UNIVERSITY - NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

WINCH AND WIRE SYMPOSIUM REPORT
TULANE/XAVIER CENTER FOR BIOENVIRONMENTAL RESEARCH
NEW ORLEAN, LA

30 NOVEMBER – 1 DECEMBER 1999

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Introduction:

This is a report of the Winch and Wire Symposium held 30 November and 1 December 1999 at the Tulane and Xavier Center for Bioenvironmental Research (CBR) in New Orleans, LA. The agenda for this meeting is included as ***Enclosure 1***. Approximately eighty persons attended, see ***Enclosure 2***.

The meeting format opened with a panel discussion. The panel consisted of scientists representing the four disciplines of oceanography plus ocean engineering and ship operations. The panelists reviewed summaries, in their respective disciplines, extracted from responses to a questionnaire circulated throughout the sea going oceanographic community. The speakers that followed were challenged to respond to the needs of the community as represented by the panelist's summaries.

The ten speakers provided the attendees with a discussion on winches, cranes, wires, ropes and cables. The talks included state-of-the-art designs, safety concerns, maintenance and operational aspects of their respective equipment. At the completion of the talks the six panel members summarized what they heard and how it can contribute to advancing winch, wire and crane operations. The panel has provided written reports of their summaries. These are included as ***Enclosure 3***. Glosten provided a follow-up report on working wire safety factors. This is included as ***Enclosure 4***. Comments from Mike Prince were also received and are included as ***Enclosure 5***.

Below are excerpts from these summaries followed by recommendations for future action. These recommendations have been reviewed by the panelists and steering committee and represent a consensus of this group.

Summary excerpts:

- Instrument demands for greater band width require a new standard fiber optic cable of the .322 size or possibly larger.
- A high strength synthetic fiber cable of the .68 range is needed.
- Interchangeability of wires is important.
- Training of the crews in winch operation and wire maintenance must be an on-going process.
- The safe working load (SWL) of .322 cable needs to be clarified.

- Motion compensation systems such as articulated cranes are needed.
- More emphasis is needed on the portability of winches for UNOLS ships.
- Complete records of all winch and wire systems should be maintained.
- Communications between winch and wire manufacturers and the UNOLS community need to be strengthened.
- The scientific community needs to be aware of the limitations imposed by current winch and wire technology.
- There are clear advantages to making towed profiling a part of the general shipboard technical services.
- New innovations in winch and wire use such as the Curly Wurly need to be considered.

Recommendations:

- UNOLS (RVOC/RVTEC) be tasked to establish a safe working load (SWL) criteria for .322 cable.
- NSF entertain proposals to develop specifications for a new wire to replace .322 EM cable that is stronger and provides a broader band width.
- NSF entertain proposals to develop specifications for a stronger cable to replace the .680 cable.
- NSF entertain proposals to develop specifications for a lighter .680 cable with the same breaking strength.
- UNOLS be tasked to increase and standardize operator training for winch operations, wire care and maintenance.
- UNOLS operators be encouraged to maintain a complete set of records on winches and wires and NSF include a requirement in the NSF Inspection to review these records.
- UNOLS operators be encouraged to investigate new innovations in winch and wire handling systems such as motion compensation.
- NSF fund a winch and wire symposium every five years to bring scientists, operators, technicians and manufacturers together for information exchange.
- This report, including the attached panel comments, be made available to the community at large through direct email and posting on the UNOLS web site.

ENCLOSURE 1

Winch and Wire Symposium Agenda
30 November – 1 December

0800 – Registration, coffee, juice and pastries

0830 - Welcome by Tulane/Xavier Center for Bioenvironmental Research (CBR) and University-National Oceanographic Laboratory Systems – (D. Meffert and J. Bash)

0845 - Introduction Purpose and Schedule of events – (J. Bash)

0900 - Panel Discussion – Six panelists (Smith, Lee, Johnson, Bloomer, Williams and Althouse) will review the summaries for future needs of the scientific community.

0930 – Coffee

WINCHES/CRANES

1000 – Mike Markey (Markey Machinery) to discuss issue raised by science needs presented through the panelists and provide a review of single drum winch technology, present and future including maintenance, operations and safety.

