WEATHER ROUTING: A NEW APPROACH

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"Some people are weather wise, but most are otherwise"
Benjamin Franklin

Weather is inevitably the first thing that defense lawyers look for in litigations involving loss or damage to ships or cargo at sea. After all, it's easy to blame the weather. "Act of God", "peril of the sea" and "rogue waves of unprecedented magnitude suddenly coming from nowhere" are often invoked when placing blame for damages at sea.

The agonizing inquiries into the tragic loss of the Derbyshire have at last been completed, and once again the unpredictability of weather and sea is the culprit. While it is true that rough weather was the proximate cause of the Derbyshire sinking, a more fundamental question remains unanswered. How did the ship get into the situation in the first place and what was the vessel's condition at the time? Why did the master of the Derbyshire not have access to information that might have caused him to make a different decision? Furthermore, are there lessons to be learned so that risk of such incidents can be minimized in future?

It is astounding that modern advances in weather forecasting and satellite communications provide unprecedented amounts of weather information to ship masters, yet ships – and seafarers' lives – continue to be lost at an appalling rate, and hundreds of containers are washed overboard every year due to heavy weather. So the question we should be asking is, why have the advances in computer technology, marine weather forecasting, ship design and satellite communications failed to reduce significantly the danger of heavy weather damage at sea? With all these high-technology resources available to us, cannot we find a better way to protect the lives of ships, cargoes and seafarers from the ravages of heavy weather? Or shall we just continue to plod along in the traditional way, accepting the weather as one of the unavoidable risks of doing

business and letting the lawyers and insurance companies sort it all out after the disaster occurs.

I suggest that the Derbyshire report, and investigations into other weather-related casualties, reveal some real but correctable weaknesses in the maritime industry. In this paper I will discuss the problem and propose a solution.

Reduced Safety Margins in "Standard" Ship Designs

The competitive nature of the shipbuilding industry and marine classification societies has resulted in reduced design safety margins in ship structures. Shipyards use sophisticated finite element models and high tensile steels to reduce steel weight and production costs in order to be competitive. Structural fatigue has become an increasing problem on relatively new ships. Over the years, there has been an overall reduction in scantling in design, to the point that the IMO has asked the classification societies to review their rules in view of large number of structural failures and losses of bulk carriers.

Likewise, there has been inadequate attention paid to the design criteria of container securing systems on post-Panamax container ships. The design rules assume the vessel will never get into a synchronous rolling motion during a lifetime of varying loading conditions and wave climates. The wider the ship, the smaller the maximum roll angle for container lashing designs. Phenomenon such as Parametric roll resonance in head and stern seas were never considered in the empirical class rules, which were derived from experiences on smaller vessels.

Undefined "Prudent Seamanship" and Operating Limits

When a vessel classified for worldwide unrestricted operations is lost or damaged, the master is often blamed not exercising "prudent seamanship." Unfortunately the definition of "prudent seamanship" is never made entirely clear to the master, who is also uninformed as to the design limits implied by the class rules.

It is very doubtful if any of the crew member of Derbyshire knew the hatch cover was designed to less than 5 meters of static head or the lashing system was designed for less than 25 degrees of roll on those large post Panamax container ships. And what about the weather routing services? Are they aware of these limitations in advising ships for optimum weather routing? Do they have the tools to predict occurrence of such events? What part did this lack of knowledge play in any of these casualties?

All Weather Routing Services Are Not Equal

More than 50% of weather routing services are ordered by charterers to monitor their chartered vessel for speed claims. As a result, there are a few "good enough" weather routing companies with minimal technology to perform post voyage analysis. Accuracy of the wind and wave forecasts is not a top concern. The criteria for routing and

speed claims are still based on Beaufort Wind Force Scale invented in the 1800s, regardless of the size of the ship and loading condition reacting to varying forecast wave height period and direction.

Traditional shore-based weather routing services operate on the principle of "storm avoidance". The so-called route analyst typically plans a route using a set of generic speed reduction curves to predict ship position to avoid storms as depicted by the lows on surface pressure charts. After trying out several candidate routes, the recommended route, is sent in a brief email/telex to the ship requesting the service and updates when workload permits or requested again by the ship. Was the duty analyst too busy to send a telex to warn the crew on Derbyshire the approaching Typhoon Orchid, or was he aware of the swell generated by the Typhoon may have already propagated much beyond the forecast track indicated by the wind radius and Typhoon eye?

