# USCGC Healy Scientific Trials

Warm Water: 17 February - 05 March 2000

Cold Water: 25 May - 29 June 2000

# AICC Report

draft of 17 August 2000

# Summary Document of the Daily Science Reports for Healy Shakedown Legs 1 & 2 Warm-Water Evaluations: 17 February- 05 March 2000

## Prepared by: Lisa Clough, Chief Scientist

Scientific Equipment evaluated concurrent with warm-water test memos: (followed by evaluator(s))

Acoustic Doppler Current Profilers (Jules Hummon for Eric Firing, jules@soest.hawaii.edu efiring@iniki.soest.hawaii.edu)

CCTV (evaluated by Joe Farmer and Bob Parsons)

Coring Equipment (Jim Broda and OSU (Pete Kalk and Chris Moser), broda@npolar.no kalk@oce.orst.edu cmoser@oce.orst.edu)

CTD (Bill Martin, bmartin@ocean.washington.edu)

Science Data Network (Barrie Walden, bwalden@whoi.edu)

SeaBeam 2112 or Bottom Mapping Sonar (Dale Chayes, dale@ldeo.columbia.edu)

Winches (evaluated as part of the coring and CTD testing)

Additional equipment evaluated (incorrect test memo due to different equipment being purchased):

Bathy 2000 (Barrie Walden and John Freitag jfreitag@gsosun1.gso.uri.edu)

Additional science personnel on board:

Jack Bash (UNOLS, jbash@gso.uri.edu)
Jon Berkson (USCG-Headquarters, jberkson@comdt.uscg.mil)
Lisa Clough (AICC, cloughl@mail.ecu.edu)
Larry Lawver (AICC, lawver@ig.utexas.edu)

Additional Testing:

Acoustics (Tim Gates and team (Kevin O'Neill, Rob Tutton, and Tim Cullis), tgates@mantech.com)

**Overall Summary**

The warm-water testing phase was very productive. Without exception, the first comments from those participating in the evaluation process concerned the exceptional level of dedication and willingness of the crew to assist in all aspects of the science testing. In general, the "over the side science" (winches, CTD, and coring) went very well, while portions (SeaBeam 2112, the 300 KHz ADCP, and the Bathy 2000) of the "underway" science will require some more troubleshooting before being judged acceptable for scientific usage. General overviews for each piece of gear evaluated follow, more complete descriptions of results can be found in the complete set of daily science reports. NOTE: In all cases, full evaluations are works in progress and will not be complete until after cold-water testing.

**ADCP**

Both the 150 and 300 KHz broad band ADCPs were subjected to a number of scientific evaluations during the warm-water testing phase. Preliminary results indicate that the 150 KHz ADCP is returning valid data to ~150 meters water depth. Much energy has been expended on providing error-free navigational and time information to the ADCPs and multi-beam system, and we now appear to have error-free inputs from the ship's integrated bridge system. We will continue to explore ways to provide direct navigational and time inputs to the ADCPs. On a precautionary note, the 150 KHz ADCP may be susceptible to bubble interference at higher ship speeds and sea states (pitching may be the primary cause of bubbles). Preliminary results indicate significant problems with the 300 KHz ADCP. The ship's 356 KHz speed log produces significant interference, and even with the speed log off, the 300 KHz ADCP is only returning acceptable data for the upper 20M of water.

**Bathy 2000**

The Bathy 2000 was initially judged to be unacceptable for determination of bottom depth and pinger returns. Some of the initial problems seem to be clearing up as the operators gain more experience with the system, however all evaluators encourage the CG to acquire a Knudson system. A remote Bathy (or Knudson) display would be enormously helpful in the aft science conning area (currently the Bathy display is in the computer lab and accessing it requires either using the phone or running across the passageway). In general though, use of the aft science con for ship's navigation is going very well. Formal evaluation of the Bathy will take place during cold-water testing.

**CCTV**

At present the CCTV cameras do not pan or focus, and as such are not very useful for science operations (e.g., only one of the winch cameras provides a reasonably complete and focused view, and the cameras located on the A frames cannot be panned to where the wire/ equipment is in the water). The problems have been classified NSI (NavSea Investigate)

## Coring Equipment

Several successful dead weight tests were done on the trawl/ core winch. At that point testing proceeded to 1) dredging, 2) gravity coring and 3) piston coring. All coring evolutions were done off the stern. Dredging was done in the Puerto Rico Trench in water depths of ~5600M. Dredging began within 30M of the desired station location. A 10 foot gravity core was successfully deployed in 5272M of water, and was completely full of red clay when brought back on deck. Finally, a 40 foot piston core was smoothly and successfully deployed, and approximately 39 feet of red clay was recovered from ~5300M of water. Processing of wire tension data clearly showed "hits" and "pull-outs" of both the trigger and piston cores. Work is underway to make such displays real time by the beginning of cold-water testing.

## CTD

Both CTD/ rosette systems were evaluated and found to be functional and ready for science data collection in the cold-water phase. In addition to temperature and conductivity sensors, a fluorometer was deployed and appears to be working well. With the exception of one presumed lanyard problem, all bottles fired successfully.

## SDN

As mentioned above, many person-hours were expended on providing error-free navigational and time inputs to the ADCPs and SeaBeam. During the San Juan to Lauderdale leg, the information being sent via the integrated bridge system improved dramatically, and seems to be error-free, but the evaluators encourage pursuing the direct input option. The SDN displays are very useful on the CCTV monitors, and suggestions have been made for possible enhancements to the system. E-mail for the scientists seems to be working well under the present configuration of using WHOI as the shore-based termination.

## SeaBeam 2112 (Bottom Mapping Sonar )

Pitch and roll bias tests were successfully completed on the SeaBeam 2112. However, the formal scientific evaluation of the SeaBeam 2112 was deemed to be inappropriate at this time given the large number of problems with the SeaBeam system, so reports on the SeaBeam primarily annotate a set of problems. Some problems have been fixed (replacement of bad OAR and DSP boards, establishment of reliable connections to the VRU), but serious concerns about the cabling and common mode noise remain. Warranty cards have been written, and all parties involved are working to solve the identified problems. Solving the problems related to EMI seems to be the first order of business.

## Winches

Oceanographic winch #1 was found to be inoperable during our first attempt to deploy the CTD. Replacement parts were immediately ordered, and the MSTs swapped out the wire, and successfully switched to Oceanographic winch #2 while underway. Initial software and hardware problems were rapidly solved, and both oceanographic winch #2 and the trawl/ core winch worked very well on subsequent deployments, in fact the smoothness of starting and stopping the winches was noted as being exceptional. A final attempt to use the winches on 3/05 indicates a few winch control problems still need attention. Suggested improvements to facilitate winch operations have been submitted to the ship by the MST force.

# Final Report Leg 1 Phase IV Healy Science Trials
# 7 June 2000
# Dr. Kelly Kenison Falkner-Chief Scientist

To begin I would like to thank Captain Garret and his crew for greatly facilitating science activities during leg 1 of the science trials. Their dedication and cooperation made the experience a pleasurable one. I would also like to thank ALL members of the science team. The individuals who responded to the UNOLS request lived up to and beyond their excellent reputations. Others involved at the Coast Guard and Navy's behest contributed far more than we could have accomplished on our own. Finally, I would like to thank everybody involved for welcoming the teachers on board and facilitating their activities throughout the trials.

Principal objectives of Leg 1 (25-31May 2000) Phase IV of the Healy Science Trials were:

1) to test science acoustic equipment, including the SeaBeam 2112 swath mapping system, the RDInst. 150 and 300 kHz broad band acoustic doppler current profilers (ADCP), and the ODEC Bathy2000 and Knudsen 320B/R bathymetry systems, both in open water and heading into the marginal ice zone
2) to test the Sippican Mk12 XBT system
3) to evaluate the science data network (SDN)

In addition, we were charged with assessing communication systems as they pertained to science activities.

We were able to meet all of our objectives with the exception of testing in the marginal ice zone. The ice had simply retreated too far north to reach within the allotted time frame for this leg, however, the acoustics gear can still be exercised during legs 3 and 4 in the ice. With help from Captain Garrett and his crew, the science testing team was able to effectively trouble shoot and establish successful operations of all but the 300 kHz ADCP. We also undertook an initial assessment of the performance of both climate control chambers, the refrigerant of which had been recharged in port before we sailed. Details can be found in the daily reports of the chief scientist and in the summary reports from the science testing team members. The latter constitute comment section input for the test memos for this leg and the brief summaries below are excerpted from them.

**SEABEAM 2112**

Based on examination of real time data, the SeaBeam 2112 now appears to be functional. Tim Gates and Kevin O'Neill determined that rerouting the hydrophone cables has effectively eliminated EMI noise problems identified during warm water trials. They also observed other sources of noise on the ship were observed to be at or below 50 db level in the 12 kHz frequency range as required for optimal SeaBeam performance. Consistent communications with a now properly oriented vertical reference unit (VRU) appears to have resolved repeated software crashes. New pitch and roll calibrations were performed and a variety of mapping exercises undertaken. Potential users of SeaBeam on the Healy can expect to obtain good bathymetric data in moderate seas, at most headings and at reasonable speeds in open waters. They can expect to

encounter similar data artifacts, reliability and capabilities that have been experienced by the science community on UNOLS vessels. A more quantitative assessment of system performance and deficiencies awaits post-cruise data analysis by Peter Lemmond. In addition, there remain several outstanding issues to be resolved. These include clarification on the depth dependence of the software controlled switch from shallow to deep operating modes, additional verification of the pitch and roll bias corrections and checks on repeatability, and assessment of system performance in the ice. Finally, maintenance and operation of SeaBeam system needs to be planned and reviewed.
I note that the efforts of both Dale Chayes and Peter Lemmond have been critical to troubleshooting this system on Healy. It would be highly advantageous to keep both parties and the AICC in the loop on further developments related to this system.

**ADCP's**

The 300 kHz ADCP is not presently capable of acquiring water velocities below about 20 m. This does not appear to be due to exposure of the transducers to air. The ship's speed log operates in a similar frequency range (about 350 kHz) and so interferes with this system. Furthermore, the operation of the 300 kHz ADCP impacts the 150 kHz ADCP. It was judged at the beginning of leg 1 that the 300 kHz system was not likely to be of scientific benefit and so Jules Hummon's efforts were devoted primarily to characterizing the 150 kHz ADCP. It may be advisable to replace the 300 kHz system with newer technology (phased array 75 kHz? or other) once it has become proven.

The 150 kHz ADCP appeared to operate as well as can be expected of a broad band instrument showing underway acquisition of water velocities to about 150 m and perhaps even to 200 m when the ship is idle. A small amount of acoustic interference from the Knudsen and to a lesser extent the Bathy2000 was noted but other acoustics systems on the ship (apart from the 300 kHz ADCP) showed essentially no interference on the 150 kHz ADCP. The primary interference appears to be associated with bubble sweep down under the hull as has been observed with other vessels. A more quantitative assessment of data quality as a function of heading and speed awaits post-cruise data processing by Jules Hummon. There remain issues regarding the optimal configuration for obtaining heading and position information and location and cabling of the 150 kHz logging system. Also, there appears to be a leak in its transducer well, most likely out the seal of its window. It is recommended when this leak is corrected that a sound speed sensor be installed in the transducer well. This would assure that ADCP data could be properly calibrated no matter what the actual antifreeze composition in the well.

**BATHYMETRY SYSTEMS**

The Bathy2000 bathymetry system is functional. Tests were undertaken to supplement findings during the warm water trials. In "Single Ping" mode the system successfully tracked a pinger to 2000m in moderate seas. A straightforward 1 second travel time display of both the direct and bottom bounced return paths is provided, allowing for manual counting of crossings. An additional "Pinger Mode" that provides both depth and height off the bottom information could potentially be quite useful but remains to be tested under suggested operating procedures.

Upgrades to both software and hardware for the Bathy2000 are to be made subsequent to leg 1. The affects of these changes will need to be tested.

The Knudsen bathymetry system was installed in port just prior to this cruise. It functioned well and is readily configured with straightforward controls. It produced clean 12 kHz bottom traces to 4000 m at speeds of 15 knots. With a little care in set-up, the 3.5 kHz provided adequate sub-bottom penetration (about 30 m) in the survey region under similar operating conditions. In a comparison test, the Knudsen and Bathy2000 generated comparable (within a few meters) bottom depths for approximately 4000 m soundings. Data from the Knudsen were logged to the SDN via the ship's Ethernet. Supplied post-processing software allowed successful playback of this data and depth data were integrated into the SDN. A number of potential improvements to the system were identified and enumerated in Barrie Walden and John Frietag's final reports.

**XBT DEPLOYMENT SYSTEM**

The Sippican Mk12 XBT system was tested and worked without problems. The launcher is a through-the-hull type located in the aft fueling room on the 1st platform. Probes exit the ship from the stern approximately 6 feet above the waterline and 12 feet starboard of the centerline. Though data was successfully transferred to the SDN, issues remain for proper handling of data output as detailed by Barrie Walden.

**COMMUNICATIONS**

A number of facilities/strategies were exercised to overcome the challenge of efficient science communications on a vessel as large as Healy. In general, the available facilities are excellent and require but minor tweaking. The strategies can be expected to vary somewhat from mission to mission. An overview of the available systems and recommended strategies for communications should be provided in the cruise planning manual. It may also be useful to spell out the expectations of the chief scientist in the manual in so far as they can be generalized. I strongly recommend that the AICC should take the opportunity to review the cruise planning manual (current status?) as soon as possible upon termination of science trials, while our experiences are still fresh in our memories.

*Meetings*

As chief scientist, I was served well by a daily schedule that included science briefs in the science conference room at 8:00 and 18:00, attendance at the crews call to quarters at 12:30 and participation in the conference in the captain's quarters at 19:00. The science briefs were scheduled for just after breakfast and dinner and were generally short (15 minutes or less). They involved updates on daily plans, reporting of progress, input for changes in strategy and housekeeping updates. They were generally attended by all of the science party, excepting those engaged in uninterruptable work or catching up on sleep. We found that attendance of a representative of the MST's at these meetings streamlines communications considerably. Predictable meeting times seems to foster attendance although the requirements for the frequency of such meetings will certainly be mission dependent. Attempts to use bribery in the form of chocolate treats to achieve promptness were thwarted by the ship's excellent food. There was a suggestion that it would be more convenient to hold such meetings in or adjacent to active science spaces. This will depend upon how the science labs will be utilized in a given mission.

I initially attended both the officers call to quarters (5 minutes before the crew's) as well as the crew's but found that it was more efficient to attend just the latter. This gives the chief scientist an opportunity to stay abreast of the crew's activities and concerns and aids in understanding the larger context of planning for science activities. It also lends an appreciation of Coast Guard culture that might otherwise be invisible to the science community.

To my understanding, the evening conference in the Captain's quarters was and will be generally attended by the Captain, Executive, Operations and Engineering Officers, an MST to provide the weather brief, the chief scientist and others as invited. This was an excellent opportunity to update and undertake iterative planning with science, weather and ship operations all under consideration. In my experience, plans laid out at this meeting could be readily changed as the situation warranted.

*Phones/Pagers*

Phones are placed conveniently throughout the ship. I do not recall being in a space in which I lacked for a phone and stateroom phone numbers conveniently match stateroom numbers. All Coast Guard personnel carry a pager that can be activated from any phone on the vessel. Pager and phone numbers of the Coast Guard folks were posted conveniently at many phones and I found this system to be extremely responsive. It also minimizes the need for disruptive piping over the ship's PA system. A few pagers were also distributed to scientists. It took some time to become accustomed to the proper operation of the pagers and the scientists' numbers were not posted widely. Both aspects can readily be addressed for future missions. Apparently it is planned that all science party members be assigned a pager for future missions which would be excellent. A streamlined plan for updating the printed pager list at the beginning of each mission needs to be implemented. It may be useful to assign a consistent pager number (same as stateroom number?) to the chief scientist and perhaps a duty pager for the MST's.

*Other*

Deck operations are facilitated by hand-held 2-way radios. I am uncertain of the number of units or policies for distributing them but they are essential for conducting efficient and safe operations. Certain spaces are equipped with an MC intercom system (science labs, aft conning station, bridge, chief scientist's quarters etc..) that provides an additional convenient-to-use pathway of communications redundant to the phone-based one. Information about how to operate this system would have been useful although trial and error sufficed to get things going.
Closed circuit TV's are located in many spaces throughout the ship and can be used to view SDN parameters and video cameras mounted throughout the ship . SDN parameters displayed are chosen by the SDN system operator. I found it exceedingly useful to use the speed, location and heading information to assess our status while working in the chief scientists stateroom and other science spaces. It was also useful to be able to watch various cameras to assess weather and sea-state. (At times the ship rode so stably, it was very difficult to determine by feel whether we were underway or what conditions we were encountering.)

The white board in the conference room proved useful for keeping the science party posted of changes to schedule and other announcements between meetings. I reserved this board for this purpose as chief scientist. When plans are changing rapidly and activities require the chief scientist's presence, it is difficult to keep this board up-to-date. In retrospect, I should have tapped into the science party for help with this. The pager system could facilitate this in the future. It is conceivable that the ship's web site could serve this function as long as it could be updated on an as-needed basis. I note that the multiple roles and requirements of the ship's web site should to be defined in a dialogue involving both the science and Coast Guard communities.

**Summary of Science Data Network Discussion**
**7 June 2000**
**Leg 1 Phase IV HEALY Science Trials**

On May 31, 2000 an open discussion of issues pertaining to the science data network (SDN) was held on board HEALY. The discussion was lead by myself (K. Falkner) in the capacity of chief scientist. Attendance and participation were voluntary. Most of the science testing team was present. In addition the meeting was attended by Captain Jeff Garrett, Operations Officer David Vaughn, Bill Hamberg, Jim Arias, Bob Parsons, Joe Farmer, Don Chambers, MSTC Hendrikson, MST El McFadden, MST Hutchinson and other members of the ship's officers and crew. The event was filmed by Jerry Oldham and a complete record of it can be obtained from him.

