Aalto University
School of Engineering

MEC-E1004 Principles of Naval Architecture

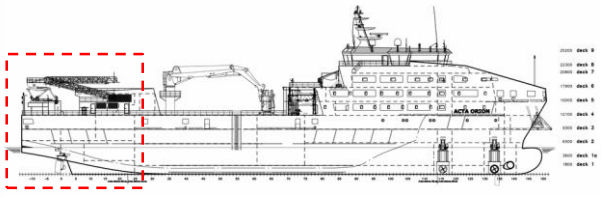
Tutorial 6 – General Arrangement

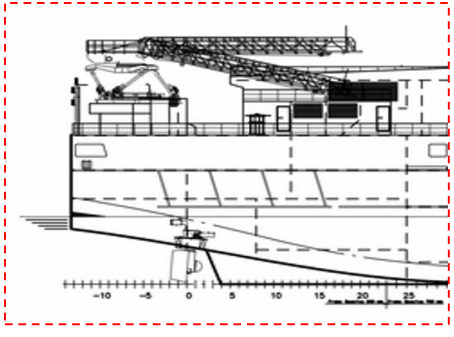
General arrangement

Question: How can we efficiently design a ship's general arrangement ? … a step by step guide.

Introduction

- There is no specific procedure with rules stated for the same.
- Different ship types have different innovative characteristics
- A naval architect needs to know the basic process to follow in order to come down to an optimum design.





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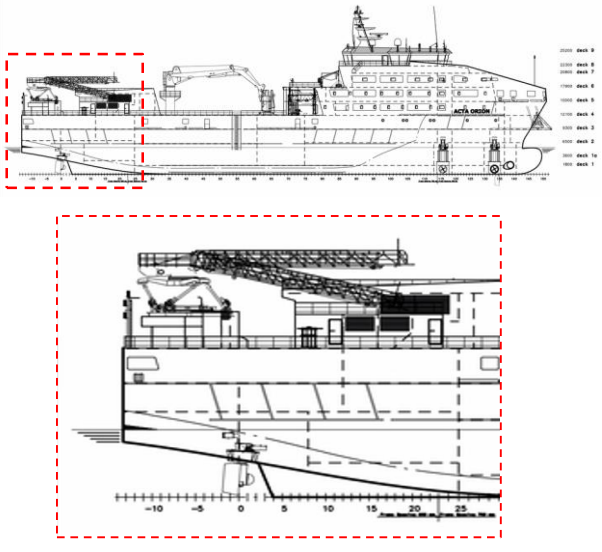
Introduction

A GA of any ship will consist of the drawings of the following views:

- Profile View (generally looking from starboard side)
- Midship sections (looking from aft, and looking from forward)
- Main deck plan (also shows the accommodation layout)
- Navigation deck plan.
- Forecastle deck plan
- Tank top plan
- Tank plan

It should also be noted that a the process of developing the general arrangement drawing is slightly different for various design firms, depending on their procedures and practices.

However, the underlying principle always remains the same. It is an iterative process, and the final GA is derived after repeated approvals by the classification society and the owners party.



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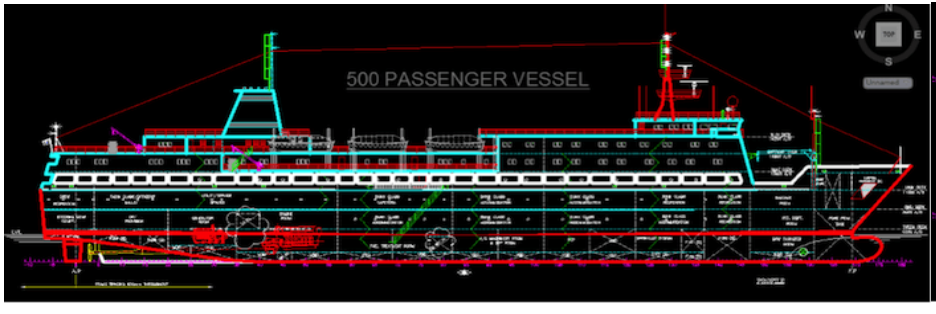
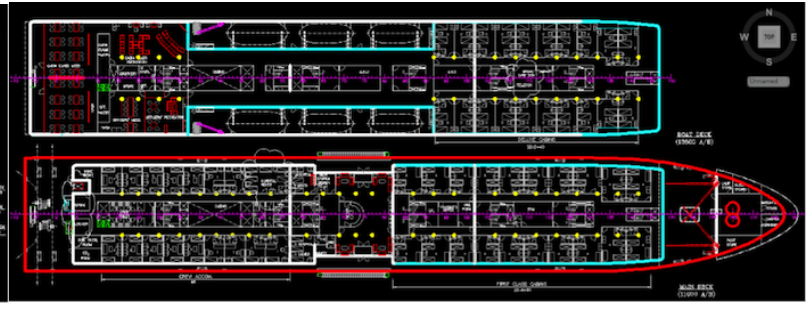
Step 1

