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MEC-E1004 Principles of Naval Architecture

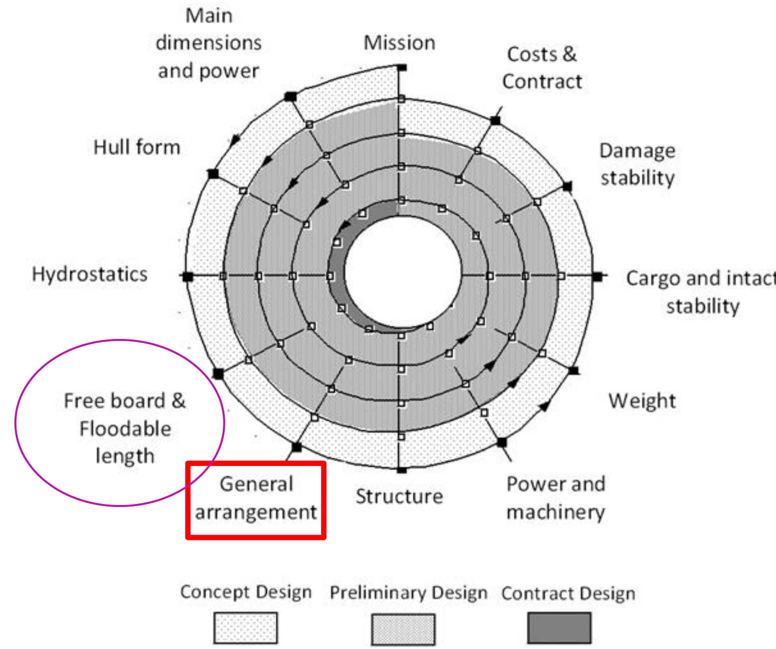
Lecture 6 – General Arrangement

Learning points !

❑After the lecture, you will be able to

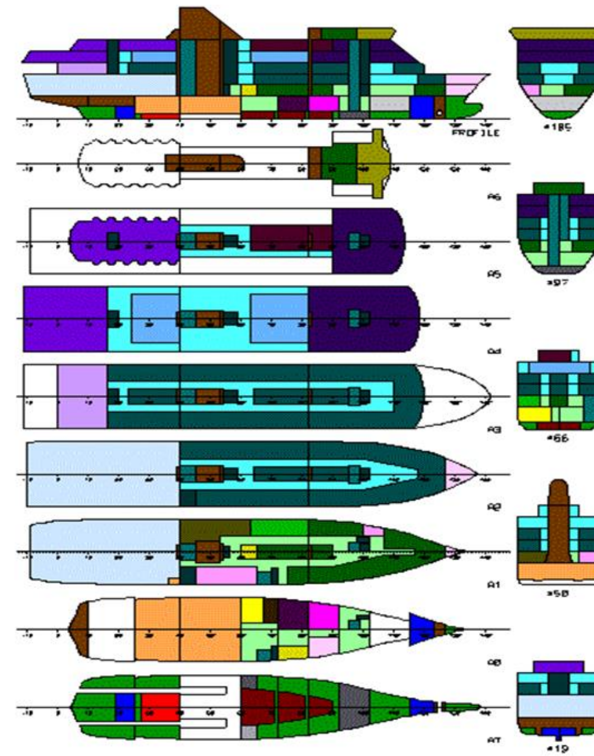
- *List and explain the main design criteria for a ship's General Arrangement (GA)*

- *Start the development of the a GA for your project ship*



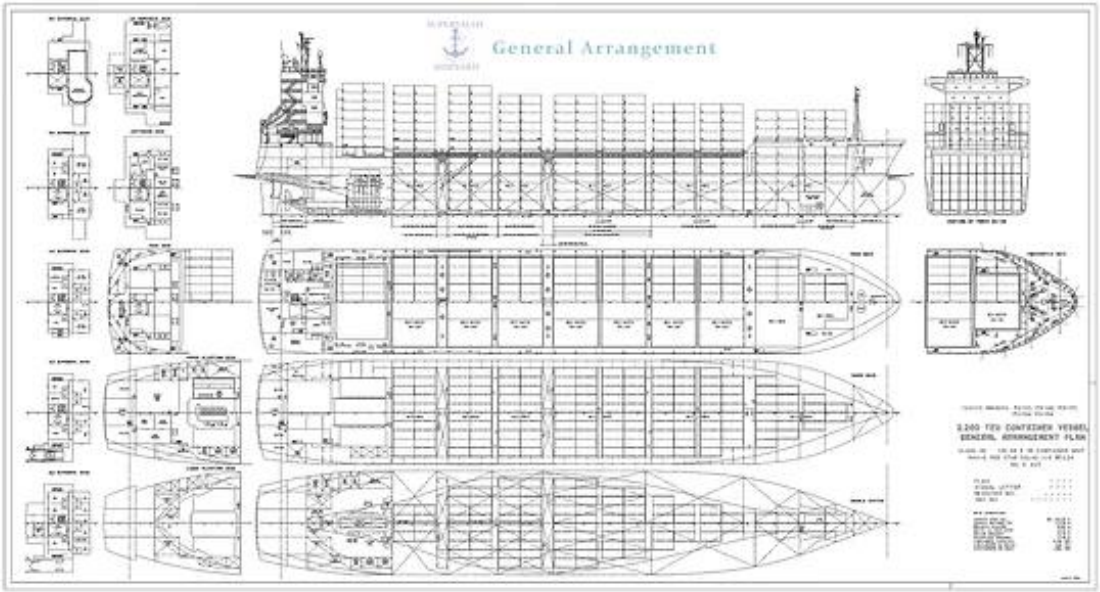
Assignment 6 – General Arrangement

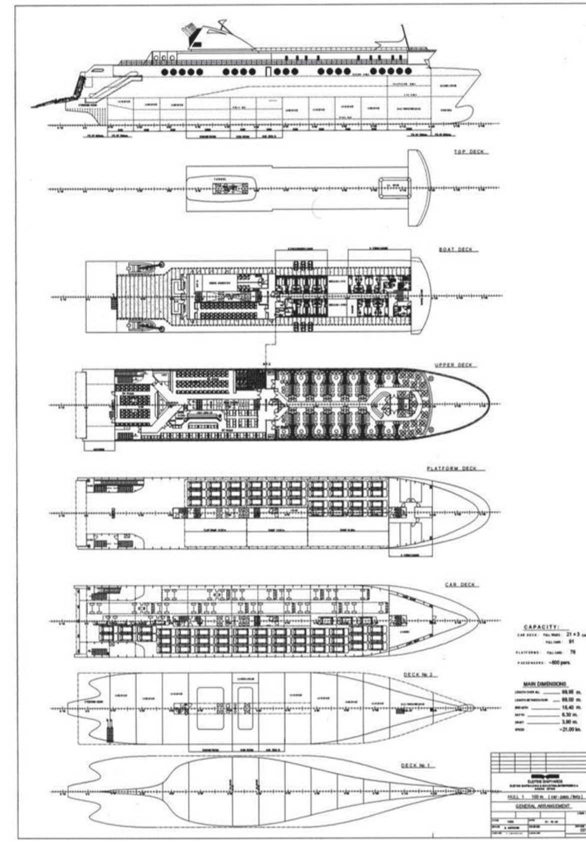
Define an initial GA for you ship. Consider :



- ❑ Capacity/space/area requirements
  - ✓ Public spaces, accommodation, engine room
  - ✓ Cargo tanks
- ❑ Functional requirements
  - ✓ Safety and Environmental performance
  - ✓ People and cargo flows/handling (logistics)
  - ✓ Cargo handling (e.g. deck cranes), auxiliary (e.g. fuel, waste treatment, air conditioning), and safety systems (e.g. evacuation)
- ❑ Rules and regulations (e.g. fire zones, watertight compartments)

Introduction - Example GA's

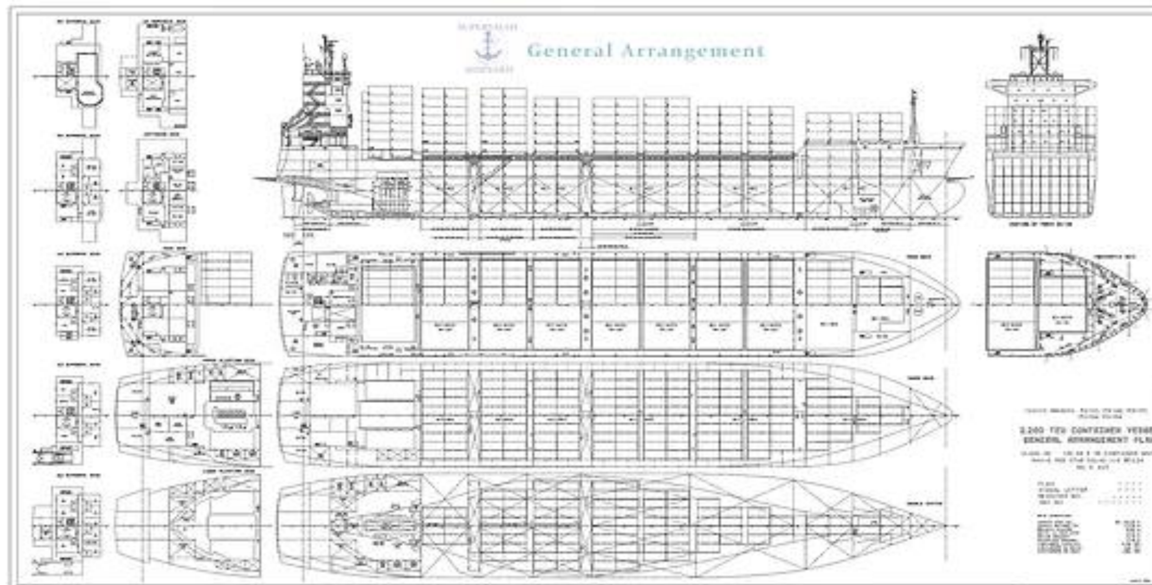




https://www.yachtshipyard.com/container-ship-cargo-ship-shipbuilding

Can you recognise the spaces ?

- ❑ 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



Cargo capacity – a key factor

- ❑ Container ship capacity is measured in Twenty-foot Equivalent Units (TEU)
- ❑ LNG ship tank capacity in cubic meters

Length	Width	Height	Internal Volume	TEU
20 ft (6.1 m)	8 ft (2.44 m)	8 ft 6 in (2.59 m)	1,172 cu ft (33.2 m³)	1
40 ft (12.2 m)	8 ft (2.44 m)	8 ft 6 in (2.59 m)	2,389 cu ft (67.6 m³)	2

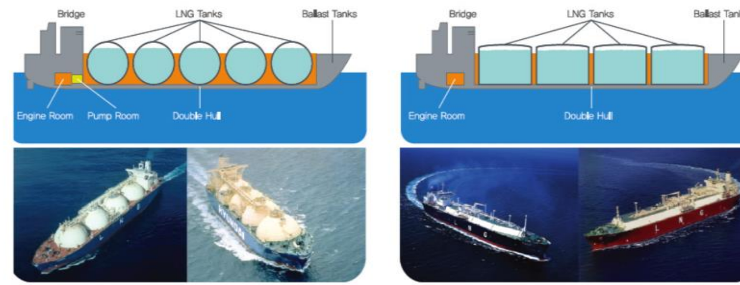


Figure 1.a.Example LNG carrier types: Moss sphere design (Left) and membrane design (Right) *(Source: KOGAS)*

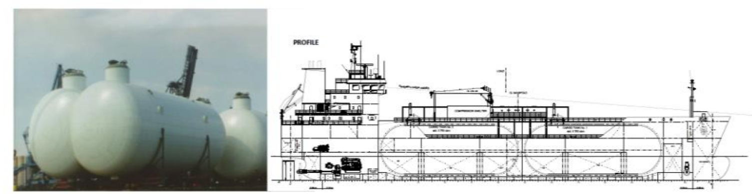
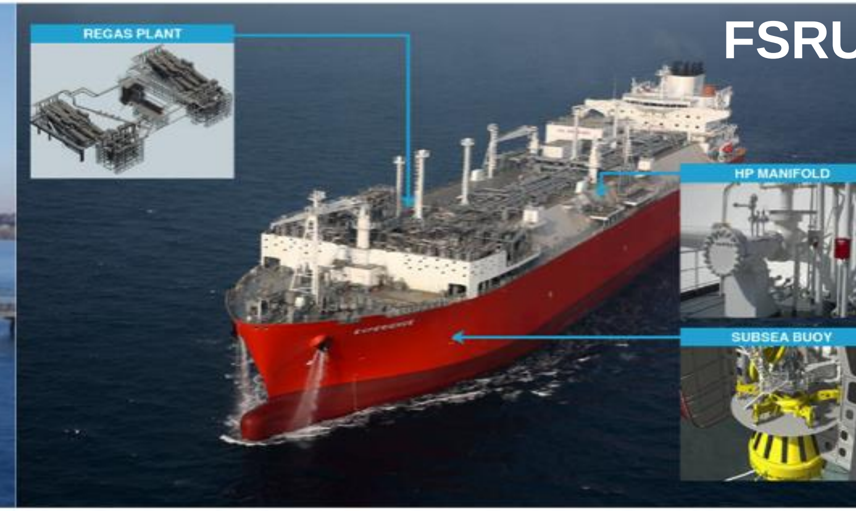
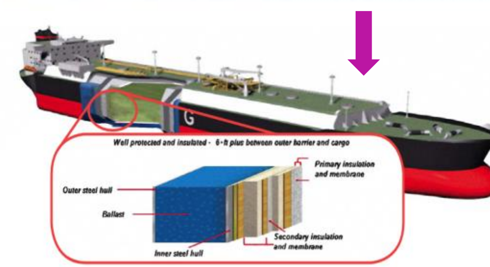


