WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS 02543

Department of Geology and Geophysics
McLean Laboratory

Phone: (617) 548-1400
Telex: 951679

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Dr. Robert Embley
NOAA/MRRD
Hatfield Marine Science Center
Newport, Oregon 97365

Dear Bob:

As we discussed on the phone we will be glad to provide dredging equipment for your cruise aboard the Atlantis II this fall. The sole condition for its use will be that you replace, according to our specifications, any equipment that you lose.

There are a variety of topics I'd like to address concerning your upcoming dredging cruise and I'll list them separately below:

DREDGE RIGGING:

Please refer to enclosed blue-line diagram. It shows shackles in red, the weak links and swivel in their appropriate positions, and the unusual, but essential, loose bight of "shock absorbing" chain. It's purpose is to tone down the impact on the No. 2 weak link if the first one parts due to excess strain on the wire. The theory is if the top or No. 1 Weak Link parts, the chain leading down the bail to the second link will hopefully pull the dredge off the hang-up with a sideways jerk, and still retain the sample. One important thing is to keep the loop of chain, and the second weak link securely fastened to the yoke of the dredge. Rope alone tends to chafe in the rocky terrains, thus I've suggested the use of large hose clamps or banding if available. If this bundle breaks loose from the bail it can hang up in cracks and show misleading "bites" and fluctuations in tension. After clamping to the yoke, lash the bundle with generous amounts of line, and then streamline it with tape (fiberglass and duct). Remember to seize with stout wire, all shackles, and use a good ball-bearing (provided) Miller swivel between the wire termination and the first weak link.

WEAK LINKS:

As is clear in the diagram, we use two weak links on each dredge. They should be of equal shear-strength but it is safe to add up to 500 lbs of extra strength to the No. 2 link to help resist the surge of the first one breaking.

Weak links of course are used to prevent damage or breakage of the trawl wire if the dredge hangs up during operations. We set the links so that they will let go, in a given water depth range, before the elastic-limit of the trawl wire is reached. This is the point on the tension curve at which permanent deformation by stretching begins. If this limit is exceeded by a few thousand pounds, the wire will not necessarily break, but will be damaged such that it can never be trusted to perform according to original specifications. Repetitive pulls to the elastic limit or beyond can result in a severe weakening of the wire such that it may break at a tension well below even the elastic limit at some event in the future.

The trawl wire on the Atlantis II is 1/2" 3x19 Torque Balanced Tiger Brand, manufactured by U.S. Steel. It's important properties are:

ELASTIC LIMIT:	19,275 lbs.
YIELD STRENGTH:	25,700 lbs.
WT. IN WATER:	1.1 lbs/meter

KNORR - 9/16" 3X19 WIRE
EL. LIM. 24,375 lbs
YIELD ST. 32,500 lbs
WT. IN WATER 1.4 lbs/m

To set the weak links follow these procedures:

1) Overestimate the total amount of wire you'll have out on the upcoming station. I usually add 30%o - 40%o to the proposed maximum water depth. Multiply this figure by 1.1 to find the approximate weight in water of that length of wire, then add 1000 lbs to provide a margin of safety.

2) Subtract this figure (rounded up) from the elastic limit of the wire (19,275 lbs).

3) Referring to the Shear Pin Chart and the formula included, work out a combination of shear pins that will get you close to the difference between the elastic limit and the wt. in water of the wire out.

4) Suggestions: Try to use as many double shear pin values as you can; single shear pins require spacers and are somewhat less reliable (see attached figure 2). Also where possible, employ the 8900 lb 1/4" double shear stainless steel pin as the foundation of your weak link ..... the more strength in any single pin the better.

5) Assembly: Refer to blue-line diagram. Check plates are provided.

6) Example:

Water depth = 3000m.
Max. wire out = (3000 x .3) + 3000 = ~4000m
Wt. of wire = (4000) x 1.1 = ~4500 + 1000 = 5500 lbs.
Strength of link = 19,275 - 5500 = ~13,500 lbs.
* note: always round in favor of the wire.

Select appropriate pins

$$T = T_1 + .9\,(T_2+T_3) \text{ etc.}$$

$$T = \underset{\substack{1/4\text{" S.S.}\\ \text{double}\\ \text{shear}}}{8900} + .9\,(\underset{\substack{1/8\text{" S.S.}\\ \text{double}\\ \text{shear}}}{2370} + \underset{\substack{1/4\text{" Brass}\\ \text{double}\\ \text{shear}}}{2500})$$

$$T = 13{,}283 \text{ lbs} \ldots \text{close enough to } \underline{13.5K}$$

Insert selected pins in link and seal up according to the provided diagram. Be sure to inspect links after each station ..... pins may stress and weaken without breaking lowering strength of weak link drastically!

