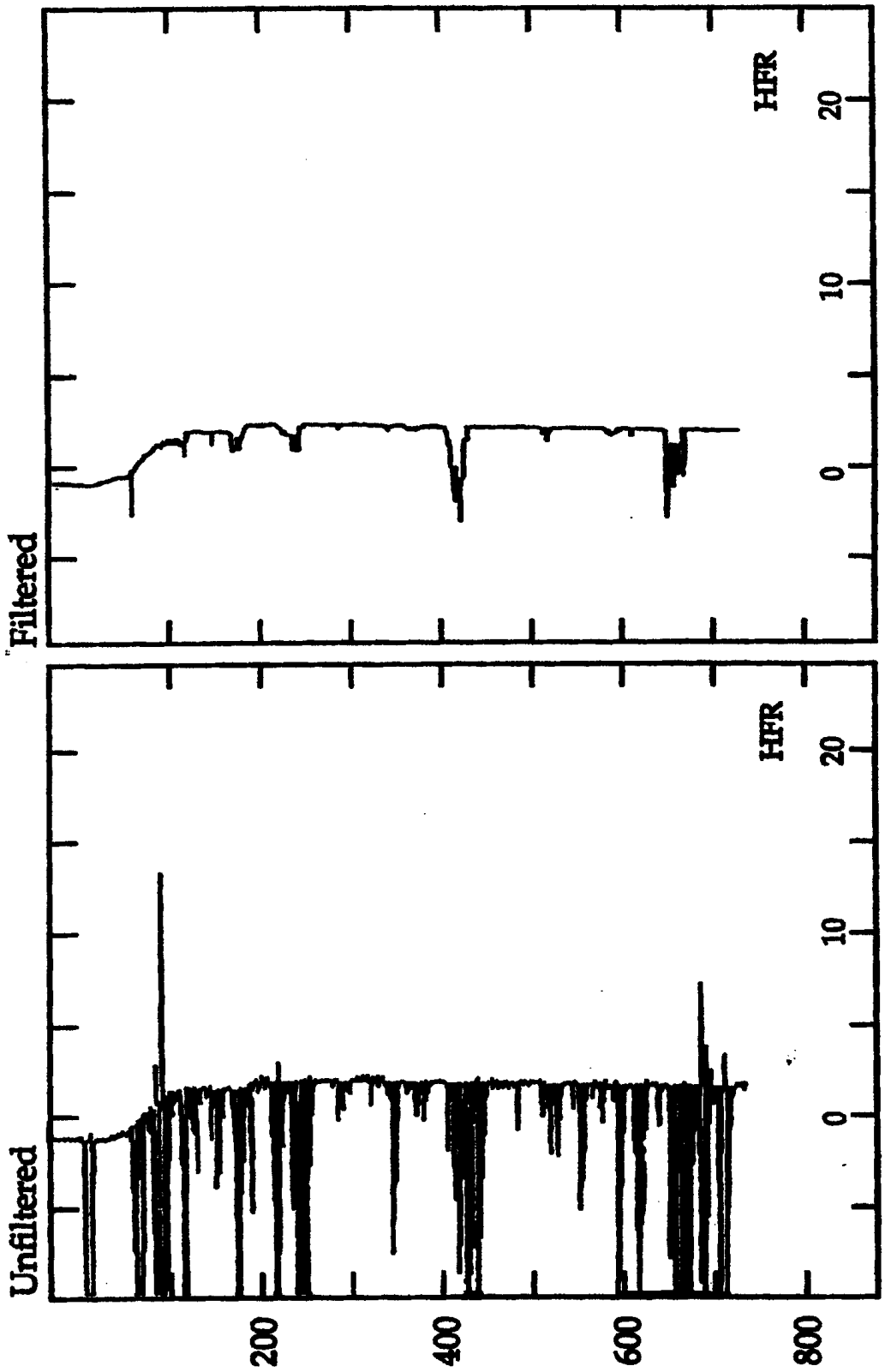

Figure 8e. High Frequency Reject (HFR)