Barry Walden lead off the discussion by stating that the present SDN hardware appears to be robust and capable of doing the job. He thanked El McFadden and Bill Hamberg for acquainting him with the nuances of the system. Aspects of the system operation were identified as areas of possible improvement. He stressed that changes to the system should adhere to guiding principles of simplicity (particularly for maintenance) and flexibility. Barrie's general comments were followed by suggestions by Jules Hummon, John Freitag, Barrie and myself of specific changes to be made to the data acquisition system that need to be handled at the vendor level (as the code is proprietary). (Subsequent to our meeting, it was requested that these be summarized in written format and provided to Don Chambers and Bill Hamberg so that they might be implemented during the remainder of the science-testing phase. Copies of this list will follow this report. I note that this level of responsiveness is very encouraging. It is incumbent upon the science parties during the remainder of trials to collate and pass on to Bill Hamberg any additional items of this nature.)

The discussion then focused on longer-term maintenance of the SDN system. It appears to at least some of the science party that the present level of Coast Guard staffing may be insufficient for future science demands. The Coast Guard has recognized this issue. Don Chambers (Sherikon, Inc.) is in the process of writing a contract for maintenance of the HEALY SDN. At the beginning of this testing leg, Don solicited input on a draft from Barrie Walden and myself. I expressed concern that the AICC was unaware of this action and that the academic research community needed to be in the loop with respect to the tasks under contract. After discussion with Captain Johnson, Don agreed to wait until the end of science trials to put the contract on the street in order to incorporate additional feedback that the AICC may have.

The draft contract involves maintaining the system, shoreside troubleshooting during missions, availability to sail with expertise as the need arises and keeping abreast of technological developments and implementing changes among other things. The contracted entity would interface with the Coast Guard ESU (Electronics Support Unit) which is located in Seattle. The ESU has been staffed to reproduce the HEALY's SDN (with the exception of the system redundancies) for maintenance and testing purposes. This facility will be available to the contracted entity. Exactly where the division of labor lay between the ESU and contractor is somewhat unclear to me although the ESU has responsibilities beyond just HEALY.

Motivational factors and the infrastructure to insure ongoing training certainly differ in the private versus academic sectors. The contract strategy may well prove to be the appropriate way to address the problem but the speed with which the contract situation was being developed precludes any academic group from developing a competitive response to it. Jim Arias suggested that consultation with the academic community could be made to be part of the contract. I reiterated that the science research community would want the system to meet its needs on a continuing basis and that it be in the governing seat with respect to determining what its needs are. It is my understanding that the contract is likely to be given the go-ahead but that our concerns will be registered in the final version. The AICC needs to stay on top of this.

A related issue is the level of staffing that will be required to keep the SDN system running when a full science complement requiring instrument and personal computer connectivity comes on board. Captain Garrett expressed that part of the labor crunch problem could be resolved by adequate pre-cruise planning. Demands to be placed upon the system need to be made clear in advance and that compatibility of demands with system capabilities could be clarified in the planning process. While it was agreed that advance planning is essential and that the science community needs to strive in this direction, we noted that there will likely be surprises for which flexibility will be essential. The success of many science data collecting missions will rest on this system and so policies governing its operation need to be given thorough ongoing attention by both the academic community and Coast Guard.

A few "hardware" issues were tabled. It was asked whether a plan was in place for maintenance of the batteries of the multiple UPS systems upon which some of the "permanent" science gear depends. The ship's crew gave a summary of the current maintenance status and the Captain suggested that an ongoing maintenance plan be put into place. It was queried whether scientists would expect UPS coverage in staterooms. The consensus was no but that the situation needs to be made clear to participants in advance. It was noted that there are insufficient outlets in the present science computer lab since they cover only the instruments now in place. This had been previously noted and is apparently going to be rectified as part of PSA.

The meeting was concluded with a discussion of the e-mail size limits. The current situation is not necessarily representative of the post trials one however there are lessons to be learned as the present system is being tweaked for the remainder of trials. I had asked how the size limitation of messages came into being for trials and who is responsible for making such decisions. The size limitation appears to be a practical one devised for conditions encountered during the phase III trials (challenges include high latitude, blockage by the ship's stack, MST time required to complete an e-mail session). Basically, the smaller messages had greater likelihood of successful transmission over the Inmarsat A system in its current configuration. (Note: The size per individual message was increased to 60 kbytes before I departed the ship. I also note that mime encoding nearly doubles attachments and so text attachments are better sent directly as e-mail text without special formatting requirements.)

Bill Hamberg gave an overview of the technical arrangements for the science and Coast Guard e-mail traffic. It is possible to set up Inmarsat A for high speed modem connectivity (transmission rates of up to 64 Kbs) as long as the ground connection has ISDN lines. Woods Hole was not wired for this possibility. The present arrangement with Woods Hole serving as the shore side service for science will terminate when the ship arrives in Seattle. The question of whether the Inmarsat A would be replaced by an Inmarsat B science connection was raised but no clear answer emerged. John Freitag noted that encouraging technological developments (such as M4) with potentially superior performance to Inmarsat B have recently been demonstrated to him. There was some question about whether the arrangements with Woods Hole were optimal at present and Barrie Walden agreed to check into this. Science transmissions are presently occurring at 2.4 Kbs (2400 baud). Since returning to Woods Hole. Barrie has determined that it should be possible to transmit at 9.6 Kbs (9600 baud) and has Bill Hamberg and Jim Akens (WHOI) investigating this.

The issue of having to send e-mail off ship to communicate between the science and Coast Guard systems was raised again. Bill Hamberg suggested that it should be possible through linkage to a common server to get around this problem yet retain desirable separation (for security and safety purposes) between the two networks. I note that anything that facilitates communications on such a large vessel is highly desirable.

In summary, all agreed it is important for the AICC and Coast Guard to sustain an open dialogue on what is likely to be evolving challenges in the realm of electronic communications and computing. The list of specific software fixes to the SDN will follow as a separate message to this one.

# USCGC Healy
# Phase IV Test Program
# Leg 2, 3-9 June 2000, St Johns, Newfoundland, to Nuuk, Greenland
# Science Report
# James H. Swift, Chief Scientist

— version of 25 June 2000 —

AICC participants: John Freitag, Jim Swift, Terry Whitledge
Other science team participants: Tony Amos, Susan Klinkhammer, Peter Lane, Bill Martin, Mike Realander, Janice Rosenberg, Andrea Rowe, Bob Whritner

## OVERVIEW & NARRATIVE

USCGC Healy left port ca. 2000 local time 3 June 2000 and headed north toward the western Baffin Bay ice edge along the best track. The plan was to keep specific track and waypoints flexible, depending on ice conditions, preferences from the test teams, and ship operational needs. The leg was to include ice and open water operations. The overall plan for this leg was to steam north to a deep water location offshore off an ice edge that covered the shelf and slope, and to run a section into the shelf, with station locations selected by isobath or ice condition. The planned tests were partly procedural, i.e. to help develop an efficient methodology, including effective communications, for carrying out similar survey work expected in 2001-2004.

After departure from St. Johns at 2000 on 3 June most of the effort was expended toward securing equipment for possible rough seas and becoming acquainted with crew members and the layout of the ship's laboratories. During the first night of the transit to an open water area off an MIZ, winds rose to about 40 knots from the north, but the wind peak was short lived and the first full day (4 June) featured beautiful weather with winds of 10-15 knots out of the north, blue skies, air temperature about 2°C, and fast steaming. There was a cycloconverter problem on 4 June, but cruise speed of 15+ knots was not affected. More troubling was the very light ice cover in Baffin Bay, but Bob Whritner and the MSTs located a suitable region south of 60°N. (The ship was not permitted to work north of 60°N before 10 June in its configuration and status during this cruise leg.)

The uncontaminated seawater system received a careful going over on the first day at sea. The thermosalinograph and fluorometer were working (the latter due to Tony Amos' last-minute dash to get garden hose fittings before sailing). Debugging and fixes continue apace. It was found that someone - months ago - installed the temperature sensors for the underway seawater system so that the sensors sat in air, with huge offsets applied to make the readings look like seawater readings, but of course whenever seawater temperature and air temperature in the fitting did not co-vary - meaning nearly all the time - strange readings resulted. The salinometer was set up.

The Chief Scientist planned a short section of stations over the North American continental slope near 58° 45' N, where ice conditions inshore were likely suitable for in-ice science systems tests.

On 5 June Terry Whitledge and Peter Lane carried out a test cast to ca. 1000 m with the 0.680" conducting cable, with only a large weight, followed by an open water MOCNESS tow on that cable. After an initial delay for reprogramming the winch software, both operations were successful, and capably led by the MSTs.

Preparations for tests of the uncontaminated seawater system by Tony Amos and Andrea Rowe continued on 5 June with location and cover removals of all outlets and calibration of the flowmeter (bucket) with help from the galley. They awaited inspection and cleaning of the sea strainer before beginning the flow tests, which were carried out with the help of the two teacher-participants, Susan Klinkhammer and Janice Rosenberg.

The CTD test team, Bill Martin and Mike Realander, changed over the lanyards on the rosette bottles, carried out electrical tests, and otherwise assured that the CTD/rosette system was ready for its tests. They were also helpful with the 0.680" cable test and MOCNESS tow. They saw to it that the CTD computer was networked so that the data can be stored on a network drive available for scientists to view.

John Freitag continued to work busily on various data systems and tests and made progress. The final uncontaminated seawater taps were adjusted for temperature sensors and the logger for the inlet temperature in the bow thruster room was programmed to record data. Further attempts were made to communicate to the logger via the laptop but without success as the communication software was corrupted. Logging on paper tape, with manual transcription to a computer, was instituted.

Bob Whritner and MST "Hutch" Hutchinson were invaluable in helping to locate suitable ice for our planned in-ice casts. Sea ice was a rare commodity at these latitudes this year.

Steady 30 knot winds on 6 June did not deter the day's over-the-side operations. With the Healy riding with very little undue motion, the only clue to the wind speed was the wind whipping at one on deck.

The day was planned to begin with a deep CTD cast in open water, but new problems cropped up in communications with the underwater unit. During the repairs the Healy moved into the marginal ice zone and Terry Whitledge, with the assistance of one of the teachers, carried out a helicopter ice survey to locate areas suitable for casts and tows in light ice cover and in moderately heavy ice cover. The ship then moved to the light ice cover location and carried out a CTD cast and a MOCNESS tow. The CTD cast used the altimeter to determine height above bottom. It worked, the cast went smoothly, all but one bottle closed properly (the non-closure was due a lanyard out of adjustment), and all but one of the closed bottles sealed well (the one leak was minor). The teachers then learned how to draw salinity samples. The MOCNESS tow in light ice cover went very smoothly and was a complete success.

Meanwhile uncontaminated seawater supply flow rate and temperature tests were completed at all locations. The preliminary data suggest that temperature rise in the system is well under 1°C.

6 June was a beautiful day to be in the ice, with blue skies, light winds, air temperature near 4°C, the whole gamut of ice and water colors, and the occasional iceberg, polar bear track, or seal to add to the view.

The ship had moved in the evening to the region chosen for the moderate-to-heavy ice MOCNESS tow, and so 7 June began with that tow in 80+% ice cover. The weather was cloudy with occasional light snow showers and light to moderate winds. The tow went very well. The bow simply pushed ice aside. Little ice was ducted into the wake of the ship and so there was never adverse effect on the tow. The MOCNESS and winch systems and deck operations worked very well. The tow brought up a variety of interesting small organisms.

In-ice CTD operations had not differed in any significant manner from open water operations, and so it was decided to carry out a station on the 1900 meter isobath. This would permit a deep cast, needed to check minor CTD conductivity cell discrepancies, and to check altimeter function in deep water. In route the ship carried out two helicopter training flights. The 1900 meter isobath was located, and the ship positioned, without incident. The CTD cast went very well, except that as it was being brought aboard, the CTD cable jumped the sheave, making for a difficult recovery. The CTD/rosette was recovered without loss or damage. But until the sheave is modified (short-term) or replaced (recommended for the first field year), CTD casts should not take place.

The evening of 7 June and the day of 8 June were spent in transit to Nuuk, Greenland, with some crew training exercises. Winds were generally light to moderate (ca. 20 knots or less), air temperature was near 0°C, and there were occasional light snow showers.

On 9 June the Healy completed the transit to Nuuk, Greenland, including some crew training exercises offshore. The vessel come to the dock ca. 3:00 pm local time, on a pleasant day with light winds (ca. 10 knots), partial sunshine, and with air temperatures near 4°C. This ended Leg 2 of Phase IV.

Final narrative note: As has been the case on other legs, the support and initiative of the ship's company, making special mention of the MSTs, has been impressive. One typically finds the MSTs engaged in a productive endeavor well tuned to upcoming science events, and they provide valuable information, guidance, and assistance at all times.

## TEST PROGRAM

The systems scheduled to be evaluated during this period were:

* CTD/rosette
    preferably with altimeter; with pinger if altimeter not available
    coordination of bathymetry info with bridge/navigation
    procedural check out

in-ice and open water casts; to include deep cast
* MOCNESS (towed net with sensors)
  system performance
  procedural check out
  open water tow; in-ice tows at different ice concentrations
* incubator support systems
  set up system as if it were running; temperature, flow rate, and drain
* uncontaminated seawater system
  temperature and flow rate at each outlet
* thermosalinograph
run 24 hours/day
  check against CTD
  check against salinity samples
* XBT [test deleted at sea]
  (no further tests required)
* fluorometer
  system performance and calibration
* salinometer [test added at sea]
  instrument function
* starboard A-frame
  as per test memo

Other considerations:
teacher participation
CTD station by isobath in MIZ and/or pack ice
coring bucket not under starboard A-frame
aft space and cable for MOCNESS
winch readouts and/or CCTV of starboard launch area available in labs
navigation and bathymetry information available to science watch
SDN inputs to CTD system
SDN inputs to MOCNESS system
logging underway data
surface water samples to verify thermosalinograph
temperature monitoring to incubator outlet for seawater system
monitor temperature in biochem lab
ice forecasts, images, and reconnaissance

## TEST REPORTS

**Towing Tests**
**(see also "Cable Handling, Winch, and Winch Control Systems")**

Towing tests devised for Ice Trial testing used a 1$m^2$ MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System). The required equipment and technical help were found at the University of Miami Rosenstiel School of Marine and Atmospheric Science. Dr. Sharon

Smith provided the equipment and technical help at sea was supplied by marine technician Peter Lane. The MOCNESS equipment was loaded in Fort Lauderdale, Florida, and was set up during Phase IV, Leg 1, hence those events are described within the report from the previous leg.

After termination and a test cast with a weight (see "Cable Handling, Winch, and Winch Control Systems") the MOCNESS was rigged satisfactorily and all electronics were functioning. The net system was deployed in open water to 500 meters depth at approximately 2 knots tow speed. Line speed was approximately 20 meters/minute on the out deployment and was easily and precisely controlled. The return cast was made at 5 meters/minute. Eight nets were used to sample at 100 and 50 m intervals. All nets deployed and all sensors displayed data from temperature, conductivity, and sampling intervals. Deployment and retrieval of the MOCNESS was safe and efficient. The operation went well but would have been simpler for the operator with the changes outlined in the winch control system discussion. Control seems to have been lost entirely at speeds below about 40 motor RPM.

In terms of the operations themselves, for ship course and speed, winch control (not the control system itself, but its effectiveness in the operation), or deck communication there were no recommended changes. Minor additions to deck handling gear are needed but several items are on order which will solve this deficiency. Deck resources such as salt water wash down hoses and laboratory tables for sample processing needs some attention. The best solution to this problem would be the addition of a wet lab bench in the after storage bay. This would prevent formaldehyde from being used in the active laboratory areas and would be close to the deck area. This sample processing area would probably also be useful for storage of the many cases of sample bottles, processing of sediment samples from box corers and grab samples and other wet, smelly or muddy sample processing.

The first MOCNESS tow in ice was undertaken during the afternoon of 6 June in approximately 30-40% ice cover. An ice reconnaissance was first made by helicopter. The weather was sunny with a wind of about 10-15 knots from the south. A patch of fairly uniform 30-40% ice cover was located about 20 miles from the Healy in about 190m of water. The MOCNESS tow started immediately after a CTD cast at that location. The MOCNESS was deployed to 175 m at 2 knots and samples were collected at 7 strata: 175-150m,150m-100m, 100-80m, 80-60m, 60-40m, 40-20m and 20m-surface. All samples were collected successfully with no operational problems. Specifically, ship handling, winch operation, deployment and recovery operations and communications were excellent as on the previous open water MOCNESS tow. The better weather conditions allowed a smoother deployment and retrieval so that no tag lines were required. Some of the small deck items (e.g., snatch hooks) were still missing as before but with no overall negative effect. The overall sampling evolution was faster than the first tow as the result of the shallow water depth but also the better acquaintance of the sampling team for the required protocol. The samples again mainly contained large copepods, amphipods and ostracods but not very many chaetognaths. The deepest sample strata also large centric and chain forming diatoms.

The final MOCNESS tow was accomplished on 7 June in approximately 70-90% ice cover. The weather was overcast with light winds of 5-10 knots. The MOCNESS tow was started at 0915 in 775 m of water after some generator startup delays. The MOCNESS was deployed at 2 knots to

300m and samples were collected at 7 strata: 300-200m, 200-150m, 150-100m, 100-75m, 75-50m, 50-25m and 25m-surface. All samples were collected successfully with no operational problems. Ship handling, winch operations, deployment and recovery operations, and communications were excellent. The light winds allowed for smooth handling of the gear during deployment and retrieval. The overall sampling evolution was reasonably quick and safe. The upper layer contained the largest quantity of plankton including considerable amounts of phytoplankton that were captured in the 150 micron mesh nets. Large copepods again dominated the numbers and biomass in the tows.

