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**Criteria of manoeuvrability for transport ship in Yangtze
River**

长江运输船舶操纵性衡准

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Criteria of manoeuvrability for transport ship in Yangtze River

1 Scope

This document specifies the index form and value of the manoeuvrability criteria for transport ships sailing on the main line of the Yangtze River, the principle of criterion value selection, the test method, the determination of the value.

This document is applicable to transport ships (except high-speed ships), which are sailing on the main line of the Yangtze River (Yunnan Shuifu to Wusongkou).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Directional stability

The ability of the ship to automatically stabilize on a new course, without the need for steering equipment, such as steering and thrusters, after the interference is eliminated.

3.2

Straight line stability

The ability of the ship, to maintain the ability to navigate in a straight line, without the need for steering equipment, such as steering and thrusters, after the interference is eliminated.

3.3

Course-keeping ability

The ability of a ship to maintain its course, by relying on steering equipment, such as steering and thrusters.

4.1.1.1 The form of the manoeuvability criteria for a motorized single ship includes four performances: directional stability, course-changing ability, steady-turning ability, astern stopping ability.

4.1.1.2 The form of the manoeuvability criteria of the fleet includes five performances: directional stability, course-changing ability, steady-turning ability, astern stopping ability, astern stability.

4.1.2 The form of directional stability index

In the initial state of constant ship speed AND the heading direction is basically consistent with the water flow direction, use the course-changing amount (ΔC_0) of sailing for 3 minutes in the state of zero rudder angle OR the average steering angle (δ_0) of maintaining the course for 5 minutes, as the criterion index.

4.1.3 The form of course-changing ability index

In the initial state of constant ship speed and stable heading, the single motor ship shall be subject to the Z-shaped test, according to the specified rudder angle; use the yawing index (P') as the criterion index.

In the initial state of constant speed and stable heading, the fleet steers according to the specified rudder angle AND changes direction by 15° ; take the average direction change angular velocity ($\overline{\gamma_{0-15}}$), from the first move to the direction change of 15° , as the criterion index.

4.1.4 The form of steady-turning ability index

When the ship is in the state of constant driving, steady speed, full rudder, steady-turning, in wide and slow-flowing waters, use the ratio ($\overline{D_0}$) -- of the diameter (D_0) of the arc motion trajectory at the ship's center of gravity TO the length (L) of the ship, -- as the criterion index.

4.1.5 The form of astern stopping ability index

The ship is in a wide, slow-flowing water area, from the state of constant driving at a steady speed to the state of reversing at 70% of the rated speed of the main engine; take the ratio -- of the stroke (A_h) to the ship's length ($\overline{A_h}$), -- from the start of the command to reverse to the stop of the ship's forward movement, as the criterion index.

4.1.6 The form of astern stability index

When the ship sails downstream, in the initial state of parking at a low speed and the heading is stable, it drives back and steer the ship in a steady direction for 3 minutes;

5.1.2 Linear stability test or steering stability test

5.1.2.1 Test principle

The ship sails at 0° rudder angle for 3 minutes, to continuously measure the change of the heading direction. OR keep the heading direction for 5 min, to continuously measure the change of the steering angle, as relative to time.

5.1.2.2 Test requirements

5.1.2.2.1 The ship test is carried out, in a straight channel, which has smooth water flow and stable flow velocity. During the test, the forward and reverse wind force shall be less than Beaufort level 3; the cross wind force shall be less than Beaufort level 2.

5.1.2.2.2 Generally, driving against the current shall prevail. If necessary, two to three repeated tests can be carried out.

5.1.2.2.3 Before starting the test, the ship is to maintain a constant speed, a stable course, AND be parallel to the direction of the water flow.

5.1.2.2.4 The difference in rotational speed of each propeller in ships, which have two or more propellers, is to be less than 1% of the rated rotational speed.

5.1.3 Course-changing ability test

5.1.3.1 Test principle

The motorized single ship and the fleet respectively conduct Z-shaped tests, according to the specified rudder angle, to completely measure the time-varying curve of the rudder angle and heading angle, including the overtaking angle, the delay time of turning, the position of the characteristic point.

