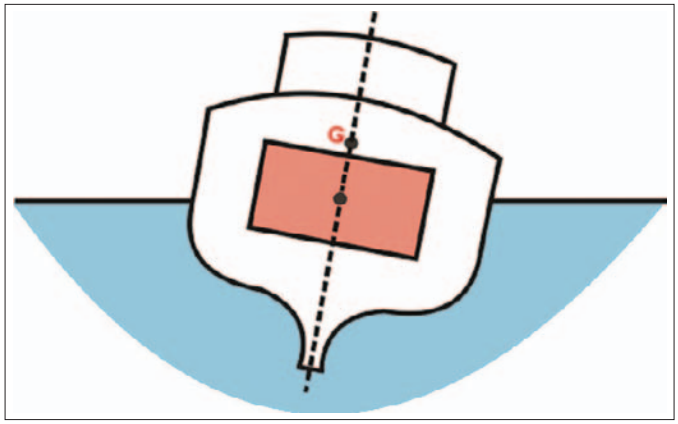
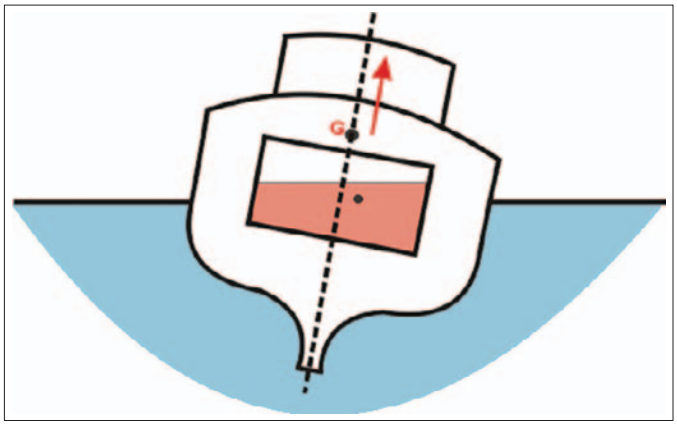
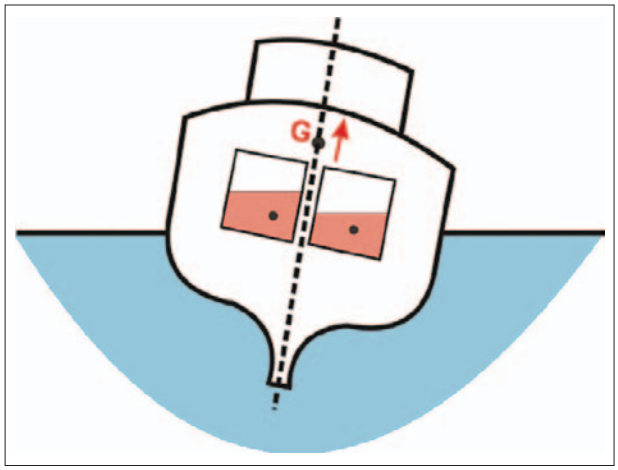
FREE SURFACE EFFECT



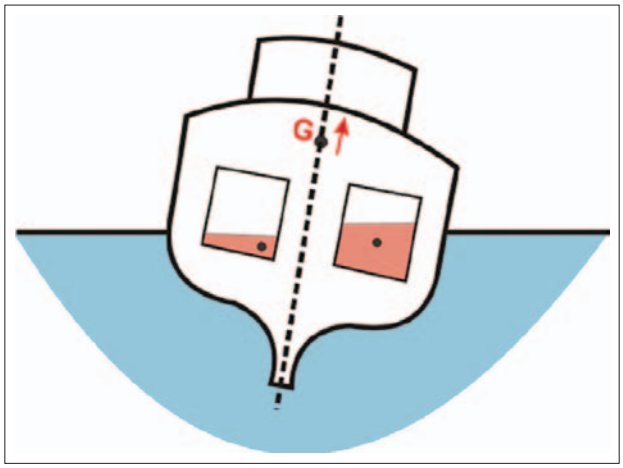
When a vessel with a full tank is heeled, the liquid within the tank acts like a solid mass. Its centre of gravity, being the centre of its volume, remains constant and therefore does not cause any change in the vessel's centre of gravity (**G**) or its metacentric height (**GM**) as the vessel is heeled.



When a vessel with a partially-filled tank is heeled, the liquid will seek to remain parallel with the waterline. The centre of gravity of the liquid, being the centre of its volume, will move with the liquid and can have a considerable effect upon the vessel's stability. This effect is similar to that caused by adding weight on deck, i.e. rise of the vessel's centre of gravity (**G**) which causes a decrease in the vessel's metacentric height (**GM**) and thereby its stability.