1100- James Stasny (Dynacon) to discuss issues raised by science needs presented through the panelist and provide a review of traction winch technology, present and future including maintenance, operations and safety.

1200 – Lunch

1300- Bill Hurley (Glosten) to discuss structure, stability and safety of winch systems, installation and operation

1400 – Reed Okawa (North American Crane) to discuss cranes for over-the-side gear handling

1500 - Questions on winches and cranes from symposium participants

1530 – Refreshments

WIRES, ROPES AND CABLES

1600 – Tom Coughlin (Vector) to discuss issues raised by science needs presented through the panelist and provide a review fiber optics and EM cables design, structure and operational parameters.

1700 – Adjourn for the day

1 December (day two)

0800 – Coffee, juice and pastries

0830- Sim Whitehill (Whitehill Manufacturing) to discuss issues raised by science needs presented through the panelist and provide a review of synthetic rope technology and its application in the science community.

0930 - Phil Gibson (Tension Member Technology) to discuss cable mechanics, handling systems, terminations, testing methods and cable specifications.

1200 – Lunch

OPERATIONS AND SPECIALITY APPLICATIONS

1300 - Emil Grignard (Grignard Company) – Cable maintenance

1400 - Questions on wires and ropes from symposium participants

1430 – Refreshments

1500 - Moya Crawford (Deep Tek Ltd.) to discuss the design and operation of the Curly Wurly winch recovery system.

1600– Bill Hahn/Jon Alberts - Review a summary of the UNOLS winch inventory

PANEL DISCUSSION

1630 - Panel give a wrap-up of the symposium and field questions from the floor with speakers available to answer questions.

1700 – Adjourn

ENCLOSURE 2

Winch & Wire Symposium
November 30 - December 1, 1999

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ENCLOSURE 3

Comments from Ken Smith

Summary of Biological Perspective from Winch and Wire Symposium

The two-day Winch and Wire Symposium was very enlightening, regarding the current resources available to conduct winch and crane operations from UNOLS ships. Technology now exists to conduct most of the biological operations
envisioned over the next several decades. Direct-drive and traction winch arrangements are now available for use with a variety of ropes ranging from steel to synthetic fiber cables. The coupling of these winch and wire combinations with heave compensation devices such as nodding-head cranes will be essential for conducting state-of-the-art biological research into the next century.

Four critical issues became apparent during this meeting which need to be addressed for the future viability of the UNOLS fleet.

1. More emphasis should be placed on the portability of winch and handling systems between ships. The cost of special winch and handling systems
precludes the luxury of redundancy throughout the UNOLS fleet. For example, systems for giant/long coring and large deep-sea trawling should be designed so
that they are compatible with a wide variety of intermediate to large multi-purpose ships.

2. As the winch and handling systems become more sophisticated, better training is required for the shipboard personnel to operate and maintain this instrumentation. This responsibility should be shared jointly between the manufacturers and the ship operators. Routine training should be implemented to
reinforce initial instruction and provide new information on upgrades to existing systems.

3. Complete records on all winch and wire systems should be maintained and updated routinely on all UNOLS ships. These records should range from maintenance records for each winch to the age, condition and historic use of each spool/drum of steel or synthetic rope. For example, the length, termination date and maximum tensions experienced by the rope on each lowering is essential to determining its suitability for the next scientific operation.

4. Direct communication between winch/wire manufacturers, ship operators, engineering firms, and scientists must be improved as both the handling systems and scientific instrumentation become more complex. Scientists must become more educated in the capabilities and operating constraints of winches, cranes and wires on board ships prior to their utilization of such facilities.

Comments from Sandy Williams

UNOLS Winch and Wire Symposium

Report from the Ocean Engineering perspective, Sandy Williams reporting

From my viewpoint the presentations were amazingly informative, both in their demystification of aspects of wire rope, and in the infinite complexity they revealed. I was edified about the issues of torque balance and discovered that there is no simple answer to torque balance.

Fiber optic cable is not simple. My belief is still that it should become an optional standard on UNOLS vessels in the 2 to 5 year time frame because of instrumentation demands. The standard cable should be small, .322 if possible. But I heard that the demands on .322 cable are stressing it beyond its safe working load, particularly when pulling back at high speed with a rosette on it. I believe that fiber optic bandwidth is necessary for video applications and accommodates all other sensors through frequency multiplexing avoiding multiconductor cables (6 or more conductors). The demand for bandwidth will not decrease.

