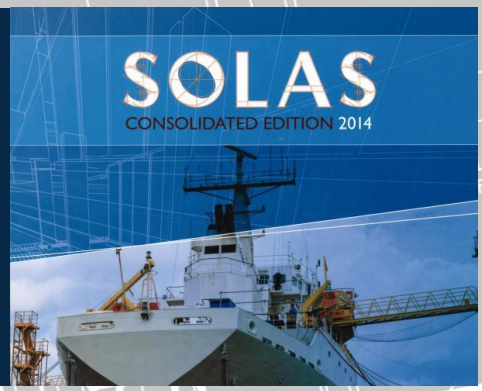
Rules & Regulations

AND HOW THEY AFFECT PASSENGER SHIP DESIGN

July 2020



FORESHIP
AT THE SHARP END

What are the rules and who makes them?

IMO

- **International Maritime Organization**
- United Nations Specialized Agency with responsibility for the **safety** and **security** of shipping and **prevention of marine pollution** by ships.
- Established 1948
- Headquarters in London
- 170 member states
- Makes rules for International Shipping
- Different technical committees and sub-committees:
  - MSC (Maritime Safety Committee)
  - MEPC (Maritime Environmental Protection Committee)
  - HTW (Human Element Training & Watchkeeping)
  - SDC (Sub-Committee on Ship Design and Construction)
  - etc.

IMO Regulations

IMO regulations have different status with different level of details:

1. Conventions:
   - SOLAS
   - MARPOL
   - Load Lines, COLREG, Ship's Ballast Water and Sediments, Recycling of ships...
2. Codes (more detailed technical requirements for ship types, equipment and materials):
   - High Speed Craft Code, Special Purpose Ships Code, IBC, IGC, (Ship types)
   - Polar Code, IGF, IMDG (Special features)
   - Fire Safety Systems, Fire Test Procedures, LSA, (Systems, materials, equipment)
3. Resolutions (Amendments of conventions and Codes, more detailed and clarified requirements):
   - Issued by Assembly, MSC and MEPC other committees
4. Circulars (More detailed requirements, unified interpretations, testing methods, guidelines):
   - Issued by Assembly, MSC, MEPC and other committees and sub-committees

For example, fire test procedures are described in FTP code

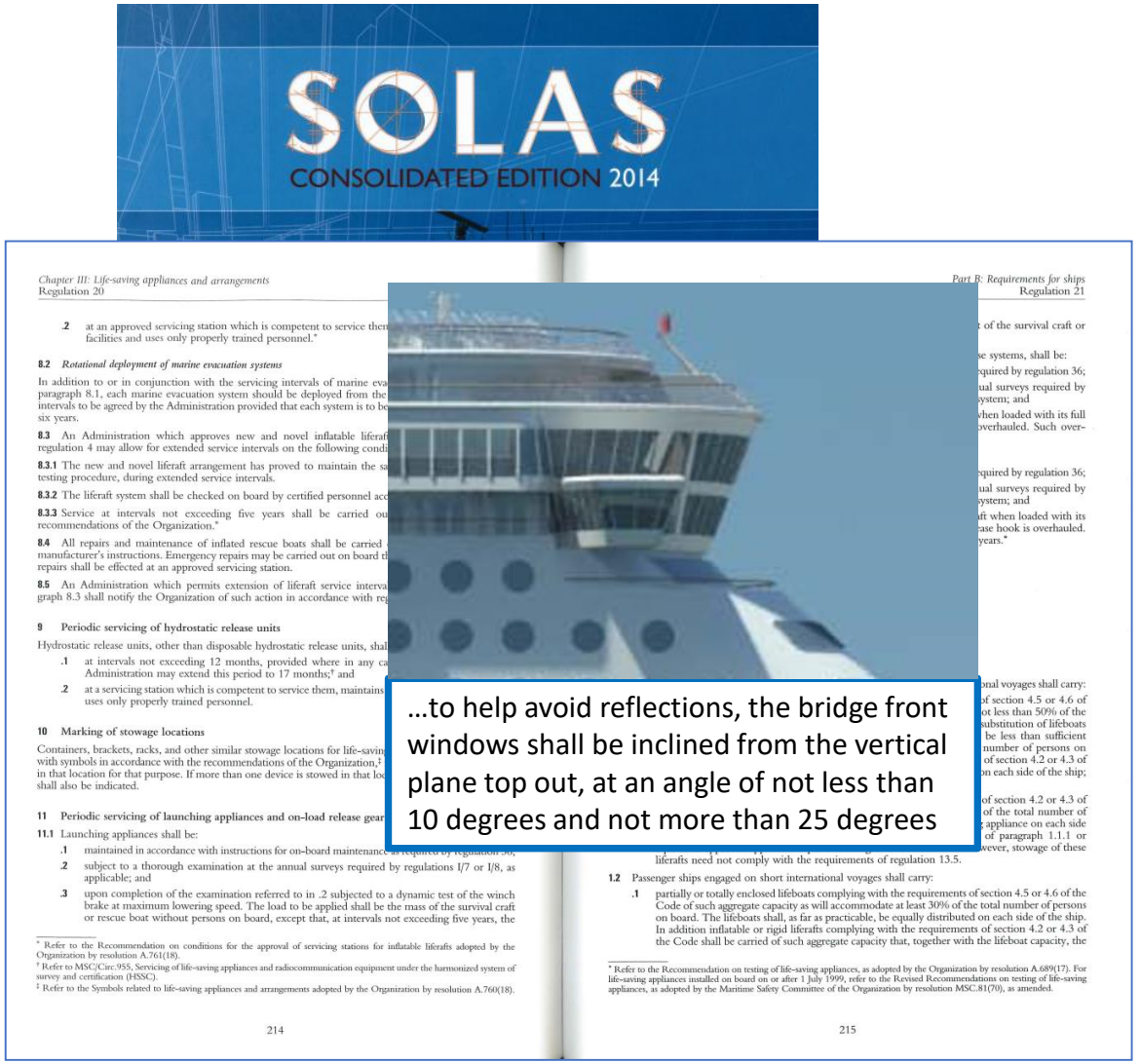
For example, dimensioning of escape routes is defined in FSS Code.

IMO Vega Database is a good way to find all IMO regulations.

SOLAS

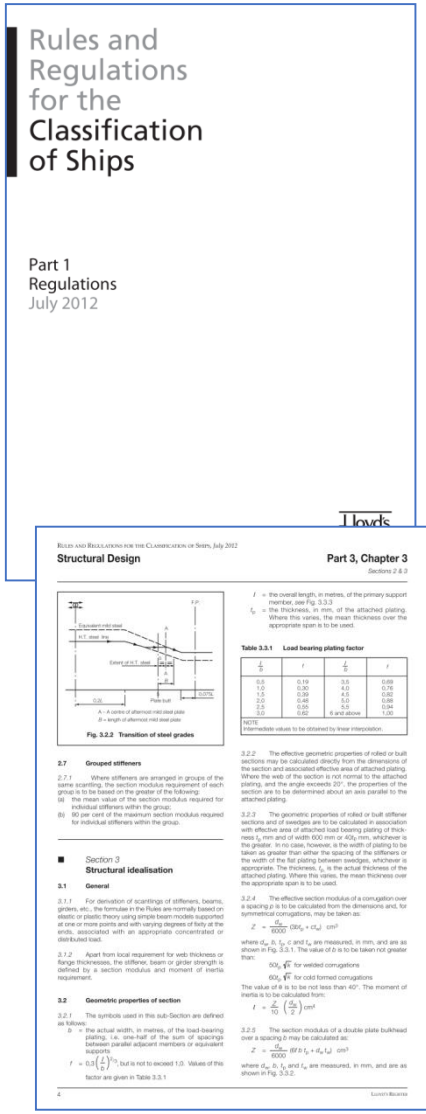
Best known rule book is **SOLAS**

- International Convention for the **Safety Of Life At Sea**
- Rules came because of sinking of Titanic
- Governs structures, stability, life saving, fire protection, radio communications, etc.
- Published by IMO



