7.5 Test procedure

7.5.1 Procedures followed in conducting the inclining test and light-weight survey should be in accordance with the recommendations laid out in annex 1 to this Code.

7.5.1.1 Freeboard/draught readings should be taken to establish the position of the waterline in order to determine the displacement of the ship at the time of the inclining test. It is recommended that at least five freeboard readings, approximately equally spaced, be taken on each side of the ship or that all draught marks (forward, midship and aft) be read on each side of the ship. Draught/freeboard readings should be read immediately before or immediately after the inclining test.

7.5.1.2 The standard test employs eight distinct weight movements. Movement No. 8, a recheck of the zero point, may be omitted if a straight line plot is achieved after Movement No. 7. If a straight line plot is achieved after the initial zero and six weight movements, the inclining test is complete and the second check at zero may be omitted. If a straight line plot is not achieved, those weight movements that did not yield acceptable plotted points should be repeated or explained.

7.5.2 A copy of the inclining data should be forwarded to the Administration along with the calculated results of the inclining test in an acceptable report format, if required.

7.5.3 All calculations performed during the inclining test and in preparation of an inclining test report may be carried out by a suitable computer program. Output generated by such a program may be used for presentation of all or partial data and calculations included in the test report if it is clear, concise, well documented, and generally consistent in form and content with Administration requirements.

7.6 Determination of ship's stability by means of rolling period tests (for ships up to 70 m in length)

7.6.1 Recognizing the desirability of supplying to masters of small ships instructions for a simplified determination of initial stability, attention was given to the rolling period tests. Studies on this matter showed that the rolling period test may be recommended as a useful means of approximately determining the initial stability of small ships when it is not practicable to give approved loading conditions or other stability information, or as a supplement to such information.

7.6.2 Investigations comprising the evaluation of a number of inclining and rolling tests according to various formulae showed that the following formula gave the best results and it has the advantage of being the simplest:

$$GM_o = \left(\frac{f\,B}{T_r}\right)^2$$

where:

f = factor for the rolling period (rolling coefficient) as given in 7.6.4;

B = breadth of the ship in metres;

T_r = time for a full rolling period in seconds (i.e. for one oscillation "to and fro" port - starboard - port, or vice versa).

7.6.3 The factor f is of the greatest importance and the data from the above tests were used for assessing the influence of the distribution of the various masses in the whole body of the loaded ship.

7.6.4 For coasters of normal size (excluding tankers) and fishing vessels, the following average values were observed:

	f values
Empty ship or ship carrying ballast	$f \approx 0.88$
Ship fully loaded and with liquids in tanks comprising the following percentage of the total load on board (i.e. cargo, liquids, stores, etc.):	
20% of total load	$f \approx 0.78$
10% of total load	$f \approx 0.75$
5% of total load	$f \approx 0.73$
Double-boom shrimp fishing boats	$f \approx 0.95$
Deep sea fishing boats	$f \approx 0.80$
Boats with a live fish well	$f \approx 0.60$

The stated values are mean values. Generally, observed *f* values were within $\pm$ 0.05 of those given above.

7.6.5 The above *f* values were based upon a series of limited tests and, therefore, Administrations should re-examine these in the light of any different circumstances applying to their own ships.

7.6.6 It should be noted that the greater the distance of masses from the rolling axis, the greater the rolling coefficient will be. Therefore it can be expected that:

.1 the rolling coefficient for an unloaded ship, i.e. for a hollow body, will be higher than that for a loaded ship; and

.2 the rolling coefficient for a ship carrying a great amount of bunkers and ballast - both groups are usually located in the double bottom, i.e. far away from the rolling axis - will be higher than that of the same ship having an empty double bottom.

7.6.7 The above recommended rolling coefficients were determined by tests with ships in port and with their consumable liquids at normal working levels; thus, the influences exerted by the vicinity of the quay, the limited depth of water and the free surfaces of liquids in service tanks are covered.

7.6.8 Experiments have shown that the results of the rolling test method get increasingly less reliable the nearer they approach GM values of 0.20 m and below.

7.6.9 For the following reasons, it is not generally recommended that results be obtained from rolling oscillations taken in a seaway:

.1 exact coefficients for tests in open waters are not available;

.2 the rolling periods observed may not be free oscillations but forced oscillations due to seaway;

.3 frequently, oscillations are either irregular or only regular for too short an interval of time to allow accurate measurements to be observed; and

.4 specialized recording equipment is necessary.

7.6.10 However, sometimes it may be desirable to use the ship's period of roll as a means of approximately judging the stability at sea. If this is done, care should be taken to discard readings which depart appreciably from the majority of other observations. Forced oscillations corresponding to the sea period and differing from the natural period at which the ship seems to move should be disregarded. In order to obtain satisfactory results, it may be necessary to select intervals when the sea action is least violent

and it may be necessary to discard a considerable number of observations.

