

# MARINE DESIGN & SURVEY

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## INCLINING EXPERIMENT SHIP PREPARATION

### 1. GENERAL

An inclining experiment is performed on a ship to determine three things about the ship in the “as inclined” condition:

- (a) the mass of the ship,
- (b) the longitudinal position of the overall centre of gravity of the ship (LCG), and
- (c) the vertical position of the overall centre of gravity of the ship (KG).

These three results are used later in the stability calculations for the ship. The inclining experiment is not in itself a measure of the stability of the ship. The results of the stability calculations will determine if the ship meets the stability requirements and the load the ship is allowed to carry (the ship’s earning capacity).

#### 1.1 SHIP’S MASS & LCG

The ship’s mass and LCG in the “as inclined” condition are determined from taking accurate draught and freeboard readings. With these readings and a lines plan of the ship, the naval architect can calculate the overall mass of the ship and the LCG in the “as inclined” condition to a relatively high degree of accuracy.

#### 1.2 SHIP’S KG

By moving weights of known mass through a known distance so as to heel the ship by between 2° and 4°, and accurately measuring the actual angle of heel, the naval architect can calculate the KG of the ship in the “as inclined” condition to a relatively high degree of accuracy.

### 2. DATE OF INCLINING EXPERIMENT

The date for the inclining experiment should be set for a time when the ship will be complete or close to completion. Although allowance can be made for items that may still need to be fitted on the ship and items that may need to be removed from the ship, these allowances must err to the side of caution and tend to disadvantage the ship’s stability and hence carrying (earning) capacity. It is therefore important to ensure that the ship is as near to completion as possible.

### 3. CONDITION OF SHIP

To achieve the most favourable results in an inclining experiment, the ship should be as near to lightship condition as is reasonably possible. The ship is in lightship condition when it is complete in every respect in the “ready for sea” condition with-

- all its equipment and outfit including spare parts
- machinery in working condition

- lubricating oil in all machinery (but not in storage tanks) [see 3.5]
- water in piping systems
- hydraulic oil in their piping systems and header tanks
- water in fresh water systems and fire mains

**but without** any items of a consumable nature or normally variable load such as-

- liquids in double bottom tanks, deep tanks, storage or reserve supply tanks [see 3.3 & 3.4]
- any cargo, stores, passengers, crew and their effects.

A check will be made of the entire ship during the inclining experiment to determine the condition of the ship. If the ship is not substantially in the lightship condition, the inclining experiment may have to be abandoned and re-performed at a later date. This will entail additional cost to the ship's owner/operator. The following conditions are preferred.

### **3.1 CARGO**

No cargo (either liquid or dry) should be on board the ship.

### **3.2 TANKS**

All tanks must have a suitable means of determining the location of the level of liquid in the tank. If a tank does not have such a suitable means, it must be empty and its drain plug removed.

#### **3.2.1 Ballast Tanks**

All ballast tanks must be empty and dry (i.e. no free surface).

#### **3.2.2 Fuel Tanks**

No fuel should be on board the ship. All fuel tanks should be empty and dry (i.e. no free surface). If fuel must be on board, permission must first be obtained from the naval architect and it should be kept to a minimum number of tanks. Those tanks with fuel in them should be between 25% and 75% full.

#### **3.2.3 Fresh Water Tanks**

No fresh water should be on board the ship. All fresh water tanks should be empty and dry (i.e. no free surface). If fresh water must be on board, permission must first be obtained from the naval architect and it should be kept to a minimum number of tanks. Those tanks with fresh water in them should be between 25% and 75% full.

#### **3.2.1 Lubricating Oil Tanks**

No lubricating oils should be on board the ship. All lube oil tanks should be empty and dry (i.e. no free surface). If lube oil must be on board, permission must first be obtained from the naval architect and it should be kept to a minimum number of tanks. Those tanks with lube oil in them should be between 25% and 75% full. Machinery should however, have its normal amount of lubricating oil in its sump.

### **3.3 CREW, PASSENGERS & PERSONAL EFFECTS**

No crew, passengers or their personal effect should be on board the ship.

### **3.4 FOOD STORES**

No food stores should be on board the ship.

### **3.5 BILGES**

All bilges must be dry with no free surface. This means that they must be sponged out so that there is no liquid in and bilge.

### **3.6 MACHINERY & PUMPS**

All non-essential machinery and pumps must be shut down.

**3.7 VALVES**

All valves that allow cross-flooding between tanks (even those tanks that are empty) must be closed.

**3.8 LOOSE GEAR**

All items of loose gear (e.g. doors, suspended masses, booms and derricks etc.) must be secured to prevent their movement.

**3.9 SAILS, SPARS & RIGGING**

All sails, spars and rigging (if carried) must be on board and stowed in their normal location.

**4. COMPARTMENTS**

All compartments on the ship must be opened to allow for inspection during the inclining experiment. If a compartment has to be opened during the inclining experiment, there may be additional cost to the ship's owner / operator for the extra time involved.