Figure 1.b. Type-C pressurised tanks and LNG carrier *(Source: TGE Gas Engineering, SHIPTECH PTE LTD)*

Cargo loading

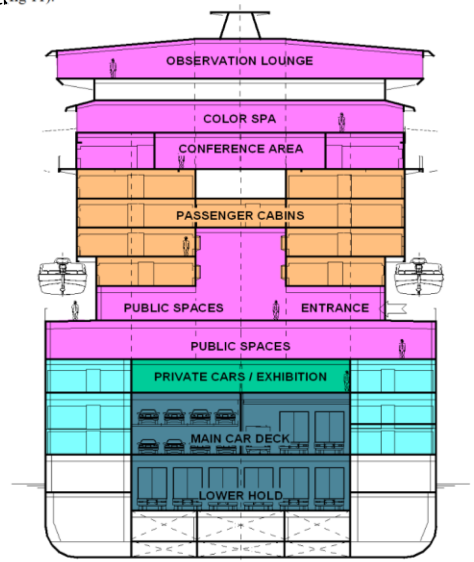


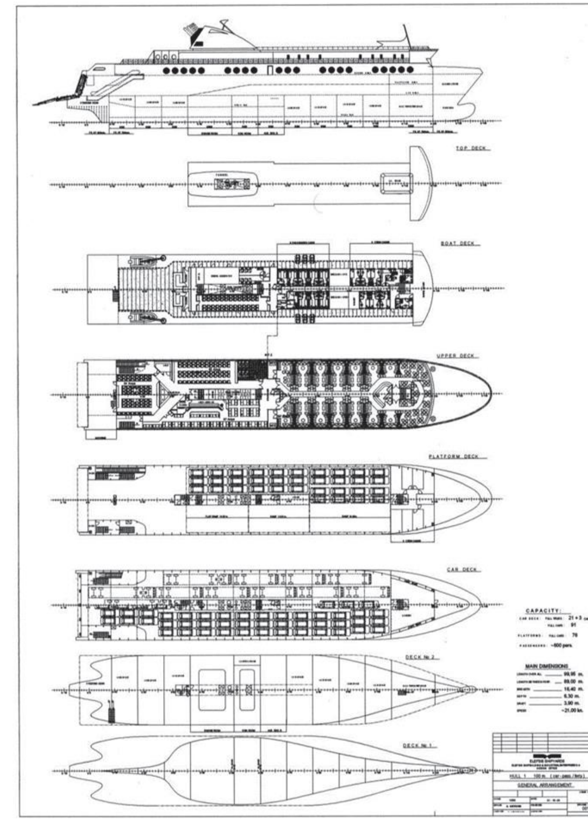
- ❑ Manifold
- ❑ Chemical processing
- ❑ Containment system specifics
- ❑ Cranes



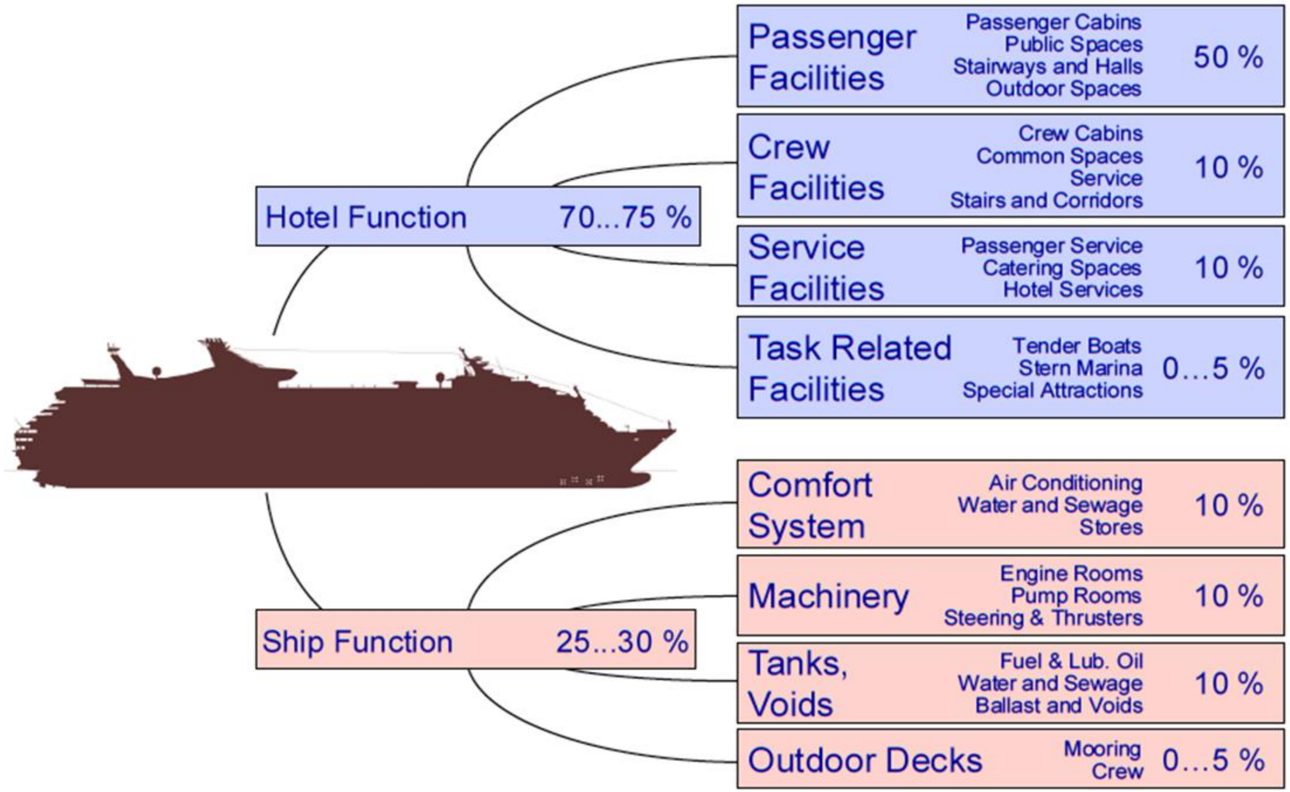
Can you recognise the spaces ?

- Profile View (generally looking from starboard side)
- Mid ship section
- ***More emphasis on deck plans and evacuation measures***
- Forecastle and tank plans
- Loading and unloading arrangements……





Space distribution (key for cruise ships)

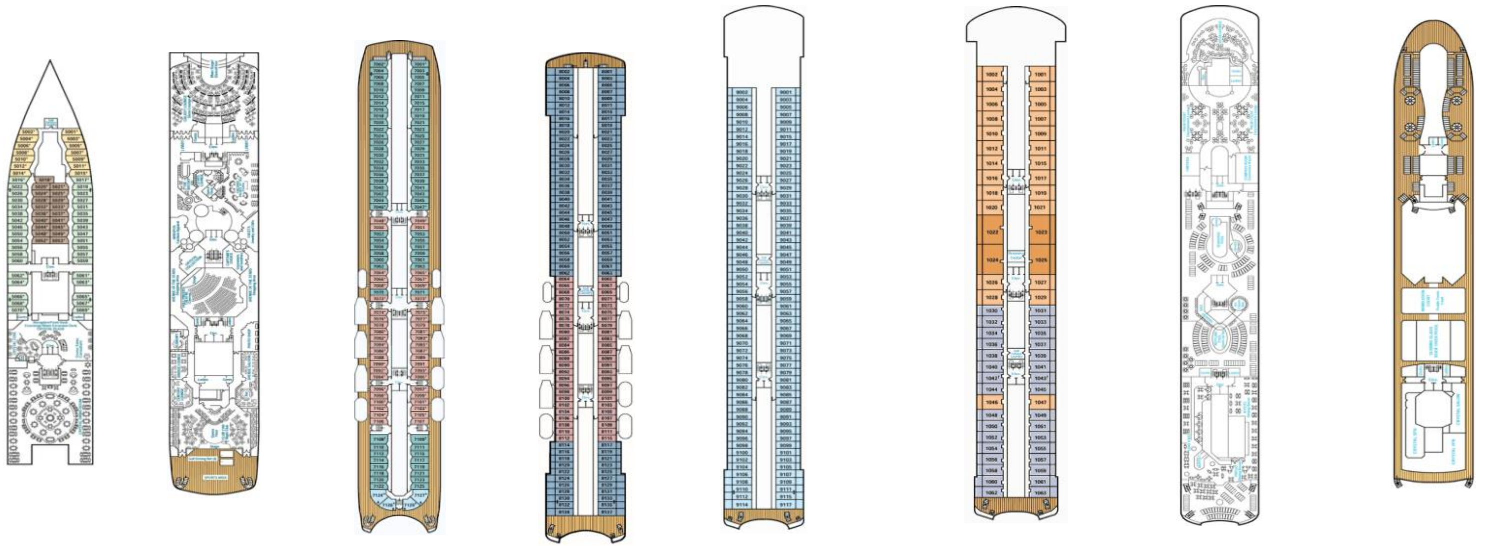


The case of MS Crystal Symphony

- Length of cruise product : 7 - 19 days
- Machinery in double bottom
- 480 cabins
- 985 passengers
- 545 crew
- 9 decks
- Balcony to cabin ratio 58% (ergonomics)

Hotel decks of MS Crystal Symphony

Deck 5 Deck 6 Deck 7 Deck 8 Deck 9 Deck 10 Deck 11 Deck 12



- ✓ Deck 5 : crew and service functions
- ✓ Deck 6 : Dining room and entertainment
- ✓ Deck 7,8 : Life boats, outdoor promenade
- ✓ Deck 10,11 : cabins and entertainment. Note airconditioning rooms in between cabins
- ✓ Deck 12 : captain

General arrangement

Question: How can we efficiently design a ship's general arrangement ?

Can we define the GA prescriptively?

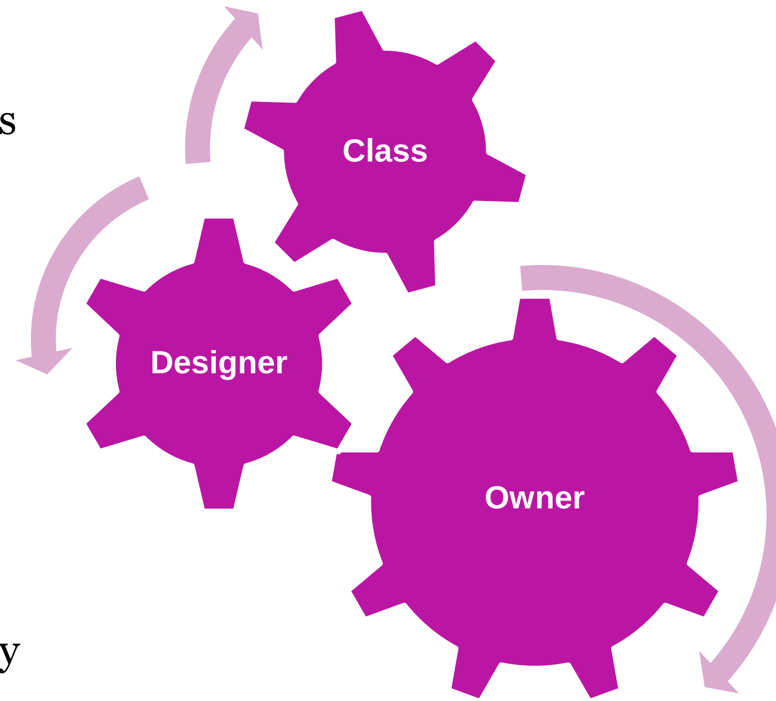
- ***There is no specific procedure with rules stated for the same***

- Different ship types have different characteristics

- The process may be different for various design firms, depending on their procedures and practices

- ***Innovation versus Risk ?***

- The final GA is derived after repeated approvals by the classification society and the owner's party



Key items for consideration

- ❑ **Ship mission, main dimensions, hull shape, frame spacing**
  - *Operational requirements vs. the available space, strength, stability*

- ❑ **Frame spacing**

- ❑ **Capacity requirements**
  - ✓ *Cargo type and amount*
  - ✓ *Cargo handling*
  - ✓ *Passenger capacity (no. of passengers, standard of cabins and other areas in [m2/person])*
  - ✓ *Crew capacity (no. of crew and their comfort standard [m2/person, regulated], windows required for crew cabins)*
  - ✓ *Machinery (type, size, no. of engines, type of power transmission)*
  - ✓ *Tanks (other than cargo) for fuel, system liquids, ballast water,…*

- ❑ **Rules and regulations**
  - ✓ *Criteria regarding watertight compartment and fire zones (e.g. number and location of watertight bulkheads and fire bulkheads on upper decks)*

- ❑ **Dimensions of cabin and other prefabricated modules**

What is the process we could follow?