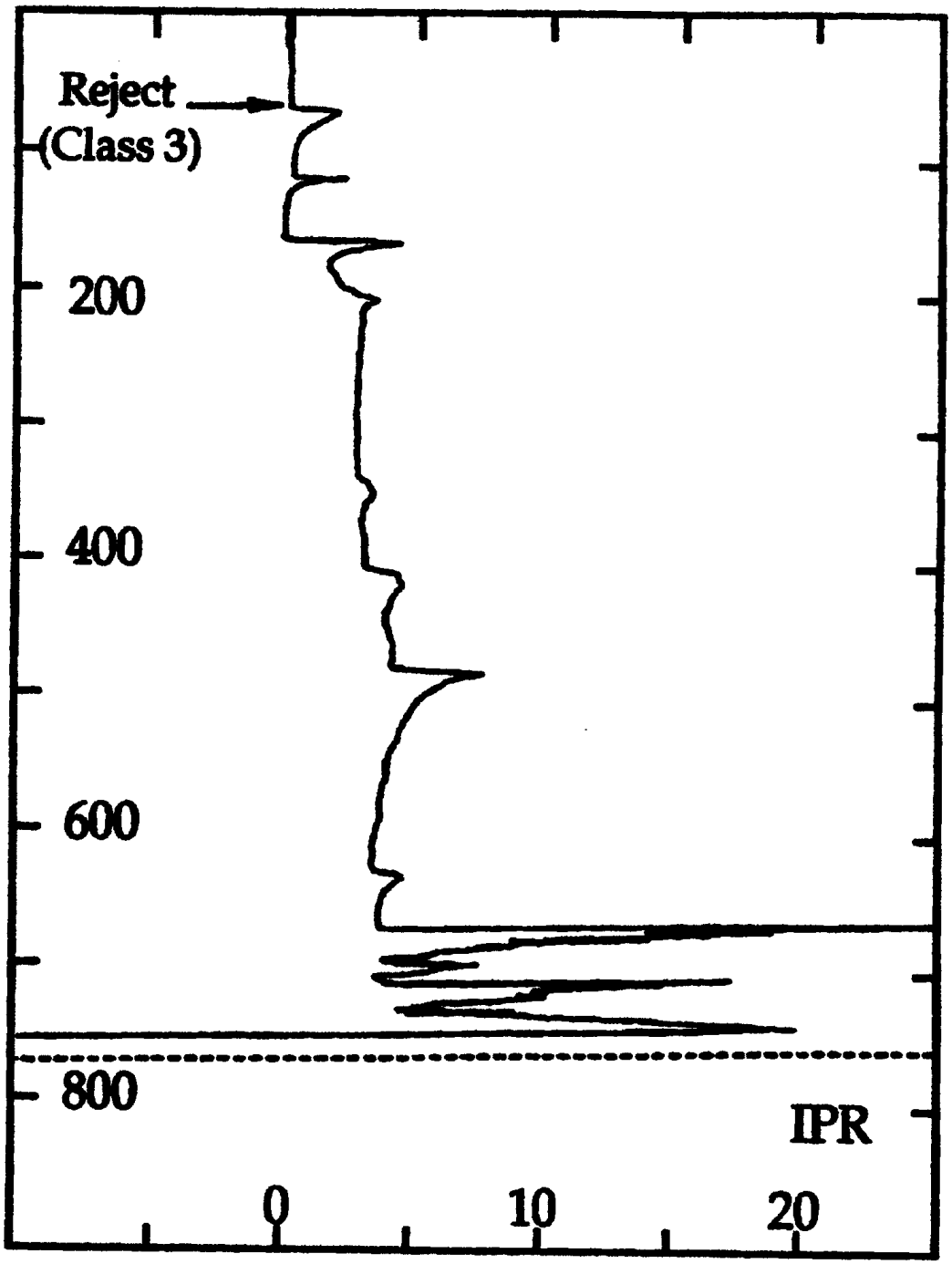

Figure 8f. Insulation Penetration Reject (IPR)