- To have a visual approximation of the ship dimensions, draw
  - *an outline of the profile view,*
  - *main deck or uppermost deck that contributes to longitudinal strength,*
  - *the forecastle deck.*
- In some ships, the upper deck is stepped, i.e. it has a poop deck at the aft. Make sure you show that in the profile view and the deck outline view.



Profile view of a 500 Pax ship



Main deck and Boat deck plans

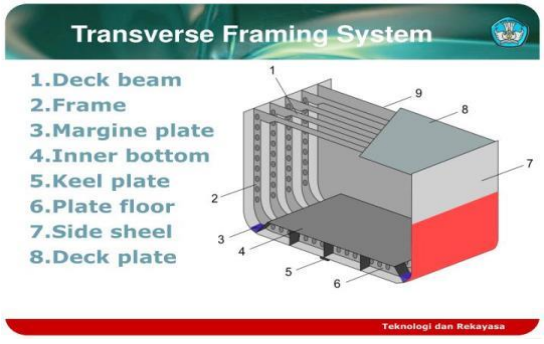
Step 1 - Clarification

The reasons behind deciding the particulars (Especially height) of the forecastle deck at this stage are :

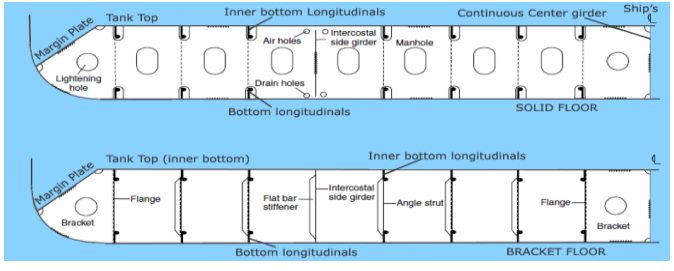
- Minimum bow height has to be attained (according to ILLC Regulations) in order to reduce the deck wetness
- To provide forecastle deck area for anchoring and mooring equipment
- Adequate volume underneath for storage and chain locker, etc.
- To provide additional cargo space (in lower decks) in case of certain ships

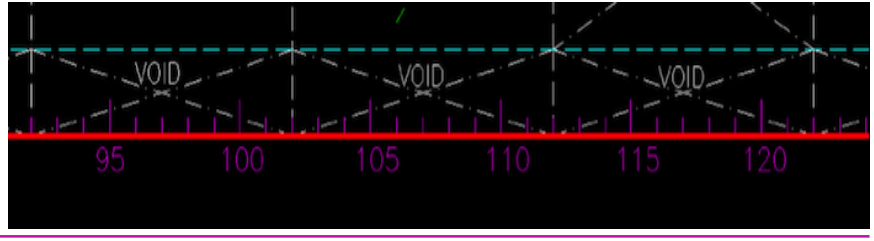
Step 2

- After having drawn the profile plan, the first thing a designer should do is decide on the framing and frame spacing of the ship.
- The framing, whether longitudinal or transverse is decided on the basis of the length of the vessel.
- Generally, all ships longer than 120 m are longitudinally strengthened.
- Frame spacing is the basic module length. Frame location is defined by frame number
- The frame spacing is then calculated by the formula specified in the rule book of the authorized classification society. The value obtained from the formula is generally rounded off to the nearest hundreds or fifties, so as to attain ease of production and design.