A naval architect needs to know the basic process to follow in order to come down to an optimum design.

Ship mission and design objectives

Define double bottom & twin deck heights

Fore peak tank & engine room bulkheads

Cargo handling equipment

Cargo spaces

Define ship framing

Longitudinal subdivision

Define fire zones

Develop ship profile view

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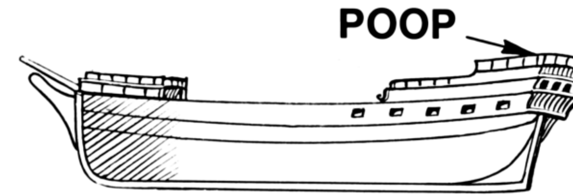
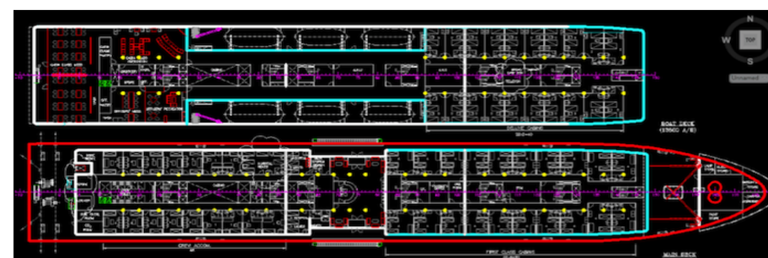
Step 1 : Ship profile view

key considerations



- ❑ Structural continuity & longitudinal strength
- ❑ Good visual approximation of the ship dimensions
- ❑ 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 and the deck outline views*

Profile view of a 500 Pax ship

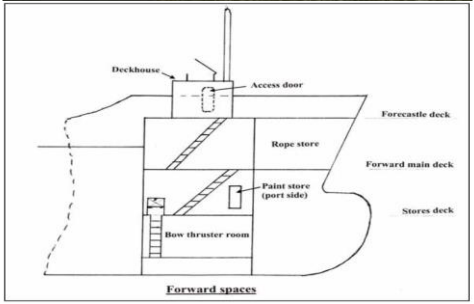


Main deck and Boat deck plans

Forecastle deck

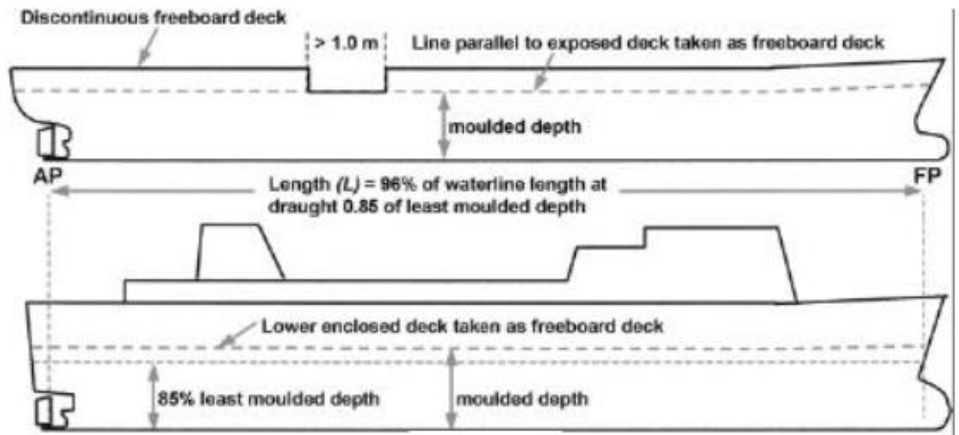
The reasons behind deciding the height of the forecastle deck at this stage are :

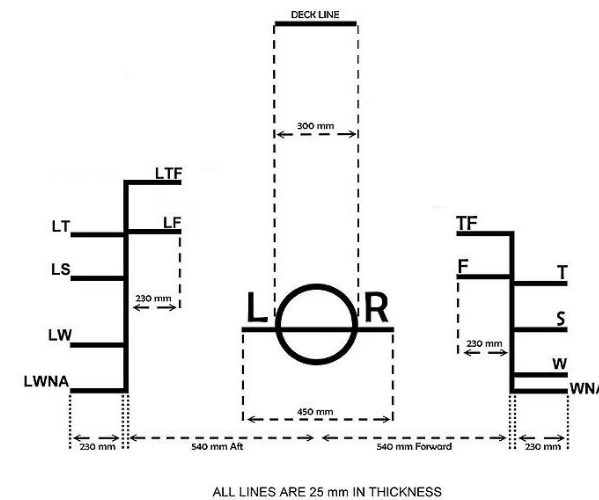
- ❑ Minimum deck wetness
  - ✓ *Bow height* has to be attained as per ILLC Regulations
- ❑ Deck area for anchoring / mooring equipment, adequate volume underneath for storage and chain locker, etc.
- ❑ Space (in lower decks) as/if necessary



Freeboard

- **Freeboard** : height amidships from summer load waterline to main deck





- It is necessary for reserve buoyancy, damage and intact stability

Freeboard

- International Convention on Load Lines ILLC 1966 sets instruction for the minimum freeboard calculation based on ship type, L, Cb, L/D, superstructure.
  - ✓ **Type A Ships** designed to carry only liquid cargoes in bulk and in which cargo tanks have only small access openings closed by watertight gasketed covers of steel or equivalent material.
  - ✓ **Type B Ships** corr03.
  - ✓ Complex calculation with many exemptions / corrections . Please refer to **Note on ILLC.pdf** for background and **Claculation for freeboard.pdf** in mycourses

Length of Ship (m)	Type A (mm)	Type B (mm)
24	200	200
50	443	443
76	786	816
100	1135	1271
150	1968	2315
200	2612	3264
250	3012	4018
300	3262	4630
350	3406	5160
365	3433	5303

Example : The tabular freeboard Type B ship between 24 m and 100 m in length having enclosed superstructures with an effective length of up to 35% of the length of the ship must be increased by:

$$7.5\,(100 - L)\left(0.35 - \frac{E}{L}\right)\ mm$$

Where L = freeboard length,

E = effective length of superstructure

To this basic freeboard the various corrections are applied to arrive at the minimum freeboard to be assigned.

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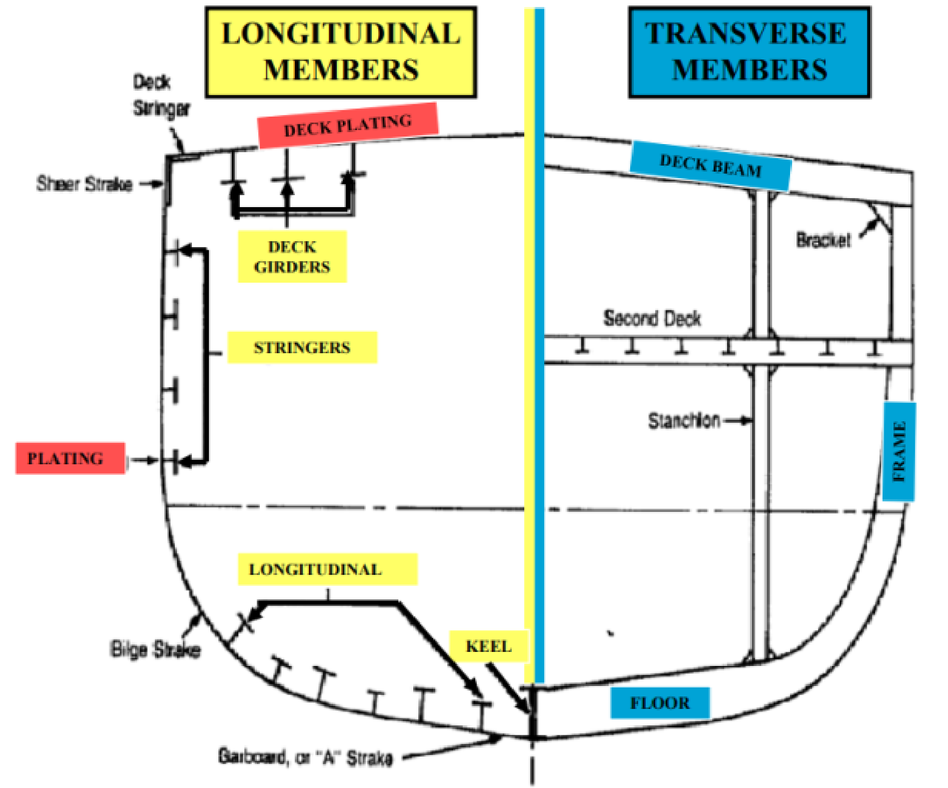
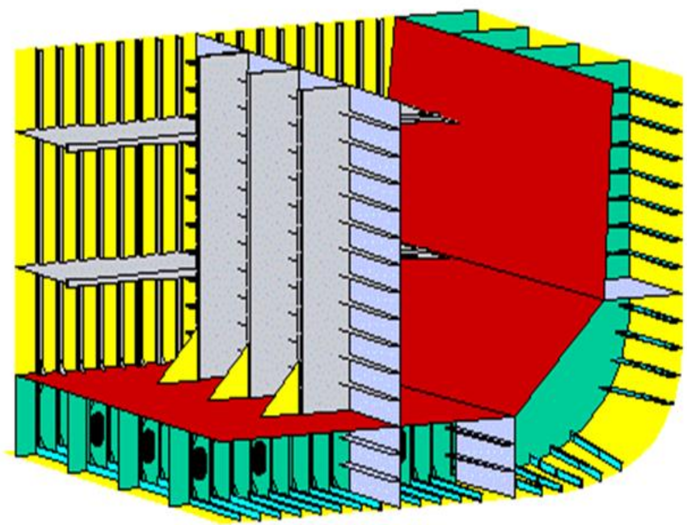
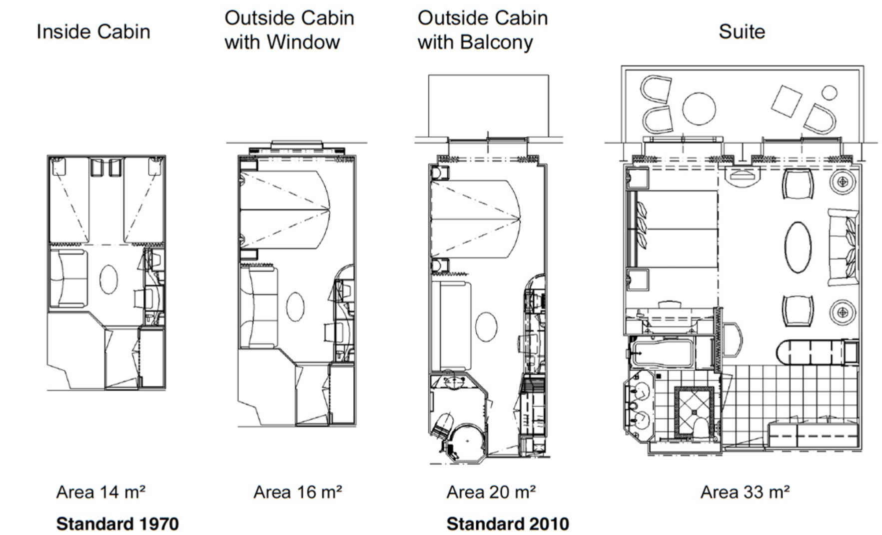
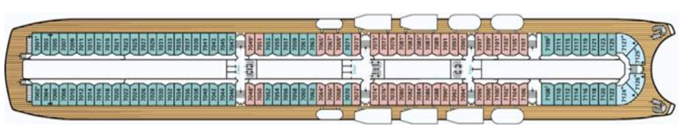
Step 2 : Frame spacing



Key considerations





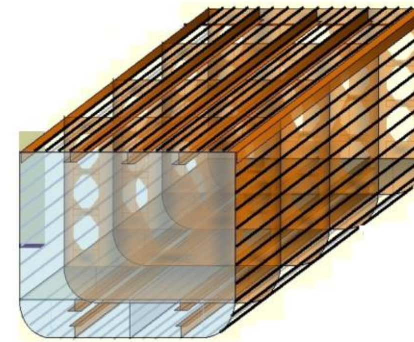


7th deck of Crystal Symphony (cruise ship)

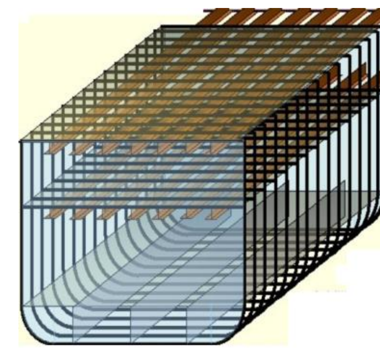
- *Frame spacing can influence the continuity of structural elements in accommodation and main deck areas.*

Longitudinal vs Transverse framing

- **Longitudinal framing**
  - ✓ Closely spaced longitudinals support shell plating
  - ✓ Side shell longitudinals (stringers) placed in high stress areas under deck
  - ✓ Inner bottm gives longitudinal and transverse strength
  - ✓ Bulkheads increase strength transversely
  - ✓ Good for tankers, LNG, cheaper, difficult to stow bulk items

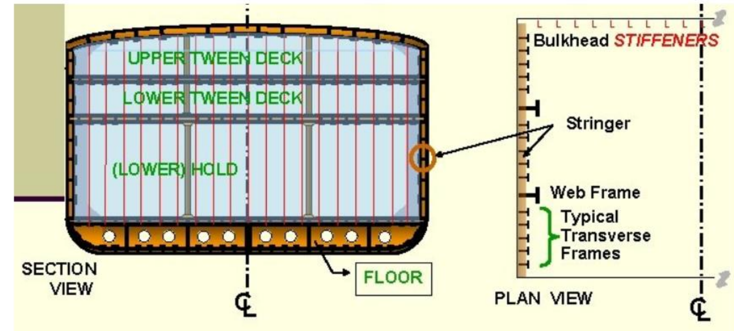


- **Transverse framing**
  - ✓ Deck beams tie upper ends of frames
  - ✓ Widely spaced longitudinals
  - ✓ Inner bottm gives longitudinal strength
  - ✓ Longitudinals supporting decks called girders
  - ✓ Additional decks increase strength
  - ✓ Good for Ro-Ro or bulkers, more expensive requires many pillars or longitudinal bulkheads to help strengthen decks.