High strength cables are required. For deep pulls, long high strength cables would benefit from being synthetic. Perhaps a standard long strong Kevlar cable in the .68 size should be considered. But there is also a need for high strength with power and bandwidth for ROV's, plows, etc. Presently these cables are owned by the projects that use them but there is room for standards here too, at least in the .68 size. Concentrating wire and winch demands to basically two sizes means that level winds and Lebus grooves will be available to spool the wire and cable with minimum damage. Obviously there will also be a demand for larger cable than .68. But I would suggest that giant piston coring operations with their special cable and demand for long rail space be restricted to one UNOLS vessel at present. I don't think equipment of that weight should become a general requirement. Heavy lifts such as telephone cables also are probably not best accommodated on UNOLS vessels as long as cable-laying ships can be chartered for the job.

Instruction about winches revealed that they are capable in single drum configurations. Most of our work can be done with single drum winches. Interchangeability of wires can in some cases be accommodated with double drum winches. Traction winches have now overcome a class of problem (stripping off the jackets of wires) by canting the sheaves so that each pass is in line with the next sheave. Traction winches can also be made with a small footprint overcoming another barrier to their use. Motion compensation using a nodding crane is less damaging to the wire than ram accumulators, principally because there are fewer surfaces that the wire must go over. It is flexed less. I was surprised to learn that non-metallic construction can be vulnerable to traction winching. Changing diameter of the cable when the tension changes during the traction winch passage can permit the sheath to slip and bunch. Jacketed strands rather than jacketed rope prevents the sheath from doing this. But there is also a problem when the tension drops too low and the inner strands go into compression. This is a failure mode for Kevlar and Spectra that weakens the rope a great deal. Higher tensions on the storage spool are required to avoid this. These concerns make traction winches a mixed blessing. At least the use of them requires understanding.

Alec Crawford taught us that thinking outside the box results in capabilities unimaginable to me. The curly wurly winch recovery system is extraordinary. The description of corrosion prevention and lubrication was surprising to me but also explains why modern wire rope looks so much better than it did 30 years ago when I first saw oceanographic cables. It was comforting that it sticks so well. What was not explained is how contamination for chemistry can be avoided. The corrosion resisting materials seem to contaminate some chemistry samples. There was some talk of titanium wire but I am suspicious that it is not just expensive but perhaps not the best wire. Improved galvanized plow steel with suitable pretreatment works well and is forgiving. Careful cable construction coupled with proper sheave size and care to avoid going slack and avoiding really excessive tension should keep the conductors from z kinking, the dominant electrical failure mode.

Training was mentioned repeatedly and considering how much I didn't know despite a long interest in the subject, training would go a long way to extending cable life and minimize loss of equipment. In fact, the termination issue alone is worth training aids. From Cerrobend to resin encapsulants to Kevlar braiding, high strength cables require sophisticated terminations. Loads and speeds must be regulated with understanding and this requires training of engineering and deck officers and of winch operators. I was pleased to learn that records on wire use are better than I thought and that there is pretty good traceability of what maximum load and length of service each wire has seen. I wonder if it tells what the minimum radius may have been that the wire went over under what load since this is a critical value.