Partially-filled tanks have the greatest adverse effect upon a heeled vessel's metacentric height (**GM**). The division of the tank into two equal parts by the use of a watertight bulkhead will reduce the adverse effect on the vessel's metacentric height (**GM**) by up to 75 percent of that of an undivided tank.



Care should be taken when endeavouring to correct a list by filling tanks. Having two partially-filled tanks will create additional free surface effect. If there is a possibility that the vessel's list is caused by loll, it is recommended that the tank on the low side be filled before commencing to fill the tank on the high side.

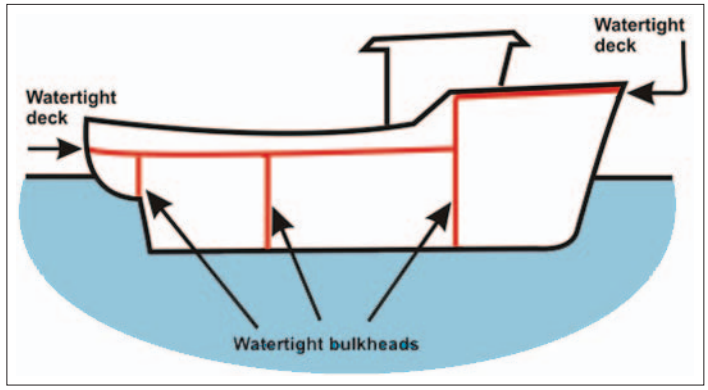
(See also the section on loll on page 5.)

Free surface effects are not only caused by partially-filled tanks. They can, for example, also be caused by accumulated water on deck. To enable the water to run off quickly, a vessel should have adequate freeing ports. Poundboards should be arranged so that water can flow easily to the freeing ports which should always be clear.

Anti-rolling tanks have a free surface effect which decreases the vessel's metacentric height (**GM**). They should, therefore, always be emptied when the metacentric height is small and, in particular, when there is a risk of ice accretion.

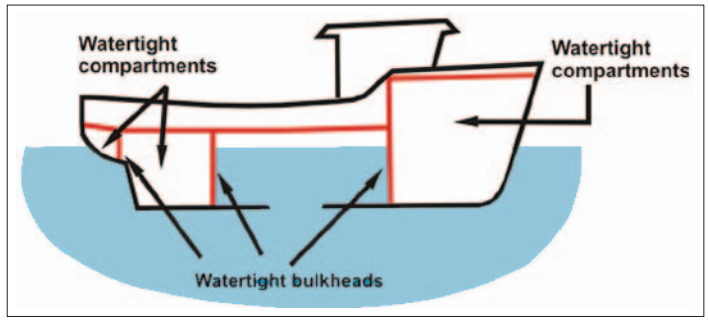
At any one time the number of partially filled tanks should be kept to a minimum. Tanks that are either completely full or completely empty do not have a free surface effect and therefore do not reduce the vessel's metacentric height (GM).

WATERTIGHT AND WEATHERTIGHT INTEGRITY



The vessel's hull must be tight to prevent water from entering the vessel. Closing devices to openings, through which water can enter the hull and deckhouses, should be kept closed in adverse weather. This applies to doors, hatches and other deck openings, ventilators, air pipes, sounding devices, sidescuttles and windows and inlets and discharges. Any such device should be maintained in good and efficient condition.

Vessels are often subdivided into compartments by bulkheads in order to minimize the effects of water flowing from one part of the vessel to another.