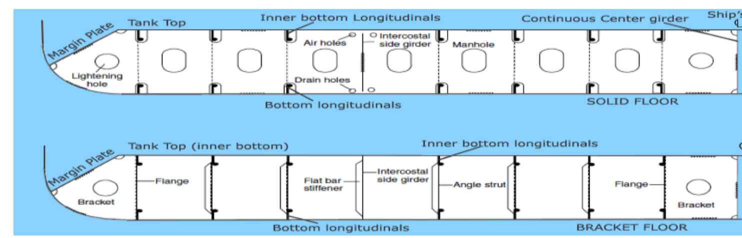


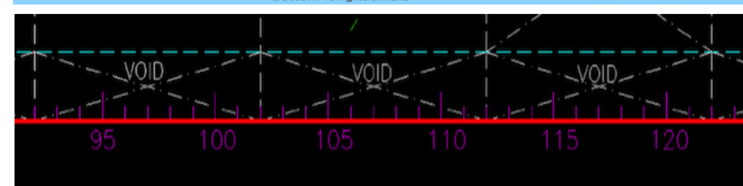
Framing for GA development

- Typically ships have some combination framing
- At concept ship design it is good to stick with longitudinal framing
- Spacing(s) 500 - 900 mm of **L**
- Ships longer than 120 m are generally longitudinally stiffened



Longitudinal framing system





Rule based evaluation of framing

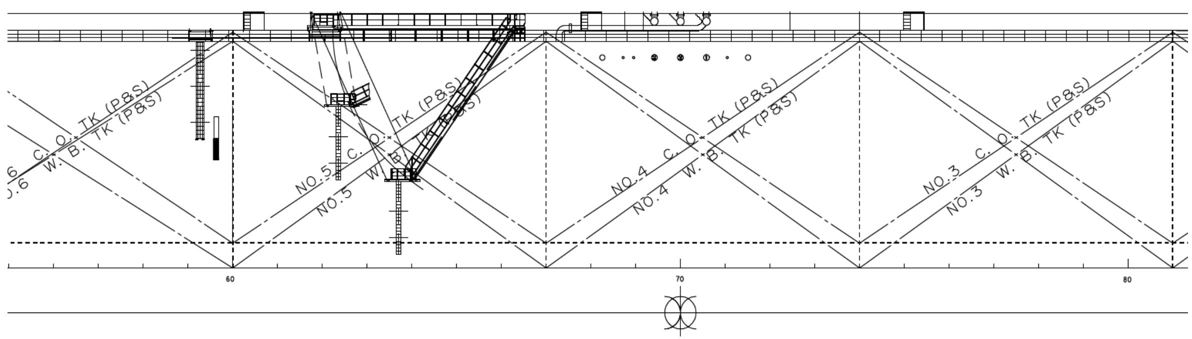
- Frame spacing is the basic module length. Frame location is defined by frame numbers

- Calculated as per Classification Society; e.g., according to DNV the web frame spacing is

$$\boldsymbol{S} = \boldsymbol{n} \times \boldsymbol{s}$$

for $n = 3{,}4$ and s[mm] = 2(240 + L[m])

- The decided frame spacing will be the scale on the GA drawing helping you to locate every point on the ship



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Step 3 : Beyond general particulars

RULES FOR CLASSIFICATION OF
Ships

PART 3 CHAPTER 1

NEWBUILDINGS
HULL AND EQUIPMENT – MAIN CLASS

Hull structural design - Ships with length 100 metres and above

JANUARY 2016

The electronic pdf version of this document found through http://www.dnvgl.com is the officially binding version

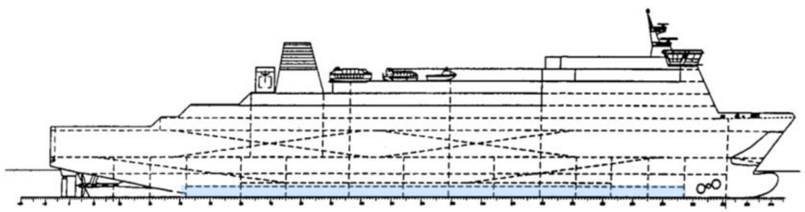
DNV rules “Hull Structural Design, Ships with Length 100 meters and above

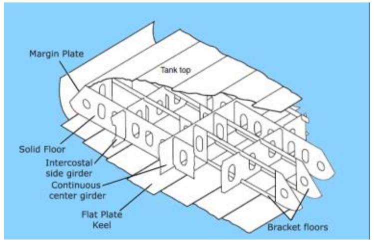
[Ship rules Pt.3 Ch.1 - Hull Structural Design, Ships with Length 100 metres and above (hvl.no)]

Ship double bottom (DB)

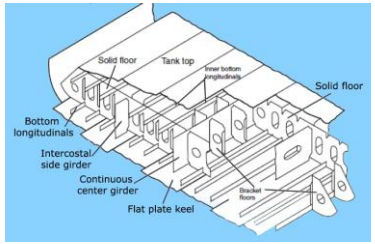
- Single bottom for small ships
- Double bottom compulsory on passenger ships and cargo ships beyond 100 m
- Double hull (or equivalent) compulsory on tankers (MARPOL, 1992)

Image credit BP





Transverse frame



Longitudinal frame

Ship double bottom (DB)

- The minimum height of the double bottom is determined by relevant regulations of recognized classification societies as a function of ship's beam B and draft T.
  - ✓ *Det Norske Veritas, DNV [mm]: 250 + 20 B[m] + 50 T[m], with minimum height 650 mm.*
  - ✓ *Lloyd's Register, LR [mm]: 28 B[m] + 205 $T^{1/2}$ [m], also with minimum height 650 mm*
  - ✓ *American Bureau of Shipping, ABS [mm]: 32 B[m] + 190 $T^{1/2}$[m], for ships with L ≤ 427 m.*
- The height of the double bottom can be increased in the engine room compartments and at the bow for operational and constructional reasons (size of double bottom tanks, accessibility, and strength).

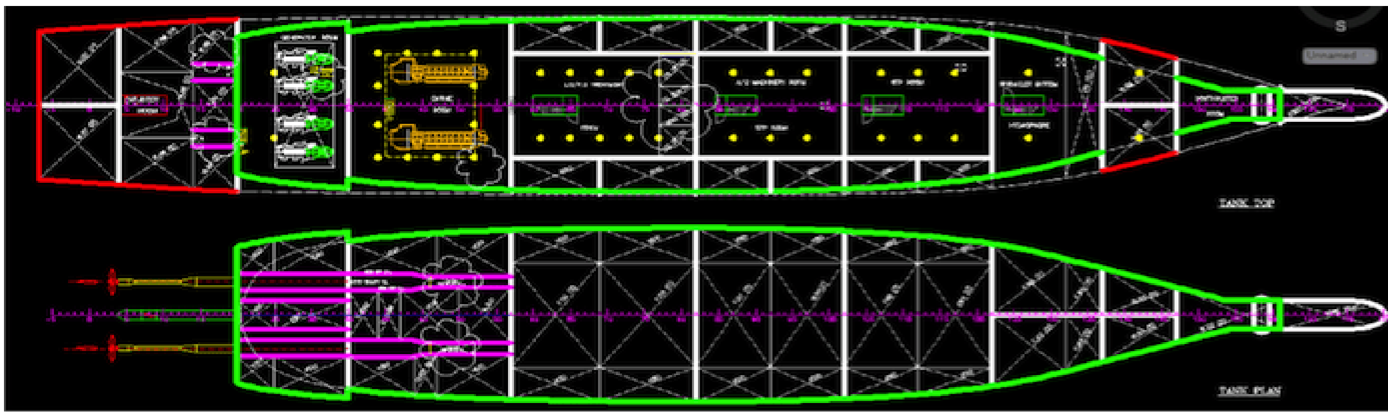
The actual value of the double-bottom height must represent a compromise between the volume of ballast required (due to ballast voyage condition, stability, etc.) and the associated decrease of the cargo volume. In tankers, MARPOL requirements establish in addition

$$H_{DB} = MIN(B/15, 2.0 \text{ m})$$

Ship double bottom (DB)

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



Superstructure height

- ❑ The total height of the superstructure can be estimated based on the IMO SOLAS visibility requirements

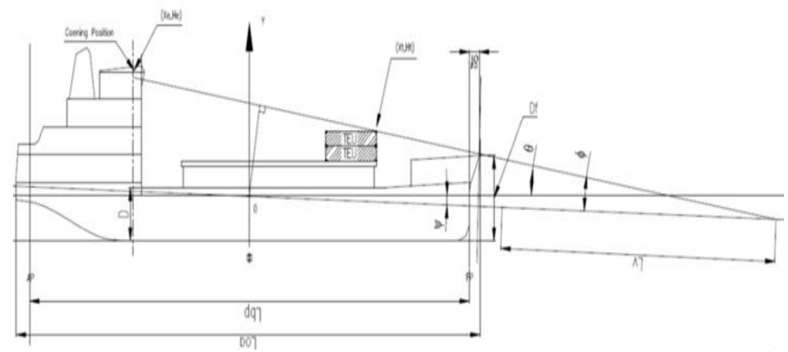
$$H_{SPST} = \left(\frac{0.85 \cdot L_{WL}}{L_{VIS}}\right) \cdot (D - T_M + H_{DK}) + H_{DK} + 1.5$$

where:

Lvis = MIN(2Lpp, 500)

Hdk = average height of the superstructure decks

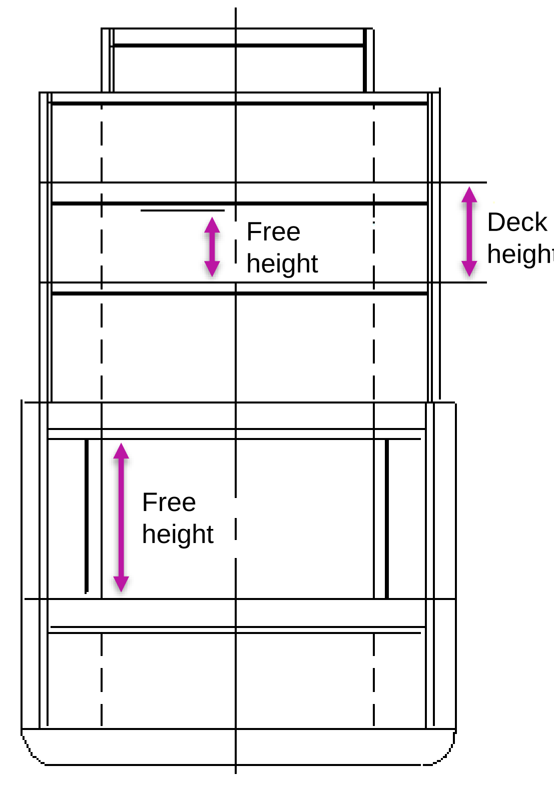
Tm = average draught



- ❑ Calculator : https://www.mermaid-consultants.com/ship-bridge-visibility.html

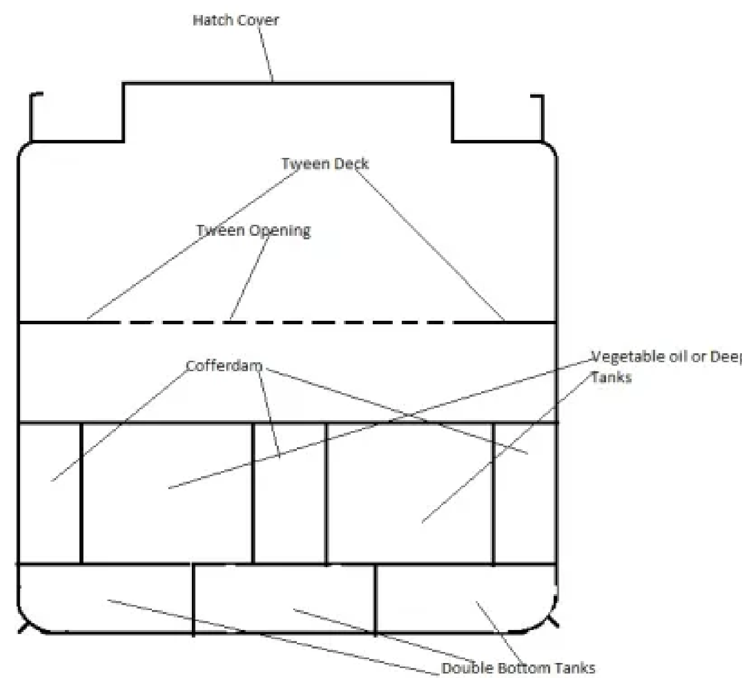
Passenger ship superstructures

- Free height vs. deck height
  - *Deck height include structures and pipes*
- RORO decks
  - *The required free height is 4.3 m for lorries and 4.6 - 6 m for roll trailers*
- Accommodation (cabin) areas
  - *In cabin areas the minimum free height is 2.1 m*
    - Requires approx. 2.6 m deck height
  - *In public spaces deck height is typically 2,8m - 3,2 m, depending on the width of the space*
    - Spaces going through many decks also possible
- Deck curvature has to be considered