Based upon what I heard, and considering the safety issues that require a 4.7 to 1 breaking strength to safe working load limit for cargoes, I have a recommendation for future discussion. An over the side load on a .322 wire with breaking strength of 11,670 lb. may be 4500 lb. and this exceeds the Coast Guard ratio. But if one went to the 4.7 to 1 ratio, the breaking strength would have to be 21,000 lb. and the deck equipment at 1.5 times the breaking strength of the wire would have to be 32,000 lb. Now what was being lowered that caused this 32,000 lb. deck strength figure was probably a lift weight going over the side of 2300 lb. This is a little absurd and this seems to not be the standard that operators use. I suggest that the definition of a cargo lift be one where it could fall on someone if the wire breaks. That would limit the deck lift to a SWL of the breaking strength of the cable divided by 4.7. For a .322 cable at 11,670 lb. breaking strength, that is a lift weight of 2500 lb. When the load is in the water, dynamic forces can greatly increase this load and when the cable is mostly paid out, the weight of cable over the side can add to that. When it is in the water, failure is a broken cable with all the danger that this can cause but it doesn't drop a load on anyone. Also, the requirement that the load carrying ability of the deck equipment be 1.5 times the breaking strength of the cable implies that the preferred failure mode is a breaking cable. So a breaking cable is in some sense acceptable. Now the deck gear strength is 1.5 times 11,670 lb. or 18,000 lb., a more reasonable number. I believe this is in fact what operators do but this argument may be more defensible than just doing it. Next is the sheave diameter issue. At 20% of the breaking strength of the wire, the recommended D/d or sheave diameter to cable diameter ratio is 40:1. This is a common sheave size used. But what Phil Gibson showed in curves of fatigue and damage to the conductors was that at 40% of the breaking strength, the D/d ratio should be 80:1. I suggest that operators retain the 40:1 ratio only up to 20% of the breaking strength of the wire. Where rapid re-haul is anticipated and where drag is high so that higher loads are expected, an 80:1 diameter sheave should be required. It seemed to me that this would reduce cable damage.

Looking into the future, bandwidth demands will increase. Power down the wire demands will increase for large deep instruments such as ROV's and plows. Some devices will become very heavy but these will require specialized wires and winches. All of our UNOLS work must be cost effective. We will demand faster winch speeds coming up (when the problem is tension not slack). Standardization is desirable to avoid what Sim Whitehill described as the custom cable for every scientist. Are four types of standard cable enough? Two EM and two mechanical? How about six? Should there be at least one Kevlar standard? I think there will have to be a small fiber optic cable. If not .322, perhaps a larger one. It will happen in 10 years, probably in 2 to 5 years.

We need bigger sheaves. Also I think there is more room for articulated cranes with variable reach and less torque about the pedestal when the ship is rolling. But I also don't think every UNOLS ship should have every wire, winch, and crane that is demanded somewhere in the UNOLS community. There are wire lengths and diameters that should only be on the medium and large ships. Yet there is a need for standardization wherever possible.

Albert J. Williams 3rd, WHOI
12/9/99

Comments for Tom Althouse

Jack,

Sandy Williams has done an excellent job of summarizing the presentations and discussions of the Wire and Winch Symposium.

The operators' basic questions of how strong do the wires have to be, how much bandwith is really needed, how do we handle demands for a large variety and quick change capability, what new technologies must be included in wire inventory and how fast do winches really have to go are still unanswered.

In order to start moving into the future, I recommend that the fleet operators propose some actions based on the data presented at the symposium.

There appears to be general agreement that a relatively small diameter wire containing both conductors and fibers on the order of our current .322 but a bit stronger is needed in the near future in the UNOLS Fleet. A cable of this nature does not seem to be under development by the manufacturers. I propose that we develop a specification for such a cable and ask the scientific community to comment on the spec. Once we have agreement on the requirement, the manufacturers can be asked to review the spec and tell us what is possible. In the first cut, we should probably try to keep the current .322 diameter to prevent having to modify the large inventory of CTD winches in the fleet. If we are told that the diameter of the wire has to increase to provide the capability required, we can assess the impact on deck equipment which will include winch drums, level winds, sheaves, frames, etc. This would probably make a phased upgrade of any new cable into the fleet necessary.

The requirement for a larger cable incorporating the ability to carry high power, provide a large bandwith for data and have high strength in the range of the current .680 EM cable but of lighter weight to allow deeper work also seems to be valid. This would seem to argue for a synthetic cable. Presentations at the symposium detailed several problem areas with synthetics that must be dealt with before such a cable can become a reality. Again I propose that we establish a specification for the desired characterists, have them reviewed by the science community and then ask the manufacturers what they can develop.

Once we develop acceptable specifications for these two cables, proposals can be submitted to NSF for funding to develop, install and test them. Once we have an acceptable piece of equipment, the impact on handling equipment will become clear and funds can be programmed in an orderly fashion for upgrades.

It would help if we had some wiz-bang equipment ready to hang on these cables as soon as tesing is complete but this would have to come from our scientificos. Hopefully, they are just waiting for this capability to arrive and can support us in that way.