It should be noted that this tow was undertaken with appreciable ice cover without incident. Specifically, the extensive ice cover presented no operational problems. Ship speed would drop below 2 knots when the ice concentrations were 90% but the speed never dropped low enough to cause problems with net retrieval. The wire angle was observed to increase slightly during the drops in speed but recovered shortly. Loose ice was not a problem in the "slip-stream" of the ship in the vicinity of the towing wire. The few small chunks of ice that were observed immediately aft were immediately pushed aside by the prop wash. Several photos of the ice field ahead of the vessel and the open path immediately astern of the vessel were taken for documentation in the final report.

Summary:

The collection of samples with towed systems should present no problems in most ice conditions. The MOCNESS towing tests were accomplished without incident and were comparable to experiences on the best UNOLS vessels. The maneuvering capabilities of the Healy make it an excellent platform to sample with a MOCNESS. Portable lab bench areas for sample preservation and use of formalin should be installed in the bay area of the back deck. The aft control room should also have electronic racks installed to accommodate MOCNESS and other special sampling system electronic controls. Replacement of the oversize chairs with attached stools would allow room for the electronic rack to be mounted on the forward bulkhead. This would give the MOCNESS operator a view of the equipment on the back deck and would be close enough for convenient direct communications with the winch operators.

## CTD/Rosette System
## (see also "Cable Handling, Winch, and Winch Control Systems")

Tests of the CTD/rosette system focused on its use as in a science mission. In preparation the altimeter was mounted on the rosette frame and connected to the SeaBird underwater unit and checked; the 0.322" conducting cable was inspected for kinks and terminated; the NMEA input was installed to one of the CTD deck units; the AutoSal salinometer was installed; the bottle lanyards were replaced; communication between the computer, deck unit and underwater unit was verified; and CTD calibrations were entered.

*Test Remarks*

Cast One

The first cast encountered problems at the very beginning. The team was able to establish instrument communications on deck but while deploying they lost all communications. They recovered the system and began troubleshooting. They determined the manner in which the wires were terminated at the winch and at the instrument end caused noise to be inserted into the data signal. The wires at the winch end have only one conductor wired all the way through to the deck unit, along with the armor. The test team had twisted together all three inner conductors at the wet end and, with two wires not terminated at the winch, noise was injected onto the data signal. The wet end was then rewired so that the two floating conductors were not used. It is suggested that the other two wires be connected through the slip rings to the junction box so they can be used. When carrying out CTD casts the three inner conductors should be connected together in the junction box and also at the wet end. A Datasonics altimeter was mounted on the package and was able to find bottom at the surface (this was a shallow cast) and track it all through the cast.

All bottles were fired but bottle number 9 did not close. It was determined that the lanyard was too tight, binding the release mechanism. It was corrected. Bottle 21 leaked when the valve was opened. The test team changed O-rings. Salinity samples were collected at the bottom (180 meters) and at 10 meters (depth of uncontaminated seawater intake). The cast showed possible problems with the conductivity sensors since the upcast did not overlay the downcast. When the salinity samples were analyzed none of the readings matched. It was decided to replace one set of sensors with the set from the second underwater unit for comparison.

Cast Two

Cast two was performed to test the temperature reading from the MOCNESS cast and the thermosalinograph. The depth was only 100 meters and the cast was conducted before the sensors were changed. All bottles were fired and all closed. Bottle 21 still leaked. The neoprene spring inside bottle 21 was tightened before the next cast.

Cast Three

This cast was performed at the 1900 meter isobath. The cast started well but when the package was brought to the surface to begin the cast the ship took a slight roll and the wire jumped the sheave. The sea state was no more than a two and probably only a one. The test team was able to get the wire back into the sheave after about 20 minutes of various attempts. The wire was inspected for damage but none was observed and communications were never interrupted with the electronics, so the cast was continued.

Prior to this cast an email from SeaBird Electronics was received explaining how to change a jumper on the NMEA interface to accept a 9600 baud input. This change was made and as a result on deck box serial number 0417 the NMEA interface is now functional. There is no NMEA interface installed in the other deck unit (0416).

The replacement conductivity sensor looked to be giving good data. The altimeter did not track bottom well. It should have picked up the bottom at 300 meters above bottom but it did not until around 150 meters. Then bottom was observed only once every 3-4 updates. At 50 meters above bottom the downcast was stopped since the altimeter data still did not track reliably. About every second or third scan had what might be considered an accurate bottom return. All bottles were fired and all bottles closed. Bottle 21 did not leak. During all three casts a Chelsea Fluorometer was mounted and looks to be supplying good data.

Guildline AutoSal

During this testing period the Guildline AutoSal was set up and run. It seems to be working properly and giving good data. It was used to verify the CTD data and thermosalinograph system.

*General Observations*

- The MST's are hardworking, enthusiastic, amicable and supportive of the scientific mission. They will assist in any way possible to ensure the science mission is accomplished. This is a very good crew to work with.

- The CTD block needs to be replaced or modified so that the wire jumping is no longer a problem. The present block will sometime in the future result in injury to personnel and/or loss of equipment.

- Realign the block and wire sheaves so that everything aligns with the center of the A-frame.

- The time it takes to put something over-the-side is much too long. Science time will be impacted severely with the way procedures are now. This is partly due to the 'newness' of everything and in time will be corrected. This brings up the point that this time delay might become an issue when personnel rotate to other duties/ships.

- A means other than shouting across the aft control room needs to be established for CTD console and winch communications.

- The CTD console is not located in a good area. It is currently in the entrance of the aft control room and the traffic is very disturbing. Not much room is available for writing information without crossing the traffic aisle to a desk. The glare from the windows makes it difficult, almost impossible, to read the CTD video display.

- The winch wires that come up to the CTD console should be wired into individual junction boxes rather than to CTD deck box connectors. At present when equipment other than CTD's are used the ends must be cut off and rewired. A junction box would allow for easier changes. All three inner conductors along with the armor should be available in these junctions boxes for the 0.322" cable and the armor, coax shield and coax inner conductor for the 0.680" wire.

- Purchase and install a NMEA interface board in deck box 11P10703-0416

- At the end of the warm water testing suggestions were made to purchase for the cold water testing items such as spare fuses, pigtails and others. None of these items were available during the ice tests. This may indicate that procurement procedures need to be examined. If the purchase and/or repair of equipment takes this long results then science missions will definitely be affected.

- The MST department seems to be understaffed for the work that is required of them. For CTD maintenance and repairs the UNOLS test team had to perform 95% of the tasks. The MSTs were just too busy doing other required tasks. In the future, if a CTD group is not contracted then eventually science will be affected by delays to maintain/repair various equipment that is the responsibility of the MST department.

- Equipment log books must be kept.

- Conductivity sensors serial numbers 1742 and 2361 must be sent back for repair and recalibration.

*Miscellaneous Comments Apart From CTD*

- Unistrut hardware, eyebolts, eyescrews, etc. should be made available for science use in the labs.

- Head areas in the labs spaces should be cleaned and stocked daily.

- In the main lab at the tables away from the bulkhead, more electrical receptacles are needed, possibly by putting plug strips on bench tops.

- Better communications are needed to oncoming scientists as to ship's policies (paying for meals, linen cleaning, etc.) and procedures, what is and isn't supplied for the scientists (clothing, hardware, etc.) and available resources.

- Communications between winch and deck operation need improving. Hand signals, reliable radios, intercoms or preferably a combination of all these.

- Serial NMEA GPS, heading, etc. outputs must be provided in lab spaces.

- The salinity bottles used leaked when turned upside down. Better sampling bottles should be purchased.

- A network printer is needed in a main deck lab so one is not required to climb ladders to get printouts.

- Is sufficient space, hooks, etc. provided in the port passage for 35-50 scientists to hang their cold weather gear? If not, where will everyday deck wear be stored?

- The spare parts inventory should be increased so that problems while underway can be addressed.

- Because it is impossible to safely traverse to the mess while carrying a cup of coffee, a coffee service should be added in the lab area.

## Cable Handling, Winch, and Winch Control Systems

*0.680" conducting wire on aft A-frame*

It was needed to terminate the 0.680 inch conducting wire before any deck or water testing could be accomplished. Termination was successful, as determined by electrical continuity checks. This task was accomplished by the joint efforts of the MST's and members of the sea trials science team and all of the steps were documented by video.

It was decided to stream the wire on station to test winch operations and spooling characteristics. That first test for the 0.680 winch was delayed due to Alstom upgrading the software in the drive. This was to simplify the control console switchover during winch operations. It was not successful and necessitated contacting Alstom in England to resolve the problem. Testing began with a dummy cast with a 200 kg weight to test winch operation prior to committing the MOCNESS system to the wire. About 1000m of the 0.680 inch wire were streamed through the aft A frame, with a ship speed of two knots. Two problems were noted with the winch/cable system. First the tension read 980 pounds with no tension on the wire. This problem was not solved and a mental constant had to be carried by the winch operator. The second problem was incorrect speed/payout readout. This was traced to a sensing magnet which had fallen out of its holder on the wheel. The magnets were reglued and the sensor then operated properly. There was an inherent problem at low speeds, however, due to the fact that only 4 magnets are used in a wheel having a circumference if 3 meters. This equates to only one pulse every 0.75 meters of wire. In order to have readout at low speeds it is necessary to use an inordinately long time constant in the electronics. The effect of this is exceedingly slow response. For example, if the winch is going 30 meters/minute and is stopped suddenly, the readout leisurely drops from 30 to 20 to 20 to 5 and on down to zero over a period of 6 or 8 seconds. This is not satisfactory and should be corrected by adding more magnets to the wheel. Upping the magnet count to 16 would give a pulse every 187 CM. This would be a far more satisfactory situation and would allow the time constant to be reduced by a factor of 4, a decided advantage at low speeds. Five meters/minute is not an unrealistic speed for winch operations in some biological sampling situations.

Winch speed control was precise but awkward to control because the control parameter is motor RPM rather than line speed directly. This involves mental calculations - the science operator asks for X meters per minute, requiring the MST to guess at a winch motor RPM that will give close to that speed - and changes as the reel unwinds and its effective diameter changes. The feedback should be taken from the line speed sensor rather than the motor speed. Another small problem was the location and size of some of the crucial parameters on the winch control screen. Wire out, line speed and tension should be in a large font, grouped, and shown in a contrasting color for easy and quick identification. The many other parameters shown on the screen are useful but not nearly as critical to quickly locate as the three mentioned.

*0.322" conducting wire on starboard A-frame*

The final CTD cast during Leg 2 amply demonstrated that there are problems with the CTD wire starboard overboarding arrangement. The angle of the wire feed onto the sheave is not optimal to begin with, because the 0.322" cable does not take a correct 90 degree path from the last turning sheave to the pad eye on the starboard A-frame. The turning block is located too far forward. The second problem is that the overboarding sheave is the incorrect type for the 0.322" wire use: (1) it is on a swivel and (2) the throat is too wide to constrain the wire properly. The swivel allows the block to turn when the wire goes slack. The wide throat then helps a slack cable to climb the sheave. This occurred upon recovery of the final CTD cast when the wire went slack and subsequently jammed between the block and the cheek protector flange. Thus the 0.322" sheave presently on the starboard "A" frame must be replaced with one that does not swivel and has a deeper throat. Such a sheave, preferably with a larger radius [xxxJohn Freitag, please specify here the optimum diameter in accord with standard UNOLS large ship operationsxxx], would not so seriously threaten loss of the CTD package. It is suggested that General Oceanics and Kahl Scientific, and perhaps other vendors, may offer CTD sheaves that will solve the problem.

*winch control systems*

During Leg 2 the 0.322" and 0.680" winches appeared to be functional, providing steady payout (there was cable rate drift but no particular oscillation) and haul-in at a wide range of speeds, without level-wind or other problems. No particular cable handling problems were noted over the paths of the cables internal to the winch room and leading to the work areas. There was, however, no concerted effort to observe these paths. (Notes from the ship's MSTs should supercede these comments, which are not based upon close observation.)

The winch control system, when programmed, provides precise, steady control of winch speed (but not wire speed to the same degree). During actual operations during Leg 2 neither the control system, the cable handling system (except for the 0.322" cable sheave on the starboard A-frame), nor the winches and drums themselves caused appreciable problems. Yet it is the opinion of the Chief Scientist that to an unknown degree the control system is an accident waiting to happen. Thought will be given to this matter during evaluations on subsequent test legs.

## Uncontaminated Seawater System

It became evident early on that the readings recorded on the uncontaminated seawater measurement system temperature logger had little or no relation to reality. There was a single point in the biochemical laboratory which seemed to be close. After investigating the possibility of faulty sensors, incorrect sensor ID's and improper connections, a diagnostic display module was connected which showed all calibration factors to one of the modules in plain English. It was thus noted that an offset had been inserted. Investigating other modules it was learned that offsets of up to 12 °C had been inserted. After removing the offset from a sensor the reading became more believable.

Further investigation revealed the root of the problem and the probable reason that the offsets had been inserted in the first place. All PRT sensors had been placed in "T's" installed adjacent to the faucets. The manner in which they had been installed allowed, or rather guaranteed, an air bubble to form around the sensor tip effectively insulating the sensor from the flowing water. When the original calibration had been done the technician used a digital hand thermometer to measure the stream. Because the sensor bulb was not in the water stream the two readings did not agree and the technician inserted an offset into the module to bring them into agreement, not realizing, of course, that this was not addressing the problem.

The offset was eliminated from one of the faucet sensors and the "T" which allowed the water to surround the sensor element was inverted. A check with the hand held digital thermometer confirmed agreement in the readings.

The remainder of the outlet taps were corrected and offsets eliminated. The logging software provided by the manufacturer of the system was corrupted on the diskette and useless. "Manual" logging using a paper tape output with results keypunched into the computer was substituted. The logger for the inlet temperature in the Bow Thruster room was programmed to record data at 10 second intervals. The logger in the reefer room was set to log at 30 second intervals. The second logger recorded only intake temperature from 2 Pt resistance sensors mounted on the intake line about 8 inches above the hull. The line was heavily insulated. These sensors recorded temperatures 0.2 Degrees C apart. The flow through team, Tony Amos and Angela Rowe, tested temperatures at all seawater outlets at various flow rates. During the measurement evolution the seawater inlet temperature changed from 4.5 degrees C to -0.4 Degrees, a fortuitous event.

**Incubator Arrangements**

A preliminary test of the science seawater incubator site was undertaken. This unit has several obvious problems that will require changes before and/or during the first scientific uses of the incubator system. This preliminary test is intended to document the present state of the incubator system and to offer some suggestions for changes that may meet some of the operational requirements. It should be noted that it is a rare ship that can fulfill all of the stated requirements. Normally the most important requirements are optimized. For instance, some zooplankton incubations do not require sunlight but must maintain surface seawater temperatures while others have a critical need for direct sunlight without shadows as well as the ambient seawater temperatures.

Incubator Requirements (in approximate rank order):

1. Full sunlight with no shadows from vessel structures
2. Cooling water at sea surface temperatures
3. Incubator drainage that does not present safety hazard

4. Direct access to incubator location from lower weather decks
5. Electrical power to operate lights and mixing devices
6. Clean air and water to minimize contamination of samples
A. Normal seawater system for temperature regulation only
B. Uncontaminated science seawater
7. Low vibration environment

An incubator was not available for testing purposes, however several known deficiencies would make a total incubator test impractical and a waste of time. The major problem with the existing incubator system is the warm cooling water that is several degrees above ambient surface seawater temperatures. This is caused by using the fire control water source which has waste heat added to it. It was decided that a check of the flow rate and temperature of the existing system was needed and a quick check of the distribution manifold if possible. The hose connecting the fire main to the distribution valve could not be located so only flow rate and temperature measurements were collected from the main valve. It should be noted for the record that the only access to the incubator site requires passage through interior passageways. Carrying bottles of water through the interior is not advisable or practical.

The flow rate test was conducted with a bucket and stopwatch with the valve fully open. Two gallons of water were collected in 3.6 sec at a temperature of 11.8 °C. This is roughly a flow rate of 33 gallons/minute and well below the test criteria of 50 GPM. The temperature of the uncontaminated scientific seawater was 1.86 °C for a differential of approximately 9.4 °C. The incubation area was not fully assessed with regard to sunlight because there are serious shadow problems with the nearby exhaust stacks. See the recommendations below for suggested alternatives. The gang distribution manifold could possibly be operational but it was not tested. The probable flow rate from the five manifold valves should be about 6 GPM from each valve.

It should be noted that piping for uncontaminated scientific seawater system does not extend to the 04 deck where the incubation system is located. Even if the piping were present there would not be enough pressure to reach the 04 level thus requiring the installation of a larger pump. The lack of access to the incubator site from the weather decks below is a big issue that cannot be satisfactorily remedied with cranes or hoists. Many of the incubations require multiple trips between the incubators and the scientific laboratories for rapid processing of the samples. The present area is simply too far removed from the scientific laboratories to be useful. While an extensive search was not undertaken it was also noted that electrical power was not available nearby at the present location. An additional concern is the lack of effluent drain into heated space. A standard over the side deck drain will have serious freezing problems in sub-zero weather. Lastly, it was noted that there were considerable amounts of fumes from the exhaust stacks and the aft portion of the nearby stack was discolored by soot. Since several severe problems exist for this system in the present location, recommendations below will concentrate on other locations that offer more options.

Recommendations:

There is no ideal site that will fully satisfy incubation needs. There are some options near present outlets of the uncontaminated scientific seawater system on the weather decks. One likely site is probably on the 02 deck at a van location on the port side not too far from the helicopter shed. The flow rates of the two spigots (6.4 and 6.1 GPM) from the uncontaminated seawater system at this site are quite good and the temperature was only about +0.49 °C above ambient over the range of -1.0 to +4 °C (See uncontaminated scientific sea water system report for details). Incubators near the rail would also enjoy mostly sunlight without shadows during hours of peak radiation input. Depending on other scientific programs there may be places on the main deck fantail that could be used although some shadows will be present at all locations. These locations offer uncontaminated science seawater for those incubations that require continuous flow feed water for chemostat or turbidistat phytoplankton growth experiments.