A note on twin deck heights

- Twin deck heights required for ships t carry packed cargo and cars.
- This is because they need more deck space to attain max stowage capacity
- This consideration is not required for volume based cargo carrier, like oil tankers, chemical carriers and bulk carriers.
- For container ships, the top of each container serves as the floor for the n container to be stowed above it



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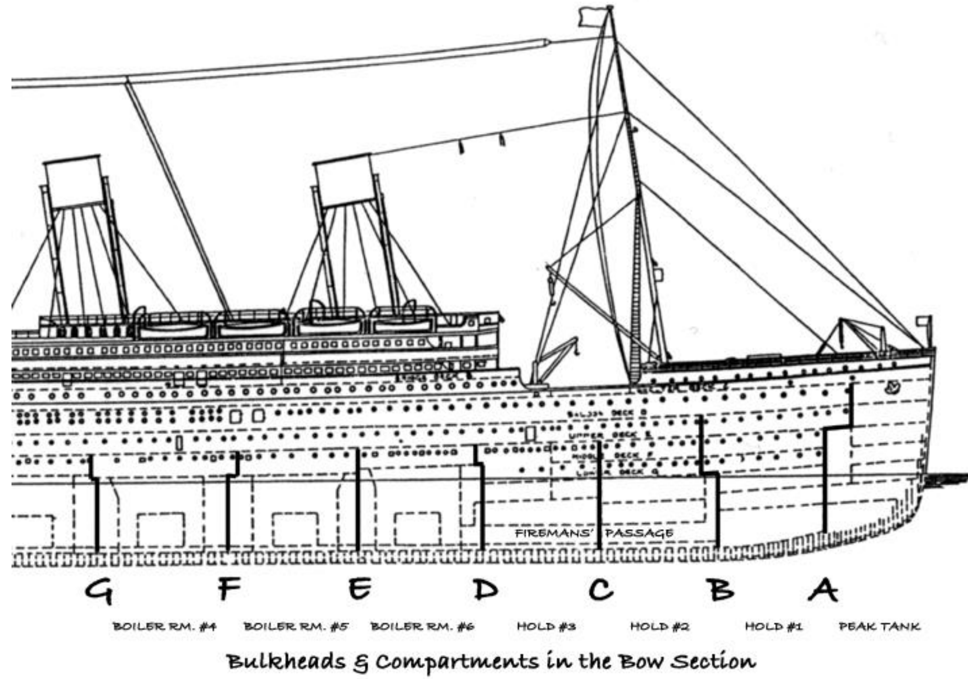
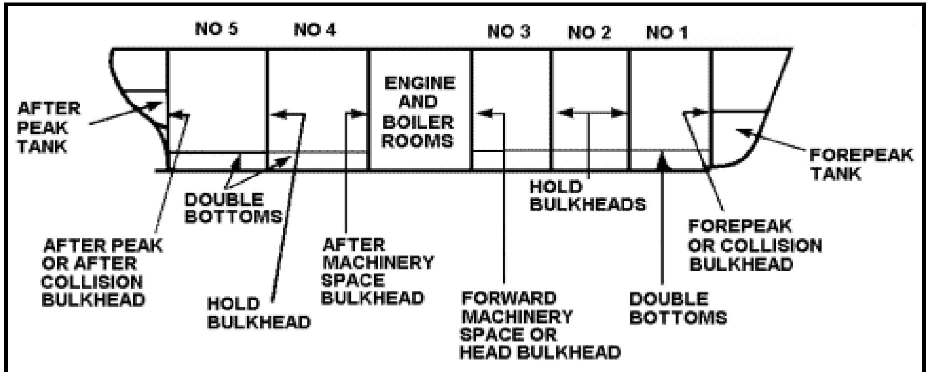
Step 3 : Subdivision and related arrangements

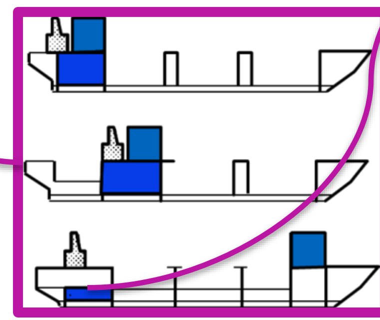


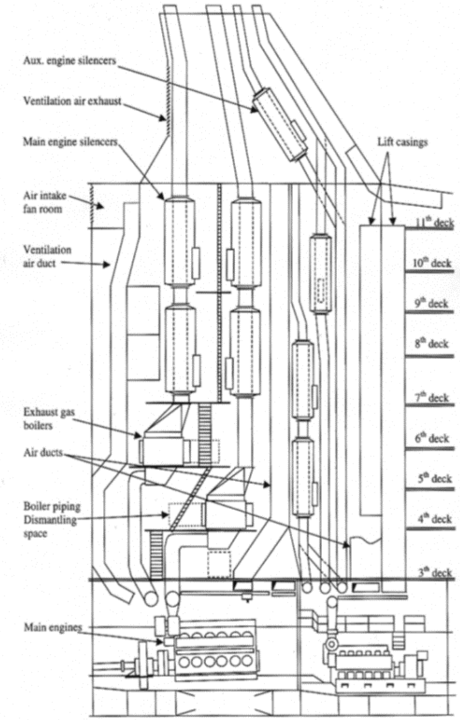
DNV rules "Hull Structural Design, Ships with Length 100 meters and above"

[Ship rules Pt.3 Ch.1 - Hull Structural Design, Ships with Length 100 metres and above (hvl.no)]

Key considerations







"There are no typical values for the number of watertight compartments. The watertight subdivision of passenger ships can be accomplished by fitting of both transverse and longitudinal bulkheads and combinations of both. The density of the watertight subdivision is determined by the damage stability regulations of SOLAS".

Key considerations

You must now divide the ship into certain number of watertight compartments,

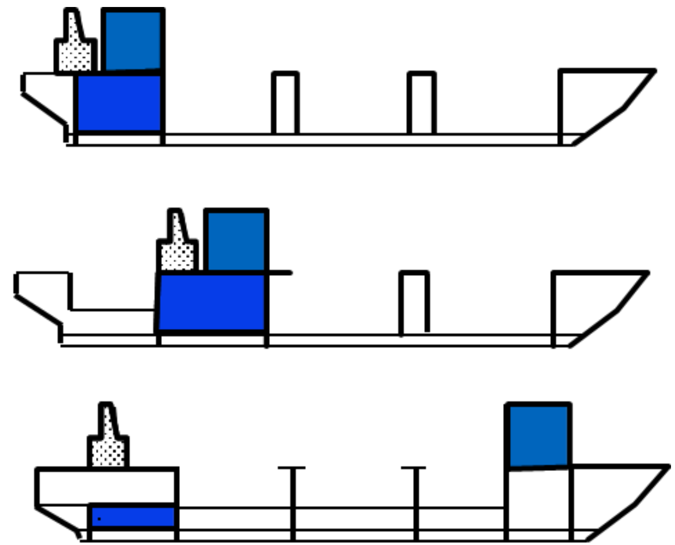
The rules specify the total number of watertight transverse bulkheads that are necessary to maintain watertight integrity of the ship.

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

Deckhouse location

- A high and narrow deckhouse is typically space efficient

- Various possibilities:
  - *bow, 1/2L, 3/4L, aftship*



- Things to consider
  - *Comfort (ship movement, noise and vibrations)*
  - *Visibility from the wheelhouse*
  - *Connection to the engine room*
  - *Weight distribution (trim)*
  - *Construction costs*
  - *Continuity of the steel structures*
  - *Use of space*

- Engine casing can be located outside the deck house

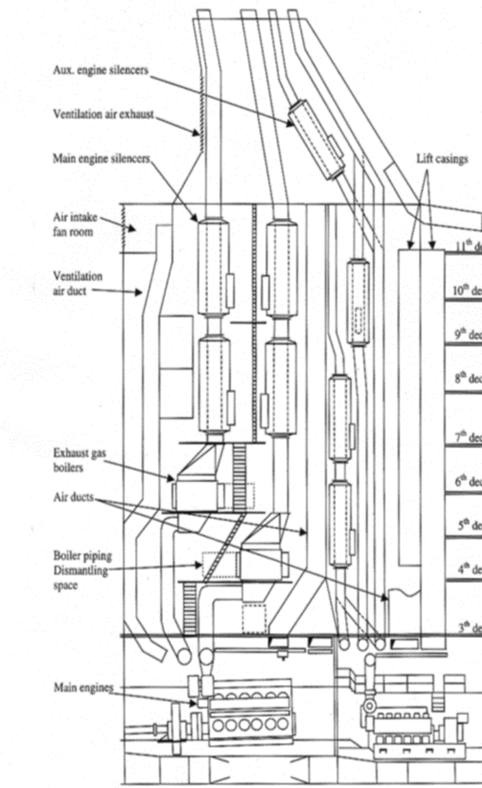
Engine room

- ❑ Space depends on the main engine and propulsion system

- ❑ Factors to consider
  - ✓ *Engine room size and location vs. payload spaces*
  - ✓ *Length of propeller axis should be as short as possible*
  - ✓ *Requirements for damage stability and trim*
  - ✓ *Connections to the accommodation area*

- ❑ Location of the engine room
  - ✓ *AMidships → enough space for a large number of engines*
  - ✓ *1/4 L → good weight distribution*
  - ✓ *Aft end of ship → efficient use of space*

- ❑ Tanks: fuel, lubrication oil, fresh water, ballast water
  - ✓ *Centralized location of fuel tanks reduces production costs (painting, outfitting), but the trim requirements have to be fulfilled*
  - ✓ *Environmental protection requirements (e.g. MARPOL)*



Engine room length

- The length of the Engine Room <LER > can be estimated as a function of the power of the main machinery

- With the current trend of the decrease of the length (LENG) of the Diesel engines used it is acceptable to estimate:

$$L_{ER} = 2 \sim 3 \times L_{ENG}$$

- The resulting length should be rounded to a value multiple of the frame spacing in the Engine Room

DNVGL rules "Hull Structural Design, Ships with Length 100 meters and above" section 3 DESIGN PRINCIPLES Ship rules Pt.3 Ch.1 - Hull Structural Design, Ships with Length 100 metres and above (hvl.no)

Number of bulkheads

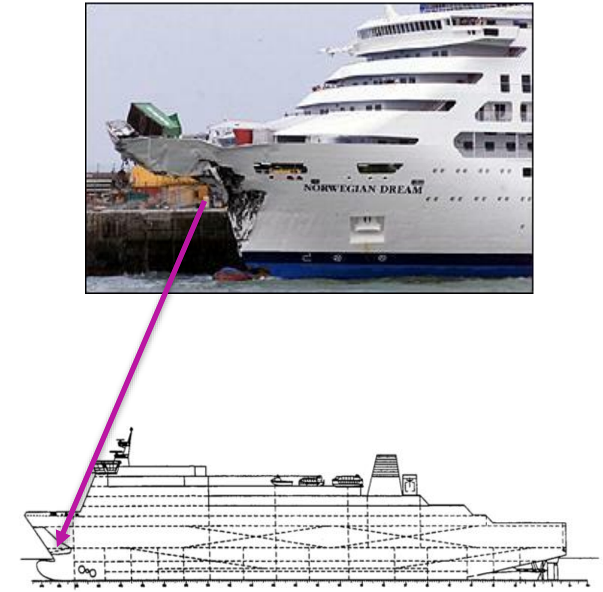
- The position of bulkheads is determined by the dimensions of the carried cargo and the requirements regarding minimum distances between bulkheads.
- DNV require minimum number of TWB as shown below

Number of transverse bulkheads		
Ship length in m	*Engine room*	
	Aft	*Elsewhere*
$85 < L \leq 105$	4	5
$105 < L \leq 125$	5	6
$125 < L \leq 145$	6	7
$145 < L \leq 165$	7	8
$165 < L \leq 190$	8	9
$190 < L \leq 225$	9	10
$L > 225$	specially considered	

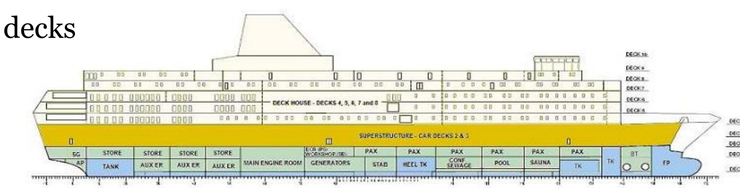
For ships without longitudinal bulkheads in the cargo region.