It is my strong opinion that we should get started down this track immediately.

Tom

Comments from Craig Lee

UNOLS Wire and Winch Symposium, 30 Nov - 1 Dec 1999

Physical Oceanography perspective,

Many thanks to all of the speakers- I learned a great deal about wire and winch technology, and now have a much greater appreciation for the challenges faced by the engineers and ship operators working to meet the always increasing demands of the oceanographic community. I've had the good fortune to read the report filed by Sandy Williams on behalf of the Ocean Engineering community, which does a wonderful job of providing a scientific perspective on the lessons learned at this symposium. Below, I'll try to restrict my comments to issues not covered in Sandy's summary, and to subjects directly bearing on the Physical Oceanography community.

The symposium highlighted the need for greater communication between the scientific community, equipment manufacturers and ship operators. The scientific community needs to be aware of the limitations imposed by current technology. Personally, the discussion around the trade-offs involved in trying to create a durable, 0.322 torque balanced 3-fiber/3-conductor cable is an example of this. There was strong agreement among symposium participants that more extensive training of seagoing personnel would be required to insure proper care and maintenance of increasingly complex shipboard equipment. Equipment should be designed so that maintenance is simple, easy to explain and easy to implement. This could increase the safety of winch and crane operations and extend the working life span of the gear. An effort should be made to encourage more scientists to participate in the planning and decision making process for equipping UNOLS vessels. The members of the science panel noted that the community-wide level of response to the wire and winch questionnaire was somewhat disappointing. Greater scientific participation might lead towards science getting more or the kinds of equipment and services that they want from the UNOLS fleet.

The drive towards larger packages (e.g. trace metal rosettes, deep-towed sleds) and innovative sensors such as the video plankton recorder and the new generation of bio-optical sensors places ever increasing demands on cable strength and data bandwidth. Current 0.322 cables are being pushed beyond their safe working loads when used for deep deployments of large packages. The desire to do high speed vertical profiling (or to simply execute high-speed up casts) and modern, towed applications also place stiff demands on cable strength. Current electro-mechanical cable standards do not provide enough bandwidth to accommodate many state-of-the-art sensor packages. The desire to pipe increasing amounts of data up the cable for real-time display and collection will continue to grow. Appropriate shielding might decrease data-line noise induced by power transmission down the cable, thereby allowing increased data rates. A combination of shielding and multiplexing might go a long way towards meeting our current bandwidth needs. Fiber optic cable offers a high bandwidth solution that meets our current needs and allows for a great deal of growth. These cables are currently costly, more difficult to terminate than electro-mechanical cable and may be less durable. There are a number of sea-going research groups across the country that are using electro-optical cable for their own specialized applications.

However, this technology has not yet seen widespread, routine use in the oceanographic community.

In light of safety and bandwidth concerns, it is probably time to reevaluate UNOLS cable standards. Like Sandy, I believe that we need to establish a fiber optic standard that would be offered as a basic cable option on board UNOLS vessels. This would meet the ever-increasing demand for bandwidth. Settling on one or two standard fiber optic cables should reduce costs, while increased experience with these systems would make maintenance, handling and termination more routine. We need stronger cables to accommodate both vertical and towed profiling. For towed profiling, drag concerns make it desirable that the cable be as thin as possible, so thicker cables may not be the answer. Alternatively, perhaps towed profiling groups are specialized enough that they need to rely on their own winch and wire solutions. Careful consideration will need to be given to the interfaces between the winch/cable subsystem and the user-supplied sensor packages and control/data acquisition systems. For this to succeed, researchers must be able to design their instruments around a standard, well-defined and well-documented interface. The science and engineering communities should participate in the specification and design of this system.

Towed, undulating profilers (e.g. SeaSoar, Scanfish) have gained increasing popularity, and the question of whether these should be offered as 'standard' shipboard equipment, similar to CTDs, was raised. Though not specifically a 'wire and winch' issue, the winch/cable assembly is an integral part of these systems and the decision to offer towed profiling as a standard shipboard service bears on some of the questions raised at the symposium. Towed profilers offer quasi-synoptic, high-resolution, three-dimensional snapshots of the upper ocean and can accommodate large, interdisciplinary sensor suites. Given recent developments in biological, chemical and bio-optical sensors and the interdisciplinary nature of many experiments, towed profiler use should continue to increase over the next few years. Typically, these vehicles are operated by specialized research groups who custom-configure the platform for each experiment. Knowledge is freely shared between groups, but there is only limited sharing of hardware resources.