Classification Societies

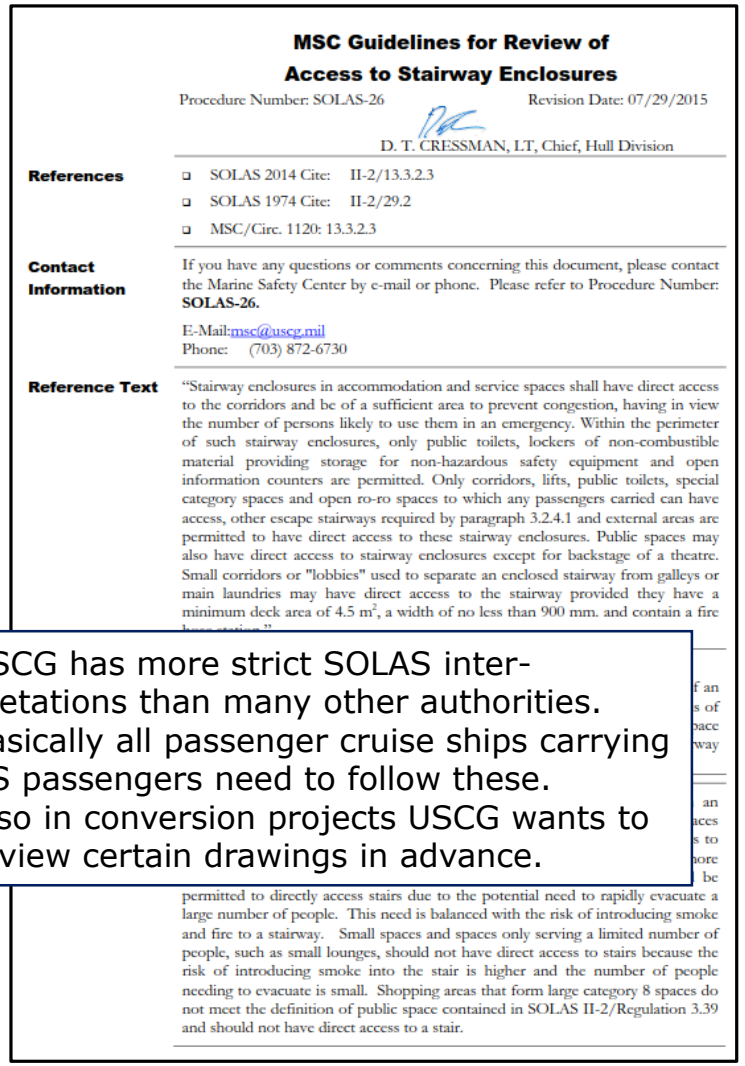
- Classification Societies have own regulations.
- Well known Classification Societies are:
  - DNVGL (Det Norske Veritas + Germanischer Lloyd)
  - LR (Lloyd's Register)
  - BV (Bureau Veritas)
  - ABS (American Bureau of Shipping)
  - RINA (Registro Italiano Navale)
- Classification is required for every ship.
  - At minimum for the Owner to be able to insure the ship.
  - SOLAS requires classification, and so do some EU directives.
- Regulations concentrate mainly on:
  - Structures
  - Machinery & Piping System
  - Control & Electrical Systems
  - Ice & Cold Operations
  - Special Class Notations



Flag States

- Most of Passenger Cruise Ships fly Flag of Convenience (Bahamas, Panama, Malta…), in which case the Classification Society (RO) usually takes care of approval process for their behalf.
- "Regular" flags (including Finland and Sweden) are also delegating more and more approvals to Class Societies.
- However, "Alternative Design" or far reaching interpretations cannot be approved without Flag.
- Other than Flags of Convenience can have regulations affecting the design: for example, some flags (=unions) require that all crew cabins have windows.
- Even if not US flagged, all cruise ships visiting US ports and carrying US passengers have to fulfill certain regulations of USCG (United States Coast Guard). Ships carrying US passengers and arriving first time in a US port have to pass a USCG ICVE (Initial Control Verification Examination).





MSC Guidelines for Review of Access to Stairway Enclosures

Procedure Number: SOLAS-26 Revision Date: 07/29/2015

D. T. CRESSMAN, LT, Chief, Hull Division

References
- SOLAS 2014 Cite: II-2/13.3.2.3
- SOLAS 1974 Cite: II-2/29.2
- MSC/Circ. 1120: 13.3.2.3

Contact Information

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone. Please refer to Procedure Number: **SOLAS-26.**

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Phone: (703) 872-6730

Reference Text

"Stairway enclosures in accommodation and service spaces shall have direct access to the corridors and be of a sufficient area to prevent congestion, having in view the number of persons likely to use them in an emergency. Within the perimeter of such stairway enclosures, only public toilets, lockers of non-combustible material providing storage for non-hazardous safety equipment and open information counters are permitted. Only corridors, lifts, public toilets, special category spaces and open ro-ro spaces to which any passengers carried can have access, other escape stairways required by paragraph 3.2.4.1 and external areas are permitted to have direct access to these stairway enclosures. Public spaces may also have direct access to stairway enclosures except for backstage of a theatre. Small corridors or "lobbies" used to separate an enclosed stairway from galleys or main laundries may have direct access to the stairway provided they have a minimum deck area of 4.5 m^2, a width of no less than 900 mm. and contain a fire

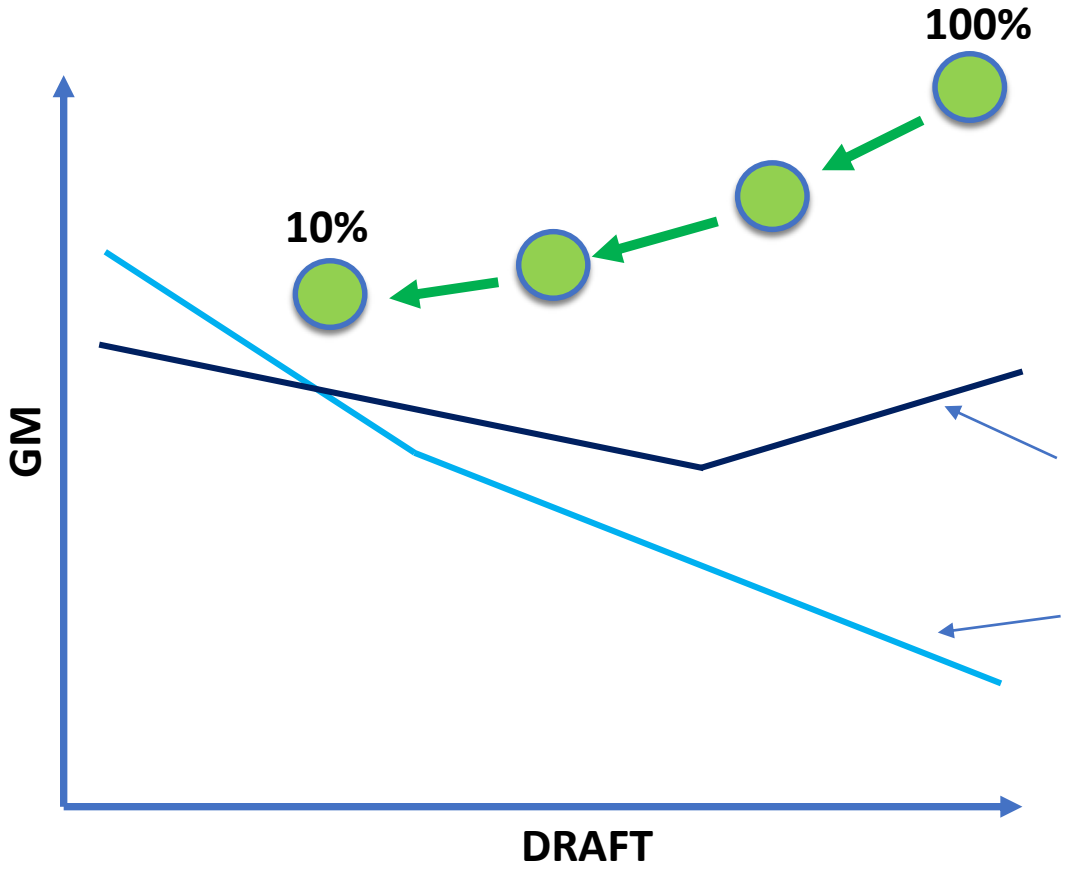
permitted to directly access stairs due to the potential need to rapidly evacuate a large number of people. This need is balanced with the risk of introducing smoke and fire to a stairway. Small spaces and spaces only serving a limited number of people, such as small lounges, should not have direct access to stairs because the risk of introducing smoke into the stair is higher and the number of people needing to evacuate is small. Shopping areas that form large category 8 spaces do not meet the definition of public space contained in SOLAS II-2/Regulation 3.39 and should not have direct access to a stair.

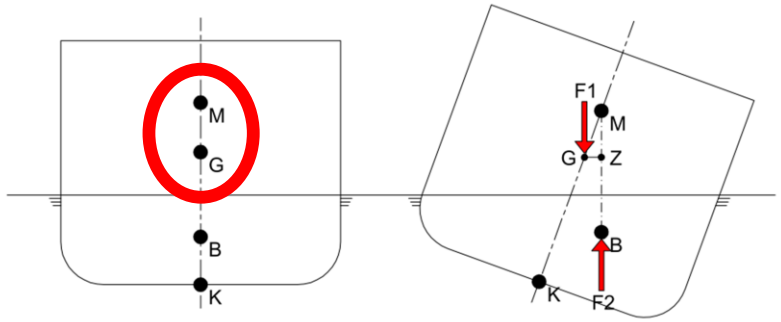
USCG has more strict SOLAS inter-pretations than many other authorities. Basically all passenger cruise ships carrying US passengers need to follow these.
Also in conversion projects USCG wants to review certain drawings in advance.

Stability

Stability; principles

- All vessel loading conditions need to meet stability criteria.
- In daily use stability criteria are calculated into GM limit curves.