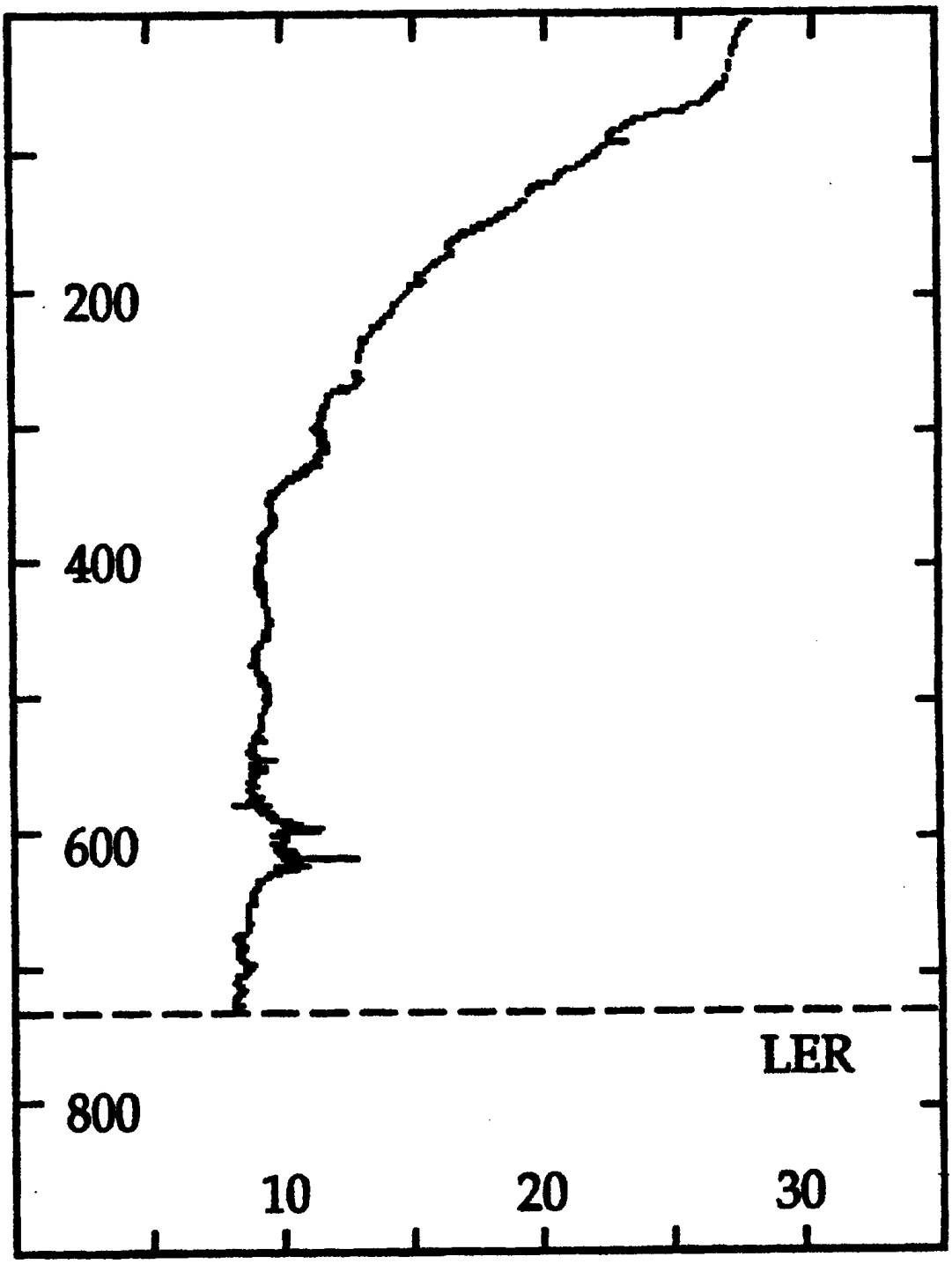

Figure 8g. Leakage Reject (LER)