Bulkhead types

- ❑ Different types of bulkheads
  - *Watertight bulkheads*
    - Limit the flooding of water in case of collision or leak.
    - Contribute to the ship strength; like strength deck
    - Main deck limits the upper extension of transverse bulkheads
  - *Aft peak, engine room and collision bulkheads*
    - Aft bulkhead forms the forward boundary of the aft peak tank
    - Engine room bulkhead located aft the engine room
    - No spaces for humans in front of the collision bulkhead
  - *Specialist types of bulkhead*
    - Portable bulkheads divide long holds into separated sections
    - Corrugated bulkheads formed by corrugated plating.
    - Fire bulkheads: Concern primarily the layout of the accommodation decks



m/v ESTONIA GENERAL ARRANGEMENT – OVERVIEW WT-INTEGRITY

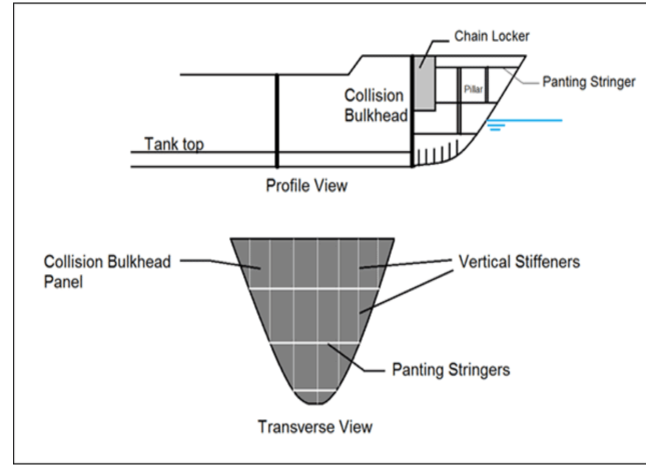


SUPERSTRUCTURE & DECK HOUSE - 3 906 m^3 solid material
WATERTIGHT HULL BELOW DECK 2 - 16 822 m^3 air, 1 994 m^3 solid material

- ❑ Regulated by SOLAS

Fore peak collision bulkhead

- The distance of the forepeak collision bulkhead from the forward perpendicular is to be based on a Classification Rule that specifies the min. and max 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



Fore peak collision bulkhead

- DNV Rules say that for ships of length grater than 100 m the collision bulkhead shall be taken between the following limits:

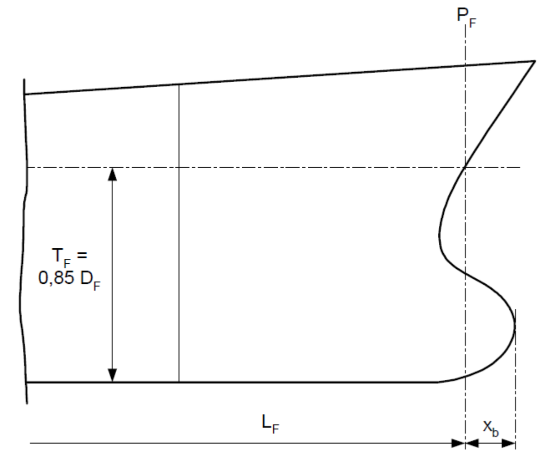
$$x_c\ (\text{minimum}) = 0.05\,L_F - x_r \quad (\text{m})\ \text{for}\ L_F < 200\ \text{m}$$
$$= 10 - x_r \quad (\text{m})\ \text{for}\ L_F \geq 200\ \text{m}$$

$$x_c\ (\text{maximum}) = 0.08\,L_F - x_r \quad (\text{m})$$

where $x_r = 0$ for ships with ordinary bow shape. For ships with bulbous bow.

$$x_r = 0.5\,x_b \quad (\text{m})$$
$$x_r = 0.015\,L_F \quad (\text{m})$$
$$x_r = 3.0 \quad (\text{m})$$

x_b = distance from P_F to the forward end of the bulbous bow

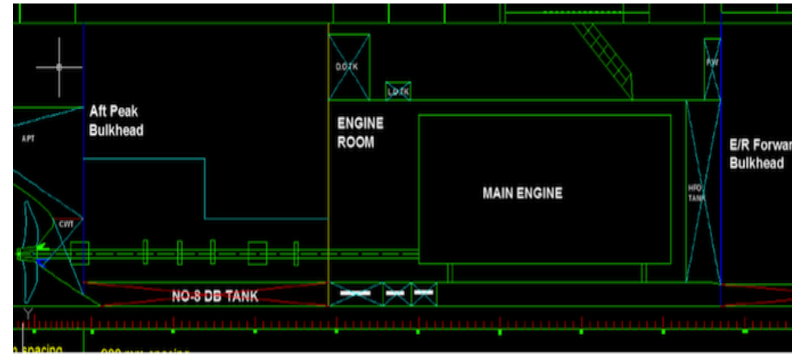


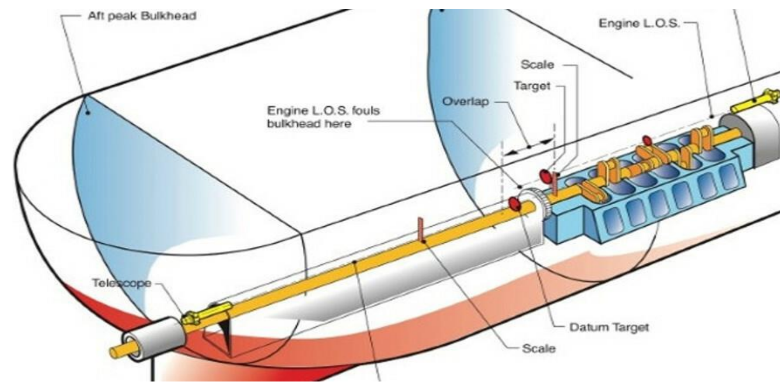
L_F = 96 % of the total length on a waterline at 85 % of the least moulded depth.

DNVGL rules "Hull Structural Design, Ships with Length 100 meters and above" section 3 DESIGN PRINCIPLES http://rules.dnvgl.com/docs/pdf/dnv/rulesship/2016-01/ts301.pdf

Aft peak / engine room bulkhead

- ❑ Fixed according the position of the holds.
- ❑ 4 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.
- ❑ 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.
- ❑ 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





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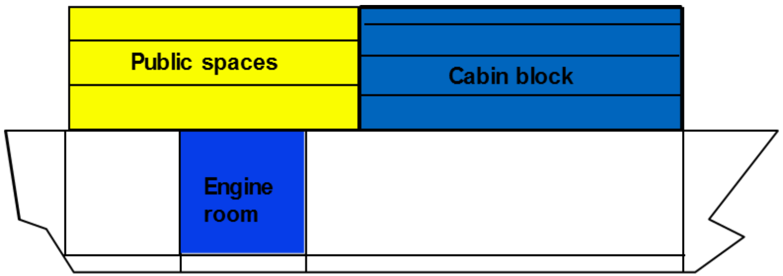
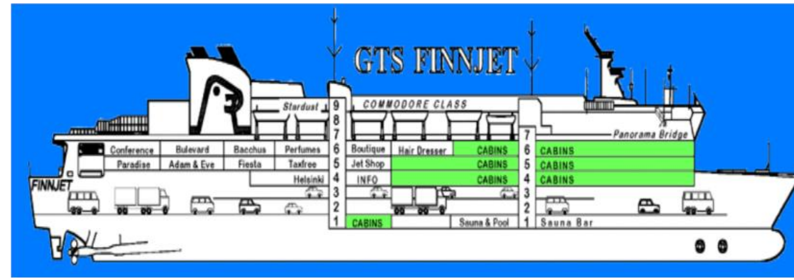
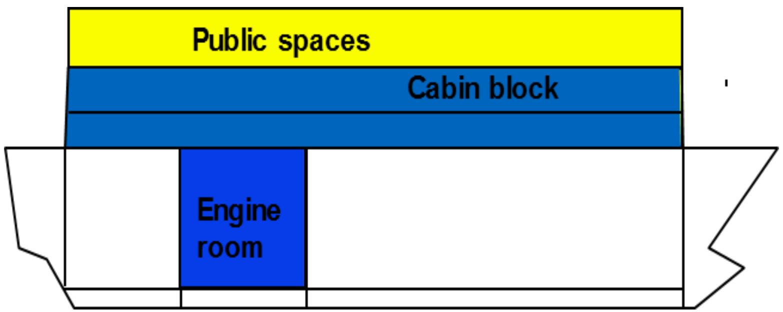
Step 4 : Accommodation and other functional arrangements

Positioning of passenger cabins



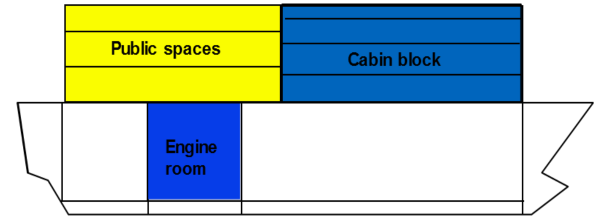


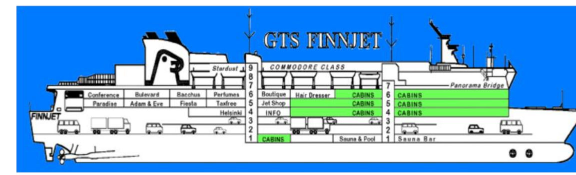


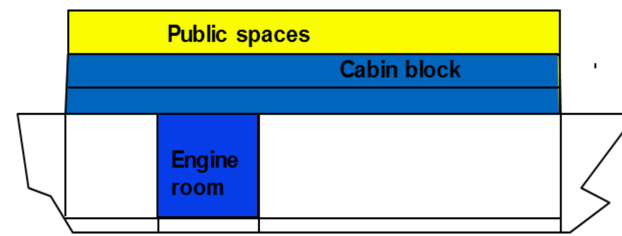
Cabin Location (passenger ships)

- Concentration of cabins to a specific block/area
  - *Easy to meet noise and vibration criteria (+)*
  - *The cabin area might feel claustrophobic (-)*
  - *Longitudinal deck height variations → structural strength challenges (-)*

- Homogenous decks, distributed cabins
  - *Avoidance of claustrophobic cabin areas (+)*
  - *Continuous decks → High structural strength (+)*
  - *Can be challenging with regards to noise and vibration (-)*







Lifeboat location (passenger ships)

Image credit RCCL

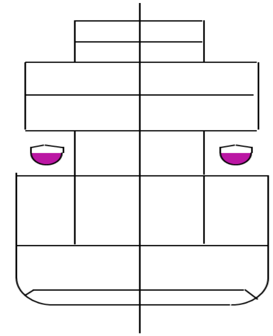
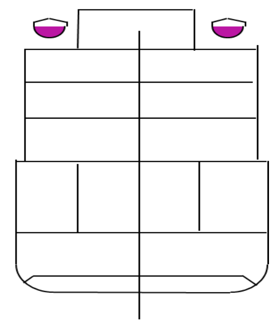


Image credit Viking Line



Lifeboat location

- On the main deck
  - *Modern standard*
  - *Short distance to the water (+)*
  - *Occupy valuable onboard space (-)*

- On the top deck
  - *Not disturbed the functionality of the ship (+)*
  - *Long distance to water (-)*