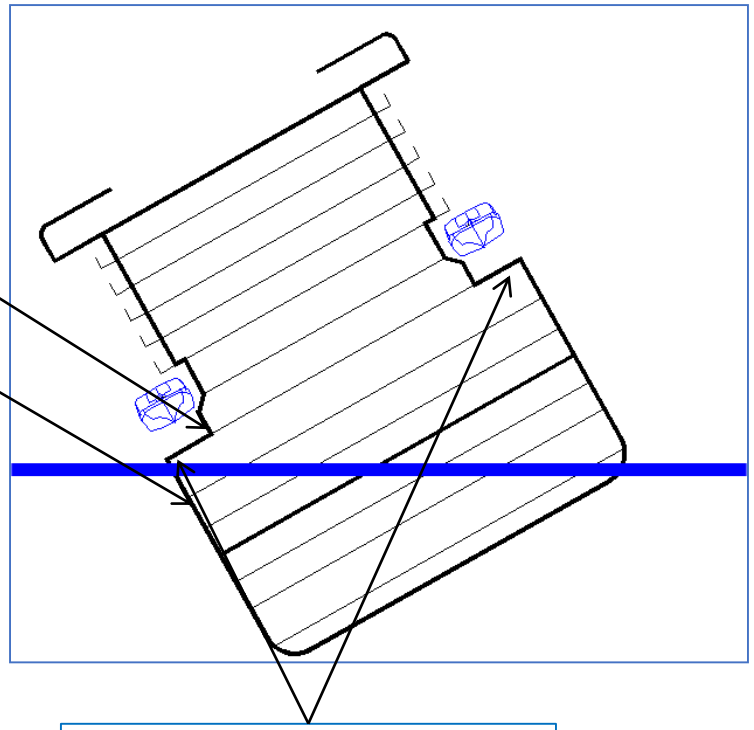


DAMAGE STABILITY LIMIT

INTACT STABILITY LIMIT

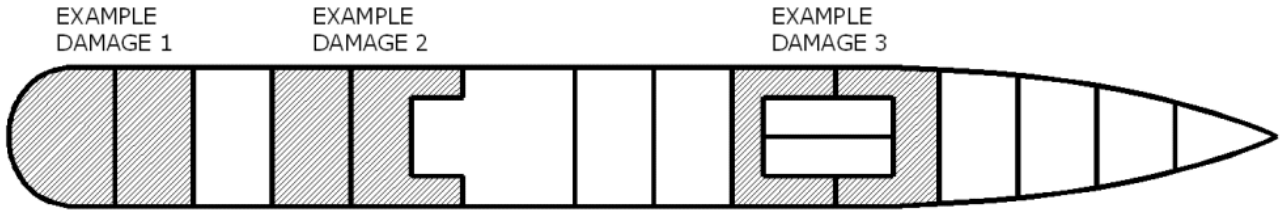
Stability; principles

- Basic requirement for intact stability is a good hull geometry, i.e. main dimensions with proper proportions and not too high or too narrow ship.
- There should be no openings in lower part of ship. Watertight shell doors and weather tight doors are possible.

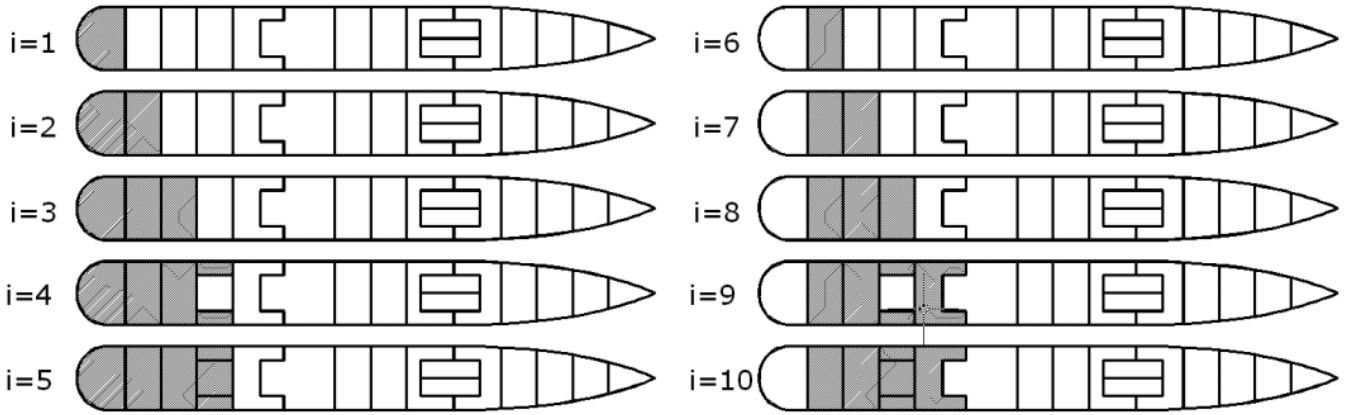


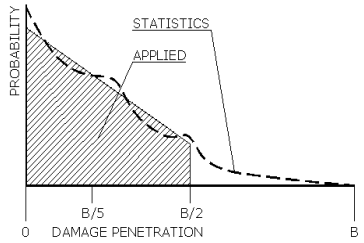
Damage Stability

- For older ships (before 2009) the damage stability was simple: the ship had to survive any damage into two adjacent compartments damage was no deeper than beam/5. Smaller ships were ok with one compartment damages only.



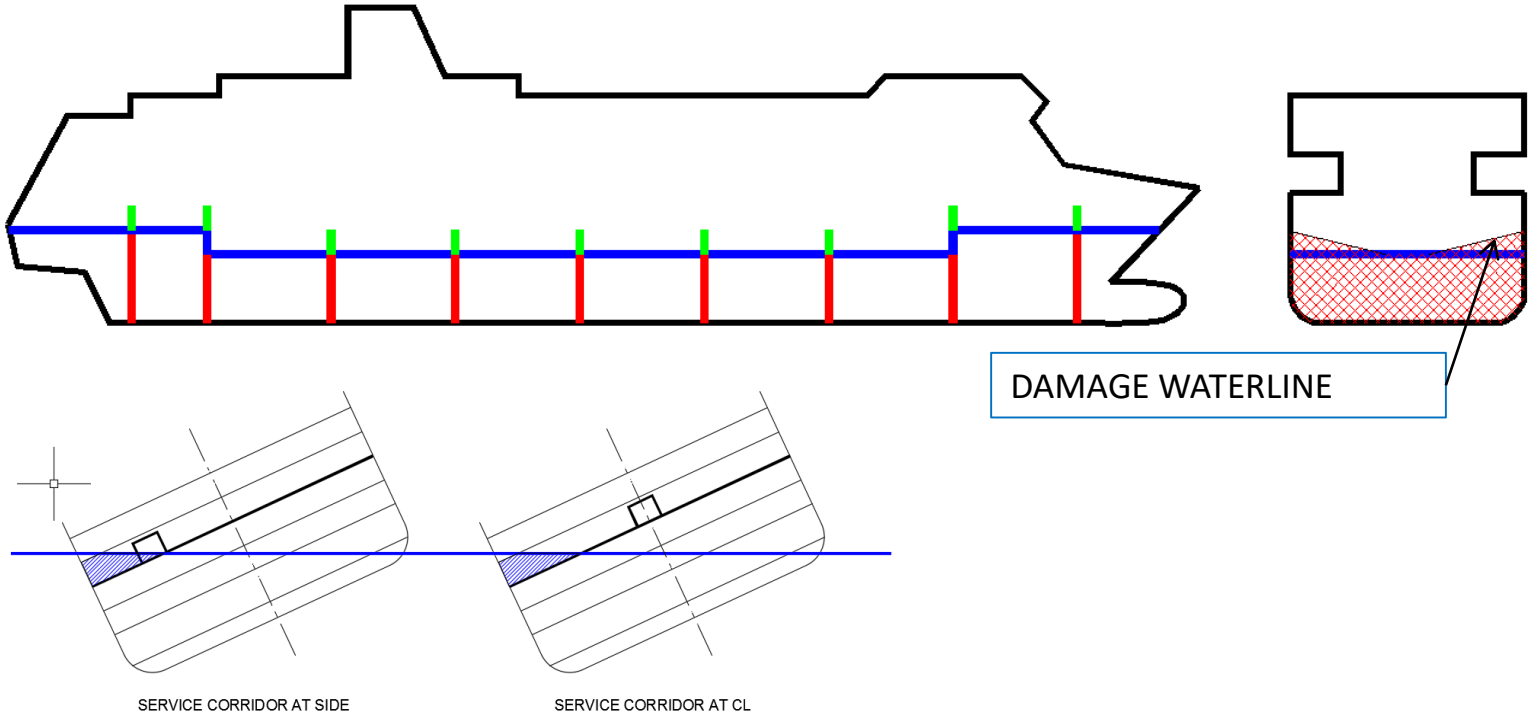
- **SOLAS 2009** introduced Probabilistic Damage Stability.
- These rules are much more complex and hundreds of different damage scenarios are calculated to find out the "probability of survival in case of collision".





Damage Stability

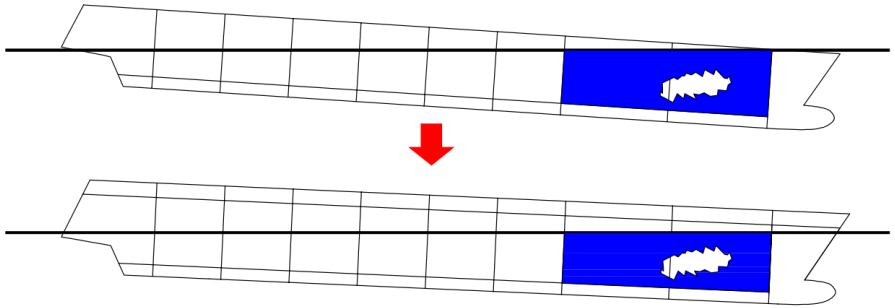
- Damage stability requires consideration from the beginning of GA development. It is important is to locate service corridors, stairs and similar open spaces close to the centerline.
- Watertight bulkheads should continue at sides of bulkhead deck (as semi-wt bulkheads). Also often even on deck above.
- To avoid semi-wt bulkheads e.g. in dining room, watertight deck could be used as an alternative.