**Bathymetric Systems**

Upon entrance to the ice observations were made on the operation of the Sea Beam and the Bathy 2000. The Knudsen was inoperable after being moved between Phase IV Legs 1 and 2, but because the transducers used are the same for each system this was not deemed to be a problem for Leg 2.

Both SeaBeam and the Bathy 2000 exhibited data holidays during periods of ice ingestion under the vessel. The Bathy 2000 simply showed blanks in the data and recovered as soon as the ice passed. The SeaBeam on the other hand behaved differently. If a few returns were recorded correctly within 4 or 5 ping cycles after the event the system recovered without incident. When this was not the case the system did not recover in many cases and had to be corrected manually. The gates needed to be opened up until a few pings were recovered. In most cases this was the extent of the correction needed. Most of the observations were in water under 200m with the sonar in the Shallow mode. Further observations will be made after a transit to deeper water and the instrument switches to deep mode.

Similarly the operation of the Bathy 2000 was observed in a transit into an ice field. The main effect of ice transit were gaps in the record. The sonar recovered after each event.

**Laboratory Environmental Controls**

The controlled environmental chambers have been under test since midway through Phase IV Leg 1. The first evolution held the chambers at –10 °C. Chamber 2 was far more satisfactory than Chamber 1, which had severe evaporator icing problems at this temperature. Roughly 50% of the evaporator surface was occluded after 5 days of operation at this temperature. Chamber 2 escaped this problem, probably because this chamber was equipped with an operating external dehumidifier unit. Hot gas defrost cycles occurred approximately every 8 hours and affected each chamber differently. Overall temperature regulation for both chambers was ± 0.25 °C for both chambers except for the fact that the defrost cycle had a much larger effect on #1. Both chambers had the temperature changed by 1.2 degrees during the cycle but #1 has the effect duration of approximately 6 minutes versus approximately 2.5 minutes for #2.

The temperature was changed to +15 °C and monitored for approximately 5 days. Regulation for both was roughly ± 0.6 degrees. The defrost cycle seemed to have a greater affect at this temperatures. Humidity control, not tested at –10, was significantly better for chamber #2 and was roughly ± 0.4%RH. These figures are preliminary. The data were recorded on the SDN and transferred to CD-ROM. Data will be analyzed upon return home and summarized.

**Teacher Participation (Legs 1 & 2)**

Susan Klinkhammer and Janet Rosenberg completed 30 journals with pictures and posted them to the tea.rice.edu site as well as to the ship's SDN server. They provided a hard copy of these journals to the Chief Scientist for the records. They answered over 100 e-mails each to children from classrooms as well as a couple from crew members' families.

They appreciated that the e-mail system was up and operational for the entire period that they were on the Healy. They were given excellent technical support from Bill Hamberg as well as from El McFadden. Moving their working space to the Future Lab gave them both a place to work as well as putting them in a place more accessible to science operations in progress. Many people stopped by as they were working there. It made it easy for people to find them quickly as well. El McFadden will transfer their journals to the Coast Guard side of the server for the crew to read as they wish.

The teachers were able to observe, participate in, and/or learn about: acoustic testing using the ADCP, acoustic interference from the ship, vertical referencing systems, SeaBeam operations, sub-bottom mapping, rosette casts, salinity sampling, MOCNESS operations and sample collection from that operation. In addition they each were given the opportunity to participate in a helicopter ice reconnaissance mission. Styrofoam cups were shrunk for classes as well as for members of the Healy crew and scientists.

They learned much from the crew regarding the operation and navigation of the ship as well as general seamanship information. Several crew members provided them with support materials for them to take back to classrooms. John Albrough is sharing with them his "Partnership in Education" newsletter. He has completed four issues detailing the Healy's progress from the start. Scott Bailey has produced a PowerPoint presentation about the Healy geared for young children. He is providing each of the teachers with a copy of that. Ray Campbell made a CD-ROM with a PowerPoint collection of polar bear pictures for each of their school districts.

The teachers enjoyed the opportunity to learn and begin the process of getting information transferred back into classroom not only in the format of journals, but in time with additional supporting materials. They felt they would be better science teachers because of this opportunity. They said they will enjoy being able to share the science group's enthusiasm for polar science with students for years to come.

**Miscellaneous**

1. All sink drains should have holes cut in the grating to allow hoses to extend well into the drain to prevent overflow. Hoses should be designed for efficient drainage.

2. Create a site to install an optional benches and/or a bench with portable wet sink in the aft science staging area (the bay that opens to the deck) for washing and other processing of zooplankton and sediment samples. All, or nearly all, of the necessary connections planned for vans are already available. The optional bench(es) could be configured to provide sample and equipment staging functions installation would, for example, isolate very wet and muddy sample processing from the other labs, provide a workbench for and would also remove some hazardous chemicals (e.g., formaldehyde and gluteraldehyde in biological work) from the laboratories.

3. Relocate the gas bottle storage rack now in the starboard science staging area (the bay that opens to the deck), perhaps into the - small, almost unusable (because of the large motor placed there) - assembly room just aft of the staging area, and install additional Unistrut in its place.

4. Consider moving the large stacked tool and supply box now in the starboard science staging area to the assembly room just aft of the staging area. In its present position it nearly blocks access to the Unistrut and portable sink unit.

5. Staging for scientists who wish to process samples or prepare equipment on deck could be supplied by providing Unistrut along the outside starboard bulkhead, from which temporary benches could be constructed. For similar service to the fantail it may be possible to utilize the tie-down bolt holes on the fantail to secure temporary benches there.

6. The ship should carry a moderate supply of benchtop plywood, 2x4s, and other standard lumber used to build and strengthen bench tops

7. Modify the aft control room by replacing oversize chairs with stools. One or two electronic racks should be mounted on the forward bulkhead for CTD, MOCNESS and other electronic scientific control modules. There is possibly room to create a bench for low-rise electronics, log book storage, and so forth on the electronics cabinets on the after bulkhead. A computer monitor user-switchable between several of the science systems, such as SeaBeam, Bathy 2000, and/or Knudsen echosounders, or SDN should be added.

8. Air flow in each fume hood should be checked with a certified flow meter to ascertain the proper door opening for maximum rated performance. Arrows should be installed to indicate the proper height of door on each hood. This should be checked annually for performance during off season or maintenance periods.

9. Lights on electrical control switches should be repaired to indicate when the circuits are energized.

10. The starboard "A" frame should be configured with another sheave to accommodate hydrowire to permit both CTD and bottom grabs (or simple vertical net tows) at the same station while maintaining the capability of MOCNESS from the stern "A frame.

11. Log books should be maintained for each instrument to log all calibrations, repairs and changes in configuration. This is especially true for the Guildline salinometer, Turner fluorometer, CTD/rosette and the flow-through Salinity/Temperature.

12. It is highly advisable to dock a van at one of the main deck stations and hook up all services. This will simplify a future installation and check out process, i.e. when vans appear for science cruises.

# USCGC Healy
# Phase IV Test Program
# Leg 3, 11-16 June 2000, Nuuk, Greenland RT
# Science Report
# James H. Swift, Chief Scientist

— version of 27 June 2000 —

| | |
|---|---|
| AICC participants: | Jack Bash, Lisa Clough, Jim Swift |
| Other science team participants: | Rich Findley, Todd Hindman, Captain Greg Johnson, John Kemp, Jeff Lord, Jay Schauer, Bob Whritner |

## OVERVIEW & NARRATIVE

USCGC Healy left Nuuk, Greenland, at 0900 on Sunday, 11 June, in good weather with air temperature ca. 10 °C and light winds. After part of the day in fog, we were underway on heading 320, nearly into winds of 25-30 knots, to the ice edge to begin Leg 3 of the Phase IV cold water science test program. Science program goals this leg included anchor-last deployment of a scientific mooring in open water, recovering that mooring, anchor-first deployment of a scientific mooring in heavy ice cover, recovering that mooring, and continued testing of the ship's underway systems, winch control systems, communications, and CCTV. The mooring tests were led by John Kemp and Jeff Lord from the Woods Hole Oceanographic Institution mooring group, and the underway and other related testing was led by Rich Findley from the University of Miami. There was also a full-power in-ice propulsion plant test scheduled by the Coast Guard.

Lisa Clough (East Carolina University) and Jack Bash (University of Rhode Island) were aboard to supervise and carry out testing. The science team was also fortunate to have Captain Greg Johnson, the head of the Healy construction team, on board, getting a chance to ride his vessel in the ice. He kindly offered to help with the video records of the science mooring tests. Finally, two teachers, Todd Hindman and Jay Schauer, were welcomed to the Healy.

On Monday, 12 June, John Kemp and Jeff Lord capably lead the MSTs and deck crew as they carried out a successful open water, anchor last deployment of a 209 meter long scientific mooring in approximately 740 meters water depth at 66.78 N 57.47 W near the center of Davis Strait. The exercise was meant to mimic the complete sequence of events that would occur during real deployments and recoveries, as if they were separated by months in time.

The day began with a bathymetric survey in the mooring region, followed by a test lowering of the acoustic release on the 0.322" wire to test its functions. The mooring was then deployed without incident over the stern while the Healy steamed slowly into the wind. The anchor was released within several yards of the position that had been designated hours earlier.

The team then performed an acoustic survey to accurately determine the mooring location - as if there had been a long delay between deployment and recovery. The release was triggered, the floats popped up on cue, the ship maneuvered until it was near the floats, and a small boat was launched to attach a line to the top floats. The mooring was then hauled in and disassembled.

The mooring operation was a complete success, though because it was a learning procedure it took approximately 12 hours from the start of the bathymetric survey until recovery was completed. Notes and videos made will help the team and community evaluate the operation. John Kemp and Jeff Lord carried out valuable walk-throughs for the deck crew and MSTs, and showed excellent leadership of the operation. The performance of the ship's company was once again outstanding.

Rich Findley spent a good portion of the day discussing and reviewing winch control issues, wire terminations, overboarding sheaves, and wire fairleads. He also collected much of the information concerning the installation of wind speed and direction sensors.

On Tuesday, 13 June, an ice reconnaissance was carried out to an area with water depths near 300 meters to locate ice conditions suitable for the in-ice scientific mooring test and for the ship's full-power propulsion plant test. Later on the ship carried out two additional flights. An added bonus for those on the flights was wildlife sightings, including a polar bear and several narwhales.

The sea ice was mostly decomposing first year ice about one half to somewhat over one meter thick.

For the in-ice mooring test the ship stopped in the ice at the desired location, the anchor was hung over the stern and lowered, and each piece of cable and equipment added while the array was under tension. When the top-most floats were in the water, the mooring was released. The ship's company carried out much of the work, with John Kemp and Jack Lord supervising. Deployment went quickly and smoothly.

Wednesday morning (14 June) there was heavy fog, but the ship had no difficulty returning to the in-ice mooring location for recovery. After a ranging test, mimicking re-checking the position of a mooring after a long deployment, the ship prepared a mooring recovery "pond" in the ice at the location expected for the mooring to rise into. The release was triggered, the yellow floats appeared in the pond, and from the aft con the Healy maneuvered into position with the stern close to the floats. A person was lowered to the floats in a man-basket on the crane to attach a hook and line for recovery. Hauling in went as quickly and smoothly as deployment. The coordination between the bridge, deck crew, MSTs, and science party was very good throughout.

As with the open water mooring the deployment and recovery were videotaped, with copies made for the ship, for training, and for the AICC, to assist community evaluation.

Other tests continued. The Healy's biochemistry laboratory is specified to have tight temperature control - at typical laboratory temperature - so that instruments and analyses sensitive to laboratory temperature can be carried out to specification. Inspection of the laboratory's environmental control system revealed that no special provisions had been provided by the builder, the air supply and thermostat were the same as those supplied to the staterooms, and that there was no provision for humidity control. Several days of logging biochemistry laboratory temperature at 15-minute intervals, as part of the science systems test program, demonstrated the inability of the installed HVAC and controller to meet the specifications for this space. Modifications will be recommended so that specifications can be met.

The ship next searched for a heavy ridge of ice to push against for a propulsion system test. The search was hindered by fog. A test carried out Wednesday night was inconclusive, indicating alikelihood of additional tests next leg and/or some other time before the ship reaches Seattle.

Thursday, 15 June, during what was originally intended as simply a test cast to continue scientific evaluation of the winch control system by Rich Findley, Lisa Clough carried out a successful dredge haul in approximately 900 meters of water in a long lead in the ice field, bringing up rocks, mud, and several bottom dwelling organisms. Lisa and the teachers studied the samples, along with samples of the ice algae that has been super-abundant in the ice-covered waters crossed this leg.

Testing of the environmental control systems in the climate control chambers continued. Lisa Clough imitated use cycles with a schedule of door openings, and placed a small heater in one chamber to mimic the thermal load of a person and equipment.

## TEST PROGRAM

The systems scheduled to be evaluated during this period were:

* scientific mooring deployment and recovery
* meteorological systems
* aft A-frame & capstans

Other considerations:

teacher participation
coordination of SeaBeam with mooring work
CTD at (near) each mooring site after deployment [deleted]
navigation and bathymetry information available to science watch
monitor temperature in climate-controlled chambers
ice forecasts, images, and reconnaissance

## TEST REPORTS

**Scientific mooring deployment and recovery**

As part of the USCGC Healy Sea Trials, Woods Hole Oceanographic Institution (WHOI) was tasked to demonstrate Healy's capabilities for mooring work to the Coast Guard and AICC. John Kemp and Jeff Lord of WHOI's Mooring Operations and Engineering Group performed open and ice covered water mooring deployments and recoveries.

While the Healy was in St. John's Newfoundland, Prior to Phase IV trials, WHOI personnel loaded and stowed mooring components and deck gear that would be used during Phase IV, Leg 3 trials.

On 10 June, while the ship was docked at Nuuk, preparations for mooring operations commenced. This preparation included placement of anchors, hanging a mooring block and vertical chain stopper from the aft A-frame using the ship's crane. Equipment secured for transit from St John's was moved into position for deck operations. Hardware and deck gear was inventoried and inspected.

On 11 June, while under way to the first mooring site, final preparations were made on deck. Work included placement of fairlead plate, removal of seized deck plugs, and final preparation of vertical chain stopper. An air acoustic check of releases was performed.

Also on 11 June, at the request of the Chief Scientist, a mooring orientation meeting with ships crew and science participants was held. The purpose of the orientation was to familiarize personnel with the entire mooring process, including site survey, deployment, anchor survey, and mooring recovery. It also provided a good opportunity to answer questions about equipment requirements, personnel needs, and safety issues.

On Monday, 12 June, John Kemp and Jeff Lord carried out a successful open water, anchor last deployment of a scientific mooring in approximately 740 meters water depth at 66.78 N 57.47 W, near the center of Davis Strait. The exercise was meant to mimic the complete sequence of events that would occur during real deployments and recoveries, as if they were separated by months in time.

The day began with a bathymetric survey in the mooring region, followed by a test lowering of the acoustic release on the 0.322" wire to test its functions.

An on-the-deck walk through of the deployment sequence with ship's Marine Science Technicians and Bos'n's Mates was performed prior to commencing deployment. The mooring was then deployed without incident over the stern while the Healy steamed slowly into the wind. The anchor was released within several yards of the position that had been designated hours earlier.

An acoustic survey was performed to accurately determine the mooring location - as if there had been a long delay between deployment and recovery. The release was triggered, the floats popped up on cue, the ship maneuvered until it was near the floats, and a small boat was launched to attach a line to the top floats. The mooring was then hauled in and disassembled.

The mooring operation was a complete success, though it should be mentioned that because it was a learning procedure for all but the WHOI personnel, it took approximately 12 hours from the start of the bathymetric survey until recovery was completed. Notes and videos made will help the team and community evaluate the operation.

On Tuesday, 13 June, an ice reconnaissance flight was carried out to locate a site with the best condition for the in-ice scientific mooring test. Dense ice in water approximately 300 meters was desired to most accurately mimic a real life science mooring objective. A site was located, and the Healy steamed to the new location.

For the in-ice mooring test the ship stopped in the ice at the desired location, the anchor was hung over the stern and lowered, and each piece of cable and equipment added while the array is under tension. When the top-most floats were in the water, the mooring was released. The 209 meter long scientific mooring was deployed in approximately 300 meters water depth at 67 37.59 N, 58 26.07 W . The ship's company carried out much of the work, with John Kemp and Jeff Lord supervising.

On Wednesday 13 June, after a ranging test, mimicking re-checking the position of a mooring after a long deployment, the ship prepared a mooring recovery "pond" in the ice at the location expected for the mooring to rise into. The release was triggered and the yellow floats at the top of the mooring appeared in the pond at the stern of the ship.

From the aft con the Healy maneuvered into position with the stern close to the floats. A person was lowered to the floats in a man-basket on the crane to attach a hook and line for recovery. Hauling in went quickly and smoothly. The coordination between the bridge, deck crew, MSTs, and science party was very good throughout.

As with the open water mooring the deployment and recovery were videotaped, with copies made for the ship, for training, and for the AICC, to assist community evaluation.

*Conclusion*

Science program goals for this test this leg which included anchor-last deployment of a scientific mooring in open water, recovering that mooring, anchor-first deployment of a scientific mooring in heavy ice cover, and recovering that mooring, were met.

Additionally, many of the ship's crew got hands on experience assisting with the mooring operations. The Marine Science Technicians, Bos'n, and Bos'ns Mates were very helpful and worked well together. The crew on the bridge did an excellent job during mooring operations, ice clearing, and survey work. In the future, deploying simple science moorings, similar to what was demonstrated in this test, can be accomplished with a minimum of five personnel.

The Healy will be an asset to the science community involved in Arctic research. All systems performed as expected, and the crew seems very receptive to recommendations to improve its capabilities.

*Recommendations for Improvements/Changes*

Deck

The towing bit in the center of the fantail raises many concerns about science use of the deck. First, it takes up prime space for mooring and traction winches. Also, it makes access to vans behind the bit difficult. Doors may swing open, but hauling cargo in and out of vans will be almost impossible. The bit will impede any AUV operations that require a track for launching. Most of these operations require a straight shot from the "roll-in-roll out" container to the A-frame.