TACTICS:

Each and every rock hound has his own best way to go about getting Davy Jones to give up his precious boulders. I've tried dredging many ways and the following seems to do the trick reliably, with the least hang-ups, if there are rocks to be had.

First, a note of caution. High winds and rough seas can seriously complicate setting up a dredge station. Under severe circumstances please consult with the Captain/and or mate on watch before deploying. Show them your target and how you'd like best to approach the slope and let them decide if it is advisable to attempt under the given circumstances. Negotiations are possible but alternative targets should be ready at hand in case the bridge considers a particular proposal unsafe or impossible. Dredging downwind in a stiff breeze can easily get out of control and can be expensive in terms of time and equipment.

Under normal circumstances where the wind and seas are not a factor consider the following approach:

Complete the survey of the dredge site slowly on a reciprocal course to the proposed dredge run (i.e. downslope). Overrun the slope base or bathymetric target by about 1/4 mile and come about 180° to the dredging course and heave the ship to for deployment.

Ease the properly rigged dredge over the side and lower slowly to 150 meters. Stop winch and attach pinger (you provide). Carry on lowering slowly until sufficient weight of wire has accumulated to pay out at 75 meters per minute. During this lowering the ship should be dead in the water, thrusting only occasionally to maintain bow heading on proposed course.

As dredge nears bottom (approximately 250 meters off) slow winch to 30 meters/min. and notify bridge of its altitude off bottom, and ask them to get underway on the predetermined upslope dredging course at 1.0-1.5 knots. When dredge touches bottom, notify bridge and slow winch to 15m/min. Now as the ship slowly jogs ahead the wire should be laying out nicely and evenly on the bottom. As the pinger nears its closest point of approach (25 meters) slow and stop the winch. At this stage I get comfortable and watch carefully the tensiometer and the echo-sounder monitering the pinger. According to the slope, there will be various pinger altitudes where the most "action" takes place, but normally with the pinger between 50 and 80 meters off bottom you'll notice the dredge works best.

When the pinger gets 120m off or so I lower it again (ships course steady, speed still 1-1.5 kts) to 25 off and take another run. Bites will be quick, very visable fluctuations in tension and are normally associated with the ingestion of rock. "Power dredging" can be employed if no bites are incurred after several passes and it is simply a matter of laying out to pinger altitude 25m, delaying a few minutes then hauling in slowly as the ship jogs ahead. This simply expedites the whole situation but some times leads to flying the dredge over the bottom rather than dragging it.

After several passes with action, I recommend continued slow hauling until the dredge is clear of the bottom (150m pinger alt.). You will sometimes see a "pick off" bite as the dredge deposits the basalt (or whatever). You can then return at 80-90m/min never forgetting the pinger (don't rely on the winch operator to stop automatically) removal. The Bosun will assist you in the physical launch and recovery of the dredge itself.

If you get hung-up, my favorite tactic is simply to stop all propulsion and carefully haul the ship back over top of the dredge with the winch. Be very careful of the tension in such situations. The operation must be executed gently with frequent stops of the winch. Once overtop, some yo-yoing of the trawl winch usually breaks the dredge free. If this fails a final maneuver which requires close cooperation with the bridge can be attempted. When several yo-yo's have failed to dislodge the dredge, haul the ship back one final time. When directly over top, notify bridge to begin a turn to a reciprocal course and begin laying out wire rather quickly (40-50m/min). (Watch pinger!) When they come around on course stop the winch and begin hauling in at 20-25m/min. This usually does it, or pops the weak links, but be sure to talk it over carefully with the mate before trying it. You should plan to ship or bring with you the following:

* Hose clamps: (2-1/2" - M32) for weak link cheeks.
  (4" M56 and 6" M72) chain to bail bundling.
* Tape - fiberglass filament, duct tape, and friction tape.
* Manila line.
* Bags or Boxes in which to store and ship rocks.
* Marking or labelling equipment.
* Rock saw if so desired.

Call me the third week in August and we can discuss any questions you might have. Also please talk with Peter Kalk at OSU if you can. I'm sure he'll have some good advice.

Best regards,

James E Broda

J. E. Broda