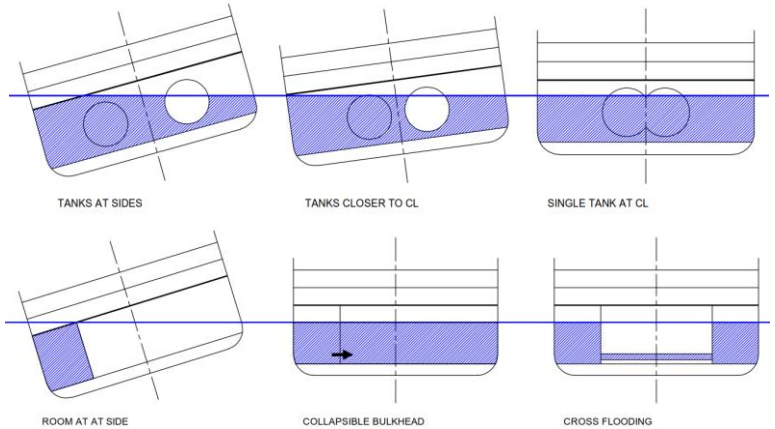
Things needed to fulfill SOLAS 2020 damage stability

- Often wider ship is needed, but, e.g., the following needs to be considered:

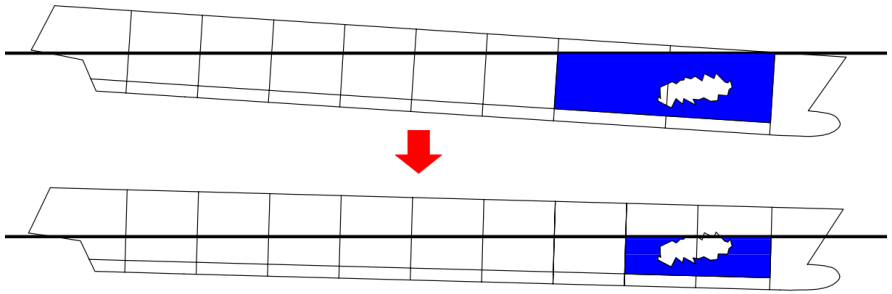
RAISED BULKHEAD DECK



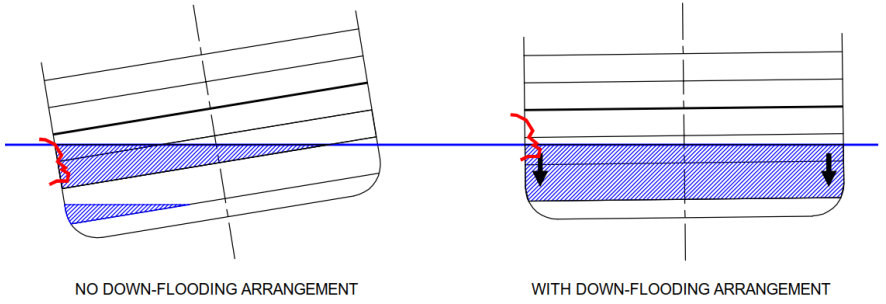
REDUCED ASYMMETRY



MORE COMPARTMENTS



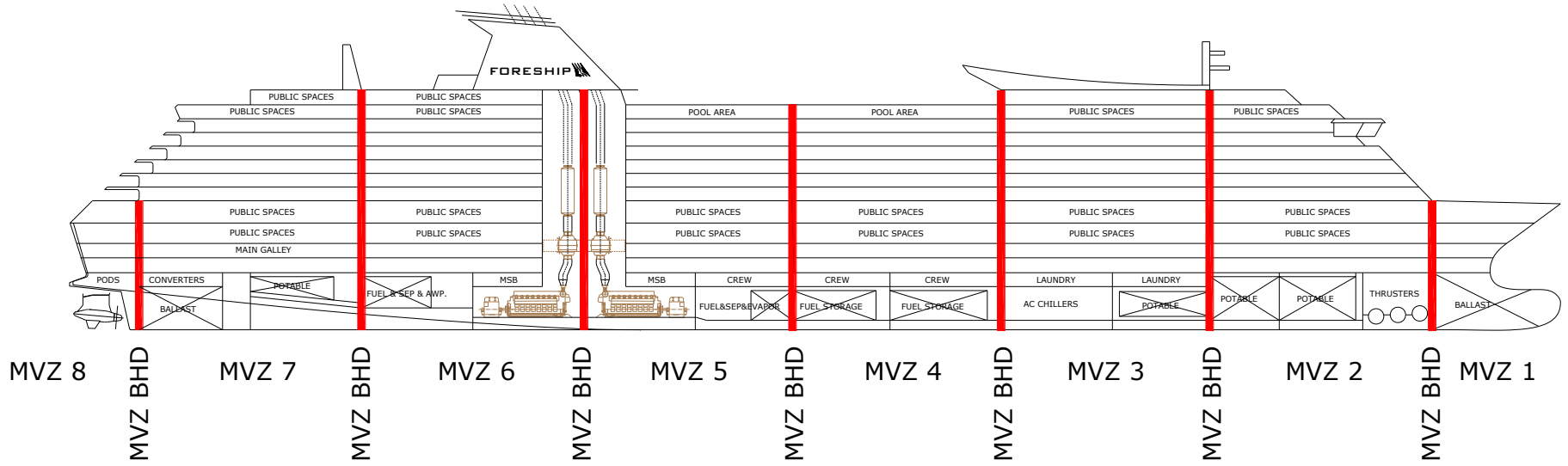
DOWN-FLOODING ARRANGEMENTS



Structural Fire Protection

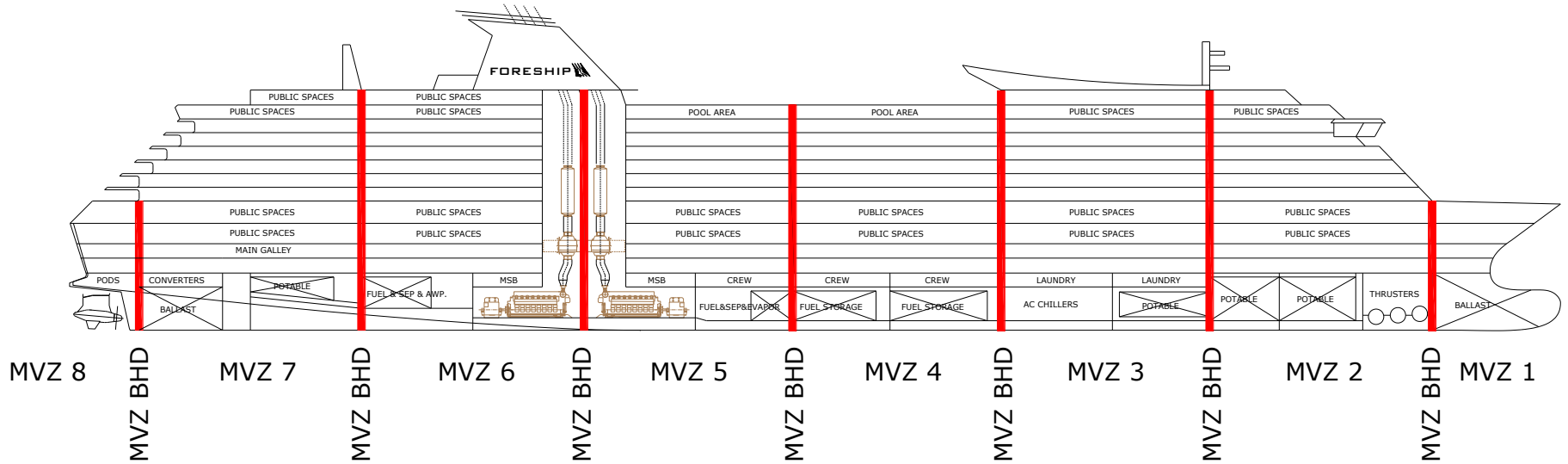
Structural Fire Protection

- Structural fire protection is the fire integrity of the bulkheads and decks between the spaces on the vessel.
- The principal idea on any cruise ship is that even if none of the fire fighting devices work and the fire can spread onboard, the vessel will in any case provide adequate safety for one hour for safe evacuation of the ship.
- The frame of structural fire protection are the Main Vertical Zones (MVZ) and Main Vertical Zone Bulkheads (MVZ BHD). Main Vertical Zones are also called Main Fire Zones.



Main Vertical Zones (MVZ)

- Main Vertical Zone bulkheads should match the watertight bulkheads.
- MVZBHD should not have steps.
- MVZs are typically numbered from fore to aft.
- As per SOLAS the maximum MVZ length is 48 m.
- As per SOLAS the maximum MVZ are on any deck is 1,600 m^2.
- Utilizing "**Alternative Design**" many new large ships now have MVZs exceeding these limits, both in length and area.