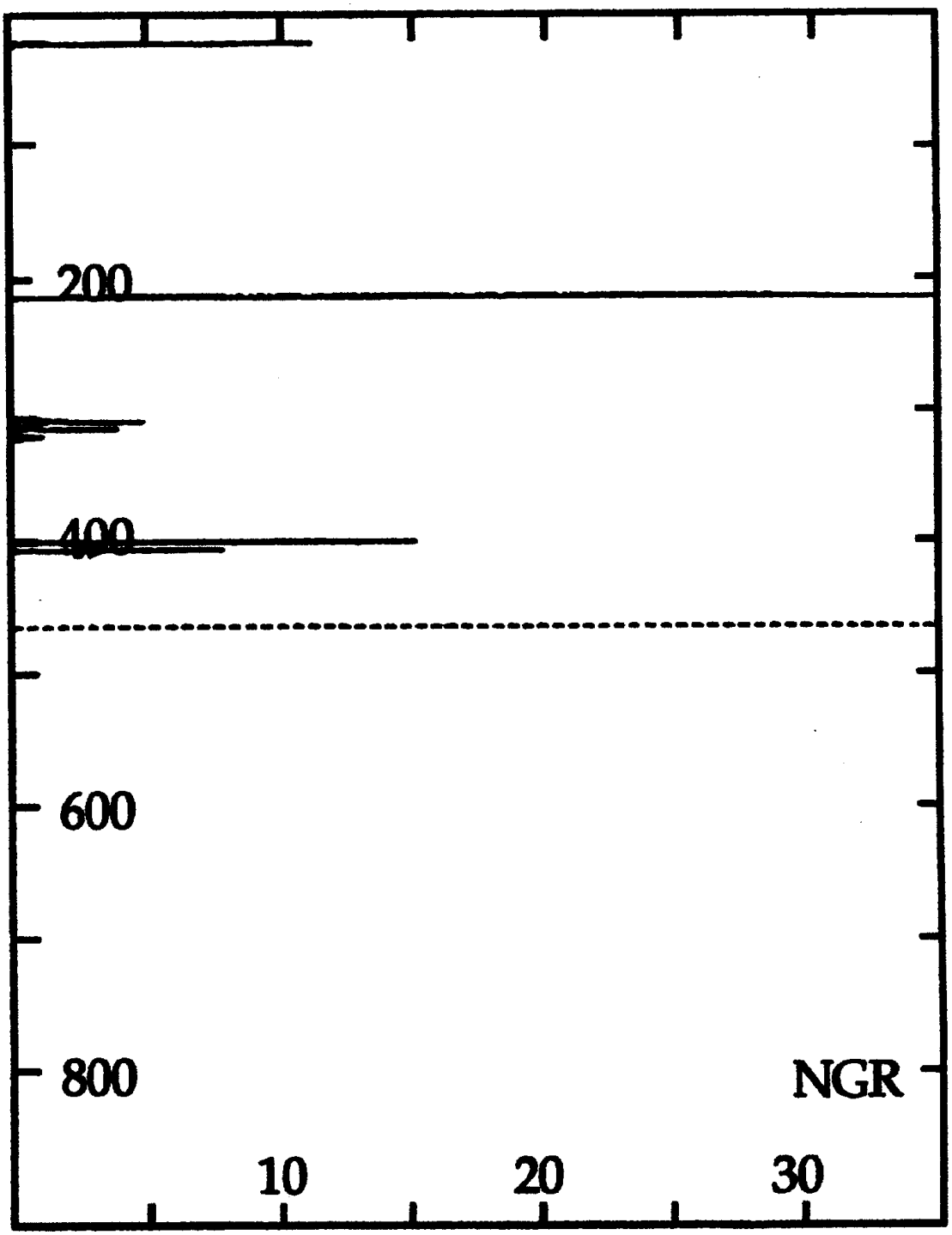

Figure 8h. No Good Reject (NGR)