**5. TANKS**

Where possible, all tanks that are empty on the ship must be opened to allow for inspection during the inclining experiment. If a tank has to be opened during the inclining experiment, there may be additional cost to the ship's owner/operator for the extra time involved. Tanks that are not empty must be provided with a means to determine the level of the liquid in the tank. If this is not done, the inclining experiment may need to be abandoned and re-performed at a latter date. This will mean additional cost to the ship's owner / operator.

**7. WEATHER CONDITIONS**

The inclining experiment can only be performed in acceptable weather conditions. Unacceptable weather conditions include excessive wind or waves, rain and adverse water currents. These can adversely affect the results of an inclining experiment. There are six weight transfers during an inclining experiment and the measurements taken at each transfer must be within 5% of the average. If this order of accuracy is not met, the inclining experiment will have to be re-performed at additional cost to the ship's owner / operator.

**8. LOCATION**

The location of the ship for the inclining experiment is of vital importance. The chosen location must be such that there is no influence on the ship from current, tidal stream, waves (even ripples over about 10mm can create problems) an wash from other vessels. The location must also allow the ship to float freely with all mooring lines slack and be such as to allow the ship to freely heel. The chosen location should be discussed with Marine Design and Survey and confirmed at least 48 hours before the inclining experiment.

**9. OTHER EQUIPMENT**

The ship's owner / operator is responsible for providing certain items for the inclining experiment. These items are listed in appendix A. If all the items are not available at the inclining experiment, it may have to be postponed or abandoned and re-performed. This will mean additional cost to the ship's owner / operator.

**10. CHECK LIST**

To assist the ship's owner / operator in ensuring the ship is properly prepared, a check list is provided in Appendix B.

**APPENDIX A**  
**ITEMS REQUIRED**

The following items are to be provided by the ship's owner / operator for use during the inclining experiment:

- (a) A dinghy suitable for carrying at least 3 persons for measuring draughts and freeboards around the ship. It is preferable (although not essential) that the dinghy is not part of the ship's normal equipment. If it is part of the ship's normal equipment, it must be launched prior to the start of the inclining experiment.
- (b) A person(s) who has a thorough knowledge of the ship's layout and systems.
- (c) A representative of the ship's owner/operator who may be a person in item (b) above.
- (d) # in number wheelie bins as inclining masses. They must be clean and sound with lids, wheels and no holes. You may be able to hire these bins from a waste disposal contractor. It is recommended that you have two more than this number available for the inclining experiment. This is to allow for those bins that are found to be cracked or to have holes or no wheels or no lids.  

If wheelie bins are not available, you must arrange for other suitable inclining masses. Other suitable masses could be plastic drums having a total capacity of not less than 1,500 litres.
- (e) A pump capable of pumping water into the wheelie bins. A suggested pumping rate is 7500 litres per hour. This may be a suitable pump fitted on the ship.
- (f) A safe means of access onto the ship that can be readily (re)moved during the measurements so as to allow the ship to float freely while being inclined.
- (g) Sufficient persons or equipment to move the inclining masses from one side of the ship to the other. Each wheelie bin, when full of water, has a mass of about 250kg.

Please contact Marine Design and Survey if you experience any difficulty in providing any of the above items.

**APPENDIX B**  
**CHECK LIST**

The following is a checklist to assist the ship's master / operator in preparing the ship for an inclining experiment. The person performing the inclining experiment will be checking the ship against a similar list before the start of the experiment. If anything is found to be not suitable, the experiment may be delayed at additional cost to the ship's owner / operator.

ITEM	CHECKED
(a) Location for experiment selected, discussed with Naval Architect and confirmed at least 48 hour before the start of the inclining experiment.	
(b) All cargo (either liquid or dry) is removed from the ship. If not, consult with the Naval Architect.	
(c) All ballast tanks are empty and dry (i.e. no free surface). If not, consult with the Naval Architect.	
(d) All fuel tanks are empty and dry (i.e. no free surface). If not, consult with the Naval Architect.	
(e) All fresh water tanks are empty and dry (i.e. no free surface). If not, consult with the Naval Architect.	
(f) All lubricating oil tanks are empty and dry (i.e. no free surface). If not, consult with the Naval Architect.	
(g) All lubricating oil portable containers are removed from the ship.	
(h) All machinery has normal lubricating oil in their sumps.	
(i) All water pipes and header tanks are filled to their normal working level.	
(j) All hydraulic oil pipes and header tanks are filled to their normal working level.	
(k) All non-essential machinery and pumps are shut down.	
(l) All valves that allow cross flooding between tanks are closed.	
(m) All bilges are dry with no free surface.	
(n) All passengers and crew and personal effects are removed from the ship.	
(o) All food stores have been removed from the ship.	
(p) All compartments have been opened up to allow for inspection.	
(q) All tanks that are empty have been opened up to allow for inspection.	
(r) All tanks that are not empty have a means to accurately determine the liquid level in the tank.	
(s) All items of loose gear (e.g. doors, suspended masses, booms, derricks, etc) have been made secure so they cannot move.	
(t) All sails, spars and rigging are on board and stowed in their normal positions.	
(u) All items in appendix A are available and have been checked to ensure they are suitable.	