7.6.11 In view of the foregoing circumstances, it needs to be recognized that the determination of the stability by means of the rolling test in disturbed waters should only be regarded as a very approximate estimation.

7.6.12 The formula given in paragraph 7.6.2 can be reduced to:

$$GM_o = \frac{F}{T_r^2}$$

and the Administration should determine the F value(s) for each ship.

7.6.13 The determination of the stability can be simplified by giving the master permissible rolling periods, in relation to the draughts, for the appropriate value(s) of F considered necessary.

7.6.14 The initial stability may also be more easily determined graphically by using the sample nomogram (figure 7.6.14) as described below:

.1 The values for B and f are marked in the relevant scales and connected by a straight line (1). This straight line intersects the vertical line mm at the point M.

.2 A second straight line (2) which connects this point M and the point on the T_r scale corresponding with the determined rolling period intersects the GM scale at the requested value.

7.6.15 Section 7.6.16 shows an example of a recommended form in which these instructions might be presented by each Administration to the masters. It is considered that each Administration should recommend the F value or values to be used.

7.6.16 Test procedure

7.6.16.1 The rolling period required is the time for one complete oscillation of the ship and to ensure the most accurate results in obtaining this value the following precautions should be observed:

.1 The test should be conducted with the ship in harbour, in smooth water with the minimum interference from the wind and tide.

.2 Starting with the ship at the extreme end of a roll to one side (say port) and the ship about to move towards the upright, one complete oscillation will have been made when the ship has moved right across to the other extreme side (i.e. starboard) and returned to the original starting point and is about to commence the next roll.

.3 By means of a stop-watch, the time should be taken for not less than about five of these complete oscillations; the counting of these oscillations should begin when the ship is at the extreme end of a roll. After allowing the roll to completely fade away, this operation should be repeated at least twice more. If possible, in every case the same number of complete oscillations should be timed to establish that the readings are consistent, i.e. repeating themselves within reasonable limits. Knowing the total time for the total number of oscillations made, the mean time for one complete oscillation can be calculated.

.4 The ship can be made to roll by rhythmically lifting up and putting down a weight as far off the middle-line as possible; by pulling on the mast with a rope; by people running athwartships in unison; or by any other means. However, and this is most important, as soon as this forced rolling has commenced, the means by which it has been induced should be stopped and the ship allowed to roll freely and naturally. If rolling has been induced by lowering or raising a weight it is preferable that the weight is moved by a dockside crane. If the ship's own derrick is used, the weight should be placed on the deck, at the middle-line, as soon as the rolling is established.

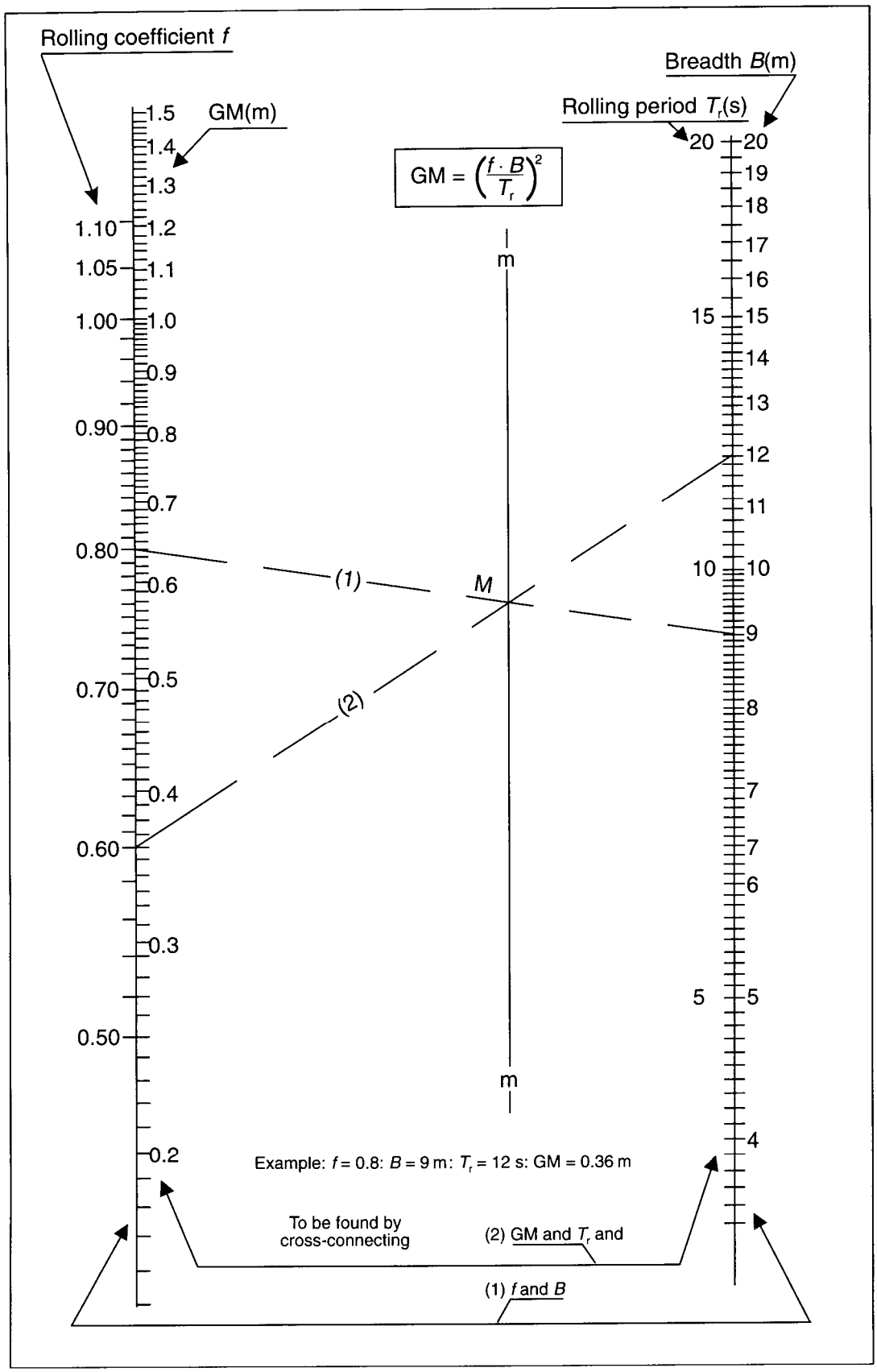
Rolling coefficient f
Breadth B(m)
Rolling period T_r(s)
GM(m)
$GM = \left(\frac{f \cdot B}{T_r}\right)^2$
m
M
m
(1)
(2)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1.10
1.05
1.00
0.90
0.80
0.70
0.60
0.50
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
Example: f = 0.8: B = 9 m: T_r = 12 s: GM = 0.36 m
To be found by cross-connecting
(2) GM and T_r and
(1) f and B
94020