Nylon plugs continue to seize in threaded holes. This caused a halt in deck operations while plugs were drilled out. Deck plugs should be stainless steel hex key type. Plugs should be no more than 1 inch in length. Our experience is that these plugs give the least amount of trouble. If ice forms in the hex detent, it can be chipped out easily with a screwdriver.

Operation of the aft A-frame and the capstan should be able to run simultaneously. Mooring operations become cumbersome when somebody must remain below decks to switch between the two pieces of equipment. Addressing this problem immediately reduces the number of personnel required to do mooring work by one.

The capstan operator's view of the working area under the A-frame is blocked by the A-Frame operator. This makes hand signals during mooring operations difficult. Moving the A-frame controls would alleviate this problem.

Cleats should be mounted on both sides of the moving portion of both A-frames. Currently, the aft A-frame has cleats on the fixed base, and the starboard A-frame has none. Frapping lines pulled through or tied to blocks and secured to cleats on the base will tension as the A-frame is moved out. Not only is this a nuisance, it is a safety issue. Lines tied to cleats on the moving part of the A-frame will not change tension as the A-frame is moved

The stock of deck lashing hardware should be supplemented. A number of SS deck bolts should be easily accessible for lashing gear to the deck. Bolt lengths of 1-1/2", 2" and 2-1/2" are suggested. A stock of flat washers for deck bolts and deck eyes will be required. Deck eyebolts should be galvanized, and available in two lengths 1-1/2" and 2-1/2" are suggested.

Moving the port side aft crane's boom cradle outboard would provide more space in the prime part of the deck, especially on cruises when several organizations with multiple disciplines are sharing deck space.

Lab

Wire feed-throughs should be installed in main lab and wet labs. This would accommodate cables to instrumentation on deck, and acoustic survey work over the side. A 5" diameter feed through (capped, or course) would be ideal. Something smaller would do.

It would be useful to link certain info to computers in the main lab, or the CCTV system. Real-time Sea Beam data, hydro winch data (line out, line speed, tension), met data, and possibly other information from ship's sensors would be useful to have in the main lab, or science computer lab.

Lab tie down hardware should be available in the main lab. This would include uni-strut anchors, eyebolts for deck and uni-strut, a limited amount of line and bungees. Scientists should bring their own screws, woods strips, Velcro, eye screws, etc. A reserve of these items would be nice.

Additional Ships Equipment

A medium sized mooring winch would improve the capabilities of the vessel and crew. When applicable, use of the winch for mooring operations would reduce the number of personnel required for mooring operations by one (using the capstan takes at least two people). The winch should have a safe working load of at least 4,000 pounds, and a drum capacity of 3,000 meters of 3/8" jacketed wire rope. If possible, the winch could be stored in the winch room or science hold when not in use.

Electrical capability for mooring winches should be available on the stern. A typical science mooring winch requires 440 VAC, 60 amp, 3 phase service. We did not notice any receptacles.

**Wind Speed & Direction**

*Make:*
R.M. Young

*Model*:
05106 Wind Sensor (2)
06201 Wind SP/Dir Remote display (2)
05631 Line Driver (2)
26732 Wind Sensor Input Module (2)
26700 Programmable Translator (1)

There are two anemometers located port and starboard on the radar mast. The voltage outputs from these sensors are converted from voltage to current to minimize radio frequency interference. The current signal from both sensors is run through a selector switch that allows the bridge to select either the port or starboard sensor. The selected sensor is then input to the programmable translator, which in turn drives several repeaters for use on the bridge and also provides the input to the SDN. The programmable translator is capable of averaging the wind speed and direction.

*Manufacturers stated accuracy of the system*:
Manual is not on board the vessel, no information available

*Method of calibration*:
Return to manufacturer

*Location of factory current calibration data*:
Unknown

*Traceable to the national bureau of standards*:
Not Applicable

*Date of last calibration*:
Unknown

*Recommended Frequency of calibration*:
Yearly

*Are calibration checks being performed & logged?*
No

*Is there a redundant system?*
Yes, see discussion below.

*Are there spares on board?*
Spare propellers are on board

*What is the data logging interval range for this sensor?*
TBD

*Can the raw data stream be made available to the science areas?*
No

*How is the data made available for real time viewing?*
Closed Circuit TV & Ship's entertainment system

*Does this sensor require additional input from other sensors?*
Yes ship speed and ship heading

*Is this sensor installed and interfaced correctly?*
No. See comments about mounting below

*How is the data from this sensor passed to the scientist?*
TBD

*General Comments and Recommendations*

- The anemometers do not seem appropriate for high latitude work. The MSTs have reported that both sensors have frozen up during previous legs. The propellers on both anemometers broke off due to ice damage during this one-week trip. Replacement sensors suitable for high latitude work need to be procured.

- The anemometers need to be relocated. The anemometers to visibly change direction as the radar antenna sweeps. There has been discussion of moving the anemometers outboard but there are additional antennas mounted in the area that would then interfere with clean air flow in that location. Several solutions are proposed;
  - Procure a new anemometer suitable for use in high latitudes and mount it on jack staff on the bow above the running light, though this may make the icing problem worse.
  - Procure two new anemometers suitable for high latitude work and mount one on the bow and the second on the top of the helo control station. This would provide undisturbed air flow to the bow anemometer and a relatively undisturbed airflow to the stern anemometer.
- The starboard sensor is not working. Repairs should be made.
- A complete manual should be obtained from the builder.
- The averaging period should be determined and put in the data file header
- The bridge selector switch allows the bridge to select the optimum anemometer for conditions when the mast interferes with the sensor or when one sensor fails. However there is no method to input the information into the logged data. The scientist cannot tell which sensor has been selected, if it is the optimal sensor or if it is being used because it is the only one. The system should be modified so that both sensors are logged independently. The switched output and the sensor switch position should also be logged automatically. The scientist would then have choice of which sensor data they used.

**Air Temperature Sensor**

*Make:*
R.M. Young

*Model:*
26700 Programmable Translator
26726 Temperature Input Module
43408 Aspirated Radiation Shield
41342 Platinum Temperature Probe

*Manufacturers stated accuracy of the system:*
+/- 0.3 degrees C
+/- 0.1 degrees C is available as an option. It is assumed that the lower accuracy probe is installed.

*Method of calibration:*
Temperature probe and Temperature Input Module can be returned to manufacturer for calibration to NIST standards.

*Location of factory current calibration data:*
Unknown

*Traceable to the national bureau of standards:*
Since calibration data cannot be located it is currently not traceable.

*Date of last calibration:*
Unknown

*Recommended Frequency of calibration:*
Yearly

*Are calibration checks being performed & logged?*
Dry bulb temperature readings are conducted approximately every 3 hours by MST's using a sling psychrometer for wet and dry bulb temperature. The time of the sling psychrometer reading is rounded to the nearest hour making it difficult to compare to the temperature sensor which is stored every second. This reading is not posted or available on the SDN or any other server. Reviewer has not determined accuracy, traceability or calibration of sling psychrometer.

*Is there a redundant system?*
No.

*Are there spares on board?*
No.

*What is the data logging interval range for this sensor?*
TBD

*Can the raw data stream be made available to the science areas?*
No

*How is the data made available for real time viewing?*
Closed Circuit TV & Ship's entertainment system

*Does this sensor require additional input from other sensors?*
No

*Is this sensor installed and interfaced correctly?*
No. See comments about mounting and power failures below.

*Comments & Recommendations*

- The forced aspiration temperature sensor is mounted on starboard rail of deck 06. The intake for the sensor is about .5 meters from the deck that is painted a dark color. Heat radiated from this surface will affect the temperature readings. A more suitable location needs to be found.

- The sensor hangs after every power failure and must be manually reset. The sensor was hung for over 10 hours and was not corrected until pointed out by the reviewer. This problem needs to be resolved.
- Spare parts should be onhand; minimally a spare blower motor should be obtained.
- There is a tag (AIR_TMPERATURE UNITS) in the data file but there isn't any value in the file. This needs correcting.
- Yearly calibrations should be scheduled. The temperature sensor and temperature input module should be sent for factory calibration as a set.
- Accuracy and traceabilty of sling psychrometer needs to resolved. Yearly calibrations of the sling psychrometer are needed.
- The thermometers on the sling psychrometer have a range from –20 to + 50 degrees C with a minor scale division of 1 degree C. The resulting precision is on the order of .2 degrees C. A psychrometer with a narrower range should be obtained.
- A determination needs to be made if this sensor is the optional high accuracy sensor. If not a new sensor should be obtained. (The current sensor had an acquisition source of $136).
- A spare temperature sensor and temperature input module set should be obtained. This set would be a rotational spare allowing calibration to take place without any down time.
- The MSTs sling psychrometer observations with the corresponding time to the nearest minute should be entered into a spreadsheet and compared with the electronic sensor.
- There is an average difference between the psychrometer dry bulb temperature and the ship's temperature sensor of 0.91 degrees C. Since there aren't any calibration records available for either method, it is not possible to determine which temperature is correct.

| Date | Time | Ships Sensor Temperature Degrees C | Psychrometer Dry Bulb Degrees C | Difference |
|---|---|---|---|---|
| 6/12/2000 | 6:00:00 | -2.17 | -2.0 | -0.17 |
| 6/12/2000 | 9:00:00 | -2.25 | -2.3 | 0.05 |
| 6/12/2000 | 12:00:00 | -2.44 | -2.0 | -0.44 |
| 6/12/2000 | 18:00:01 | -1.26 | 0.4 | -1.66 |
| 6/13/2000 | 0:00:00 | -1.66 | -1.0 | -0.66 |
| 6/13/2000 | 3:00:02 | -3.18 | -2.1 | -1.08 |
| 6/13/2000 | 6:00:00 | -4.08 | -3.9 | -0.18 |
| 6/13/2000 | 9:00:00 | -3.75 | -3.2 | -0.55 |
| 6/13/2000 | 12:00:00 | -1.03 | 0.6 | -1.63 |
| 6/13/2000 | 15:00:00 | 1.20 | 3.0 | -1.80 |
| 6/13/2000 | 21:00:03 | 1.16 | 3.1 | -1.94 |
| | | **Average Difference** | | **-0.91** |

## Gyro Compass &Heading Sensors

### *General Comments and Recommendations*

The heading system for the vessel consists of a Sperry Mark 37VT Digital Gyro Dual Gyro system combined with a Ashtech ADU-2 3D GPS system. The gyro is designed such that in the event of failure of the primary gyro the system switches over automatically to the secondary gyro. The bridge has the ability to select either the gyro or the 3D GPS as the heading sensor for distribution to the ship's systems as well as the scientific instrumentation. The combination of a gyro and a 3D GPS is fairly common for research vessels. Gyros provide heading with a high degree of reliability but are subject to errors that are too large for use with some scientific instruments, additionally at high latitudes gyros cease to function. 3D GPS systems provide a high degree of accuracy but are subject to dropouts. The system installed aboard the ship is designed to provide the best of both systems.
Data was collected from both the 3D GPS and the Gyro for a 24 hour period. A reasonable correlation exists between the sensors. The 3D GPS shows a high degree of availability indicating the antennas are well located.

There are some issues that need addressing.

- The output of the manual switch has the data tag of GYRO_SW_GPHDT_HEADING. This tag is confusing because when it is set to the 3D GPS it is not a gyro. It is recommended that this tag be changed to SW_GPHDT_HEADING.
- The output of dual gyro system has the data tag of GYRO_UNSW_GPHDT_HEADING. This tag is also confusing because it is the automatically switched output of the dual gyro system. It is recommended that this tag be changed to GYRO_GPHDT_HEADING.
- Some scientific instrumentation, for example the ADCP, is extremely sensitive to heading. Having the heading sensor change either through automatic fail over or manually by the bridge without the scientists knowledge or any record of the change would be of concern to many scientists. It is recommended that three additional outputs be added to the system to resolve this issue. Two of these outputs would be the serial data out of the primary and secondary gyros. The data tags for these outputs should be PRI_GYRO_GPHDT_HEADING & SEC_GYRO_GPHDT_HEADING. Addition of these outputs would allow comparison of the gyros and allow the scientist to compare and select the desired gyro. The third output would be HEADING_SENSOR_SELECTED. This data tag would allow users to determine which sensor had been selected. These changes **do not** require any changes to the existing connections to the ship integrated bridge or other science equipment.

## Aft A-frame and capstans

# USCGC Healy
# Phase IV Test Program
# Leg 4, 19-29 June 2000, Nuuk, Greenland, to Reykjavik, Iceland
# Science Report
# James H. Swift, Chief Scientist

— version of 29 June 2000 —

| | |
|---|---|
| AICC participants: | Jack Bash, Lisa Clough, Larry Lawver, Jim Swift |
| Other science team participants: | Garry Brass, Jim Broda, Todd Hindman, Chris Moser, Jay Schauer, Bob Whritner |

## Overview & Narrative

USCGC Healy departed Nuuk, Greenland, on Sunday, 18 June, heading north in open water and good weather west of Greenland to near 71°N. Some southwest swell on the run north at first had the ship rolling quite noticeably. The roll quickly smoothed out when the ship filled the anti-roll tanks. They were very effective and made the ride easy.

On board was a group of coring specialists, including Jim Broda (WHOI), Chris Moser and Peter Falk (Oregon State), Garry Brass (Arctic Research Commission), led by AICC member Larry Lawver (U Texas at Austin). Also on board was CDR George Dupree, the Coast Guard's head of icebreaker operations. Science team members remaining on board from Leg 3 included Jack Bash (University of Rhode Island), AICC member Lisa Clough (East Carolina University), Bob Whritner (UCSD/SIO), and the two teachers, Todd Hindman and Jay Schauer.

Although there were a few miscellaneous tests to retire, such as those for the science hoist and deck communications system, and a few ongoing tests, such as the climate control chambers and continued evaluation of the science data network and winch control systems, the focus this leg was squarely on evaluating the Healy's coring and dredging capabilities, along with the use of the bathymetric systems in support of those operations.

The plan was to carry out a rock haul with the dredge on some hard volcanic rocks thought to lie west of Disko Island. But Monday night (19 June) the team was unable to find - with the sonar gear - the proper type of rocks for dredging, and so they moved the ship west into the ice where they found sediments suitable for coring. The starboard A-frame will be used for coring work. All parties agree that the Healy's coring capabilities in open water over the aft A-frame were amply proven during warm water testing, so the emphasis on Leg 4 was on coring over the starboard, and in ice. Associated with this was use of the SeaBeam and 3.5 kHz sub-bottom profiler to survey prospective sites. The MSTs had the Knudsen system up and running, and with a slave monitor in the aft control station that could be switched between the Knudsen (or Bathy 2000) and SeaBeam.

On Monday night the ship's company enjoyed a polar bear encounter. Observedrs first saw the mother, apparently out foraging for food, but then two cubs were spotted waiting, unmoving, directly the ship's path, 400-500 yards from the mother. The ship turned to starboard and gradually came to a stop. Meanwhile, the mother made haste back to her cubs. The bears remained as close as 50 yards from the ship, but eventually moved to 150-200 yards. As the Healy resumed progress, the mother bear was sitting up nursing the two cubs.

Tuesday, 20 June, the trawl wire was rigged to the starboard A-frame, the wire was terminated and tested, the gear set up, instruction sessions were held, and then the corer, with 40 feet of pipe, was launched and recovered. By all evidence it had not only entered the sediments easily, but had plunged in to the core head. All went quite well, with only a minor miscommunication on pull out - which was a bit too fast - which may explain why the top meter or so was water and not mud. The entire operation was very capably led by the WHOI and Oregon State groups, who took laudable care to work out procedures and instruct the Coast Guard personnel.

Wednesday morning, after a short run back to the site to correct for ship drift, and some corer reconfiguration plus a new wire termination and test, a 60 foot core was launched. This time the operation was led by the Coast Guard personnel, with the academic technical specialists coaching, similar to the way the second mooring operation on Leg 3 was led by the Coast Guard. This coring operation worked well, triggering and pull-out were excellent, and the corer brought back a nearly full barrel of mud, up to the 56-foot point, where the core ran into a hard layer.

Thursday (22 June), as the coring team prepared to do a second 60-foot core in order to tune the procedures and help cement the training program, to the surprise and dismay of all, it was learned that the fine control the trawl winch requires to work safely with the massive core head was no longer available. The problem may have been generated by an on-board representative of the control system vendor loading a software "fix", or the problem may have been coincidental to that. Fixes were attempted, to no avail, for approximately 30 hours.

Meanwhile Jack Bash successfully retired the test programs for the closed-circuit TV, the scientific hoist, and the deck communications system, so a degree of test progress was continued.

Friday morning (23 June) an 80 foot coring rig was prepared, moved to the vertical and then hoisted back up onto the platform - all operations which did not involve the winch. This operation was videotaped. It uncovered a few minor issues with cranes and handling, but these were easily solved. Thus in the rigging sense, the Healy was proven ready to carry out up to 80 foot cores, the maximum length feasible with the current configuration.

The ship stood by waiting for a winch software fix, hoping the vendor would have a breakthrough using the various diagnostics sent to England, but the vendor was unable to rectify the problem. These problems were yet one more demonstration of the unsatisfactory nature of the winch control system. The control system does some functions well, but it is, quite simply, not designed around the guiding principles of scientific winch control. The MSTs spend significant time to get it to do what they want. They succeed, but perhaps as much in spite of the system as because of it. Hence the winch control system has long since been identified as requiring substantial modifications. Those modifications are planned before science cruises commence.

Friday afternoon the trawl wire was rigged over the stern A-frame and the coring gear secured, in preparation for a transit to a likely hard-rock location on a slope, where a rock dredge was planned. (Dredging was possible without the trawl winch's fine control functions.)

