Organizational Meeting of SNAME Working Group A on Fishing Vessel Stability Criteria
Professor Bruce Johnson, Chair & Professor Pasqualle Cassella Vice Chair, Southern Europe

Agenda

1. **Introduction of attendees**
2. **Review of Charter of SNAME Ad Hoc Panel on Fishing Vessel Operations and Safety** (See Johnson and Womack Paper in 1st day afternoon session) and web site
   http://www.sname.org/committees/tech_ops/fishing/home.html
3. **Discussion of organizational options for accomplishing the tasks of Working Group A**
   1. Recruit Regional Vice Chairs (or Coordinators) to plan and coordinate F/V information gathering by region including improvements in weather and wave data gathering
   2. Develop a standard format for reporting the results of model tests (and any full scale comparisons) including the essential model geometry characteristics and wave characteristics, such as rather complete statistical characteristics for irregular wave tests and long crested wave characteristics and asymmetries for wave impact capsize tests.
   3. Encourage each region to assemble and report on dynamic stability model tests of the typical F/V types used in that region.
   4. Build a database of dynamic stability tests on fishing vessels and use this database to suggest new risk-based stability criteria.
   5. Work with the ITTC SCEXCAP, to formulate a cooperative fishing vessel research program to develop a complete set of scalable, non-dimensional parameters for designing and building safer vessels. It is expected that the effects of variations in length, beam, draft, freeboard, sheer line, bulwark and deckhouse arrangements and loading conditions can be correlated with a new set of risk-based stability criteria and design parameters for increasing small vessel safety and survivability in a variety of situations. Note that extending hydrostatic analysis software to 180 degrees would greatly enhance the issue of survivability assessment

4. Comments on the use of existing F/V stability standards:

A frequently used interpretation in applying the Torremolinos Protocol stability criteria is that the area under the righting arm curve represents “righting energy”. A possible solution to this misinterpretation is to change the terminology to "unit righting energy" or even “unit static righting energy”. This interpretation is correct since the righting arm is righting energy per unit displacement, m-tons-degrees/ton (ft-tons-degrees/ton). The heeling arm is also the "unit heeling energy" for the same reason. This terminology would imply the correct interpretation that righting energy increases with displacement, all other variables being held constant. If the Workshop agrees with this interpretation, it should be reflected in the ITTC Symbols and Terminology List.

Briefly, scalability in vessel stability characteristics depends on the square-cubed rule, i.e. the heeling forces, which depend on water and wind impact areas, go up with the square of the dimensions but the righting moment depends on the displacement which goes up with the cube of the dimensions.

Correctly interpreting the scalability of the Torremolinos criteria should mean that vessels double in dimensions should survive without capsizing in twice the wave height conditions. However, that is not the interpretation generally given by the existing one-size-fits-all stability guidelines. The wind heel criteria do scale with size, however, since the heeling arm analysis includes being divided by the vessel displacement as is shown in Appendix A.

As an example of what can be done while the F/V community waits for better risk-based stability criteria to be developed, the following status report on a new form of stability letter is offered by John Womack, Vice chair of SNAME Working Group B:

Appendix A
Exploration Into the Preliminary Development of a Weather Dependent Stability Criteria
for Small Commercial Fishing Boats
by John Womack, V-Chair of Working Group B

Revised 08/19/01

In a review of weather stability criteria for fishing boats over 24 meters (79 feet) and other commercial vessels, the primary type of criteria in use the Torremolinos Convention criteria or a modified form thereof. Other criteria such as the severe wind & roll criteria, water on deck, lifting weight over the side, or towing large gear are available, but they are currently used to check stability in specialized operating conditions. In all cases, these criteria are designed for a one-size-fits-all generic full storm conditions, often applied against a generic vessel. The one-size-fits-all generic full storm and a generic vessel present several problems for today's small commercial fishing boats.

First, there are many different geographical areas being fished today, each of which has unique sea conditions. For example the size and frequency of the waves encountered in the Gulf of Mexico are significantly different than those on the Mid-Atlantic eastern coastline or the Mid-Atlantic open ocean. Clearly, different stability levels are needed to safely work in the different areas. Additionally, the criteria do not take into account any seasonal differences such as occur on the Mid-Atlantic eastern coastline. These differences in working areas is reflected in current fishing boat designs such as the typical Gulf of Mexico shrimp trawler and the Atlantic Ocean stern trawler, which have evolved over time.

