§ 28.570 Intact righting energy.

(a) Except as provided in paragraph (c) of this section, each vessel must have the following properties in each condition of loading:

1. An initial metacentric height (GM) of at least 1.15 feet (0.35 meters);
2. A righting arm (GZ) of at least 0.66 feet (0.2 meters) at an angle of heel not less than 30° (0.52 radians);
3. A maximum righting arm that occurs at an angle of heel not less than 25° (0.44 radians);
4. An area under each righting arm curve of at least 16.9 foot-degrees (0.090 meter-radians) up to the lesser of 40° (0.70 radians) or the angle of downflooding;
5. An area under each righting arm curve of at least 10.3 foot-degrees (0.055 meter-radians) up to an angle of heel of 30° (0.52 radians);
6. An area under each righting arm curve of at least 5.6 foot-degrees (0.030 meter-radians) between 30° (0.52 radians) and the lesser of 40° (0.70 radians) or the angle of downflooding; and
7. Except as provided by paragraph (b) of this section, positive righting arms through an angle of heel of 60° (1.05 radians).

(b) In lieu of meeting the requirements of paragraph (a)(7) of this section, a vessel may comply with the following provisions:

1. Hatches in the watertight/weathertight envelope must be normally kept closed at sea (e.g., the live tank hatch is only opened intermittently, under controlled conditions); or
2. Unintentional flooding through these hatches must not result in progressive flooding to other spaces; and
3. In all cases, a vessel must have positive righting arms through an angle of heel of at least 50° (0.87 radians) and the intact stability analysis must consider that spaces accessed by
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such hatches to be flooded full or flood-
ed to the level having the most detri-
mental effect on stability when free
surface effects are considered.

(c) In lieu of meeting the require-
ments of paragraph (a) of this section,
a vessel may comply with the provi-
sions of § 170.173(c) of this chapter,
provided that righting arms are positive
to an angle of heel of not less than 50°
(0.87 radians).

(d) For the purpose of paragraphs (a)
and (c) of this section, at each angle of
heel a vessel’s righting arm must be
calculated assuming the vessel is per-
mitted to trim free until the trimming
moment is zero.

§ 28.575 Severe wind and roll.

(a) Each vessel must meet paragraphs
(f) and (g) of this section when sub-
jected to the gust wind heeling arm
and the angle of roll to windward as
specified in this section.

(b) The gust wind heeling arm, \( L_w \), in
figure 28.575 of this chapter, must be
calculated by the following formula:
\[
KE_n(V_n^2A_nLN/(Z_nW))
\]
where:
K=0.00216 when consistent English units are
used or 1.113 when consistent metric
units are used.
E_n=series summation notation where \( n \) var-
ies from 1 to the number of elements in
the series;
\( V_n = S(0.124LN(0.3048h_n)+0.772) \), in feet per sec-
ond \( S(0.127LN(h_n)+0.772) \), in meters per
second and is the wind speed for profile
element \( n \) on a vessel;
\( S=64 \) (19.5, if metric units are used) for a
vessel that operates on protected waters;
or \( 85.3 \) (26, if metric units are used) for a
vessel that operates on waters other than
protected waters;
LN=natural logarithm;
h_n=the vertical distance from the centroid of
area \( A_n \) to the waterline for profile ele-
ment \( n \), in feet (meters);
\( A_n \)=projected lateral area for profile element
\( n \), in square feet (square meters);
Z_n=the vertical distance between the cen-
troid of \( A_n \) and a point at the center of the
underwater lateral area or a point at
approximately one-half of the draft, for
profile element \( n \), in feet; and
\( W=\)displacement of the loaded vessel, in
pounds (Newtons).

(c) The angle of roll to windward, \( \alpha_1 \),
is measured from the equilibrium
angle, \( \alpha_{el} \), and is calculated by the fol-
lowing formula:
\[
A_1 = 109kXY[\text{Square root of (rs)}], \text{ in de-
grees},
\]
where:
\( s,X,Y=\)factors from table 28.575;
\( r=0.73+0.6 Z_g/d \);
\( Z_g=\)distance between the center of gravity
and the waterline (+ above, – below), in
feet (meters);
k=1.0 for round bilged vessels with no bilge
keels or bar keels; 0.7 for vessels with
sharp bilges, or the value from table
29.575 for vessels with a bar keel, bilge
keels, or both;
\( B=\)molded breadth of the vessel, in feet (me-
ters);
\( d=\)mean molded draft of the vessel, in feet
(meters);
\( C_b=\)block coefficient;
\( A_k=\)aggregate area of bilge keels, the area of
the lateral projection of a bar keel, or
the sum of these areas, in square feet
(square meters);
\( C=0.373+0.023(B/d) \) ¥ 0.000131L or
\( 0.373+0.023(B/D) \) ¥ 0.00043L, if metric units are used.

(d) The angle of equilibrium, \( \alpha_{el} \), in
figure 28.575, is calculated by deter-
mining the lowest angle at which the
gust wind heeling arm, \( L_w \), is equal to
the righting arm.

(e) The area “\( b \)’’ in figure 28.575 must
be measured to the least of the fol-
lowing:
(1) The angle of downflooding, \( \alpha_f \);
(2) The angle of the second intercept,
\( \alpha_{e2} \), in figure 28.575, of the wind heeling
arm curve, \( L_w \), in figure 28.575, and the
righting arm curve; or
(3) A heel angle of 50° (0.87 radians).

(f) The angle of equilibrium, \( \alpha_{el} \), in
figure 28.575, must not exceed 14° (0.24
radians).

(g) Area “\( b’’ \’’ in figure 28.575 must not
be less than area “\( a’’ \’’ in figure 28.575.

| Table 28.575—Roll Factors |
|---|---|
| B/d | X |
| 2.4 | 1.0 |
| 2.5 | 0.98 |
| 2.6 | 0.96 |
| 2.7 | 0.95 |
| 2.8 | 0.93 |
| 2.9 | 0.91 |
| 3.0 | 0.90 |
| 3.1 | 0.88 |
| 3.2 | 0.86 |