The final deck operations in support of the Healy's cold water science systems test program were carried out late Friday night (23 June): a rock dredge trawl up a small box canyon off Disko Island identified by SeaBeam and 3.5 kHz echosounder surveys. The operation went flawlessly, beginning with a bathymetric survey and the laying out of a ship's course up the narrow canyon to a suspected "lip" of hard rock, to the setting out and towing of the dredge - with the ship within a ship's width of the intended tow track despite a mild crosswind - through recovery. The sole disappointment was that through no fault of the ship or personnel the rock dredge brought up only mud, polished rocks, and a few bivalves, i.e. just enough mud and glacial debris covered the hard rock to keep the dredge from breaking off any chunks.

At that point the Healy began a long steam to Reykjavik, Iceland, where most of the science test team disembarked. Vague threats of uglier weather near the southern tip of Greenland failed to materialize until Tuesday (27 June), as the ship headed northeast across the Irminger Sea in winds of ca. 25-30 knots.

Around the western side of the southern tip of Greenland on Sunday evening we ran into several bands of well-weathered brash ice and growlers, clearly the "graveyard" of the ice carried south from the Greenland Sea and Arctic Ocean by the East Greenland Current. (These bands were also shown on the satellite images.) Seals were in abundance everywhere on the ice, sometimes swimming energetically in groups of 6-10.

Captain Garrett routed the Healy through Torssukatak and then down Prins Christian Sund at the southern tip of Greenland, in flawlessly beautiful weather. All hands enjoyed 7 hours of spectacular scenery.

## TEST PROGRAM

The systems scheduled to be evaluated during this period were:

* coring
* dredge
* deck communications systems
* CCTV

Other considerations:

teacher participation
coordination of SeaBeam with mooring work

CTD at (near) each mooring site after deployment [deleted]
navigation and bathymetry information available to science watch
monitor temperature in climate-controlled chambers
ice forecasts, images, and reconnaissance

## TEST REPORTS

### Coring

#### Synopsis (Dr. Larry Lawver)

Jim Broda of the Norsk Polar Institute of Trømso, Norway led the coring operations. He designed the Giant Piston Corer [GPC] installed on *Healy*. The evaluators for the GPC were Pete Kalk and Chris Moser of Oregon State University. They all worked to instruct and then assist the shipboard Marine Science Technicians [MSTs], Glenn Hendrickson, 'Hutch' Hutchison, Eldridge McFadden, and John Albrough.

During warm water trials, test of the Starboard launch and retrieval system for the GPC was not undertaken. A stern-launched, 40 foot core had been rigged and successfully tested on the warm water trials but lack of time precluded test of the starboard system. Relying on the only available data on piston coring in Baffin Bay [Aksu, 1983], it was obvious that at least 10 meter cores could be taken in much of Baffin Bay. The first criteria for a good coring site was location of an area with suitable sub-bottom penetration observed on either the Knudsen system or the Bathy2000 system. The second criteria was an ice covered area with a depth in excess of 1000 meters. It was not certain of the ship's station keeping ability if a winch problem developed while the core was in the bottom so deeper water was preferred. As a result we headed off towards the center of Baffin Bay with the intention of finding a dredge site enroute since the 9/16" trawl wire was rigged through the stern A-frame. Enroute no great dredging site was observed although one likely site was determined NW of Disko Island. Finding ice was not a problem because Bob Whritner was able to supply both infrared and visual ice coverage photos. The ship traveled north along the ice edge until turning west at about 71°15'N. At the time the group was still looking for a dredge site but instead found an excellent coring site. As the ship approached 61°20'W there were vedry few open leads further west in deeper water. The ship had progressed from subbottom penetration of 10 meters or less to 30 meters to a consistent, >60 meters with occasional reflectors at 70 or 80 meters observed. The ship was travelling through the ice at variable speeds from 3.5 to 7 knots, to stopped dead for a mother polar bear and her two cubs.

After stopping because there were no observable open leads to the west, there was a test to estimate ship drift. At the time, drift approached 0.5 kts with winds of 10 to 15 kts. The ship was then stopped in a lead about 150 m by 500 m. Coring operations began in the morning. First order of business was changing the stern trawl wire to the starboard A-frame. After that, a feege fitting was put on the end of the wire. A pull test of 10000 lbs was made on the first fitting. The fitting failed the test. It was then determined that the tear drop wedge used in the feege fitting was the wrong size. The wire was reterminated with the correct tear drop wedge.

Below is a synopsis of the coring operation. The first number of each entry is the Julian Day, 172 = 20 June 2000. The next entry is the time using GMT or UTC time. Ground speed is indicated where noted to estimate drift rate.

*Healy 04-GPC 01*

172/1816, 71°16.355N, -061°20.680W, Ground speed 0.13Kts, Depth 1717m
On station for first GPC.

172/1829, 71°16.339N, -061°20.585W, Ground speed 0.20kts, Depth 1715m
Stop wire at 83 m to remove pin. Pin was in main sheave by Science Con and was used to keep trawl wire from jumping off sheave.

172/1901, 71°16.275N, -061°20.362W, Ground speed 0.16kts, Depth 1710m
Resume lowering the corer to the bottom.

172/1934, 71°16.201N, -061°20.203W, Depth 1709m
Maximum wire out 1661 m. Wire was zeroed at the surface. There is a trigger core 20' below the nose of the main core. So there would be at least 20 feet plus the 40 feet of core pipe plus 5 feet of the coreweight for 65 additional feet below where the weightstand is zeroed at the surface. So the total wire plus corers would be 1681 m. There is a discrepancy between the wire out and the water depth determined by the Knudsen and by the SeaBeam. The Knudsen is not corrected for the local water temperature so over-estimates the water depth. SeaBeam is programmed with "historical water" temperature data. SeaBeam depth was 1692 m so the difference is the order of 10 m. This indicates that the "historical water" temperature data is not sufficient to give a precise depth but is close. Penetration of the corer is easily seen as a weight reduction on the winch recordings.

172/1937, 71°16.191N, -061°20.323W, Depth 1709m
Core coming up. Depth from SeaBeam = 1692 m or 1690 m depending on ping.

172/2011, 71°16.0654N, -061°20.18W, Depth 1705m [Knudson], Ground Spd. 0.3kts
Trigger arm out of the water

172/2018, 71°16.054N, -061°20.041W, Depth 1705m, Ground Spd. 0.3kts
Trigger core at surface

172/2024, 71°16.0074N, -061°20.1364W
Core out of water

172/2027, 71°16.009N, -061°20.009W, Depth 1705m, Ground Spd. 0.4kts
Core weightstand in bucket

172/2040, 71°15.9226N, -061°20.0928W

Core on deck

Core was extruded using the Broda Core Extruder [BCE]. About 10 meters of core was recovered in eight sections. The top 2.5 meters was water filled even though the exterior of the core was mud covered as was the weightstand. It was believed that the piston triggered slightly early so that it had started to move up the pipe just before the tip of the core hit the bottom. This could have been caused by a number of circumstances including a slight miscalculation of the length of wire attached to the trigger arm although in this case that was not the problem. The mud recovered was slightly soupy mud.

*2000Healy 04 GPC 02*

GPC 02 was rigged as a 60' core using the starboard A-frame. It was decided to wait until the next morning to undertake the second piston core because by the time the first core was extruded, the barrels added and the 60' core was ready to go, it was decided to wait until morning. During the night the ship had drifted eastward and up slope sufficiently to warrant moving the ship westward and into deeper water. It was also determined that the feege fitting should be replaced to be completely on the safe side. Consequently the ship was gotten underway at about 173/1030z [0830 local] while the wire was reterminated.

173/1030, 71°14.5879N, -061°19.0909W
Start survey for new core site.

173/1200, 71°13.491N, -061°30.657W
We headed west but did not find any particularly good open leads although we found good bottom. So we continued further west than planned and stopped on station as shown.

173/1301, 71°13.26N, -061°29.92W, Depth 1820m
Core in vertical position. There appears to be as much as 80 m of sediment based on the 3.5 KHz return from the Knudson. Ship is gradually drifting to the southeast.

173/1304, 71°13.253N, -061°29.904W
A-frame out.

173/1319, 71°13.223N, -061°29.814W, depth 1819m based on SeaBeam
Trigger core attached.

173/1350, 71°13.169N, -061°29.575W, 0.1 kts ground speed
Stop above bottom at 200m off.

173/1357, 71°13.165N, -061°29.598W
Start lowering at 30 m/min. Start at 1605 m of wire out. Wire angle is 0°.

173/1403, 71°13.163N, -061°29.526W, Depth 1829 m [Knudson], Grnd speed 0.1 kts.
Core enters bottom with 1771 m of wire out.

173/1406.5, 71°13.163N, -061°29.549W
Pull out.

173/1447, 71°13.193N, -061°29.338W
Trigger core at surface.

173/1506, 71°13.21N, -061°29.322W
Corer in bucket.

When the corer returned to the surface, the corehead and about the first 2.5 m of pipe was not covered with mud. It was guessed that 52 feet of mud may have been recovered. It was found that the core cutter and fingers did not contain much mud. The nose sheared off the bottom of the core. As the core was being extruded with the BCE, The bottom 5 feet or so of the core was filled with water. Below the water was a very tight plug of mud that was probably an inpenetrable layer that the GPC struck. Because the bottom of the layer was so hard, water flowed down the pipe and filled the void as the piston rose. The sediment was so hard that the overlying sediment was sucked upward with the piston leaving the gap at the base of the core. There was also the gap at the top of the corer where the pipe did not penetrate the subbottom. Consequently only 47 feet of core in 11 sections was recovered with loss at the bottom of the core. In reality, a 14+ meter core was recovered from Baffin Bay. The longest GPC yet recovered by *Healy* and the longest core known from Baffin Bay. Coring process went very smoothly. Helo ops began immediately after the core was recovered and extrusion of the core was delayed until supper. A second 60 foot core was planned for JD 174.

*Additional cores on Leg 02*

The third core began put did not get out of the bucket. The winch controls that had been adequate until the start of Core 03 took a major step backwards. There was no ability to precisely stop the winch. Consequently the winch would be stopped and 10 seconds later, the core would drop 30 to 50 cm. That was deemed unacceptable. Thirty hours were spent waiting for Alstrom to provide a fix to the winch software. The final exercise was rigging an 80 foot corer. The core was lowered over the side to a vertical position and recovered. This was considered acceptable and it is clear that a longer core is simply not practical from Healy.

**Report from OSU Coring Team**

*General Ship Status*

As with the warm water coring trials in February 2000, the coring team continued to be impressed with the interest and cooperation of everyone involved from the ship's crew during their entire time aboard. Members of the Healy crew from the Captain and officers to the Marine Science Technicians (MSTs) and deck crew were eager to learn all aspects of coring from principles of operation to deck procedures and core curation. Again, the ship's MSTs worked long and hard on varying schedules to assist the coring technicians and to learn the coring procedures for themselves.

As a special note, the assignment of the Healy's deck crew to assist the coring technicians and the shipboard Marine Science Technicians with coring operations was very helpful. This cannot be stressed enough.

All deck personnel involved were very cooperative and their willingness to help not only with the operation of cranes and deck equipment but also with coring procedures and core curation was invaluable. The deck crew and the ship's MSTs worked well together alongside the coring technicians, and by the time of the third core all involved were a well coordinated and efficient team. At the end of the cold water coring program, the MSTs and deck crew were essentially "running the show" and the coring techs were assisting while still serving as supervisors. This combined coring experience and collective memory within the ship's crew should be retained. If so it will bode well for future coring operations aboard the Healy.

In the opinion of the coring team, the addition of the deck crew to the coring operations will now allow the Healy and the MSTs to more successfully support the demands and requirements of a typical, 24-hour, round-the-clock coring program comparable to that conducted on any UNOLS vessel. Without the support of the deck crew, the team seriously doubts that only four MSTs could fulfill both their normal complement of shipboard and weather observation responsibilities as well as support a full coring program.

In addition, having the ship's flight personnel available to conduct helicopter operations was a valuable resource for the coring capabilities of the Healy. Helicopter reconnaissance for adequate areas of thinner ice or open water leads could greatly assist the ship in setting up necessary open water off the starboard side in preparation for piston coring. Open water under the starboard A-frame and along the starboard side of the ship during coring is crucial especially to prevent pre-tripping of the trigger arm during deployment and to allow unrestricted movement of the core during recovery.

*Aft Control / Science Lab / Main Lab*

The coring group would like to reiterate some important changes needed for safe coring or dredging operations previously mentioned in the Warm Water Coring Trial Report.

The Healy needs to optimize an integrated information station showing at least line scope, line tension, bottom depth, 12KHz pinger depth and pinger bottom traces. This integrated station should be in direct contact with the winch operator and the ship handler. The best solution to the present disjointed situation is to remove the corridor walls aft of the fan room separating the science lab from aft control. Placing a locking door across the end of the new corridor at the aft end of the fan room would effectively lock and secure this combined science / aft control area. Then the Bathy 2000, Knudsen, SeaBeam and CTD control systems could all be clustered along the aft wall of this new area allowing direct communication between the winch operators, ship handlers, and the scientists analyzing depth/wire/tension data. Perhaps other video screens could be incorporated into this modular data display center with multiple data and video channels to allow different scientific groups to tailor their useful data streams. It would be helpful to have this same modular data display available in the Main Lab area as well.

NOTE: It is very important for coring operations that this integrated data system also includes TWO wire tension components :

1) A large instantaneous analog dial line tension indicator; and
2) an historical real-time record of wire tension during the entire coring preocedure.

The real-time instantaneous readout of wire tension is extremely important to verify when the piston core trips at the seafloor so that the winch operator can stop the winch. During warm water coring trials, a time-delayed digital readout was inconclusive and not acceptable. Since then, the ship's MSTs have installed a one-second delayed video readout of line tension in the Aft Control area which was very helpful during Cold Water Testing to confirm when the core tripped. As presently configured, this video line tension readout successfully captures a short "snapshot" of line tension and serves a similar function to an instantaneous analog-dial indicator.

Equally important during any successful piston coring operation is the ability to analyze and review the entire record of real-time wire tension as it is being produced - initially, from the gradual increase while the core is being lowered in the water, through the instantaneous drop off in tension when the core trips at the seafloor, and finally to the gradual increase in tension to the maximum values experienced while hauling in wire during pullout.

In order to fulfill both of these requirements, two line tension readouts should be installed aboard the Healy in the Aft Control:

1) One readout should display a gradual, real-time record of line tension that covers the entire hours-long record of tension from core-over-the-side through pullout. A computer-generated tension record on a monitor best illustrates the historical record of real-time line tension. There should also be a means to print out a hardcopy of any computer generated display. A chart strip recorder can also be used to output this historical record.
2) A second readout should be optimized to display the instantaneous drop off in wire tension that occurs when the piston core trips at the seafloor. In the coring team's prior experience, a large analog-dial Metrox type readout best provides the instantaneous tension readout, although instantaneous computer monitor displays similar to what is currently installed in Aft Control have been used as well.

In addition, it is helpful to have a large readout of Wire Out and Tension in the Starboard Staging Area visible from under the starboard A-frame even at night. During recovery, this allows the coring technicians to "sight" the core as it approaches the surface in the event the line out indicator has drifted a bit during the coring operation.

Also important is a paper output of 12 Khz pinger traces and bottom depth from an EPC recorder. It is often easier to sight pinger traces on these real-time paper recorders than it is to pick the same data off of a smaller, lower-contrast video screen.

All the video cameras that are used for safety monitoring and winch operation also need to be upgraded to tilt/pan/zoom cameras. The fixed position/fixed focus cameras are not useful and do not add to a safe sea-going environment.

To reiterate from the Warm Water Trials, there are no cold water drinking fountains anywhere in the main lab area or near the 01 Science Labs. One is forced to drink from sink spigots when thirsty or walk 200 feet forward through five watertight doors to quench one's thirst in the mess.

The Aft Science Staging Area looks to be the best site for core splitting and initial curation work. These procedures are very muddy by nature and require a lot of sink cleaning with a lot of mud going down the drains. In the past, this mud has overwhelmed many shipboard drainage systems. Therefore, there needs to be a dedicated sink that drains directly overboard to keep all of this mud out of the ships drainage. A portable overboard-draining sink needs to be installed in the Aft Science Staging Area or wherever the initial core splitting and curation work will be done. Other final split core description work could best be done in the aft area of the Main Lab with split cores placed in D-tubes and boxes in the Science Reefers or refrigerated vans to prevent freezing.

NOTE: Cores should be storeed at temperatures between 35°F - 40°F. It is very important that the stored sediment cores do not freeze! Cores should be stored in a monitored refrigerated spcae. Do not store cores in a "warmed" freezer space thtat still has the potential of reaching below-freezing temperatures!

*Deck Operations and Coring Equipment*

The decks can be made safer for icy cold weather working conditions. Ideally, a heated work deck area similar to that installed aboard the RVIB Nathaniel B. Palmer would provide the safest cold weather work environment. Lacking that, installing heated deck areas under the starboard and aft A-frame areas would keep these areas safe for the strenuous lifting and ship-edge nature of piston coring work. At the least, raised gratings could be installed under the A-frame work areas and along the starboard rail for piston core preparation to hopefully allow water to drain away and ice accumulation to occur below a rugged surface with adequate footing under icy conditions.

For safety, a Jacob's Ladder should be deployed over the side near the starboard A-frame during starboard coring operations for rapid retrieval of personnel from cold waters.

During cold water trials, it was also noticed that the main winch control station is dangerously close to the direct "line-of-fire" if a coring or dredging trawl wire parted at the stern A-frame sheave. Unfortunately, this does happen at sea. The wire end can explosively whip back instantly and seriously injure personnel even inside the Aft Control Space. Bars or bulletproof glass should be installed in at least the inboard two windows to protect ship's personnel in the event the wire parts under high tension.

*Starboard Coring System*

The Aft coring system had been adequately tested during the warm water trials. All coring done during this cold water trial was from the Starboard A-frame. The ship's crew and coring technicians successfully launched and recovered two piston cores - one 40 foot and one 60 foot long core, recovering 35 feet and 47 feet of mud respectively. A harder, indurated sediment layer 40 feet deep at the coring site prevented the 60 foot core from penetrating fully even with a 4,000 lb. core weight.