5.1.3.2 Test requirements

5.1.3.2.1 The ship test is to be carried out in a wide and straight channel, which has smooth water flow and stable flow velocity. The wind force during the test shall be less than Beaufort level 3.

5.1.3.2.2 The test is generally based on reverse current driving. When conditions permit, it can be tested under two driving conditions: forward and reverse current.

5.1.3.2.3 Before starting the test, the ship is to maintain a constant speed, a stable course, AND be basically parallel to the direction of the water flow.

5.1.3.2.4 For a motorized single ship, during the test, firstly turn the rudder to +10° and keep it. When the heading angle changes to +10°, immediately reverse the rudder angle to -10° and keep it. When the heading angle changes to -10°, turn the rudder to +10° and keep it. When the heading angle changes to +10°, reverse the rudder angle to -10°

and keep it, until the heading angle change to -10° .

5.1.3.2.5 For the fleet, during the test, firstly turn the rudder to $+20^{\circ}$ and keep it. When the heading angle changes to $+15^{\circ}$, immediately reverse the rudder angle to -20° and keep it. When the heading angle changes to -15° , turn the rudder to $+20^{\circ}$ and keep it. When the heading angle changes to $+15^{\circ}$, reverse the rudder angle to -20° and keep it, until the heading angle changes to -15° .

5.1.3.2.6 The difference between the rotational speeds of each propeller, in ships which have two or more propellers, is to be less than 1% of the rated rotational speed.

5.1.4 Turning test

5.1.4.1 Test principle

When the rudder is full, continuously measure the corresponding delay, ship position, course, ship speed at each moment after each 30° change, in the heading direction of 0° , 10° , 20° , 30° , until 540° .

5.1.4.2 Test requirements

5.1.4.2.1 The ship test is to be carried out in a wide slow-flow area, which has a water depth greater than 2 times the ship's draught; the wind force during the test is less than Beaufort level 3.

5.1.4.2.2 The initial speed of each turning test shall be the same, generally the speed of the corresponding regular ship shall prevail.

5.1.4.2.3 For the surveying and mapping of the gyration trajectory, any of the following measurement methods may be used:

- Mapping angle method;
- Azimuth distance method;
- Cross orientation method;
- If the flow rate is not large, it may also adopt the integral method of the ship speed and the angle of change;
- Satellite positioning method.

5.1.5 Brake test

5.1.5.1 Test principle

From the moment when the astern command is issued, continuously measure the position, course, speed of the ship at each instant, at a certain time interval, until the

ship stops moving forward; record the driving delay of astern, the stable astern speed and its delay, the total time from the start to the end of the measurement.

5.1.5.2 Test requirements

5.1.5.2.1 The ship test is generally to be carried out, in still waters which have obvious shore marks.

5.1.5.2.2 The test condition is based on the condition that, the ship moves back at 70% of the rated speed, when it is normally driven forward.

5.1.5.2.3 Accurate control of the two measuring points of the starting and ending measurements. The measurement starts immediately after the astern command is issued; the measurement is terminated immediately when the ship stops, as relative to the shore.

5.1.5.2.4 Stroke determination can be carried out, by any of the following methods:

- Azimuth distance method;
- Downhill integral method;
- Satellite positioning method.

5.1.5.2.5 During the measurement process, the steering can be used to correct the heading deviation; however, the steering angle shall be controlled within the range of $\pm 10^\circ$.

5.1.5.2.6 If the test is carried out in a water area, which has a relatively large flow velocity, it shall add the measurement content of the water velocity in the test water area.

5.1.6 Stability test of astern steering

5.1.6.1 Test principle

Start the measurement when the ship stops moving forward, after driving in reverse. Continuously measure the change of steering angle and the change of the heading direction, whilst keeping the course backward for 3 minutes. Measure the speed of astern on the water AND the stable astern speed.

5.1.6.2 Test requirements

5.1.6.2.1 The ship test shall be carried out, in wide waters where there are straight water flow and obvious shore marks.

5.1.6.2.2 The test is carried out in a downstream driving condition. The ship shall be stopped as soon as possible to reduce the speed, before starting the test.

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