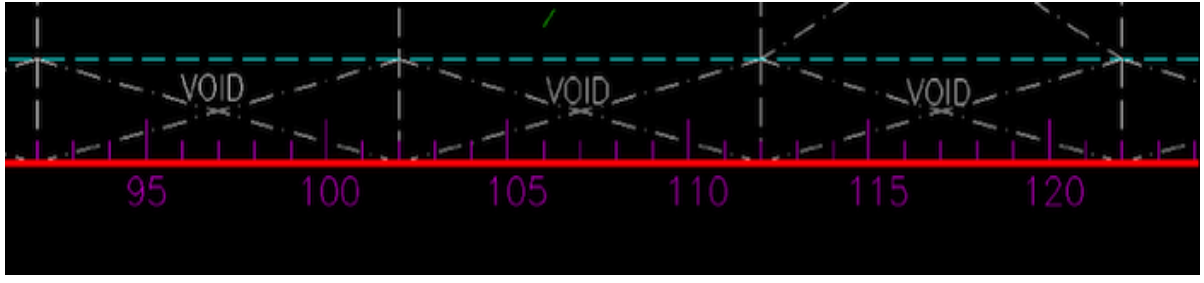
Longitudinal framing system





Step 3

- Next is to mark the decided frame spacing of the drawing. This frame spacing will now act as scale on the drawing, helping you to locate every point on the ship.



Step 4

You must now divide the ship into certain number of watertight compartments, which is decided by the subdivision rules prescribed by the classification society.

The rules specify the total number of watertight transverse bulkheads that are necessary to maintain watertight integrity of the ship. A ship generally has four types of transverse bulkheads:

- A fore peak collision bulkhead
- An aft-peak bulkhead
- A bulkhead at each end of machinery space
- Transverse bulkheads in cargo hold regions

How to decide the position of the fore peak collision bulkhead?

The distance of the forepeak collision bulkhead from the forward perpendicular is decided based on formulae prescribed by the authorised classification society. Generally, the class society would provide you with two formulae.

One, to specify the minimum distance of the forepeak bulkhead aft of the forward perpendicular. Other, to specify the maximum distance of the forepeak bulkhead aft of the forward perpendicular

It is up to you, as a designer, to provide the forepeak collision bulkheads within the above limits, depending on the dimensions of the forepeak ballast tank, anchor equipment, and chain locker dimensions

How to decide the position of the aft peak / engine room aft bulkhead?

1. The position of the engine room forward bulkhead is fixed according the position and length of the holds.

2. Once the above is done, about four frame spaces need to be left out before placing the main engine aft of the engine room forward bulkhead. That is to leave space for maintenance and crew operations.

3. Aft of the empty space, the length of the engine room is to be decided depending upon the length of the main engine, and the length of the intermediate shaft.

How to decide the position of the aft peak / engine room aft bulkhead?

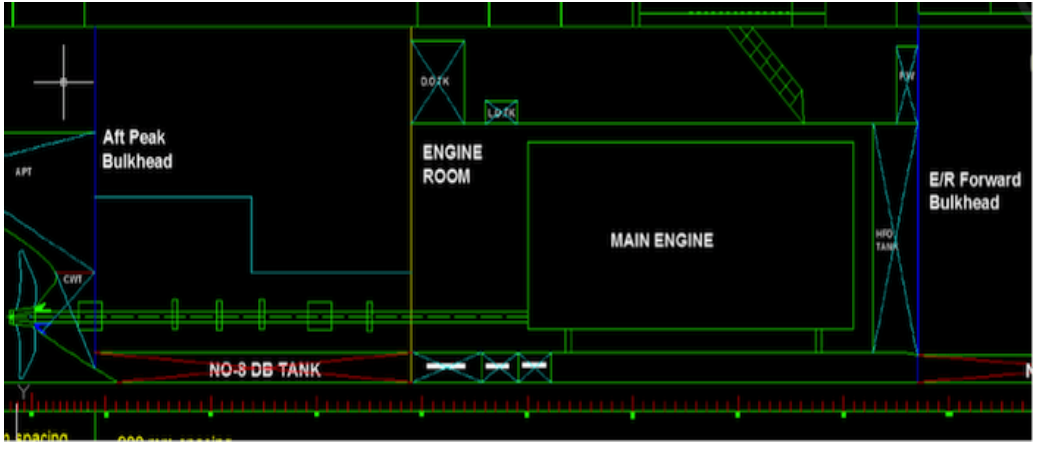
4. The intermediate shaft is coupled with the propeller shaft by a flanged connection. The coupling flange between the intermediate shaft and the propeller shaft is to be housed within the engine room itself. It is just aft of the coupling flange that the engine room aft bulkhead is positioned.