There are clear advantages to making towed profiling a part general shipboard technical services. Such a move might provide wider access to these systems for the general oceanographic community and could offer efficiencies gained though maintaining several nearly identical systems. However, several factors make this an extremely difficult, perhaps impractical, route to take. The current generation of towed profilers require considerable end-user modification, resulting in technically complex systems that need one or more dedicated individuals to maintain them. One of the primary attractions of these platforms is their flexibility in accommodating different sensor suites. Typically, sensor payload changes with every experiment. However, each new sensor requires engineering effort for mechanical, electrical and data-stream integration. Payload reconfiguration alters vehicle hydrodynamics and trim, sometimes requiring an iterative sequence of in-water tests and physical reconfiguration. Many of the most compelling new sensors (e.g. video plankton recorders and bio-optical sensors such as the AC-9 or HiStar 100) are both physically bulky and electronically complex. From experience, we know that it takes considerable time, energy and talent to integrate them into profiling systems. Cables and winches present another obstacle. Cable drag greatly influences maximum profiling depth, making faired cable a requirement for all but the shallowest applications. Fairing is typically costly and can be labor-intensive to apply and maintain. Faired cables also require specialized winch systems with drums that can accommodate large amounts (e.g. 500 m for SeaSoar) of faired cable and level winds capable of handling the fairing without damaging it. In short, towed profilers tend to be high-maintenance systems that require a great deal of dedicated engineering expertise. This may be beyond the scope of what most ship operators would be willing to support.

ENCLOSURE 4

Winch and Wire Symposium

Follow-up Comments from Glosten on Working Wire Safety Factors

The Glosten presentation focused on A-Frame structures, and during the discussion of A-frame strength relative to the wire breaking strength, the issue of wire loads relative to wire breaking strength was raised. It was stated that UNOLS R/V's typically see loads in wire to about 40 to 50% of its breaking strength (safety factor of 2.5 to 2.0), where the ABS published criteria for allowable wire loads recommend operating at about 20% of breaking strength, (safety factor of 4.7) on rated system capacity including wire weight.

This brings to question whether operations are being conducted in an un-safe manner, and possibly in violation of published guidelines.

Confirmation of the actual numbers at question is needed. It was stated that the wire loads were between 40 and 50% of wire breaking strength, but is was not clear if these were the peak dynamic loads or something less. Also, the ABS definition of Rated Capacity needs to be confirmed. We currently interpret it to mean the maximum forces encountered.

Subsequent discussion addressed the options to either

1. change the published criteria, to reflect the practices and standard of care the operators currently employ
2. reduce the load imposed on the wire, or increase the wire size, to meet the existing criteria,
3. impose additional safety measures, such as clearing personnel off the deck(s) when wire loads exceed the criteria level, to reduce exposure to injury, or add guards or other protective measures.

Option 1 – Change the published criteria

The currently applicable published criteria for wire safe working loads exist in the following rules and regulations:

- ABS rules for Building and Classing Underwater Vehicles, Systems, and Hyperbaric Facilities, 1990, Appendix D – Certification of Handling Systems. SF of 4.7 on rated capacity of the system (this is defined as the maximum load that may be lifted by the launch and recovery equipment) plus weight of wire deployed to nominal breaking strength.
- ABS Requirements for Cargo Gear on Merchant vessels- at loads less than 10 tons, SF of 5.0 maximum working load
- USCG Subchapter U does not comment on wire loads, only on wet gear handling equipment

- USCG Subchapter I, Cargo Vessels, applicable to cargo gear - at loads less than 10 tons, SF of 5.0 maximum working load (same as ABS)
- DNV has criteria, currently being researched.
- UNOLS Safety Manual does not address wire loads.