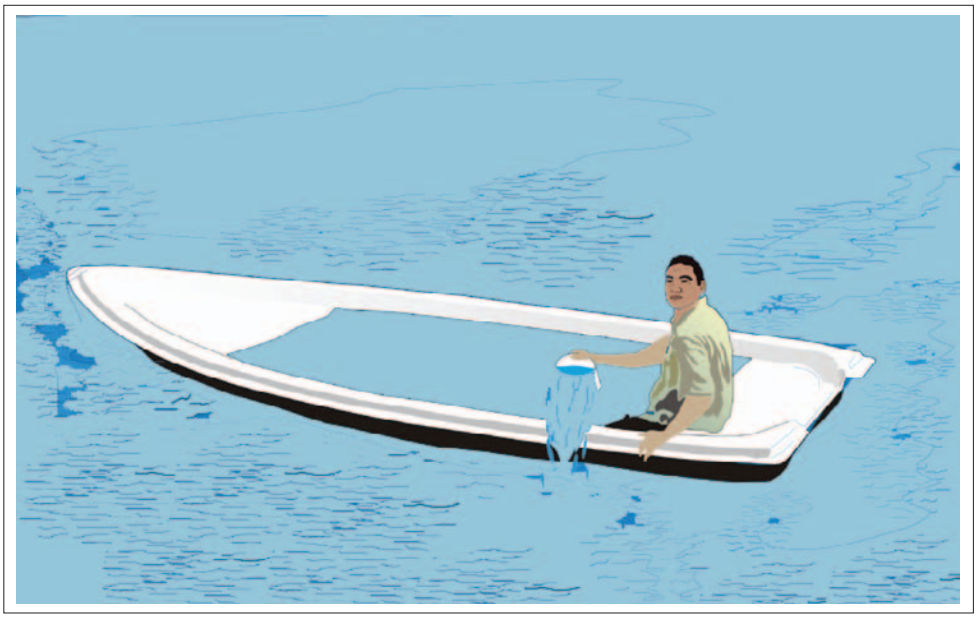
"Watertight" means that a structure is designed and constructed to withstand a static head of water without leakage. Water (or any other liquid) is not able to pass through the structure into or out of any of the watertight compartments, i.e. prevention from the passage of water in any direction. The vessel's hull, working deck (weather deck) and bulkheads between compartments must be watertight. Watertight bulkheads must be watertight up to the working deck. Any openings on such bulkheads must be equipped with watertight closing devices.

"Weathertight" means that in any sea condition water will not penetrate into the vessel, i.e. prevention from the passage of water in one direction only. Hatches, sidescuttles and windows must be equipped with weathertight closing devices. The same applies for doors and other openings on enclosed superstructures.

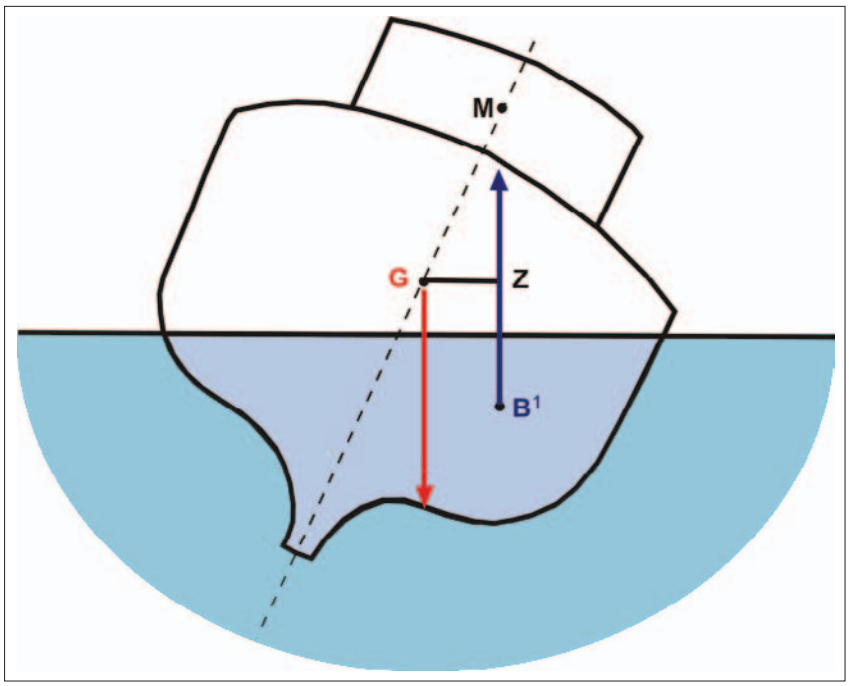
BUILT-IN BUOYANCY FOR UNDECKED VESSELS

Undecked vessels do not have a fixed watertight deck and will therefore not have the watertight and weathertight integrity of decked vessels. The safety of undecked vessels can be considerably improved if they are fitted with sealed buoyancy compartments, which are filled with solid buoyancy material.

Such compartments should be distributed so that the vessel stays afloat and on an even keel and without listing, in order to make bailing possible even if the vessel is fully swamped.



RIGHTING LEVER



When heeled by an external force, the vessel's centre of gravity (**G**), which is unaffected by the heel and the weight (of the vessel), is considered to act vertically downward through **G**. The centre of buoyancy (**B**) (being the geometric centre of the underwater section) has moved to a new position **B**^{1} and the force of buoyancy (equal to the weight of water being displaced) is considered to act vertically up through the new centre of buoyancy **B**^{1}.

The horizontal distance from the centre of gravity (**G**) to the vertical line from **B**^{1} is called the **righting lever**. This distance can be measured and is usually referred to as **GZ**.

Therefore, the force involved in returning the vessel to the upright position is the weight of the vessel acting down through the centre of gravity (**G**) multiplied by the righting lever (**GZ**). This is referred to as the **moment of statical stability**.