Room Categories

- Every room on a ship has a category depending the use and purpose of the room. On passenger ships there are 14 categories.
  - 1: Control Stations (Bridge, Engine Control Room…)
  - 2: Stairways
  - 3: Corridors
  - 4: Evacuation Stations and external escape ways
  - 5: Open deck spaces
  - 6: Accommodation spaces of minor fire risk
  - 7: Accommodation spaces of moderate fire risk (public spaces $<50m^2$)
  - 8: Accommodation spaces of greater fire risk (public sp. $\geq 50m^2$)
  - 9: Sanitary and similar spaces (bathrooms, some pantries…)
  - 10: Tanks, voids and auxiliary machinery spaces having little or no fire risk
  - 11: Auxiliary machinery spaces, cargo spaces … of moderate fire risk
  - 12: Machinery spaces and main galleys
  - 13: Store rooms, workshops, pantries
  - 14: Other spaces in which flammable liquids are stored
- Rooms can also have combined categories, like 8/4 for public spaces used as an assembly station.

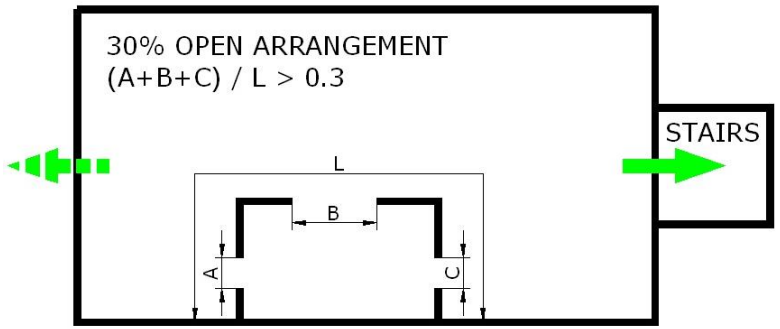
Room Categories vs. Fire Integrity

- The fire integrity between different spaces depends on the room category. SOLAS has tables both for bulkheads (below) and for decks.
- Examples: galley(12) vs. restaurant(8) ⇒ A-60 (=insulated steel bulkhead)
- Restaurant(8) vs. Restaurant(8) ⇒ B-0 (=lighter bulkhead)

Spaces		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Control stations	(1)	B-0[a]	A-0	A-0	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-60
Stairways	(2)		A-0[a]	A-0	A-0	A-0	A-0	A-15	A-15	A-0[c]	A-0	A-15	A-30	A-15	A-30
Corridors	(3)			B-15	A-60	A-0	B-15	B-15	B-15	B-15	A-0	A-15	A-30	A-0	A-30
Evacuation stations and external escape routes	(4)					A-0	A-60[b,d]	A-60[b,d]	A-60[b,d]	A-0[d]	A-0	A-60[b]	A-60[b]	A-60[b]	A-60[b]
Open deck spaces	(5)						A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk	(6)						B-0	B-0	B-0	C	A-0	A-0	A-30	A-0	A-30
Accommodation spaces of moderate fire risk	(7)							B-0	B-0	C	A-0	A-15	A-60	A-15	A-60
Accommodation spaces of greater fire risk	(8)								B-0	C	A-0	A-30	A-60	A-15	A-60
Sanitary and similar spaces	(9)									C	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk	(10)										A-0[a]	A-0	A-0	A-0	A-0
Auxiliary machinery spaces, cargo spaces, cargo and other oil tanks and other similar spaces of moderate fire risk	(11)											A-0[a]	A-0	A-0	A-15
Machinery spaces and main galleys	(12)												A-0[a]	A-0	A-60
Store-rooms, workshops, pantries, etc.	(13)													A-0[a]	A-0
Other spaces in which flammable liquids are stowed	(14)														A-30

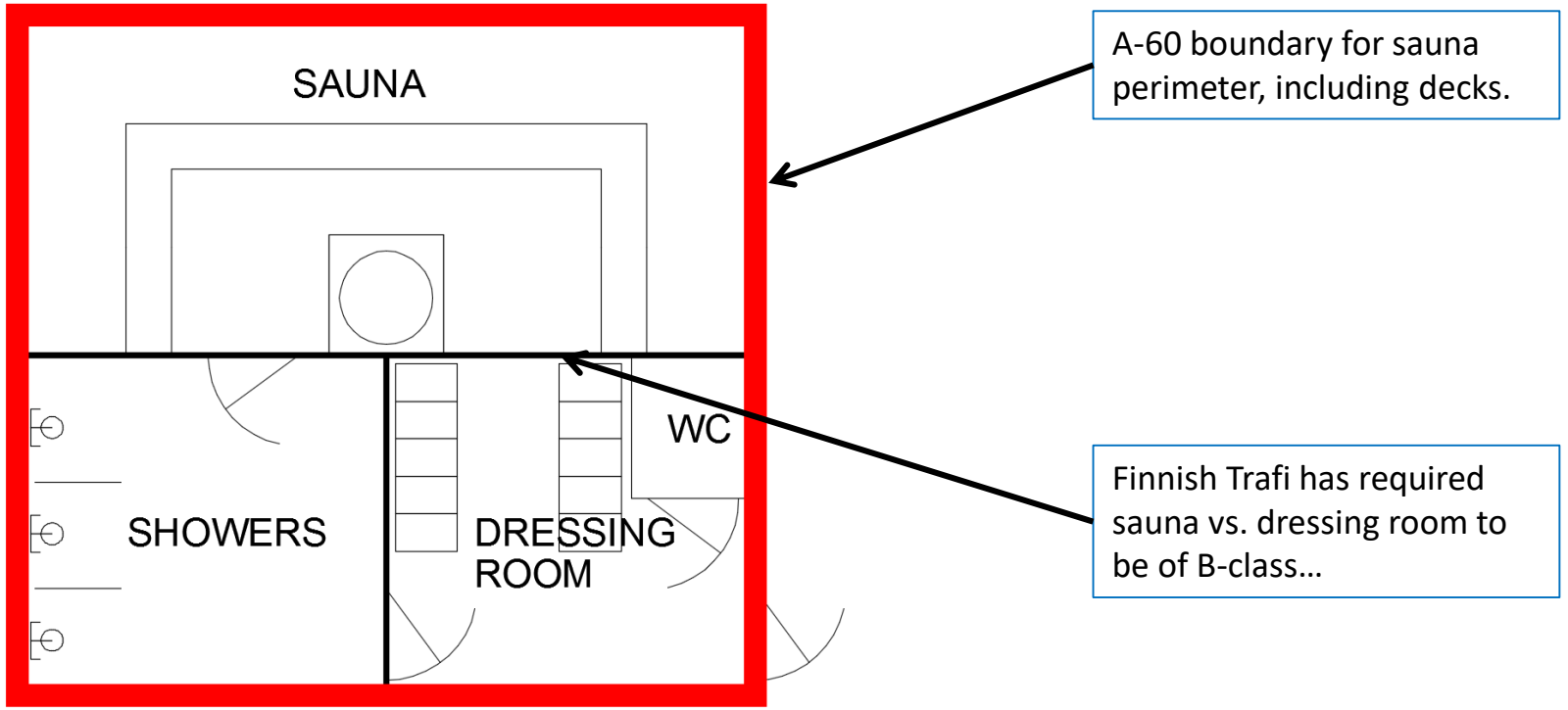
30% Open Spaces

- Two spaces have to always be separated with a bulkhead of proper fire integrity glass.
- Doors, glass, etc. in bulkhead have to have the same fire class than the bulkhead itself.
- However, if the spaces are 30% open between each other, this partial bulkhead does not need to follow tables.
- In some cases (BV) part of 30% can be of glass, but for example, USCG and DNVGL say glass cannot be taken into account when calculation 30% opening.
- USCG (and some others) include 30% rule also to decks, valid for "*deck openings that are less than 30% open, relative to the surface area of the lower space*"; in these cases additional sprinklers around the opening and additional fire alarms are needed, but still the opening should be no less than 11%.



Saunas

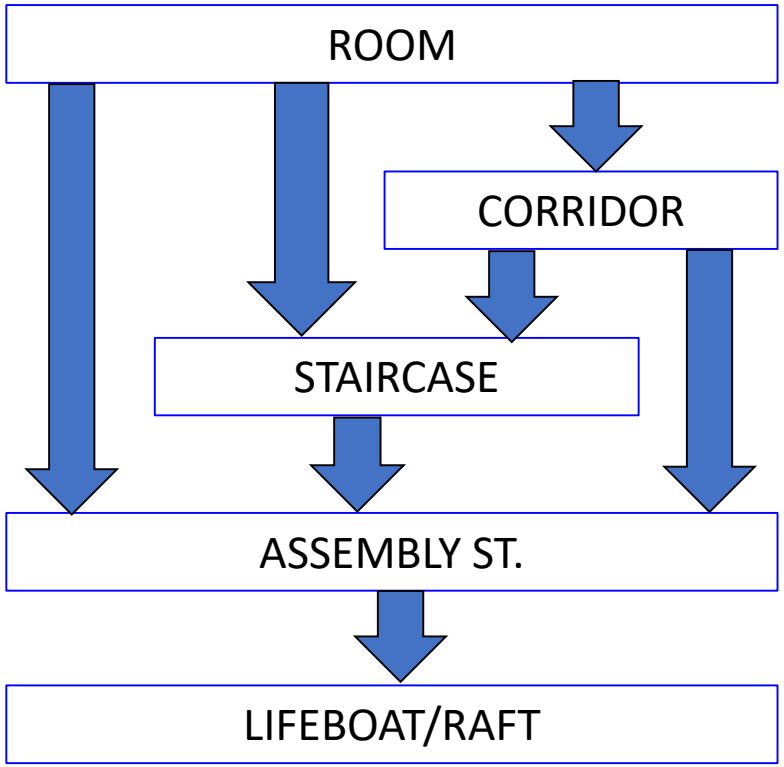
- Sauna is special case mentioned in SOLAS:
  - No bulkhead requirements within A-60 sauna perimeter.
  - Wooden lining and benches allowed in sauna.
  - Sauna perimeter can include sauna, shower, dressing room and toilet.