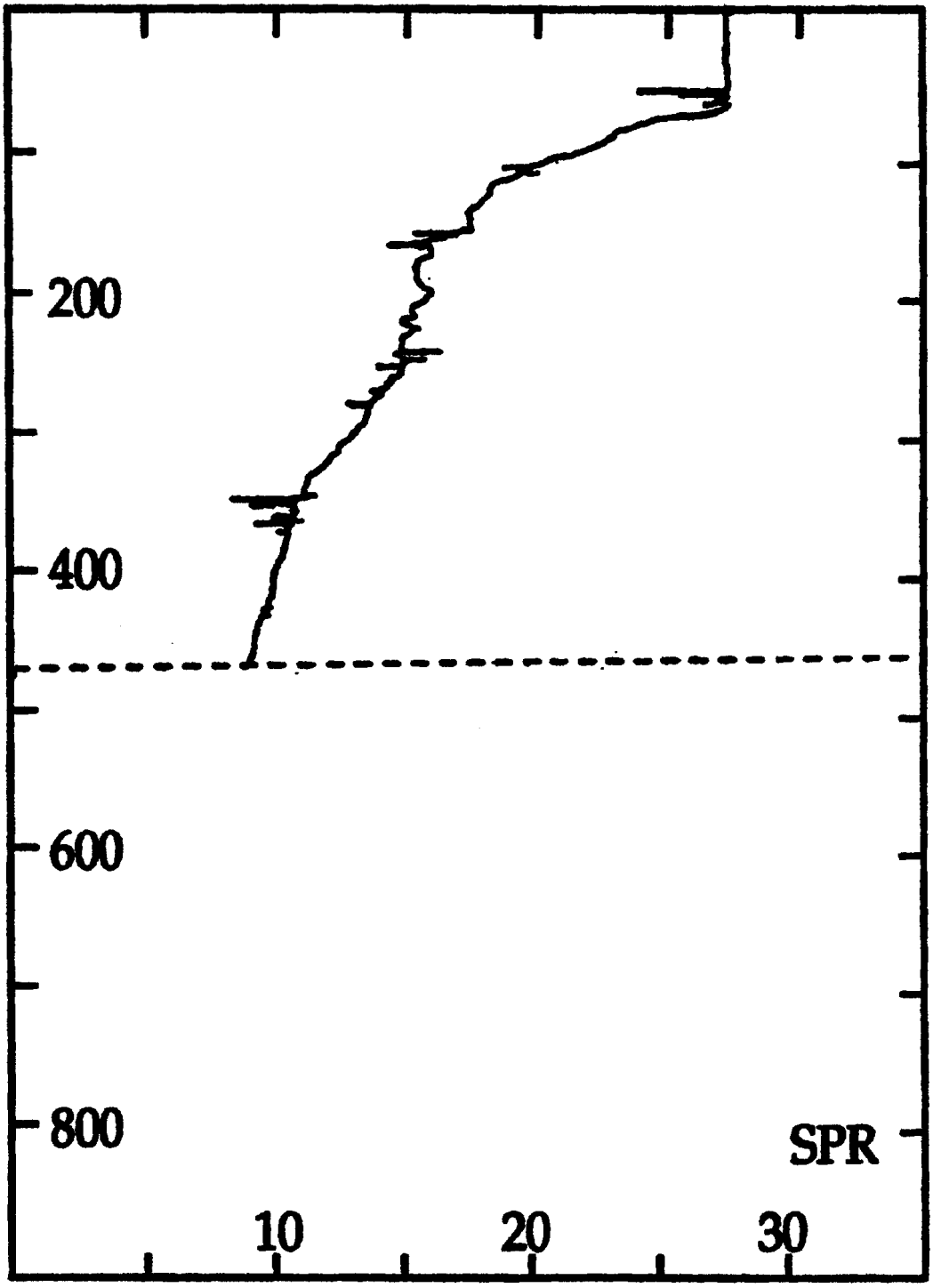

Figure 8i. Spikes Reject (SPR)