*Starboard Crane Operations*

In general, the MSTs and deck crew did an excellent job of directing and manning the starboard articulating crane operations, the starboard A-frame and the bolt-down SeaMac Marine Products deck winch. All piston core and trigger core procedures were done safely and efficiently even while learning proper coring operations from the coring techs.

*Deploying and Recovering 40 foot long and 60 foot long Piston Cores*

For deployment of both the 40 foot and 60 foot long piston cores, the starboard articulated crane worked well with a main down / jib down configuration. The crane was positioned over the midpoint of the core barrel and raised the horizontal core pipe off the deck supports with a short whip up. Then the core barrel was swung outboard to safely lower the core to the water where a pull on the quick release allowed the core to fall and pivot in the core cradle into its vertical position.

For recovery, the articulating crane was configured main up / jib up and , most importantly, with the boom initially in an inboard position. The core pivoted easily with the extra 20 foot and 30 foot long wire lifting lines placed at the midpoints of the 40 foot and 60 foot long core barrels to lift the core and swing inboard back onto its deck supports.

*80 Foot Long Piston Core Crane Launch and Recovery Procedures*

In addition, crane procedures were developed for launching and recovering an 80 foot long core. With the crane positioned main up / jib down similar to the 40 foot and 60 foot cores, the 80 foot core was successfully lifted off its deck braces, swung outboard and the core barrel was released at the water surface allowing it to pivot into a vertical position.

For recovery, however, due to the longer 40 foot lift wire required to support the midpoint of the 80 foot long core, the articulated crane was configured main up / jib up. With an initial inboard position and with this extended lift capability, the articulated crane raised that extra long 40 foot lift wire without two-blocking the whip to pivot the 80 foot core barrel out of the water and swung inboard to place the core barrel back on its deck supports. During the lift, the bo'sun reported that there was still another 6 - 8 feet of lift available even while dealing with this longer forty foot wire lift line.

<u>Starboard Coring Operations Evaluation</u>

*Termination of the 9/16" Deep-Sea Trawl Wire*

The piston corer needs the 9/16" trawl wire to be terminated with a 9/16" Electroline "fiege" fitting that allows the wire termination to pass through the core weight and attach to the piston at the bottom of the core barrel. To properly assemble this termination, one needs a large, sturdy deck vise mounted optimally three feet off the deck. At present, the only vise available is located one deck below in the DC shop on a bench at least four feet high. This makes the fitting of these Electroline terminations unnecessarily cumbersome and time consuming. The Healy MSTs need one or more large deck vises that can each be mounted on a portable, boltable stand out of the weather on the main deck to assist in coring operations such as wire terminations.

*Trawl Winch Performance*

Initially, for the 40 foot and 60 foot long piston cores, the winch controls worked partially successfully while exhibiting some peculiar traits. While wire was actively paying out or hauling in, the winch motor control seemed to be out of phase with the winch brake actuation, so that a STOP command from winch control actually took ten seconds to occur. This time lag is particularly dangerous and annoying when the piston core trips at the seafloor allowing the piston to continue travelling toward the sediment and needlessly plugging the core barrel when the corer first enters the sediment. This loss of core material from the top of the piston core is not acceptable and is normally prevented by stopping the winch instantly once the piston core trips.

More than once,the winch controls did not prove to be reliable and/or predictable. Even more dangerous was the inability of the winch to adequately control the 4,000 LB. core weight at the surface when the core was moving near ship's personnel and could catastrophically drop and pretrip endangering life and limb. Initially, once stopped, the winch controls at first would hold the 4,000 LB. core weight suspended in mid air within the core cradle as required to attach the trigger core to the trigger arm. Unfortunately, during the aborted deployment of the second 60 foot long piston core, the winch mysteriously lost fine winch control and could no longer hold the 4,000 LB. coring weight freely suspended within the core cradle. The coring crew and the ship wasted an entire day without any successful fix for this problem either from Alstom or its shipboard representative at the time.

A simple solution to this winch control problem would be to allow the winch to be controlled by means of a single HAUL IN / STOP / PAY OUT LEVER with variable speed control based upon stick position. This is the simple and reliable means of winch control on every UNOLS vessel that operates a deep-sea trawl winch used for coring. It is safe, operator-friendly and most importantly, SIMPLE and RELIABLE. No one wants something unexpected to happen when 4,000 LBS. is suspended overhead !

> A VARIABLE SPEED WINCH CONTROL WITH AN INSTANTANEOUS, OPERATOR-CONTROLLED, HAUL IN / STOP / PAY OUT STICK MODE IS THE ONLY WINCH OPTION ACCEPTABLE FOR CORING.

*Trawl Wire Reeving*

Invariably, a chief scientist on a coring cruise will want the longest cores possible with the largest surface sample. These conditions inevitably lead to deploying both a piston corer for length AND a multicorer for surface sediment. On the Healy, this means rigging the piston corer from the starboard side and rigging a multicorer from the aft A-frame. Both piston corers and multicorers can experience tensions in excess of 8,000 lbs. expecially during pullout, which necessitates using a deep-sea trawl wire to deploy each corer. As the Healy is presently configured, this means re-reeving the trawl wire between the starboard and aft A-frames.

In addition, the piston corer needs the trawl wire to be terminated with a 9/16" Electroline "fiege" fitting that allows the wire termination to pass through the core weight and attach to the piston at the bottom of the core barrel. The multicorer also uses the same fiege fitting attached to a swivel above the corer. At present, re-reeving the trawl wire is a most difficult task at best. The sheaves are only reachable with a scissor lift that has great difficulty navigating the uneven decks of the Healy even in dry conditions with the ship fast in the ice. Using the scissor lift in icy conditions or in open water would be quite dangerous and ineffective at best.

Re-reeving the trawl sheaves to the starboard A-frame is a two-step process. The sheaves have to be pinned (secured) or unpinned (free to move) and the trawl wire needs to be reeved through the sheaves with the guide pins secured in place to prevent slack wire from fouling the sheaves. A hinged, moveable catwalk should be installed that would fold up out of the way when not in use to access the sheave in the Starboard Staging Area. The present catwalk at the outboard corner of Aft Con should be extended and raised to access the outboard pass through and the outboard sheave aft of Aft Con. Another moveable, hinged catwalk should be installed out of harms way near the inboard sheave and the present catwalk so that the moveable hoist for the 20 foot container vans could still operate. This would allow sheaves to be secured and freed under varying weather and sea-state conditions instead of limited use of the scissor lift under dry, dead calm conditions now.

Even with access to the sheaves, one needs to pull the trawl wire through the sheaves. Without laboriously accessing all the sheave guide pins, that is possible only by cutting the termination off the end of the wire and pulling the naked wire end through the sheaves with a messenger line. Having to cut off and re-terminate 9/16" Electroline fiege fittings every time the wire is transferred back and forth between starboard and Aft A-frames would get quite expensive and time-consuming. Alternatively, leaving the termination attached to the wire and pulling all the guide pins, reeving the trawl wire and re-inserting the guide pins is still very time intensive and difficult, to say the least.

The solution would be to disassemble the Electroline 9/16" wire termination attached to the end of the trawl wire - i.e. unscrew and remove the larger eye socket piece from the smaller sheath and plug portion of the Electroline wire termination. This smaller sheath portion of the termination still attached to the wire could then be used to pull the trawl wire through the sheaves without having to remove and re-insert all of the sheave guide pins. After the wire is pulled through, one then re-attaches the larger eye socket piece to the sheath and plug fitting on the wire, saving both the expensive termination and valuable time.

The Healy needs only an inexpensive replacement to make this solution work. At present the sheath portion of the Electroline termination will not pass through the sheaves because the black plastic Delrin / Nylatron sheave rim grooves are too narrow at the outer edges and do not allow the sheath fitting to fall far enough into the rim grooves to miss the guide pins. The solution is to reposition the guide pins 1 1/2 inches further out and replace the 2" Wide X 4" Deep black plastic Delrin / Nylatron sheave rims with 3" Wide X 5 1/2" Deep, re-machined sections having a broader 1 3/4" diameter U-shaped groove added to the outer portion of the existing V-shaped groove. The composite U/V-shaped groove will allow the Electroline sheath piece to seat deep into the new U-shaped portion of the cross-section and pass past the repositioned guide pins. Under tension, the 9/16" wire will seat into the inner V-shaped portion of the groove cross section identical in diameter to those presently installed. NOTE: A 1:1 scale cross-sectional drawing of the existing V-shaped and proposed composite U / V - shaped black plastic Delrin / Nylatron sheave rim sections is included with this report for reference.

*Starboard A-frame Area*

As mentioned earlier, there should be a large readout of Wire Out and Tension in the Starboard Staging Area visible from under the starboard A-frame even at night. During recovery, this allows the coring technicians to "sight" the core as it approaches the surface in the event the line out indicator has drifted a bit during the coring operation.

Under the starboard A-frame it is now possible to store the piston corer weight in its cradle and safely deploy the CTD over this weight cradle. However, when the piston corer is rigged horizontally with multiple 10 foot core barrels that then rest on the present core supports along the starboard rail, the core barrels extend past the aft leg on the starboard A-frame and prevent the A-frame from extending fully. As presently configured, this means that starboard piston coring and CTD casts could not occur on the same cruise. However, it appears that if the current core supports were lengthened and placed further outboard, this would allow the horizontal core barrel to tend further outboard and perhaps not interfere with the throw of the fully extended starboard A-frame.

Rigging the piston core requires that someone stands at the starboard rail under the A-frame for extended periods of time and safety lines there are a must. During coring operations, the ship should be able to temporarily move the safety lines under the starboard A-frame all the way out to the starboard rail instead of inboard like they are now. Moveable screw-down stanchions could be built to screw into the deck without interfering with the A-frame movement to hold adequate safety lines and/or chains. These safety lines should not be attached to the A-frame itself.

At present, the 500 lb. trigger core hangs from an A-frame block that is mounted only two feet aft of the main trawl block. Unfortunately, now during core rigging, the trigger core needs to be pulled two feet further aft to attach the trigger wire to the end of the four foot long trigger arm. An additional padeye needs to be welded to the A-frame approximately four feet aft of the main trawl block padeye - ( i.e. as far aft as possible without interfering with bracing ) so that the trigger core block and wire will hang directly over the end of the four foot long trigger arm during rigging.

There is presently a bad downward and forward wire angle from the trawl sheave in the Starboard Staging Area to the hanging trawl sheave in the starboard A-frame. This allows the A-frame sheave to spin and pivot annoyingly through 360 degrees twisting the wire. A possible fix would be to limit the angular travel of the swivel holding the A-frame sheave to prevent more than a 45 degree turn fore or aft. Alternatively, the entire trawl block swivel could possibly be eliminated raising the block and limiting any unnecessary pivoting.

The A-frame controls also seem to present a safety concern. Safe coring operations must be smooth and controlled. The A-frame controls are very reactive. Even experienced A-frame operators can produce very fast, jerky and unsafe movements of any heavy piston core gear suspended in the A-frame catching personnel unawares. Perhaps the starboard A-frame controls can be "de-tuned" to allow more predictable, controlled A-frame movement at all times.

There are no adequate deck drains in the Starboard Staging Area or under the A-frame area. Unsafe accumulation of water and ice in a heavy work area can lead to slippery footing with electrical cables and tag lines also running underfoot. This flooding is made even worse during core recovery when a virtual waterfall is present in the outboard aft corner of the Staging Area Hangar. The overhead horizontal sheave "squeegees" water off of the incoming trawl wire adding to the unsafe accumulation of water and ice in that area. A simple solution would be to install a catchment drainpan and drain pipe mounted beneath the overhead trawl sheave with adequate deck drains to accommodate the additional water in these areas.

*Starboard A-frame Area Power Requirements*

The piston corer extruder power pack needs 220 Volt - 3 phase power which is NOT available in the Starboard Staging area or under the A-frame. Presently, one is forced to plug the unit into an unsatisfactory source of 220V - 3 phase power more than 60 feet aft in the starboard crane base pedestal. There should be a source of 220 Volts - 3 phase power in the Starboard Staging Area.

At present, there is a source of 220 Volts - single phase in the Staging Area that is adequate to power the SeaMac Marine Products self-contained trigger weight winch.

*Evaluation of Starboard Piston Coring System*

In general, the starboard piston coring system and all of its components worked very well. The components are rugged, well built and will allow for years of quality coring. All the coring technicians, MSTs, and deck crew involved had no major problems or concerns using the starboard piston coring components.

There are a few minor additions and corrections to the piston coring gear and procedures that can add to the efficiency and safety of the coring operations aboard the Healy.

Presently, an unsafe gap exists between the hero platform and the edge of the ship where a person's foot could slip through. An additional, small hinged grating should be added to the hero platform in that area to cover this opening and prevent possible injury.

It would also be helpful to design and build a small horizontal brace to support the trigger arm over the hero platform while the core is being rigged horizontally and prepared for deployment. This support brace should run from the ship's edge to the outboard edge of the hero platform at trigger arm height.

After core recovery, there is no good place to hang the piston core extruder under the starboard A-frame area for attachment to the core head. Usually there is a portable davit installed and available for this purpose with its own air tugger winch. Hanging this heavy, unwieldy extruder from a crane pivoting four decks above is both unsafe and impractical.

*Conclusion*

As USCGC Healy implements the modifications suggested above, the ship will become a first-rate coring platform comparable to any vessel in the UNOLS fleet.

*Other suggestions (Garry Brass)*

1. Eyebolts. The eyebolts provided for tiedowns are too long. They are made with shoulders which should end up flush with the socket when turned all the way in. Because they are too long, they stand proud for half an inch or so and allow bending moments to be taken by the threaded shaft of the bolt. The threads make a lovely stress riser and strong off-axis stresses may break the bolts. On the other hand, some gear may require longer bolts. Probably there should be a selection of bolt lengths.

2. Socket plugs. The plastic socket plugs will be a source of trouble and should be replaced with stainless steel, internal wrenching (socket) plugs. [Alternative: teflon plugs. Jack Bash]

3. Tag lines. When Broda's winch for picking up the trigger weight corer and his hydraulic power pack for the extruder were moved from the fantail to the side deck with the crane. No tag lines were attached, a practice that should be changed. There should always be a tag line, no matter how calm the weather and sea state.

4. Feege fittings. There should be a written manual for the feege fittings including a measurement of the wedges that fit the fitting. They have no markings and the only way to know they are right is to measure them. The process was filmed and the film should be edited and copies made for all concerned.

5. Reeving the 9/16 wire. The process of reeving the 9/16 wire was not a simple one and there should be some measures taken to see that it goes easier the next time. First, a test should be done to see if the wire can be reeved with the feege fitting on. Second, the process of reeving is dangerous. A tech had to stand on top of the railing above the aft staging area to feed the wire into the starboard staging area. Fun on a sunny day but scary when the rail is iced up and the wind howling.

6. Scissors platform. When the wire was brought over to the hole in the wall the scissors platform was required. The scissors platform has insufficient traction - its wheels were slipping and it was unable to climb over a length of wire. People were climbing on the side of the platform to give it traction. No telling what it will do with the deck covered in snow or worse yet ice. It would probably be useful for the ship to carry a couple of bags of sand for tough conditions if the scissors platform remains in use next year.

7. Pressure washer. On Polarstern there is a small pressure washer, about 1200 psi, which was a wonder when washing down the corer prior to uncoupling etc. It saved a lot of time compared to cleaning up with a hose as deep sea clays are so sticky that its hard to clean the couplings etc. off without pressure. These things cost around $100 and make life a lot simpler for the coring crew.

**Dredging**

On the course north to find a suitable coring site, a possible dredge site had been scouted. The plan was to find a steep scarp where some fresh rocks might outcrop. The most likely "fresh rocks" were assumed to be the flood basalts that might make up part of the Disko Island basalts that have been dated at 62 Ma. The hope was to snag the dredge on *in situ* rocks that would give a strong pull on the wire and the typical snap when the dredge breaks loose from the rocks or the rocks break off. One small canyon was found on the way north at 70°47.096 N, 59°22.245 W. The canyon was nearly a north-south box canyon with a headwall scarp that rose from 515 m to 472 m in a distance of about 100 m. The canyon was only a few hundred meters wide. On direction from the science party the ship approached the canyon on a course of 180°, coursed over the head of the canyon almost precisely at the location of where it had been crossed northbound five days earlier at 171/18:14:49. A box survey was initiated with the idea of recrossing the head of the canyon on a west to east track to see if the side walls were as steep or steeper than the north wall. They appeared to not be quite as steep an escarpment. The course was then turned south for 1 km then turned onto the planned dredging course. Wind was less than 10 kts so it was thought that *Healy* could dredge on any course wished, as was the case.

At 176/0050:31 the ship passed the point 70°47.0978 N, 059°22.2608, approximately ~12 m to the west of the previous pass five days before, and continued about one nautical mile to the south before turning west. The series of course commands executed was as follows during the survey and dredging operations:

176/0056, c/c to 270° at 12 kts.
176/0058, o/c at 270° for one mile
176/0102:15, c/c 000°, slow to 10.5 kts.
176/0104:20, o/c 000° for one mile
176/0108:29, c/c 090°, speed up to 11.45 kts.
176/0110:40, o/c 090°
176/0117:26, c/c 180°
176/0119:40, o/c 180°
176/0121:17, c/c 270°
176/0123:10, o/c 270°, slow ship to 7 kts.