Escapes & Evacuation

Escapes & Evacuation

- Every space on ship needs to have proper escape.
- The escape has to be protected (i.e. it cannot normally go to outside)
- The escape has to lead to an assembly station (and to open deck).
- The main flow of evacuation route is the following:



(cat, 8, 7, 6…)

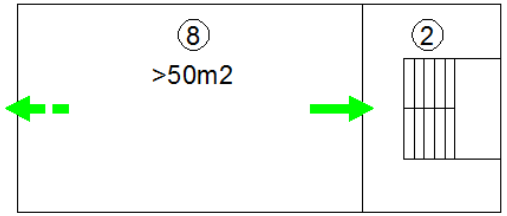
(cat. 3)

(cat. 2)

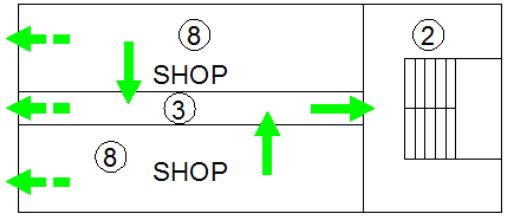
(cat. 4)

Escapes

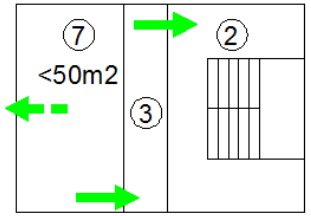
- Every room needs an escape. If the room is larger than 28 m^2 (USCG), two escapes are needed (one primary, one secondary, or two primaries). There can be exemptions to this depending on the use/occupancy of space. France requires two exits if public spaces is dedicated for more than 50 person…
- The primary escape (EXIT) needs to lead to a corridor or to a staircase. It can also lead directly to an assembly station.
- The secondary escape (EMERGENCY EXIT) can lead to another space, open deck, corridor, etc. But not to the same place than primary.
- Only the following spaces are allowed to open directly into a staircase: corridors, large (>50m^2 & >50p, USCG) public spaces, bathrooms, open decks.
- For example, offices, small public spaces (<50m^2), shops, reception areas, beauty parlors, galleys, etc. cannot directly open into staircase, but need a corridor (or a lobby) between room and staircase.
- Primary escape cannot be through wt- or semi-wt-door.
- Instead of primary and secondary escapes, you can have two primary escapes.



TWO ESCAPES ARE NEEDED



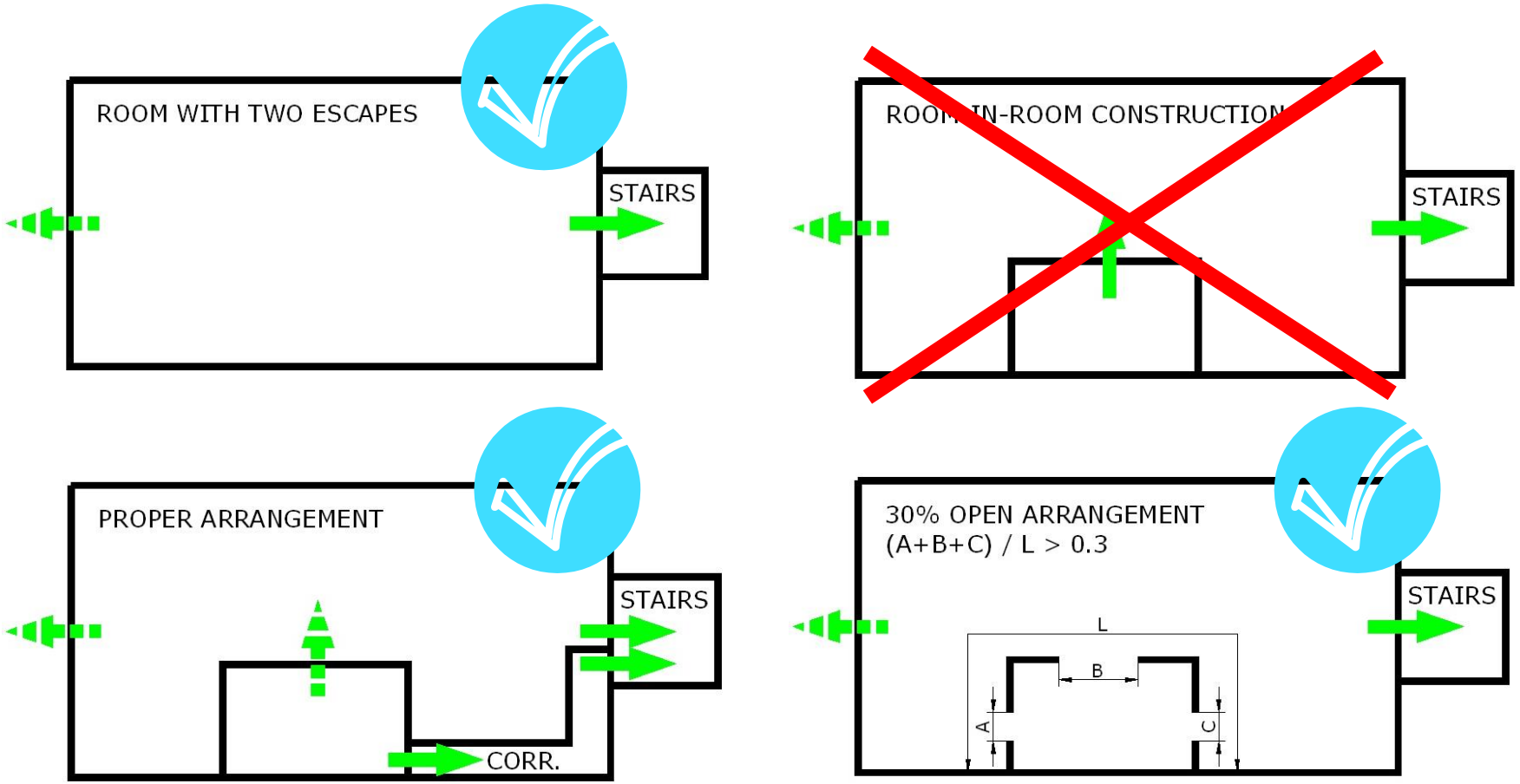
SHOPS CANNOT OPEN DIRECTLY INTO STAIRS



SMALL ROOMS CANNOT OPEN DIRECTLY INTO STAIRS

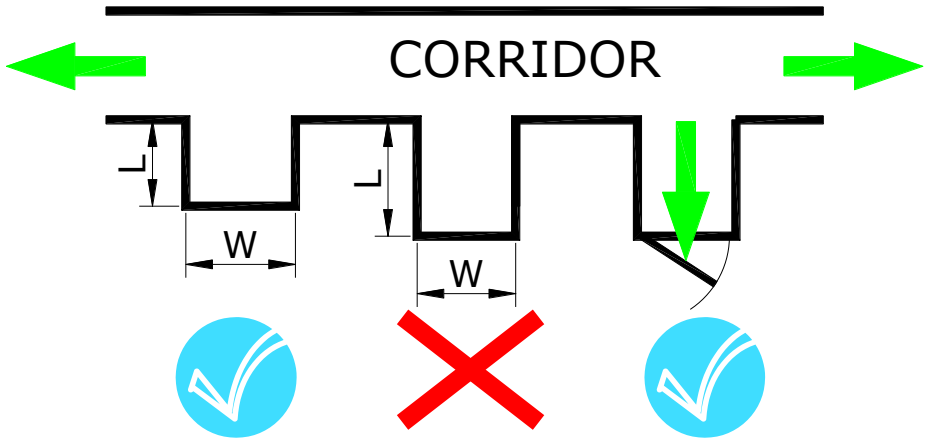
Room-in-Room Construction

As a principle, a room cannot have a primary escape into another room.



Dead-End Corridors

- So called dead-end corridors are not allowed.
- This is only valid for corridors, i.e. category (3) spaces*, not for stairs or public spaces.
- If corridor, which length is more that its width, it is a “dead-end”.
- To avoid dead-end, corridor needs to leave somewhere from where there is another escape route.