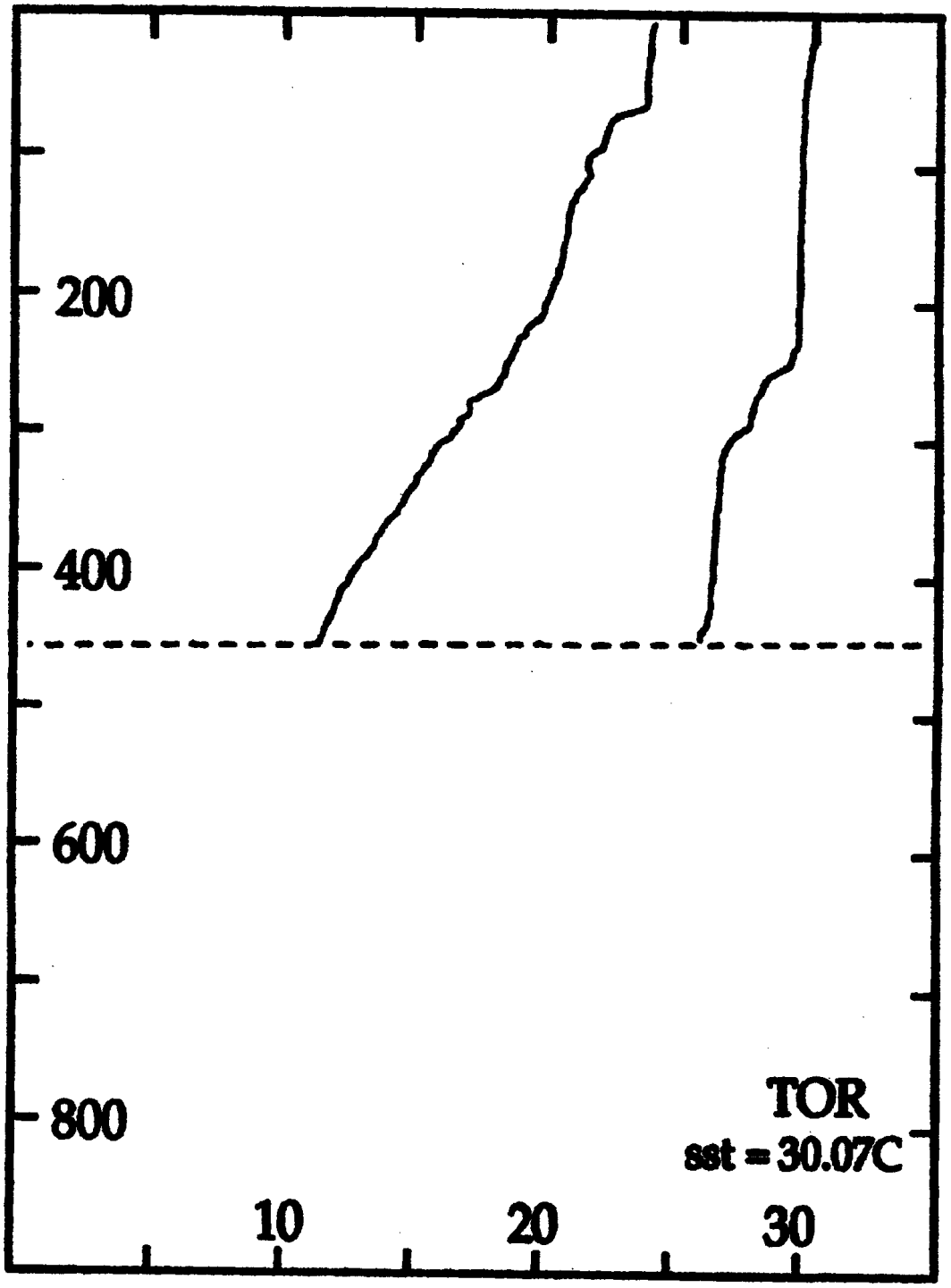

Figure 8j. Temperature Offset Reject (TOR)

