NVIC 17-82
13 Dec 1982

NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 17-82
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Subj: Intact Stability of Small Vessels; Recommendation.

1. PURPOSE. The purpose of this Circular is to advise designers, builders, owners and operators of their responsibility for the safe design, construction, and operation of small vessels relative to intact stability.

2. APPLICATION. This Circular applies primarily to those vessels of less than 79 feet in length whether or not they are designed to satisfy federal or international stability standards.

3. BACKGROUND.

   a. The basic U.S. Coast Guard "Weather Criteria" as stated in 46 CFR 93.07-10 has been applied to many vessel types. Its theoretical derivation was based on "flush deck, mechanically powered vessels of ordinary proportion and form which carry cargo below the main deck." More specifically, it evolved from experience with the vessels of the 1940 era (e.g., Liberty ships, Victory ships, etc.). This is a static" stability criteria that requires a minimum metacentric height (GM) for a given wind pressure on the vessel profile. No formal consideration is given to the action of the sea nor is the full range of stability of the vessel examined. Extension of this formula to vessels other than 1940 era conventional cargo vessels or vessels of similar size and shape has been largely judgmental and has not yet been fully proven.

   b. Righting energy criteria have been applied for several years to "special case" vessels (46 CFR 93.07-15), such as tugs and offshore supply vessels, because they do not conform to the conventional cargo vessel category above. These "dynamic" or "quasi-static" criteria were theoretically derived and are applied primarily as protection against the capsizing action of the sea (waves). Each of these criteria requires a minimum area under the vessel's righting arm curve to a specified heel angle for each operating condition. Wind pressure is not formulated in these criteria. Therefore, they are applied by the Coast Guard in conjunction with the "Weather Criteria" for a more comprehensive stability analysis.

   c. The Coast Guard has also applied or has recommended the use of the IMO (International Maritime Organization) Resolution A.167(ES IV) criteria for various vessel types. These "dynamic" criteria were developed at IMO for passenger and cargo vessels less than 100 meters in length. They were based on Prof. Rahola's doctoral thesis at the Technical University of Finland, 26 May 1939 which included casualty data from a population of European coastal cargo vessels. IMO recommends that this Resolution be applied to "decked sea-going passenger and cargo ships (other than fishing vessels and ships carrying timber deck cargoes)." Resolution A.167 is not intended to apply to vessels less than 24 meters (79 feet) in length nor more than 100 meters (328 feet). Some nations have, however, extended the applicability of the Resolution to vessels beyond these limits. Several national administrations have recorded instances of casualties to these vessels and have expressed concern over the application of the Resolution to vessels outside of the recommended range of sizes.

4. DISCUSSION.

a. The evolution of virtually all intact stability criteria has been the result of both theoretical application and empirical feedback in the form of research or casualty data. Qualitative casualty data (that in which the actual cause of vessel loss has been determined), either to develop new or to verify existing criteria, have been available predominantly for large vessels. Casualties to small vessels have been more difficult to evaluate. The reasons are the vulnerability of small vessels to a larger number of stability hazards in the sea and the lesser chance of survivors. Research relative to the stability of small vessels in a seaway has been limited by the complexity of the problem and lack of resources.

b. Federal and international standards are often the result of a trade-off between safety and economic realities. Standards must be generalized in order for them to be equitably applied to a large group of similar vessels. As a consequence, the level of safety cannot be assured to cover all unique conditions in the same group of vessels. Therefore, by definition, safety standards become the minimum acceptable level for a group of vessels.

c. Total vessel safety is a combination of proper vessel design, good construction practice, and prudent seamanship (vessel operation). It should be understood that federal or international standards offer only a minimum level of design, construction, and operational safety with the balance being the responsibility of the designers, builders, owners and operators.

d. Designers should be aware that no proven intact stability standards for small vessels exist today. Each standard has its own inherent limitations. Thus, utilization of federal or international stability standards is not a guarantee of adequacy of intact stability for small vessels. Therefore, designers, through their own initiative, should further investigate intact stability to assure themselves that their designs are inherently safe, rather than relying entirely for safety on federal or international standards.

e. Since smaller vessels are inherently more vulnerable to wind and sea, it is recommended that a comprehensive approach to stability be taken by designers to enhance small vessel safety.

f. A comprehensive approach to intact stability should include such design parameters as:

(1) initial GM

(2) righting energy - to the maximum righting arm or moment
- to 40 degrees heel
- to the downflooding angle

(3) range of positive stability

(4) wind heel moments (steady and gusting winds) using the actual vessel profile and wind gradient

(5) effect of waves (troughs and crests i~ various directions) on righting moment curves

(6) roll amplitude and period (function of vessel gyradius and damping)

(7) residual righting moment considering the effect of operational factors listed in paragraph 4.g

g. Operational factors to be considered, either separately or in conjunction with one another, if applicable, include:

(1) cargo stowage

(2) effect of free liquids (free surface)

(3) shifting cargo (bulk or solid)

(4) transfer of liquids (ballasting)

(5) towing forces

(6) crane loads

(7) maneuvering ring

(8) ice accumulation

5. ACTION. Designers, builders, owners and operators of small vessels are:

a. advised to consider the precautions and recommendations of this Circular in order to further promote small vessel safety.

b. encouraged to conduct independent research on small stability. The results of any such research or new stability should be disseminated for the benefit of

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