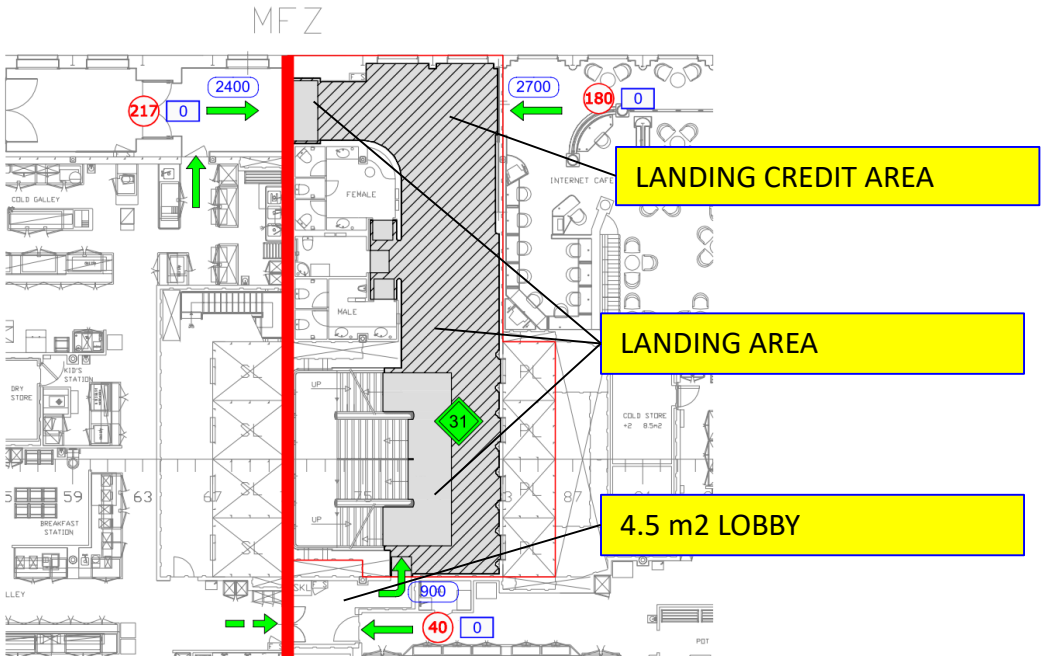
* But, for example, space below stairs (2) on the lowest level may need to protected from “dead-end” access.

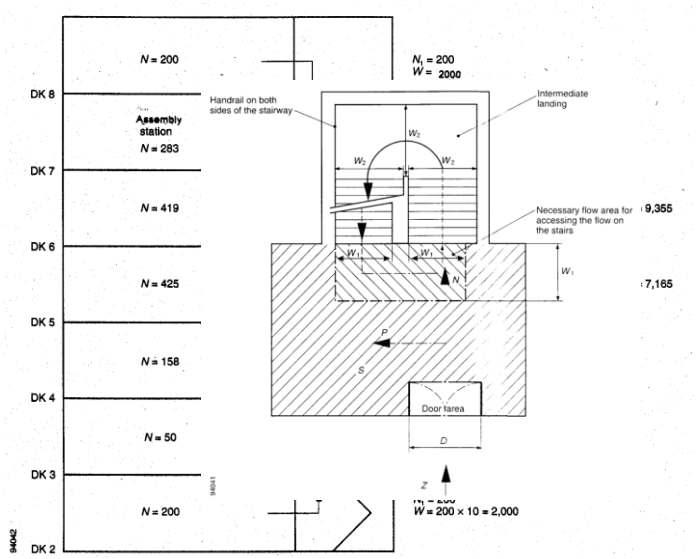
Doors, Corridors & Stairs

- The width of doors, stairs and corridors depend on the number of escaping persons.
- The minimum free width of any escape is 900 mm.
- Every escaping persons above needs 10 mm of free width.
- Examples of required widths or doors and corridors:
  - Restaurant with 50 seats + 5 crew: escape width 0.9 m
  - Restaurant with 110 seats + 10 crew: escape width 0.925 m
  - Restaurant with 1,000 seats + 25 crew: escape width 7.75 m
  - Theater with 2,000 seats + 50 crew: escape width 15.50 m
  - 50 pax cabins, 4 persons in each: escape width 2.0 m
- The required escape width can be a combination of several doors.
- Currently open deck spaces (e.g. sun decks) need not to be included into escape calculations.
- All corridors and stairs need to have Low Location Lighting (LLL).

Staircases

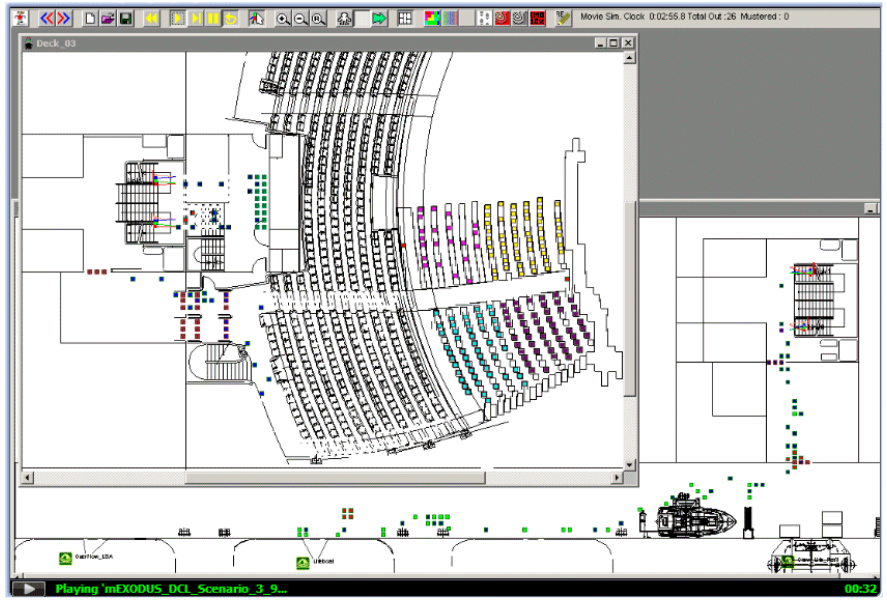
- Stair width examples:
  - 4 decks, each 200 pax in cabins, no landing credit area (LCA): 5.500 m
  - 4 decks, each 200 pax in cabins, full LCA: 4.125 m
  - 2 decks, each 1,000 pax and 50 crew in public, no LCA: 16.0 m
  - 2 decks, each 1,000 pax and 50 crew in public , full LCA: 12.0 m
- Large public spaces on top of each other and far away from assembly stations require very large stairs!





Evacuation Analysis & Simulation

- Evacuation analysis will be mandatory for all passengers vessels built on or after 1.1.2020. For ferries it is already mandatory now.
- Evacuation and/or smoke simulation is often used to proof the safety of “Alternative Designs” (extra large MVZs, extra large lifeboats, etc…)

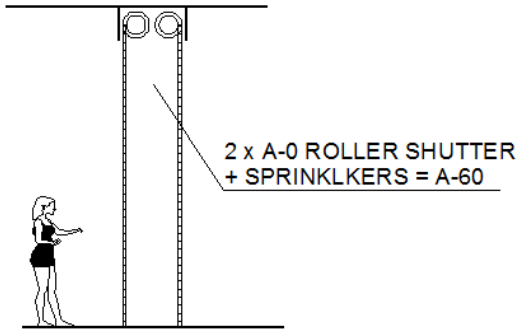


Assembly Stations

- In case of emergency passengers go to assembly stations, and when required, from there to lifeboats and to life rafts.
- Assembly stations have to accommodate all the persons escaping to that assembly stations, and has to have area of at least 0.35 m^2 per person. Note that this 0.35 m^2 is probably not adequate for comfort, so typically more should be provided.
- Assembly stations can be located on open deck (boat deck) or in public spaces, and they need to be close to boat deck. Note that open deck is not always accepted (e.g. Polar Code).
- On ferries, assembly station cannot be further than two decks away from any passenger space.
- Escapes from assembly station to boats do not need to be more than 1,500 mm wide unless normal occupancy of space so requires. If there is e.g. 100 persons in the assembly station, then less than 1,500 mm is adequate.

Doors

- Ships have several types of different doors:
  - A-class fire doors (in A-class bulkheads)
  - B-class doors (in B-class bulkheads)
  - C-class doors (in C-class bulkheads)
  - Watertight doors (in watertight bulkheads)
  - “Semi-watertight doors” (on or above bulkhead deck, in partial wt-bulkheads, actually wt-doors with reduced pressure head)
  - Weather tight doors (exterior doors on lower decks)
  - Shell doors (doors in ship’s hull)
  - Exterior doors
- Doors have to always open into the way of escape, except cabin doors
- Doors can be of different type: leaf, sliding, rolling…



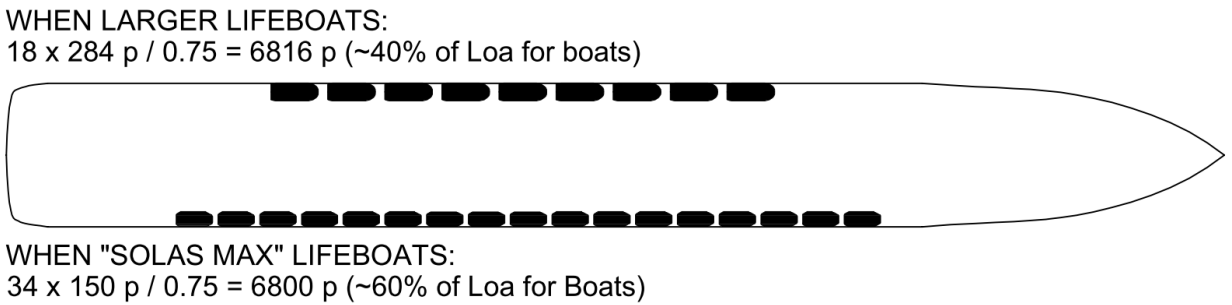
Life Saving Appliances

Lifeboats, life rafts, MES, rescue boats, lifebuoys, lifejackets, immersion suits, anti-exposure suits…