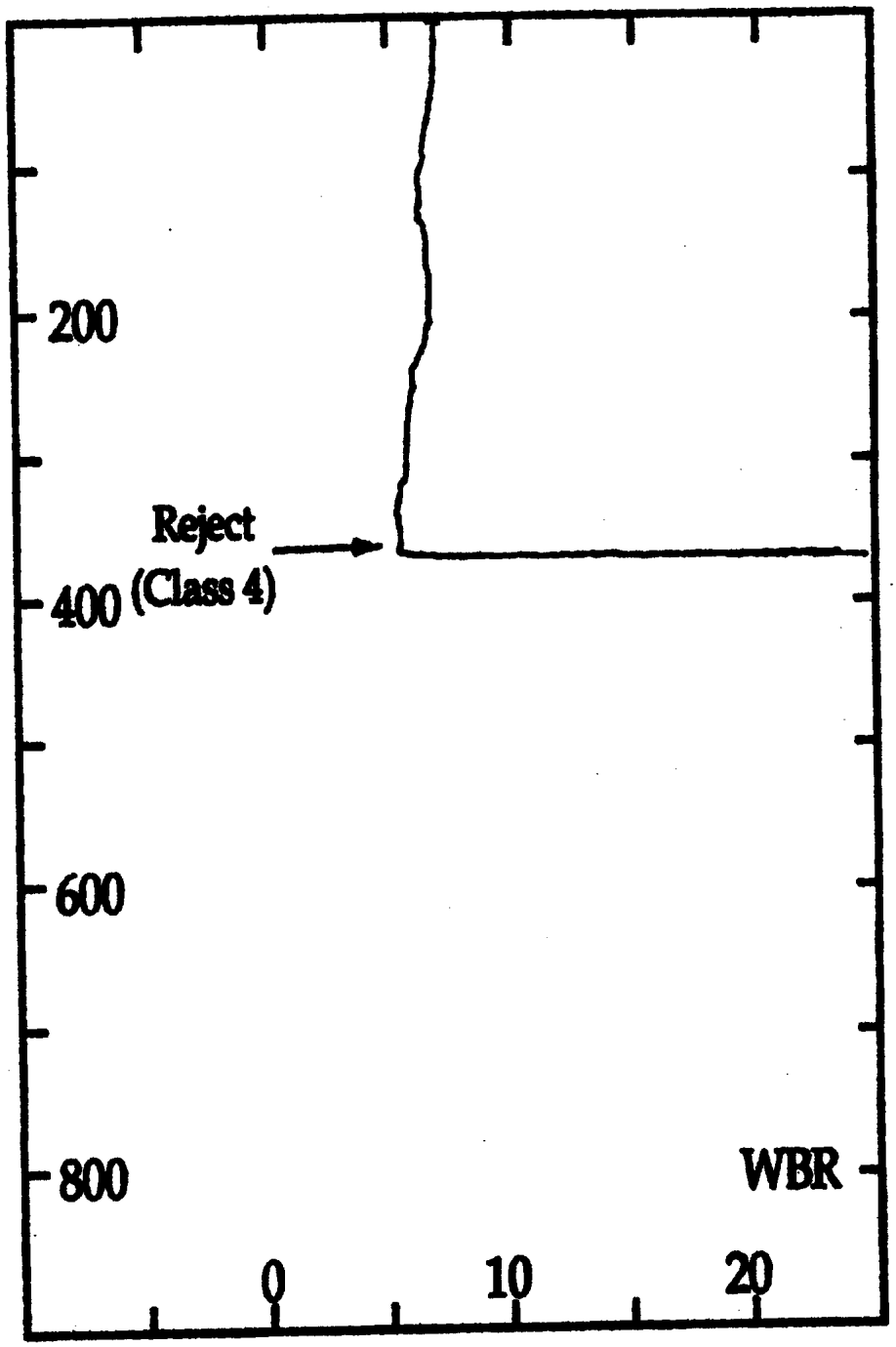

Figure 8k. Wire Break Reject from Probe Spool (WBR)

