



# Marine Safety Center Technical Note

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MTN: 02-95

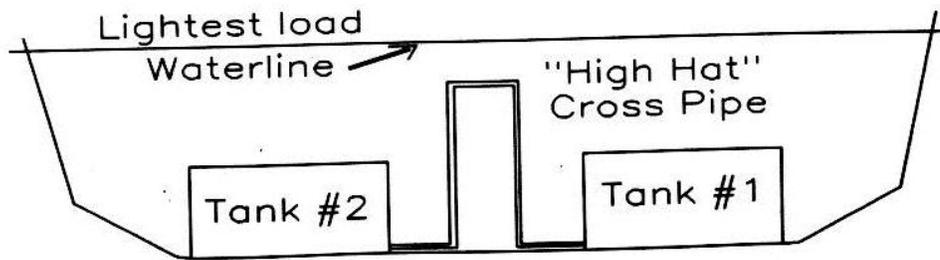
Subj: DAMAGE STABILITY EQUALIZATION FOR VESSELS (MONO HULL ONLY)  
SUBJECT TO 46 CFR 171.080(d)

Ref: (a) Title 46 CFR Parts 171.080(d) and (f)  
(b) Marine Safety Manual, Volume 4, Technical, COMDTINST M16000.9

1. PURPOSE: This memorandum provides requirements for the physical arrangement of equalization systems on vessels required to meet the damage stability requirements of 46 CFR 171.080(d), and sets specific stability criteria for acceptance of the final and interim angles of equilibrium in accordance with 46 CFR 171.080(d)(1)(ii) and 171.080(f)(3).

## 2. DISCUSSION:

a. Title 46 CFR 171.080(d)(1) & (2) allow the use of equalization systems to meet the requirements for the maximum final angle of equilibrium after damage. For all vessels, equalization systems are required to be automatic. For vessels over 100 gross tons and on ocean service, manual equalization systems may be used if the arrangement of an automatic system is impractical. Automatic systems are fully passive, such that equalization is achieved after damage in any loading condition without the use of any valves. If any valves are used, even automatically actuated valves, the system is considered manual. Typically, automatic (passive) equalization systems involve two tanks cross connected through a "high hat" system, which involves a cross connection pipe that rises above the top of both tanks but remains below the light load water line (as in figure 1 below). Automatic (passive) equalization systems must be arranged so that there will be no transference of liquid between the two tanks in the intact condition, but there will be sufficient hydrostatic head to drive the equalization after damage to either tank. This MTN sets specific requirements for the arrangement of automatic equalization systems to ensure that they are both safe and reliable.



**Figure 1. Typical Automatic Equalization Arrangement**

b. The maximum angle of heel after damage but prior to equalization must be approved by the Commanding Officer, Marine Safety Center in accordance with 46 CFR 171.080(f)(3), regardless if automatic or manual equalization is used. This MTN sets specific stability criteria to ensure that a vessel can survive the transient condition, and requires that the pre-equalization condition be analyzed in every case.

c. Title 46 CFR 171.080(d)(1)(ii) states that the Commanding Officer, Marine Safety Center can accept a final angle of equilibrium of greater than 7 and less than or equal to 15 degrees in certain cases. Reference (b), Section 6.E.15.a sets stability criteria to be evaluated when accepting the final angle of equilibrium. This MTN reiterates and clarifies those requirements.

### 3. ACTION:

a. Requirements for Automatic Equalization Systems - Equalization systems on vessels of 150 gross tons or more in ocean service must be automatic unless the Commanding Officer, Marine Safety Center considers it impracticable to make the equalization automatic in accordance with 46 CFR 171.080(f)(1)(i)(A). Equalization is considered "automatic" if a high hat cross-flooding pipe arrangement is provided such that:

i. the top of the high hat cross-flooding pipe is always below the lightest operating waterline to ensure adequate hydrostatic head to equalize the cross-connected tanks in 15 minutes or less;

ii. there is no transfer of liquid between the cross-connected tanks in the intact condition up to a heel angle of 40 degrees; and

iii. all equalization piping is located inboard of the assumed maximum transverse extent of damage as defined by 46 CFR Table 171.080(a).

If it is not possible, due to tank configuration, to install an equalization system which meets the above requirements then the installation of automatic equalization is considered to be "impracticable."

b. Requirements for Manual Equalization Systems - For arrangements where it is "impracticable" to make the equalization automatic, a cross-flooding pipe arrangement with an in-line valve is acceptable provided:

i. the cross-flooding valve controls are located above the bulkhead deck in accordance with 46 CFR 171.080(f)(1)(i)(B); and

ii. the cross-connected tanks are fully equalized within 15 minutes in accordance with 46 CFR 171.080(f)(1)(ii); and

iii. all equalization piping is located inboard of the assumed maximum transverse extent of damage as defined by 46 CFR Table 171.080(a); and

iv. the vessel can survive the transient damage condition described in paragraph (d) below.

c. Restrictions on the Use of Manual Equalization Systems - Equalization on vessels under 150 gross tons in ocean service and on all vessels in other than ocean service must not depend on the operation of valves in accordance with 46 CFR 171.080(f)(2). Accordingly, equalization on these vessels must be automatic and must meet the requirements in paragraph 3(a) above.

d. Stability Criteria for the Transient Condition - The survival criteria for the non-equalized transient damage condition, which applies regardless of the method of equalization (automatic or manual), is:

i. No downflooding points are submerged. Note that downflooding points must be specifically reevaluated in the damage stability analysis. Openings with effective weathertight closures are not acceptable, as they are for the intact stability criteria, and must be considered downflooding points because they may be submerged for continuous periods of time; and

ii. the vessel must have an after damage maximum righting arm of at least 0.05 m (0.16 feet) and a range of positive righting arms of at least 7 degrees.

Note: The margin line is allowed to be submerged and there is no specific limit on the non-equalized maximum angle of heel in the transient damage condition.

e. Acceptance of Equilibrium Angle Greater Than 7 Degrees - For vessels required to meet 46 CFR 171.080(d)(1), a final angle of equilibrium that is greater than 7 degrees and less than or equal to 15 degrees may be accepted, provided that the vessel is not equipped with equalization or is equipped with automatic equalization, and the following stability criteria are met:

i. the range of stability after damage shall be at least 15 degrees; and

ii. the maximum positive righting arm within the 15 degree range shall be at least 0.1 meters (0.33 feet); and

iii. the positive area under the curve within the 15 degree range must be at least 0.015 m-rad (2.8 ft-deg); and

iv. downflooding may not occur within the 15 degree range of positive stability.

Note: Title 46 CFR 171.080(d)(1)(i) does not allow a final angle of equilibrium after equalization greater than 7 degrees if the equalization is not automatic.

A handwritten signature in black ink, appearing to read "T. H. Walsh". The signature is fluid and cursive, with a large initial "T" and "W".

T. H. WALSH

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G-MVI-1,2