Weather Routing Does Not Take into Account Ship Responses

A ship slows down due to one of two reasons, involuntary speed reduction due to increased resistance from onset of wind and wave, and voluntary speed reduction due to navigation hazards or fear of heavy weather damage resulting from excessive ship motion, slamming or boarding seas. The weather routing advisor must take both of these into account when estimating dead reckoned ship positions in relation to the movement of weather systems. Otherwise, the best route perceived by the unknowing route analyst could lead to a dangerous situation. Would the master of the Derbyshire still take the action to outrun Typhoon Orchid if he had known that his vessel would be slowed down due to severe motions caused by advancing waves ahead of the eye of the storm? If the route analyst does not have the tools to accurately predict the ship speed, then is the route recommendation to avoid the storm still valid?

Technological Advances

There have been tremendous advances in technology over the past twenty years. The advent of super computers has resulted in a quantum jump in weather forecasting accuracy. Organizations such as the European Center for Medium-Range Weather Forecast (ECMWF), UK's MET Office, Japan's JMA, the US National Center for Environmental Prediction (NCEP) and the US Navy's Fleet Numerical Oceanographic Center (FNMOC) routinely produce skillful global weather forecast out to 5 days and beyond. Some products are available free over the Internet or broadcast via marine weather fax to ships at sea. With a good global spectral wave model, the error in wave predictions is less than 1 meter out to 3 days, enough time for most ships to divert from severe weather conditions. Long-range forecasts up to 10 days are available to show the general trend of storm tracks, although the accuracy of these predictions deteriorates beyond 6-7 days.

Satellite communications allow messages to reach virtually every GMDSS-equipped commercial ship instantly. Ships at sea can download 10 days of wind and wave forecasts in matter of minutes, or consult with experts on the shore side by simply

calling over INMARSAT A/B. There should be no excuse of not getting enough weather information onboard ships at sea.

Advances in naval architecture and hydrodynamics have resulted in the accurate prediction of ship responses in waves. Computer simulations of vessel motion and wave loads have been validated by model tests in towing tanks as well as full-scale hull monitoring systems. Coupled with accurate wind and wave forecast, accurate prediction of both voluntary and involuntary speed reduction for a specific hull form and loading condition are possible using today's standard PC.

Advances in sensors technology and reliability has increased to the level where it is possible to accurately inform the ship's crew what motions and stresses the hull is actually experiencing as well as the actual state of the sea, regardless of visibility conditions.

An Integrated Solution Is the Answer

All these advances have been incorporated into the Vessel Optimization and Safety System (VOSS). The system was developed by Ocean Systems, Inc., over the last 15 years with extensive input from ship captains. It is an onboard passage planning tool and a seakeeping expert advisory system. It is based on the premise that deck officers, giving the training and tools, can do a better job of weather routing their ship and minimizing heavy weather damage while maintaining schedule.

VOSS software is custom tailored to each vessel class in order to provide accurate predictions of the ship seakeeping and speedkeeping capabilities in any seastate. The "prudent seamanship" standard is defined as a "safe operating envelope," in terms of agreed upon ship response limits. The VOSS seakeeping advisory module shows the effect of changing heading and speed on vessel roll, pitch, accelerations, slamming, boarding waves, bending moment/shear forces on critical frames -- thus answering "what if" questions in heavy weather damage avoidance maneuvering. An optimization algorithm is also implemented to minimize the fuel cost for given arrival times without exceeding the safe operation envelope.

Wind and wave forecasts for VOSS are generated by Oceanweather Inc. headed by Dr. Vince Cardone. He was one of the expert witnesses in the Derbyshire inquiry and performed the definitive wave hindcast. The same state-of-the-art technology is used for generating twice daily forecasts of global wind and waves for the VOSS clients. Oceanweather has recently completed a global wind and wave hindcast database going back 30 years every 6 hours. The high-resolution grid includes wind and wave generated by all tropical cyclones. Application programs have been developed to use this comprehensive database for developing tow criteria of offshore structures, trade route specific ship designs, structural fatigue life estimations and validating the empirical formulae in the classification society rules

VOSS is currently used on over 100 ships on daily basis. It is integrated into Sperry Marine System's Voyage Management System and Voyage Data Recorder under the overall concept of InfoFleet. The U.S. Navy is also utilizing the technology. A special version has now been implemented at all their Optimum Track Ship Routing Centers.

An internal study carried out by a long-time client revealed the following results:

- The actual number of hours delayed due to heavy weather decreased by 80%.
- The number of structural damage claims due to heavy weather decreased by 73%, while the cost of claims declined by 29%.
- Cargo damage claims due to heavy weather decreased by 87%.

While the current technology is not perfect and more progresses can be made, it is possible to utilize the advances in weather forecasting, satellite communications and computer technology to enhance the safety and efficiency of ship operations. The answer lies in an integrated software solution that draws on all these technologies and disciplines to help ship masters making better decisions.

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