The most effective approach to change the criteria would be to work with the international oceanographic community to develop international guidelines, for adoption by the International Maritime Organization (IMO), or by the International Association of Classification Societies (IACS). However this approach would be very involved and extensive. The USCG is getting away from new rulemaking, relying more on the IMO, however the USCG should be asked for advice on the situation. The USCG typically represents US vessel owners and operators at IMO. ABS typically represents vessels they have classed at IACS.

An argument for changing the criteria and reducing the oceanographic working wire safety factor could be made, but one could assume that to reduce the safety factor from 4.7 to 2.0 would require additional, concurrent measures and considerations such as:

- Wire fatigue monitoring (an expansion of the current wire log system used by UNOLS, into a computerized wire history, including load cycles of wire sections loaded at turning sheaves)
- Documented breaking strength tests from the wire manufacturers
- Stored energy characteristics of the wire.
- Documented wire lubrication practices
- Tension monitoring.
- Documentation of ship-specific sea-state operational limits.
- Constant tensioning devices to avoid peak loads.
- Automatic (electronic, immediate) winch brake release at some percentage of breaking strength.
- Increased emphasis on operator training
- Increased emphasis in wire maintenance practices

Additionally, documented ship safety practices including working decks clear of personnel or use of guards, etc. could be explored. If deck personnel could be effectively protected, then the risk of a broken wire would be isolated to loss of the package.

We assume that the safety factor of 4.7 is established to account for the potential lack of these practices on typical vessels.

Should a UNOLS RVOC sub-committee be set-up to investigate this approach further, it should start with USCG and ABS discussions, as well as researching international practices from other research institutions, rules from other classification agencies and regulations from national administrations.

Option 2 – Reduce the wire loads on specific wires or increase the wire size while retaining the load

This option does not appear practical. We recognize larger wires increase wire loads with length deployed and increase drag. Winch and wire sizes would have to be upgraded fleet wide, i.e. all .322 would be upgraded to a new standard. Alternately, existing operations using a 0.322 EM cable with a wire breaking strength of 9,200 lbs. would be limited to a 1,950 lb. dynamic load. The fleet wide wire upgrade would bring with it upgrades of the many winches as well as possible upgrades to A-Frames and other over-side handling equipment.

Option 3 – clear personnel off decks when wire loads exceed the 4.7 SF criteria

This option may be the most practical approach to minimize risk of injury, by simply moving personnel out of harms way. Deck operations would be supplemented by additional video cameras, and with wire loads are lower and within the safety factor when the packages are near the surface, personnel can come back out on deck to handle the package on or off the ship.

Recommendation

We suggest that additional research be conducted to determine the viability of pursuing Option 1, with some investigation into international research practices and the historical evolution of the established safety factors. But in the mean time Option 3 should be pursued, with personnel cleared from the decks when wire tension monitors read in excess of 20% of the wire breaking strength.

ENCLOSURE 5

Comments from Mike Prince

1. Define the scientific needs in a very quantitative way. I would suggest that a limited and knowledgeable group do this and then circulate the draft to the broader community for review and input otherwise it will never get done. I would also suggest that a good place to start would be to define what we can do now with the existing wires and winches. We would then define what more we think needs to be done in the future.

2. Present these operational demands to the various wire manufacturers with a request for proposals of wire or cable design that would meet these needs. Use those proposals to define specifications for future wires. These could of course include current wires and cables.

3. Have a group work on defining safe working loads and speeds for existing wires. This group would also investigate incorporating this definition into CG regulations if necessary.

4. Develop a method or tables that would assist crew members in assessing dynamic loads that might occur when deploying a package during various sea states. This would be something that was ship specific or could take into account the movement of the ship based on size and displacement.

5. Develop some criteria for handling systems that would eliminate the need for human control (bumpers) when deploying and recovering CTDs and other standard packages. Also develop criteria for the design of motion compensating systems that would allow safely increasing the average speed of deployment.

6. Establish clear guidelines and training standards for wire, winch and handling equipment maintenance, inspection, operation and replacement.

7. Update the winch and wire manual using input from the manufacturers, scientists and operators. I would try to keep and add things that are of practical use to the ship operators and scientists.

8. Provide additional forums for scientists to educate them about the capabilities and limitations of existing winches and wires, the factors that affect those capabilities and finally to get their input about what needs they may have in the future or that are not being met now.