Another problem with these criteria is they are designed for full storm conditions. While correct for fisheries that work long trips more than a day or two steam from a harbor of safe refuge, many fisheries have either short trip times or work close to shore and can reach a safe port in less than a day's steam. For example, the Mid-Atlantic surf clam and ocean quahog trips are 24 to 32 hours dock to dock and range a maximum of 60 to 70 nautical miles from port.

To apply the current generic storm conditions to these vessels is overly conservative. The crews have already figured out that they can safely carry more catch in good weather. Issuing a stability letter with the conservative loading limit set by the current criteria is causing many of the crews to ignore their stability letter. Having available a criteria that provides stability guidance in less than storm conditions will give crews guidance they will trust and follow. Knowing the true risks for each loading condition, the crews will hopefully take the appropriate actions for the expected weather.

The Torremolinos Convention criteria are designed to provide sufficient stability to allow a typical vessel to survive most storms. The basic characteristic of the Torremolinos Convention criteria is minimum area requirements under the righting arm curve to specific angles of heel or the point of uncontrollable down flooding. Additional requirements for initial metacentric height, minimum righting arm values, and the heel angle of the maximum righting arm are also specified. Over time, supplementary requirements have been added to some versions of the Torremolinos Convention criteria such as a minimum range of positive stability or requirements when the maximum righting arm occurs at low angles of heel. A comparison of several versions of the Torremolinos Convention based criteria will be shown at the workshop.

Though the Torremolinos Convention criteria has proven adequate over time, it does have several drawbacks for use in evaluating a fishing boat's stability, particularly in less than storm conditions. The Torremolinos Convention criteria are for a "generic" vessel in a one-size-fits-all storm. The criteria's values do not reflect different geographical or seasonal conditions present in different fishing grounds. The criteria also does not take into account the type of vessel, its hull shape (hard chine or round bilge), the presence or absence of bilge keels or other roll reduction devices, or other unique characteristics, all of which affect a boats response in a seaway. Lastly, the criteria are not suggested for use on boats less than 79 feet long, nor can the be used to evaluate a boats stability in less than storm weather conditions.

The principal reason for these problems lies in the basic design of the Torremolinos Convention criteria. The criteria use a series of simple static calculations to evaluate a complex dynamic situation; that is the boat's static stability in calm water with generic one-size-fits-all allowances for the dynamic effects of winds and waves. The static calculations of the righting arm only reflect the gross shape of the particular hull, both the part that is submerged and the remaining freeboard. In addition, the selection of specific heel angles such as 30 or 40 degrees for certain parts of the criteria are somewhat arbitrary and do not fit many modern-day fishing boat designs.

The appeal of the Torremolinos Convention criteria is its relatively simple calculation procedure that was practical when slide rules where the computers and planimeters/integrators where the supercomputers. The only change made with the advent of readily available personal computers is allowing the boat to trim to a balanced waterline as opposed to holding a fixed trim at all angles. This change is actually somewhat arbitrary especially for small boats that are more affected by the waves than larger commercial vessels. While the ability to directly dynamically model a small boat's response to a given sea condition is a decade or more away, modifications to the current "static" righting arm curve offer an interim ability to better represent the true dynamics of a particular small boat in a given sea condition.

The "severe wind and roll" criteria offers a more direct approach to evaluate the dynamic energy in wind and waves for a given boat in a given seaway. The basic approach to this criteria type involves two parts; a gust wind heeling arm to model the effects of wind and a roll angle to windward to model the effects of the waves, which are superimposed on the traditional righting arm curve (See PNA or Appendix A of Johnson-Womack Trieste Paper). In this setup area "A" represents the unit kinetic energy (unitized by the boat's displacement) developed by both the natural righting force of the boat and the heeling force from the wind. Area "B" is then the unit potential energy (again unitized by the boat's displacement) available to dissipate the developed kinetic energy.

Versions of this criteria are currently in use such as the USCG's criteria for small fishing boats given in 46CFR 28.575. The USCG's criteria are an adaptation of the IMO developed version. The US Navy also uses a version of the severe wind and roll to evaluate the stability of their vessels from harbor tugs to aircraft carriers in protected to unrestricted ocean service.

By working with these versions as a starting point and exploring new concepts, the intent is to develop a more robust version of the severe wind and roll criteria that can reflect the particular characteristics of the subject boat when working in a given sea condition. The three key components of the severe wind and roll criteria are; the wind heel arm, the roll angle to windward, and the relationship between area "A" and area "B".