Image credit RCCL

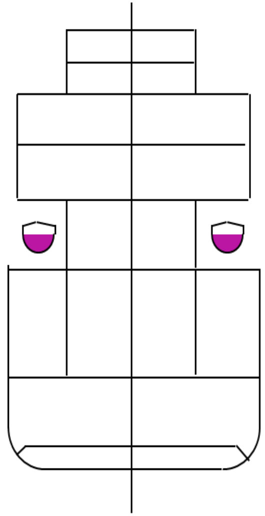
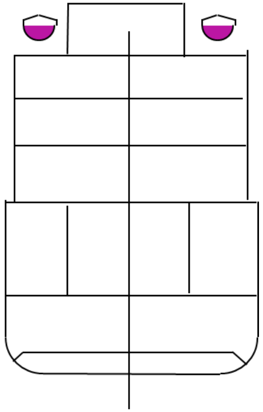
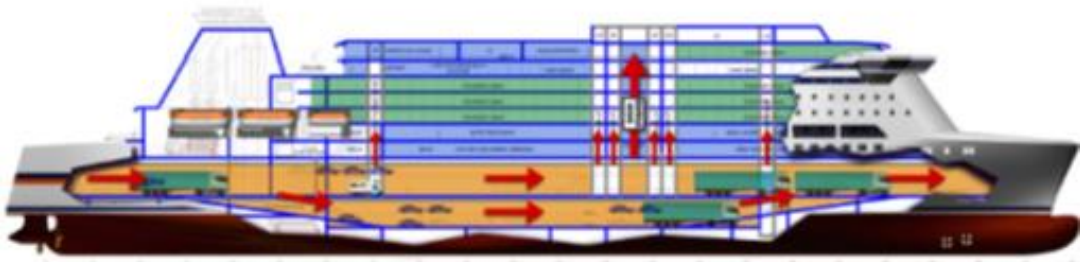
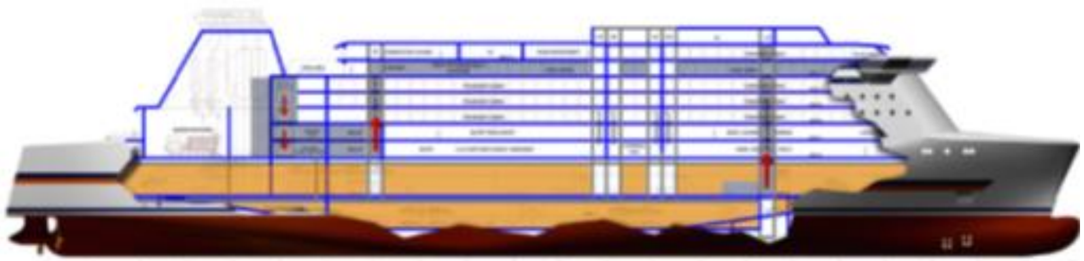


Image credit Viking Line



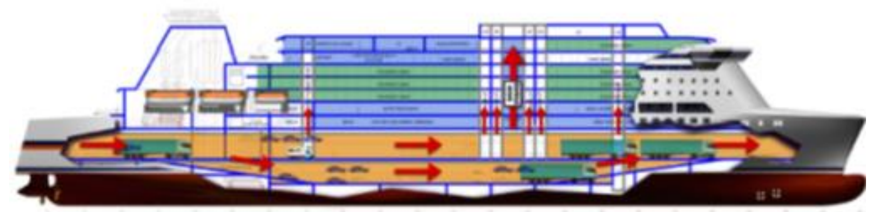
Internal connections



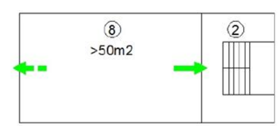


Internal connections

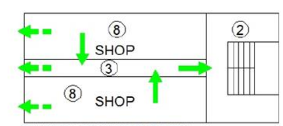
- Examples
  - *Corridors, staircases, lift casings, evacuation routes, lounges*
  - *Consideration of fire and watertight doors*
  - *Connections for hotel services, food delivery, waste, etc.*
  - *Connections for energy distribution, air conditioning and piping*



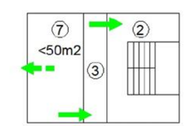
- Design criteria set by the ship's functional requirements
- Described by flow diagrams
- Design is based on system solutions
- All spaces on the ships have to reachable



TWO ESCAPES ARE NEEDED



SHOPS CANNOT OPEN DIRECTLY INTO STAIRS



SMALL ROOMS CANNOT OPEN DIRECTLY INTO STAIRS

Bow doors

- The MS Estonia accident
  - *https://safety4sea.com/cm-ms-estonia-sinking-one-of-the-deadliest-accidents-in-european-waters*
  - *https://www.youtube.com/watch?v=nJ8TASazLcA*

- Different types of bow doors
  - *Bow visor*
    - The bow visor of MS Estonia was "opened" by wave induced water pressure pushing it upwards
  - *Clam-type door*
    - Considered safer than a bow visor

- The outer bow door is typically not watertight
  - *Behind the outer door is typically a watertight door that is often also used as ramp for cargo loading/ unloading*

Image credit SVT

Image credit Wärtsilä

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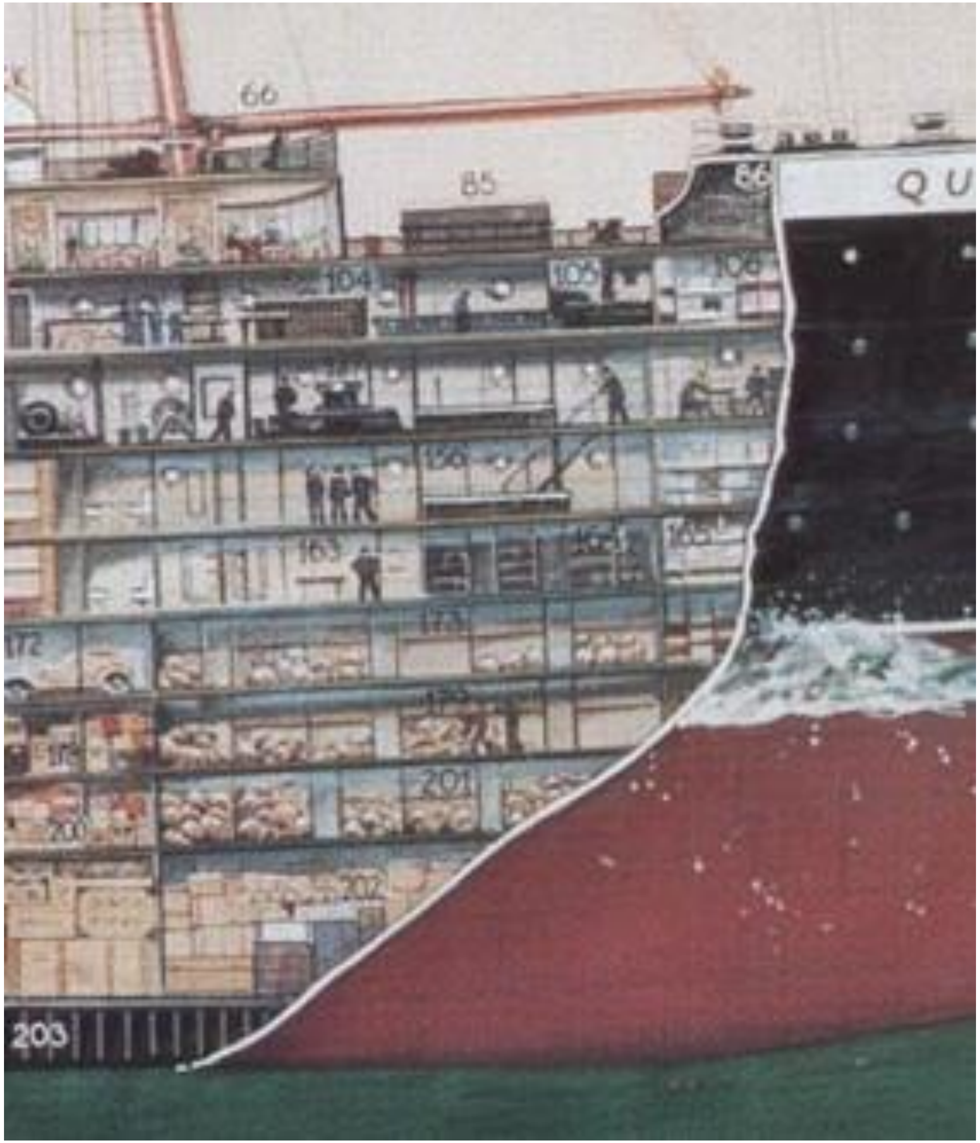
Step 5 : Cargo holds - *design, handling and loading*



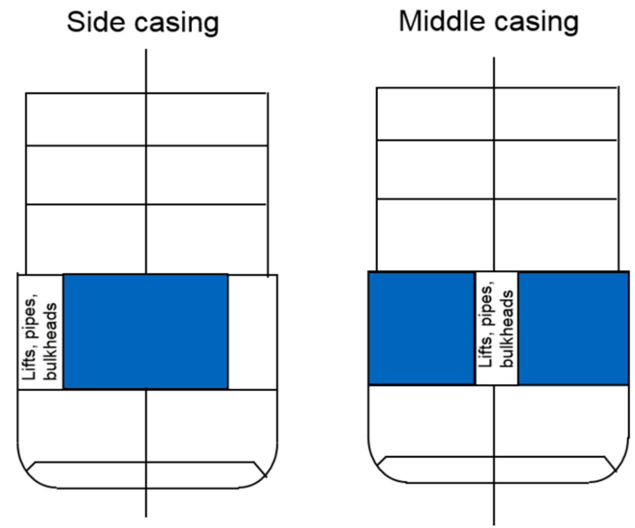
Types of cargo holds

❑Module sizes

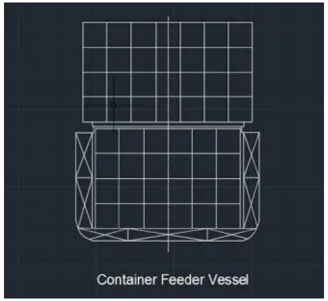
❑Space/volume requirements

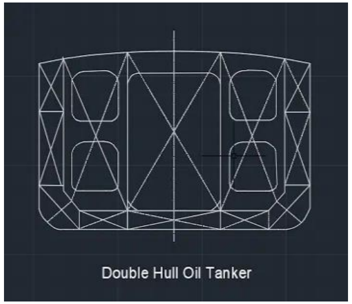
❑Stability requirements

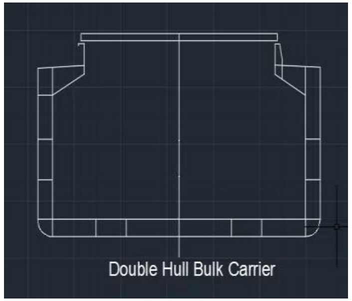
- *Might require the division of a cargo hold into separate sections / tanks*



Different layouts of a RoPax ship's cargo hold







Types of cargo units

- *Break bulk*
  - Cargo without standards (mainly in developing countries)
- *Unitized cargo*
  - Standardized cargo units (e.g. TEU containers)
- *Heavy units*
  - Massive pieces and equipment (e.g. industrial equipment, offshore structures)
- *Dry bulk cargo (irtolasti)*
  - Homogeneous unpacked dry bulk cargo (e.g. minerals, coal, corn)
- *Liquid bulk cargo*
  - Homogenized liquid cargo (e.g. crude oil, oil products, chemicals, LPG, LNG)
- *Rolling (or wheeled) cargo*
  - Cargo on wheels (e.g. trucks, trailers)

Different types of cargo units

- Pallet
- Container
- Roll trailer
- Full or semi trailer
- Train carriage/wagon
- Barge

How can we move cargo ?

- *Vertical (lift on - lift off, LOLO)*
  - Varying loading speed
    - For break bulk 20-60 ton/hr, for containers 300-800 ton/hr, for bulk 1,000-5,000 ton/hr)

Image credit Liebherr

- *Horizontal (roll on - roll-off, RORO): cargo is transported horizontally on wheels*
  - Requires ramps, lifts
  - Cargo can also be floated to/from ship
  - Cargo securing (fastening) important for safety


Image credit pacificmarine.net

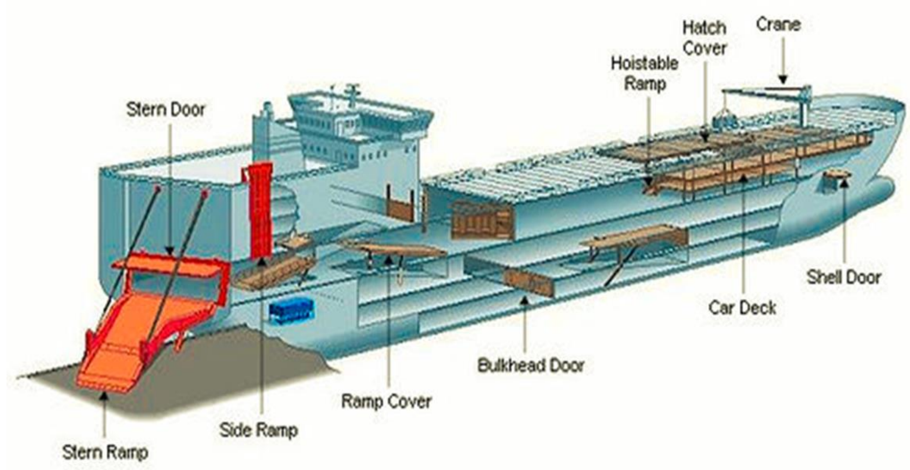
- *Pumping: transfer of liquid cargo to and from tanks by pumping*
  - The pumping capacity is often measured so that the pumping time is 24 hr


Image credit portinfo.co.uk

- The speed and cost of cargo handling are very important
  - *Cargo handling equipment onboard or ashore ?*

Cargo handling equipment

- Cargo gear /Cranes
- Hatch cover
  - *Different types: pontoon, rolling cover, folding cover, roll stowing conver,...*
- Doors
  - *Bow, side, stern doors*
- Lifts and ramps
  - *Stewing (turning) ramp, hoistable ramp,...*
- Mooring equipment