5. The propeller shaft runs from aft of the engine room bulkhead connecting to the propeller through the stern tube.

6. In many cases, the position of the engine rom aft bulkhead is also governed by the decided capacity of the aft peak ballast tank, which is always aft of the aft peak bulkhead.

7. The capacity of the tank is estimated by trim and stability calculations, which is a very preliminary stage of design.

8. But the engine and shaft lengths are decided at a comparatively later stage. This should give you an idea of how iterative the ship design process is



Aft peak bulkhead position

How to arrange cargo spaces?

- The entire cargo space needs to be divided into cargo holds by placing the specified number of transverse watertight bulkheads. The longitudinal position of the bulkheads may be decided according to the following :

  - ✓ Holds should be kept of equal lengths wherever possible

  - ✓ In some cases where necessary, alternate large and small holds are designed to meet the cargo requirements for different voyage and cargo conditions. This is normally done for bulk carriers, product tankers, and some container ships

  - ✓ In cases of oil tankers and container ships, decisions on longitudinal bulkheads should ensure proper cargo distribution and handling characteristics.

How about bottom & twin deck heights?

1. The double bottom height needs to be shown clearly, so as to ensure proper estimation and representation of the tank plan. Therefore the designer is required to estimate the height of the double bottom using the corresponding formula specified in the rules of the authorised class society.

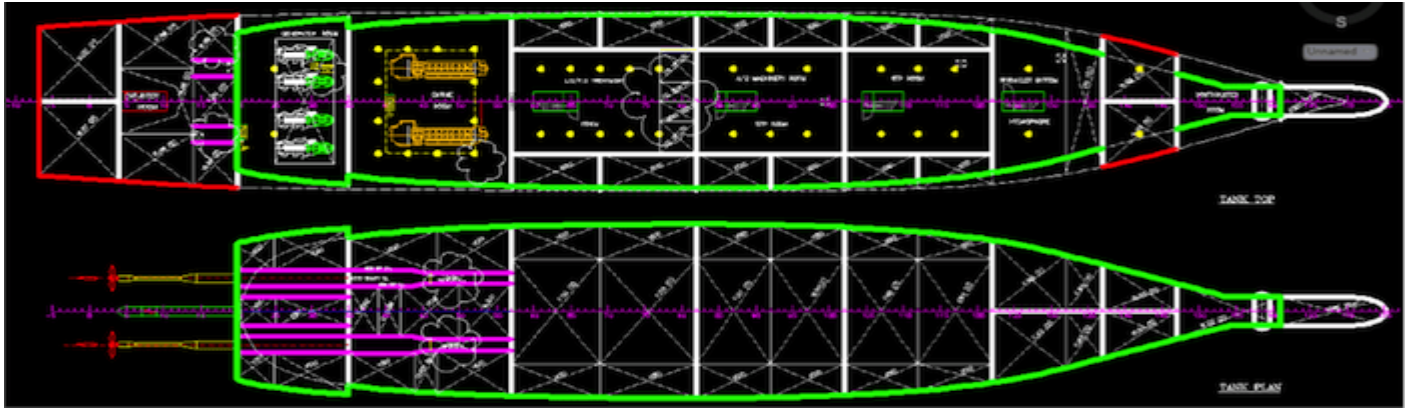
2. Ships that carry packed cargo and cars, require more deck space to attain maximum stowage capacity. In order to increase the overall deck area, these ships are provided with a number of tween decks. The height of each tween deck should be sufficient to accommodate the cargo that is to be stowed on it.

3. This consideration of tween deck is however not required for volume based cargo carrier, like oil tankers, chemical carriers and bulk carriers. And in case of container ships, the top of each container serves as the floor for the next container to be stowed above it, hence container ships do not require tween decks for cargo stowage.

How about bottom & twin deck heights?

1. Ballast capacity should be such that full propeller immersion is obtained at the aft end and forward draught is not too low to avoid the harmful effects of slamming.

2. Ballast distribution should be such that excessive hogging moment is avoided in this condition. So a designer should always ensure to segregate the ballast water tank from any other liquid tank



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Thank you

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