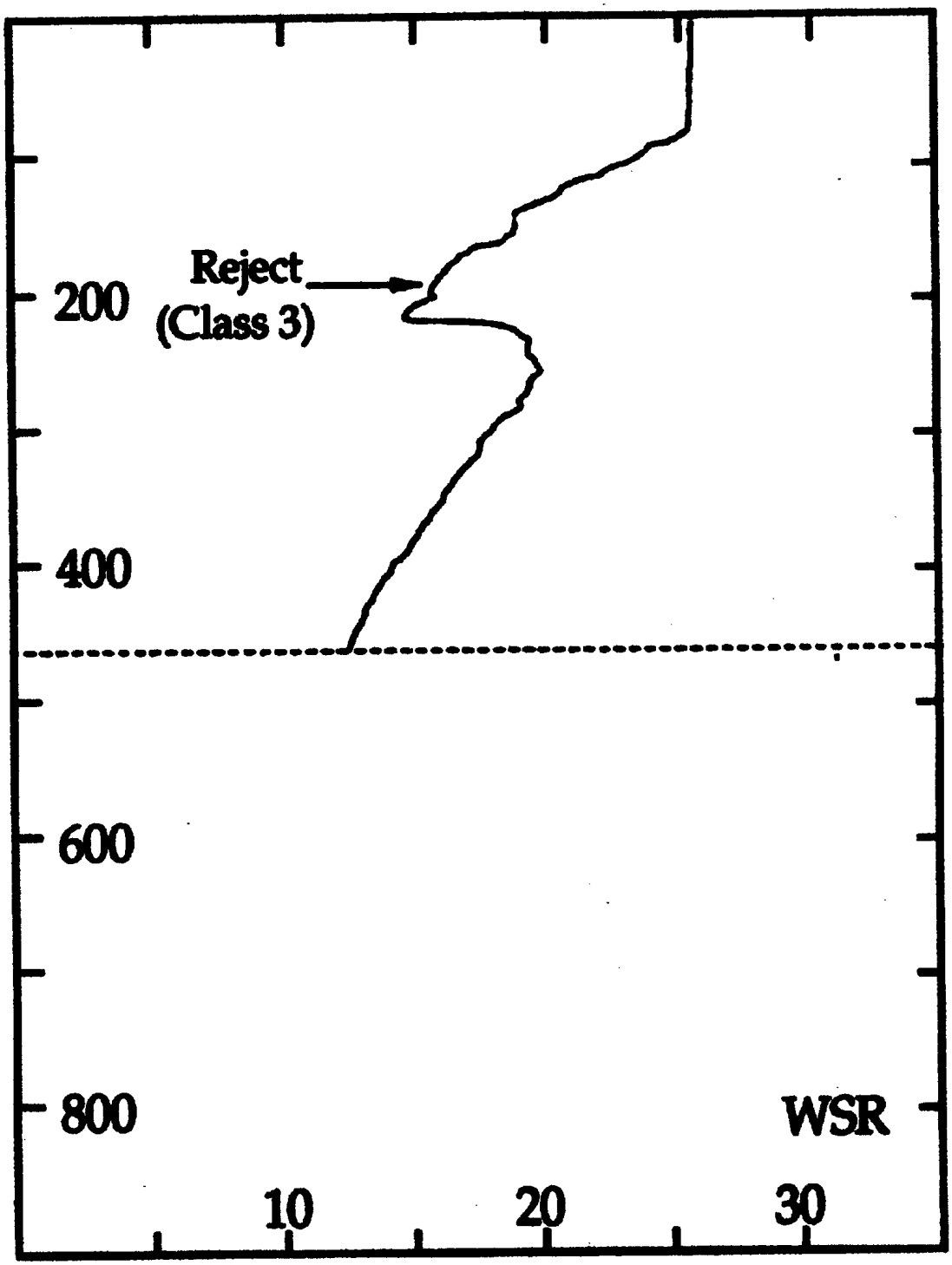

Figure 8l. Wire Stretch Reject (WSR)

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