176/0125:09, c/c 000°, come unto dredging course, slow ship
176/0126, slow to 5 kts.
176/0131:30, o/c 357° to 001°
176/0134, slow to 2 kts.
176/0148:30, o/c 348°, 70°46.885N, -059°22.172W, Stop on station, lower dredge
176/0156, 70°46.882N, -059°22.188W, on station, note within a few meters of previous time, eight minutes before, DP engaged. u/w slowly on dredge course 354°
176/0207, variable speeds, very slow
176/0222, 70°46.907N, -059°22.222W, u/w 1 kt. Ship has been moving against current of about 0.3 kts.
176/0249, 70°47.307178N, -059°22.360106W, u/w 0.6 kts.
176/0257, 70°47.420N, -059°22.363W, u/w >1.5 kts., Heading 015°.
176/0305, 70°47.611N, -059°22.327W, stop the ship, retrieve the dredge
176/0327, 70°47.8476N, -059°22.487W, furthest north point of dredge.
176/0342, 70°47.866N, -059°22.8216W, u/w slow
176/0348, 70°47.665N, -059°23.542W, u/w 7 kts.

During the course of the dredge there were only a few bites. The dredge plus cable weighed about 1000 lbs, just above bottom. When the dredge was resting on the bottom the tension dropped to about 850 lbs. As the ship moved along with the dredge on the bottom the tension increased to 1500 to 1700 lbs. There were a few bites to 2500 lbs. The largest single bite was at 3750 lbs. or a total tension due to breaking off of rock or mud of 2750 lbs. It was a short but classic bite with an increase in tension then a quick drop. That may have been when the dredge crossed the top of the short scarp at 472 m.

The dredge returned a half basket of material. There were a number of glacial dropstones, a few basalt cobbles and about half the material was mud, mostly glacial silt. Some of the mud was hard enough to have worm burrows in them. There were some clams recovered in the dredge.

While the dredge did not get hung up and produce a large bite, something on the order of 8000 to 10000 lbs beyond the weight of the dredge and cable, the dredge was a success. The station keeping ability of the ship is excellent. The operation of the winch and A-frame went flawlessly. While the dredge group would have been happier if there had been a major bite, it is difficult to find a good dredging locality when the ship is overall in sediment covered older terrain.

## Climate Control Chambers

The climate control chambers were found to essentially meet the conditions put forth in the test memos for temperature (holding various temperature for periods of 4 hours). Humidity control was more of a problem (one of the humidity units in the chambers was out of commission), and as such humidity was not evaluated by measurement. Humidity requirements are unlikely to be as important as those for temperature for oceanographic work. Temperature control will surely be put to the test for periods drastically exceeding four hours. Therefore during legs 3 and 4 of science testing several manipulations were done on the climate control chambers in an attempt to mimic possible scientific use.

Both chambers were set to 0 °C, and one person remained in each for a duration of 10 minutes at ~0, 3, 6, 12 and 24 hour intervals. Under these conditions, the chambers were able to hold temperature with no problem, although three times each day a temperature spike of ~7 °C and 20 minutes duration was noted. This was caused by the defrost cycle. Such spikes will be unacceptable when science incubation experiments are running. Therefore the defrost cycle on one of chambers was decreased to 10 minutes duration, and as a result the temperature spike decreased to 3 °C for ~ 10 minutes. Further manipulations should be undertaken to decrease the defrost (deice) spike as much as possible and/or to experiment with the maximum duration that the chambers can be run without a defrost cycle (icing occurs on the back panel of the cooling unit).

In an attempt to maximally test the system a heater (output ~750 watts) was placed in one of the chambers. Under these conditions the chambers could not hold temperature at 0 °C, instead temperature appeared to stabilize at ~ 10 °C. Inability to maintain temperature was also noted during prolonged door opening following core storage. When the persons stowing the cores were told to minimize opening time of the chambers, temperature control was quite good.

In summary, the chambers are operating within specifications. Indeed they will be used for core and sample storage en route to Seattle. The defrost cycle will likely be judged inadequate for some scientific applications which require constant temperatures of ~0 °C for durations of >36 hours. In such cases the scientists may want to supplement temperature control within the chambers by using water baths.

**Deck Communications System**

| LOCATION | Temp | PUSH-TO-TALK OPS | HANDS-OFF OPS |
|---|---|---|---|
| Bridge Control Station | ambient * | X | no (static) |
| Science Conning Station | ambient | X | no (static) |
| Main Science Lab | ambient | X | no (static) |
| Science Wet Lab | ambient | X | no (static) |
| Biological/Chemical Lab | ambient | X | no (static) |
| Electronics/Computer Lab | ambient | X | no (static) |
| Meteorological Lab | ambient | X | no (static) |
| Chief Scientist Stateroom | ambient | X | no (static) |
| Science Conference Room | ambient | X | no (static) |
| Winch Control Station (local) | ambient | X | no (static) |
| Winch Control Station (remote) | ambient | X | no (static) |

*The temperature varied from space to space and at different times but remained in acceptable limits for the spaces tested.

NOTE: The 45 MC and 21 MC were tested in the following additional spaces: Radio Room, Aloft Conn, Steering, MSCC, Future Lab, Aviation and Machinery Room. In all cases, with the exception of the radio room, the push to talk operation operated with no problem while the hands free operation mode produced static to the point of being unusable. The unit in the radio room proved to work in both modes satisfactorily.

**CCTV**

Comments: All CCTV cameras in the science areas are inadequate.

Neither of the cameras on the aft working deck are effective. The camera mounted on the after flight deck positioned to see the area under the after A frame will illuminate only a small deck area. This camera needs at least a zoom and focus function and should include a capability to also pan and tilt. The second camera should also be located on the after flight deck positioned on the starboard side. This camera should also have a zoom and focus function with a pan and tilt capability.

The two camera mounted on the A frames (Aft and Starboard) have been removed. Robust mountings are needed and the cameras need to be fixed in such a manner to not be an obstruction to movement of the frame. Each of these cameras should be positioned to view the entire area under the respective frames. They should have the ability to zoom and focus. Pan and tilt is probably not necessary unless the lens is not able to cover the full area under the frame.

All four cameras in the winch room are inadequate. A zoom and focus function is necessary on each camera to properly view the respective winch. Pan and tilt may not be necessary.

Additional cameras are needed to view the two principle areas where equipment will be entering and coming out of the water. The camera covering the water aft of the fantail could be mounted on the after portion of the aft A frame, positioned down with a zoom, focus and pan and tilt capability. The camera needed for the area under the starboard A frame could be mounted on the deckhouse starboard, forward of the A frame positioned to view the water and side of ship under the frame. This camera will need a zoom, focus and pan and tilt capability. When a location is established for topside incubator a camera should be located to fully view this equipment.

The operation of the zoom, focus and pan and tilt (where needed) functions should be performed in the Science Conning Station.

**Science Hoist**

The science hoist was operated and found to operate in accordance with the specifications. The only comments in relation to this piece of equipment relates to the opening. As constructed the opening is 8 feet high and 5 feet wide. This, however, is not the functional opening. Two different obstructions are met reducing the effective use of the hoist. The inner door, when in the open position, protrudes two inches into the opening reducing the opening to 4 foot 10 inches.

The upper frame of this door protrudes 6 inches from the top reducing the effective opening to 7 foot 6 inches. When the two outer doors are in the open position they are prevented by a bulkhead and stanchion from opening more than 90 degrees. This exposes the doors' inner structure such that it protrudes approximately 5 inches from each door effectively reducing the opening by a total of 10 inches. Therefore, the effective and useful opening is 7 foot 6 inches high and 4 foot 2 inches wide. This reduction in the opening prevents a standard rosette frame from being placed in the elevator, necessitating its disassembly.

**TeraScan (Legs 2-4)**

During the Science Trials onboard the USCGC Healy, the TeraScan satellite system operated flawlessly, during which time the system provided enhanced imagery of the ice bundaries and ice concentrations of each designated research area. Both the visible sensors on the NOAA and DMSP spacecraft provided the high resolution image data about 80% of the at sea time. During the periods of clouds/weather or thick fog, the enhanced DMSP SSMI 85GHz was valuable in detecting the ice conditions and aided in the decisions prior to the ship's movement to the next designated area.

**Teacher Participation (Legs 3 & 4)**

The two teachers on Legs 3 and 4, Todd Hindman and Jay Schauer, completed 39 journal entries. Each journal entry was posted on the TEA web site, as well as on the Healy's SDN server. These journal entries included text, photographs, and a few illustrations.

The e-mail system worked well for them. The disappointing aspect of e-mail was the lack of contact from students. They received only several e-mails from students and parents of students. They also received over 120 e-mails from teachers they knew, coworkers of family members, friends, and family. These messages often included questions about ship operations and science activities that were written about in their daily journals.

They attributed the low number of student e-mails to the timing of the expedition. Todd's students were out of school on May the 26th, while Jay's students were taking finals the week of June the 12th. It is their opinion that TEA must make a concerted effort to compile a list of year-round schools, international schools, and Internet links that would actively participate in teacher outreach activities. It is highly unlikely that classroom teachers in the future will have the resources or the time to organize a network of participants during this time of the year.

While on board the Healy, both teachers were able to participate in a wide variety of science activities, as well as daily shipboard operations. Both of became licensed to burn waste, after successfully completing an orientation and test regarding the ship's incinerator use. They also volunteered to help out the Morale Committee during "Casino Night", helping prepare the evening's food and taking the crew's Healy Bucks at the roulette wheel.

The following is a list of science activities they were able to participate in and/or observe.

1. Dredging
2. Deploying and recovery of moorings
3. Deploying, recovering, and extruding core samples
4. Obtaining meteorological and oceanographic data
5. Collecting and examining ice algae.
6. Deploying biodiscs to examine biodiversity and colonization rates.
7. Discussion of Plate Tectonics.
8. Understanding the use and capabilities of Seabeam and Knudsen software.
9. Understanding the use and capabilities of Tera Scan software.
10. Participating in bathymetry watches.

They reported that either the ship's crew or the science party quickly supplied anything they needed, in regards to materials or information. They cited both Dr. Lisa Clough and Dr. Larry Lawver as helpful, patient, and invaluable. They feel the USCGC Healy did an excellent job of incorporating TEA participants into the daily life of the ship.

*NOTES ON HEALY SCIENTIFIC WINCHES*
*(incomplete draft from J. Swift; 25 June 2000)*

Use of a scientific winch will require a trained operator; therefore presence of a trained operator at the winch controls can be presumed.

The winch mechanism must spool and unspool cable with correct lay and tension, perhaps hundreds of times per month.

The cable, sheaves, and winch mechanism must not be damaged during normal operations.

Control of winch motor speed must be precise, repeatable, predictable, smooth, and manually adjustable over a range equivalent to ca. "inching"-to-90 meters per minute.

Emergency stop must be available at all times.

Manual winch control must be the default. The winch should be operable by simply turning it on and engaging manual control. (There may be a few additional steps in the winch room unique to Healy, but these should be kept to a bare minimum. Fifteen minutes of set-up time each station on a typical CTD cruise translates into one person-day each 8 days!)

It must be easily possible for the winch operator to "zero" the wire out reading while the winch is spooling out cable, i.e. without stopping the package at or near the sea surface.

Because the time a scientific instrument package is near the sea surface presents the greatest hazard to the equipment, and to the deck personnel, that time must be thoroughly minimized. Basically it should never be required by the winch control system to stop the winch, change settings, or carry out any distracting functions (other than an easy no-look button-push for zeroing) from the time the instrument package is on deck until is well down (if then) or vice versa on haul-in.

The second most hazardous time for the equipment is during bottom approach. Therefore there must be no need to change any settings, punch in any commands, or carry out any other distracting functions during the time an instrument package is nearing or just coming away from the bottom. The sole functions of the winch operator and the control system at this point are to descend at the specified rate, which may change without notice, to stop the winch immediately on notice, to make minor up or down (cable in or out) changes if asked, and to begin haul-out immediately when asked by the electronics operator or equivalent.

The winch must stop when manually stopped and start when manually started, i.e. without excessiive delay, especially in stopping as at present. (A quick, safe ramp-down from normal speed to stop is acceptable.)

Any automatic, computer-controlled operation of the winch should ideally function more or less like a cruise control on an automobile, i.e. a system that can optionally be turned on to take over and maintain the present setting of the winch. A touch on the manual control should revert the system to manual control. If for some reason a more elaborate automatic control system is deemed necessary, that system must take minimum set up time, but be able to recall from a selection of 1-10 (?) stored settings, must be able to be engaged and disengaged in a "cruise control" like manner, and must be so totally optional that its presence (or absence) makes no difference whatsoever to normal, manual winch control.

Work on deck with the cable should be enabled by turning on the winch and using manual control.

Any alarms should be easily and quickly cut-off, similar to turning off a clock radio. Alarms tend to go off at exactly the times that clear communications are most vital; therefore use of alarms should be discouraged.

Any logging function, if provided, must be completely passive, transparent, and optional with respect to winch operation and control. A simple log book - a real log book - for each cable must be maintained whether or not there is automatic logging and display.

The cable is to approach and leave each sheave at as close to straight on as feasible.

The sheaves must not allow the cable to jump or bind. The system must be designed to withstand slack wire conditions which typically develop when an instrument package is at the sea surface under conditions of vertical sheave motion exceeding the free-fall rate of the instrument package.

There must be the lowest feasible cable wear by passing cable over sheaves. Therefore the cable is to pass over the minimum number of sheaves feasible, and each sheave must be sized (diameter, channel width) for intended cable(s).

The winch operator must be able to easily, without stretching or craning, see the working deck, under the A-frame including outboard sheave, and the wire angle overboard.

The winch operator must be able to clearly see the condition of the wire on the winch. If this is carried out via CCTV, the display must be sharp, visible under all lighting conditions, and, if needed, adjusted so as to view every critical aspect of the wire lay on the drum. If this cannot be provided, it shall be necessary to station a knowledgeable observer at the winch during all winch operations.

The winch operator must be able to manually control the winch, and preferably also the A-frame, without taking eyes off the working deck and/or outboard sheave.

The winch operator must be in clear, uninterruptable communications with the electronics operator and deck supervisor. The winch operator should have shared conversations with above and the ship control station.

The winch operator must have easy to read - in all lighting conditions - at-a-quick-glance readouts for rate of cable payout and haul-in, wire out, and tension (tension at a glance is secondary to the other two). Note: these same numbers should be available to the electronics operator and others, so it is best to have them available easily over the SDN and on ship's status displays.

*Other notes*

Replacement of the oversize chairs with attached stools would allow room for the electronic rack to be mounted on the forward bulkhead. This would give the MOCNESS, CTD, etc. operator a view of the equipment on the deck and would be close enough for convenient direct communications with the winch operators.

The CTD block needs to be replaced or modified so that the wire jumping is no longer a problem. The present block will sometime in the future result in injury to personnel and/or loss of equipment.

Realign the block and wire sheaves so that everything aligns with the center of the A-frame.

A means other than shouting across the aft control room needs to be established for CTD console and winch communications.

CTD console is not located in a good area. It is currently in the entrance of the aft control room and the traffic is very disturbing. Not much room is available for writing information done without crossing the traffic aisle. The glare from the windows makes it difficult, almost impossible to read the video display.

The winch wires that come up to the CTD console should be wired into individual junction boxes rather than to CTD deck box connectors. When equipment other than CTD's are used the ends would have to be cutoff and rewired. A junction box would allow for easier changes. All three inner conductors along with the armor should be available in these junctions boxes for the 322 cable and the armor, coax shield and coax inner conductor for the 680 wire.

Log books need to be kept.

Communications between winch and deck operation need improving. Hand signals, reliable radios, intercoms or best a combination of all these.

Winch speed control was precise but awkward to control because the control parameter is motor RPM rather than line speed directly. This involves mental calculations - the science operator asks for X meters per minute, requiring the MST to guess at a winch motor RPM that will give close to that speed - and, worse, changes as the reel unwinds and its effective diameter changes. The feedback should be taken from the line speed sensor rather than the motor speed. Another small problem was the location and size of some of the crucial parameters on the winch control screen. Wire out , line speed and tension should be in a large font, grouped, and shown in a contrasting color for easy and quick identification. The many other parameters shown on the screen are useful but not nearly as critical to quickly locate as the three mentioned.

There are problems with the CTD wire starboard overboarding arrangement. The angle of the wire feed onto the sheave is not optimal to begin with, because the 0.322" cable does not take a correct 90 degree path from the last turning sheave to the pad eye on the starboard A-frame. The turning block is located too far forward. The overboarding sheave is the incorrect type for the 0.322" wire use: (1) it is on a swivel and (2) the throat is too wide to constrain the wire properly. The swivel allows the block to turn when the wire goes slack. The wide throat then helps a slack cable to climb the sheave. This occurred upon recovery of the final CTD cast when the wire went slack and subsequently jammed between the block and the cheek protector flange. Thus the 0.322" sheave presently on the starboard "A" frame must be replaced with one that does not swivel and has a deeper throat. Such a sheave, preferably with a larger radius, would not so seriously threaten loss of the CTD package. It is suggested that General Oceanics and Kahl Scientific, and perhaps other vendors, may offer CTD sheaves that will solve the problem.

The winch control system, when programmed, provides precise, steady control of winch speed (but not wire speed to the same degree). Yet it is the opinion of the Chief Scientist that to an unknown degree the control system is an accident waiting to happen.

The starboard "A" frame should be configured with another sheave to accommodate a hydrowire for both CTD and/or bottom grabs at the same station while maintaining the capability of MOCNESS or other sample from the stern "A" frame.

Add floodlights. Some sampling operations require superb lighting.

Remove gas cylinder storage rack to a different location, perhaps in the otherwise unusable small staging room aft. Add unistrut to that bulkhead.

Consider moving large tool chests to a different location, perhaps in the otherwise unusable small staging room aft. If there is not already unistrut on that bulkhead, add it.

Greatly improve drainage, at the least by installing multiple deck drains. Consider reshaping the shape of the deck slope to feed into drains.

Consider a optional bolt-down sill (2"?) at the base of the large outer garage door.

Consider mounting a CTD winch at the back of the staging bay, high enough for a person to easily walk underneath.

Consider building out starboard winch control station from present position to position of protrusion of vents and garage door housing. Use tall, angled glass to give operator super view. Minimize and/or move to forward bulkhead the control console so as to minimize view blockage.