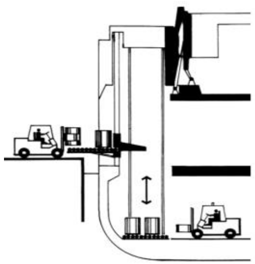
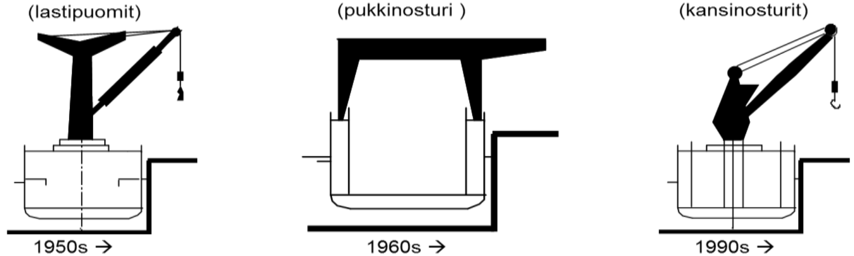


Image credit autoshippers.co.uk



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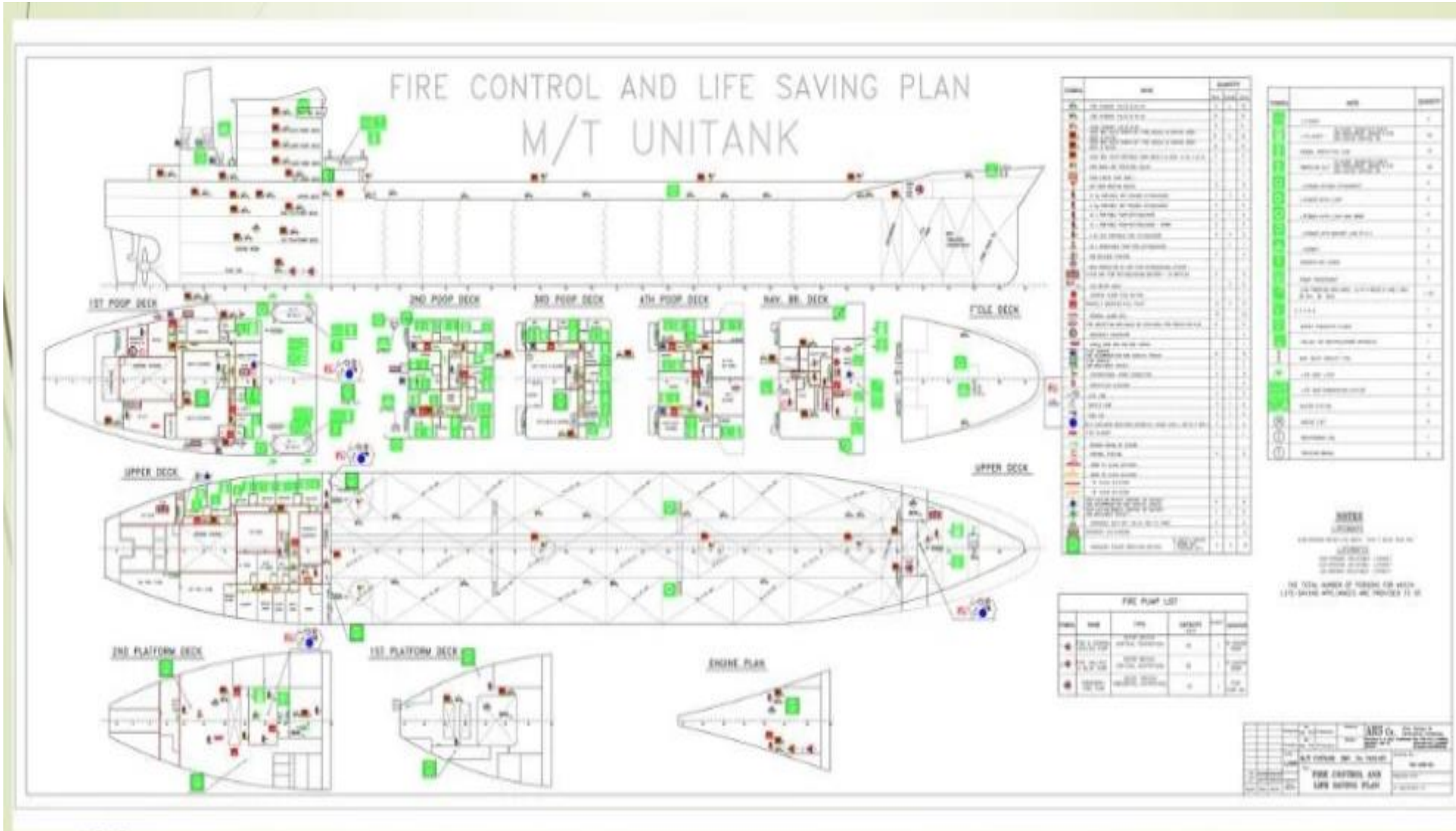
Step 6 : Ship fire zones – a simple reference


FIRE CONTROL AND LIFE SAVING PLAN
M/T UNITANK
1ST POOP DECK
2ND POOP DECK
3RD POOP DECK
4TH POOP DECK
NAV. BR. DECK
F'CLE DECK
UPPER DECK
UPPER DECK
2ND PLATFORM DECK
1ST PLATFORM DECK
ENGINE PLAN
FIRE PUMP LIST
FIRE CONTROL AND LIFE SAVING PLAN

SOLAS requirements

- SOLAS regulations require subdividing the ship by thermal and structural boundaries.The purpose of this regulation is to contain a fire in the space of origin.
- **'A' class divisions** are formed by bulkheads and decks which comply with the following:
  - ✓ made of steel or other equivalent material and suitably stiffened;
  - ✓ prevent the passage of smoke and flame to the end of the one-hour standard fire test;
  - ✓ Are insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 140 °C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180 °C above the original temperature, within the time listed below:
    - class A-60 60 minutes
    - class A-30 30 minutes
    - class A-15 15 minutes
    - class A-0 0 minutes

DNVGL OFFSHORE STANDARD DNVGL-OS-D301, Fire protection
https://rules.dnvgl.com/docs/pdf/DNVGL/OS/2017-01/DNVGL-OS-D301.pdf

SOLAS requirements

- **B class divisions** are those divisions formed by bulkheads, decks, ceilings or linings which comply with the following:
  - ✓ they shall be so constructed as to be capable of preventing the passage of flame to the end of the first half hour of the standard fire test;
  - ✓ they shall have an insulation value such that the average temperature of the unexposed side will not rise more than 140 ° C above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225 ° C above the original temperature within the time listed below:
    - class B-15 15 min
    - class B-0 0 min
- **C class divisions** are divisions constructed of approved non-combustible materials. They need meet neither requirements relative to the passage of smoke and flame nor limitations relative to the temperature rise.

SOLAS requirements

For passenger ship, ships carrying more than 36 passengers, the following division classes are applied between the adjacent spaces. Refer to SOLAS regulation for more details.

Fire integrity of bulkheads separating adjacent spaces

Spaces	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
Control stations (1)	A-0(d)	A-0	A-60	A-0	A-15	A-60	A-15	A-60(e)	A-60	*)	A-0
Corridors (2)		C	B-0	B-0 A-0(b)	B-0	A-60	A-0	A-0(e)	A-0	*)	B-0
Accommodation spaces (3)			C	B-0 A-0(b)	B-0	A-60	A-0	A-0(e)	A-0	*)	C
Stairways (4)				B-0 A-0(b)	B-0 A-0(b)	A-60	A-0	A-0(e)	A-0	*)	B-0 A-0(b)
Service spaces (low risk) (5)					C	A-60	A-0	A-0	A-0	*)	B-0
Machinery spaces of category A (6)						*)(a)	A-0(a)	A-60	A-60	*)	A-0
Other machinery spaces (7)							A-0(a) (c)	A-0	A-0	*)	A-0
Hazardous areas (8)								-	A-0	-	A-0
Service spaces (high risk) (9)									A-0(c)	*)	A-0
Open decks (10)										-	*)
Sanitary and similar spaces (11)											C

Fire integrity of decks separating adjacent spaces

Space - above below	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Control stations (1)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	A-0(e)	A-0	*)	A-0
Corridors (2)	A-0	*)	*)	A-0	*)	A-60	A-0	A-0(e)	A-0	*)	*)
Accommodation spaces (3)	A-60	A-0	*)	A-0	*)	A-60	A-0	A-0(e)	A-0	*)	*)
Stairways (4)	A-0	A-0	A-0	*)	A-0	A-60	A-0	A-0(e)	A-0	*)	A-0
Service spaces (low risk) (5)	A-15	A-0	A-0	A-0	*)	A-60	A-0	A-0	A-0	*)	A-0
Machinery spaces of category A (6)	A-60	A-60	A-60	A-60	A-60	*) (a)	A-60	A-60	A-60	*)	A-0
Other machinery spaces (7)	A15	A-0	A-0	A-0	A-0	A-0 (a)	*) (a)	A-0	A-0	*)	A-0
Hazardous areas (8)	A-60(e)	A-0(e)	A-0(e)	A-0(e)	A-0	A-60	A-0	-	A-0	-	A-0
Service spaces (high risk) (9)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0 (c)	*)	A-0
Open decks (10)	*)	*)	*)	*)	*)	*)	*)	-	*)	-	*)
Sanitary and similar spaces (11)	A-0	A-0	*)	A-0	*)	A-0	A-0	A-0	A-0	*)	*)

Notes: To be applied to Table 3 and Table 4, as appropriate.

The required fire integrity should be qualified through the conditions for the dimensioning accidental load that applies. Areas where the dimensioning fire load exceeds 100 kW/m^2, H-rated divisions shall be applied. See DNVGL-OS-A101 Sec.2.

(a) Where the space contains an emergency power source or components of an emergency power source adjoining a space containing a ship's service generator or the components of a ship's service generator, the boundary bulkhead or deck be-tween those spaces shall be an "A-60" class division.

(b) For clarification as to which note applies see [3.3.3] and [3.3.5].

(c) Where spaces are of the same numerical category and superscript "c" appears, a bulkhead or deck of the rating shown in the tables is only required when the adjacent spaces are for a different purpose, e.g. in category (9). A galley next to a galley does not require a bulkhead but a galley next to a paint room requires an "A-0" bulkhead.

(d) Bulkheads separating the navigating bridge, chartroom and radio room from each other may be "B-0" rating.

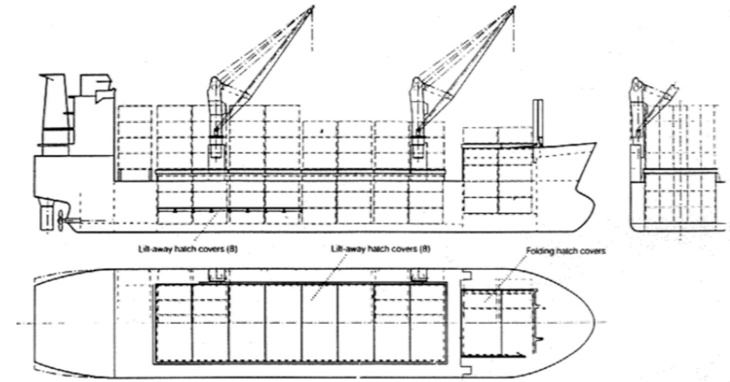
(e) An engineering evaluation shall be conducted in accordance with [3.3.1]. In no case shall the bulkhead or deck rating be less than the value indicated in the tables.

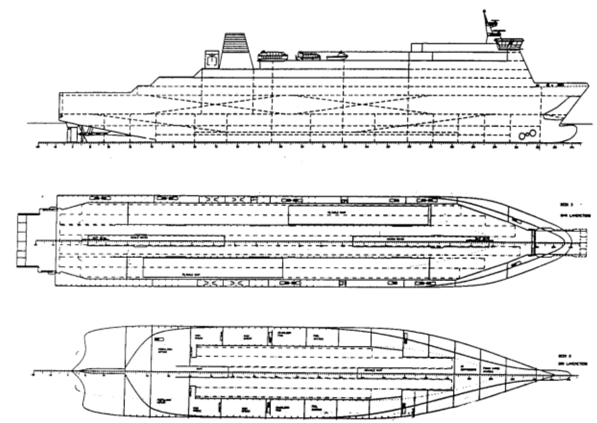
*) Where an asterisk appears in the tables, the division shall be of steel or equivalent material, but need not be of "A" class standard. However, where a deck is penetrated for the passage of electric cables, pipes and vent ducts, such penetrations shall be made tight to prevent the passage of flame and smoke.

Summary

A well-designed GA is vital for a ship's functionality and safety

- Defined considering the ships functional requirements, (safety) regulations, and business model
  - *In passenger ships, the GA strongly affects the passengers' onboard experience*
- GA development is based on empiricism and in house procedures
- Structural continuity is necessary to limit stress concentrations
- Subdivision and general ergonomics are important





Aalto University
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Thank you