The wind heel arm has been well developed over time, though it could stand a review. The IMO/USCG version uses a wind velocity that varies with the height above waterline of the surface in question. For example a pilothouse would be subject to a higher wind velocity than the hull adjacent to the waterline. While theoretically correct in the lab on a level water surface, it is not correct for a small boat bobbing on large waves. The IMO/USCG wind heel arm also does not vary as the vessel heels, which would be expected just as a sailboat would dump wind from its sails as it heels.

The US Navy uses a simple one-wind velocity for all surface areas equation, which is better approach. Their equation also varies the heel arm as the boat heels. The US Navy's wind heel arm equation is;

$$HA = C \times V^2 \times A \times L \times \cos^2(\phi) / W$$ - Where;

C = Dimensionless Coefficient

A = Projected Sail Area, Square Feet or Sq m

V = Nominal Wind Velocity, Knots

L = Lever Arm (Vertical distance from the center of lateral resistance to the centroid of the sail area), Feet or m

ϕ = Heel Angle, Degrees

W = Displacement, Pounds or Newtons

While this may seem as taking a step back, it is also important to remember the more complex a calculation, the greater the chance of a mathematical error could be made. Sometimes simpler is better, especially when the more complex version offers no better accuracy. Additional research into the correct value for the coefficient “C” needs to be done to reflect the unique profiles on the various types of fishing boats in use.

The roll angle to windward is the component of the severe wind and roll criteria that can be used to model a particular boat’s response in a given sea. In this area, the IMO/USCG version uses a calculation that takes into account the particular boat’s hull shape (hard chine or round bilge), the presence or absence of bilge keels, and the initial stability. While this does reflect some of the subject boats unique characteristics, additional review should be done to investigate the effect of other vessel characteristics such as freeboard, sheer configuration, etc. The IMO/USCG version also assumes a generic one-size-fits-all sea condition. Additional research needs to be done to reflect both different storm conditions for geographical or seasonal variations and the sea conditions in less than storm conditions.

The last component of the severe wind and roll criteria is the relationship between area “A” and area “B”. This component is where the adequacy of the boat’s stability level can be evaluated. The principal area to be researched is what cutoff point to use for area “B”. Typical points used in previous versions are the 2nd intercept point, the point of down flooding, or an arbitrary heel angle such as 40 or 50 degrees. Using, the point of the maximum righting arm should also be investigated as this is unique to the particular boat’s stability characteristics.

The relationship between area “A” and area “B” also allows ability to create a risk of capsize analysis to provided additional guidance to the fishing boat crews. Existing criteria coupled with current stability letter formats do not tell a crew how close they are to a limit. The loadings are given as safe/unsafe limits; the crews have no idea how much of a margin is present. There could be a large margin or none at all. By providing the crew with warning that they are approaching a limit will give them the ability to make better operational decisions. For example, if the weather outlook is iffy and they know they will be near a loading limit, they can elect to come in early or load less catch.

To experiment with several simple approaches to developing this new version of the severe wind and roll criteria, trials where run on a typical Mid-Atlantic offshore clamming boat. The trials use educated assumptions to explore some general concepts and trends when using these criteria in less than full storm conditions. Full theoretical and model testing needs to be done to make robust, effective criteria. The trial boat is a former 133-foot offshore supply vessel built in 1966 that around 1984 to 1986 was converted for use in the offshore clam-harvesting fishery. The boat operates on 24 to 32 hour dock to dock trips along the Mid Atlantic and New England coastline, typically ranging from 10 to 60 nautical miles from port. The catch is loaded on deck in steel cages similar to the loading of supplies on a typical offshore supply vessel. Due to the dredging gear, these clamming vessels generally work in winds less than 25 knots in order to keep the dredge in the sea bottom. Because of this wind restriction and the short trip times, this boat is ideally suited to weather dependent safe loading guidelines (See Attached Graphic). Note however, that the selection of the corresponding expected local significant wave heights and the equivalent open ocean significant wave heights need additional work. However, it is felt that the graphical approach using the stop light metaphor is a valid one.

Clearly, significant amounts of research still need to be done to make this workable criterion. In addition to the research mentioned above, many other trial boats from different fisheries and with different characteristics need to be investigated.

F/V # 1 40m OSV Clam Dredger - Safe Loading Table

Fuel Tanks 70% or Lower

All Loaded Cages are on the Main Deck