Figure 7.6.14

.5 The timing and counting of the oscillations should only begin when it is judged that the ship is rolling freely and naturally, and only as much as is necessary to accurately count these oscillations.

.6 The mooring should be slack and the ship "breasted off" to avoid making any contact during its rolling. To check this, and also to get some idea of the number of oscillations that can be reasonably counted and timed, a preliminary rolling test should be made before starting to record actual times.

.7 Care should be taken to ensure that there is a reasonable clearance of water under the keel and at the sides of the ship.

.8 Weights of reasonable size which are liable to swing (e.g. a lifeboat), or liable to move (e.g. a drum), should be secured against such movement. The free surface effects of slack tanks should be kept as small as is practicable during the test and the voyage.

7.6.16.2 *Limitations to the use of this method*

7.6.16.2.1 A long period of roll, corresponding to a GM_o of 0.20 m or below, indicates a condition of low stability. However, under such circumstances, accuracy in determination of the actual value of GM_o is reduced.

7.6.16.2.2 If, for some reason, these rolling tests are carried out in open, deep but smooth waters, inducing the roll, for example, by putting over the helm, then the GM_o calculated by using the method and coefficient of paragraph 7.6.16.1 above should be reduced by [*figure to be estimated by the Administration*] to obtain the final answer.

7.6.16.2.3 The determination of stability by means of the rolling test in disturbed waters should only be regarded as a very approximate estimation. If such a test is performed, care should be taken to discard readings which depart appreciably from the majority of other observations. Forced oscillations corresponding to the sea period and differing from the natural period at which the vessel seems to move should be disregarded. In order to obtain satisfactory results, it may be necessary to select intervals when the sea action is least violent and it may be necessary to discard a considerable number of observations.

7.7 Inclining test for MODUs

7.7.1 An inclining test should be required for the first unit of a design, when as near to completion as possible, to determine accurately the light-ship data (weight and position of centre of gravity).

7.7.2 For successive units which are identical by design, the light-ship data of the first unit of the series may be accepted by the Administration in lieu of an inclining test, provided the difference in light-ship displacement or position of centre of gravity due to weight changes for minor differences in machinery, outfitting or equipment, confirmed by the results of a deadweight survey, are less than 1% of the values of the light-ship displacement and principal horizontal dimensions as determined for the first of the series. Extra care should be given to the detailed weight calculation and comparison with the original unit of a series of column-stabilized, semi-submersible types as these, even though identical by design, are recognized as being unlikely to attain an acceptable similarity of weight or centre of gravity to warrant a waiver of the inclining test.

7.7.3 The results of the inclining test, or of a deadweight survey and an inclining experiment adjusted for weight differences, should be indicated in the Operating Manual.

7.7.4 A record of all changes to machinery, structure, outfit and equipment that affect the light-ship data should be maintained in the Operating Manual or a light-ship data alterations log and be taken into account in daily operations.