Lifeboats, Capacity

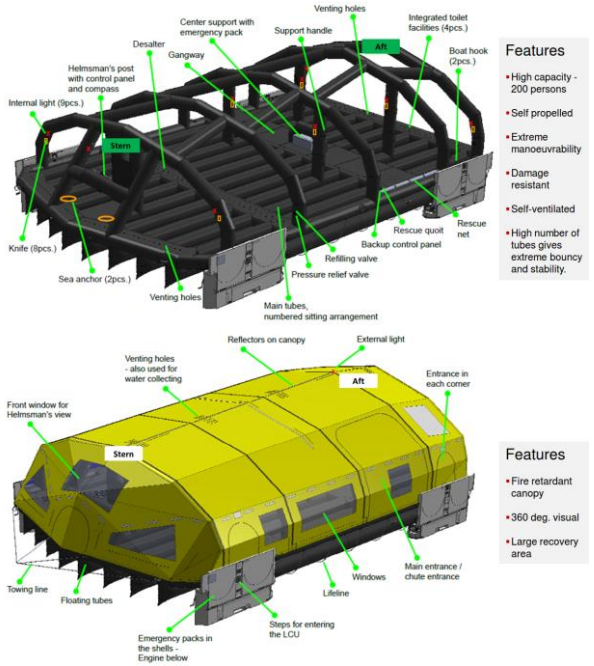
- LSA Code: "*No lifeboat shall be approved to accommodate more than 150 persons*."
- However, larger boats are today a standard on bigger ships, enabled by "Alternative Design". For example:
  - Oasis of the Seas: ~370 persons
  - Norwegian Epic: ~290 persons
  - Disney Dream: ~290 persons
  - Genting World: ~314 persons

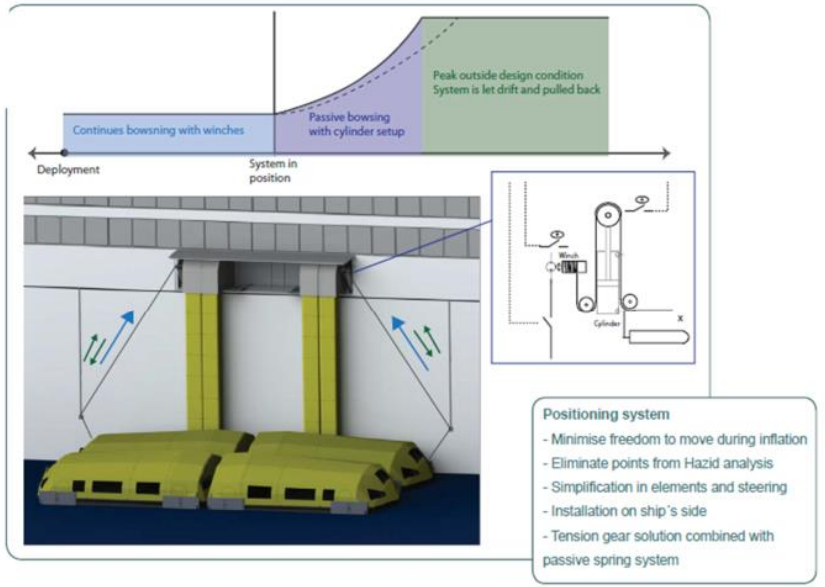
Example: ship with 6,800 persons onboard:



AES: Advanced Evacuation System

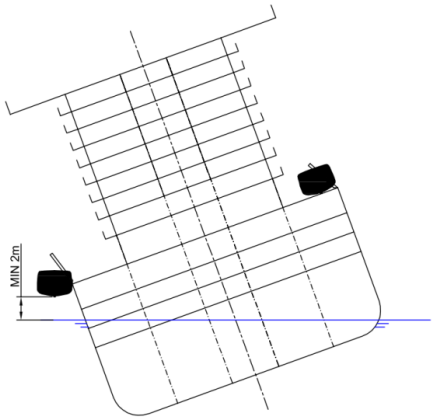
- "Inflatable" lifeboats with motor, capacity e.g. 800+ person per unit
- Requires alternative design
- Will allow new and different designs

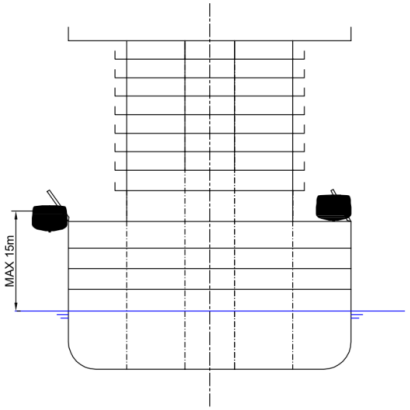




Lifeboat Location

- One of the first checks in GA are:
  - At 20° heeling angle no less than 2 m from water to boat keel (Class can approve smaller angle, but no less than 15°).
  - Lifeboat hook / davit head no more than 15 m from water.
- 10° trim does not work on large passenger ships, and thus smaller angles are approved. These can be proven by damage stability calculation.
- As with other rules, these can also be discussed and other solutions be presented and justified. For example, QM2 has lifeboats higher up due to her operation in heavy weather areas and some ship do not fulfill the 20°requirement.

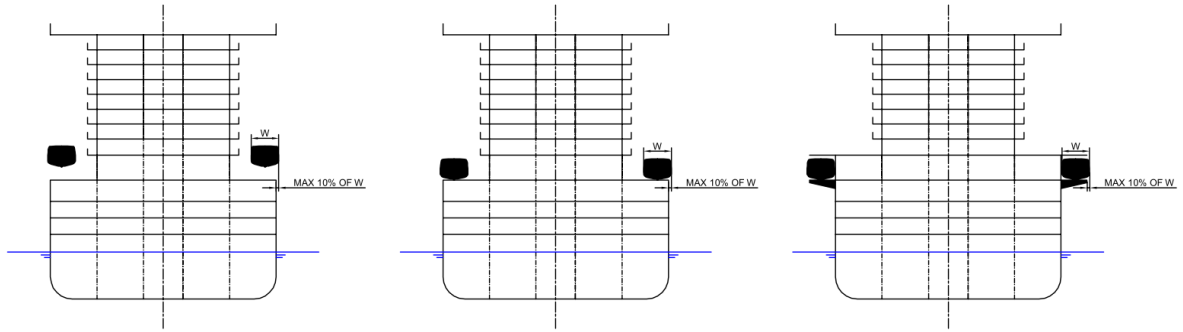




Overhanging Lifeboats

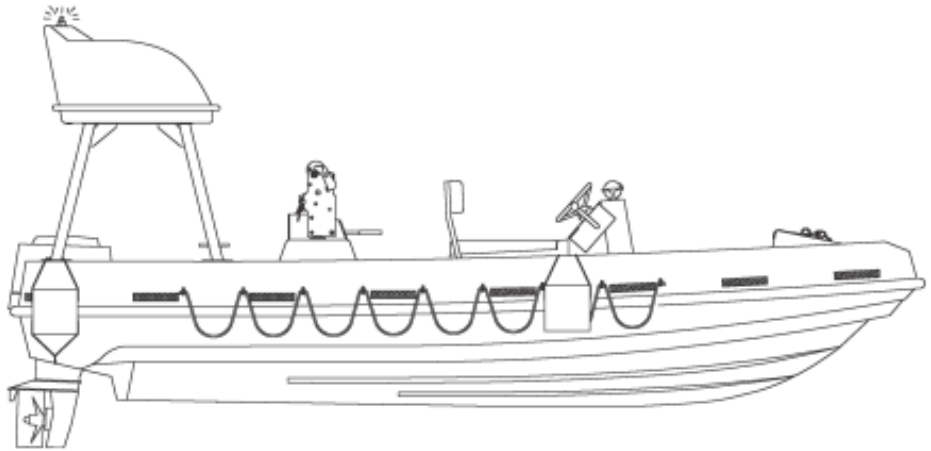
Many new ship have overhanging lifeboats, mainly due to General Arrangement reasons.

This is no more allowed for new projects (prototypes), if the ship wants to have an unlimited operation area (at least, not without extensive test. etc).
The boats should be max. 10% exposed.



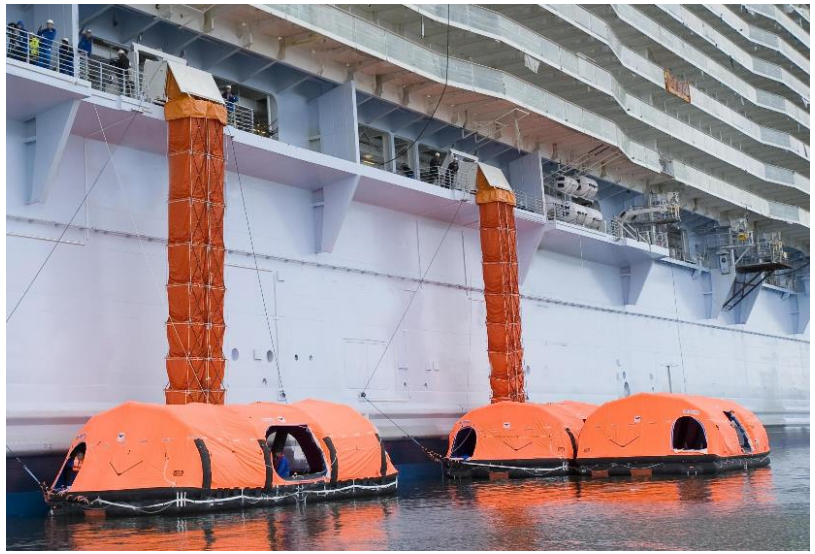
Rescue Boats

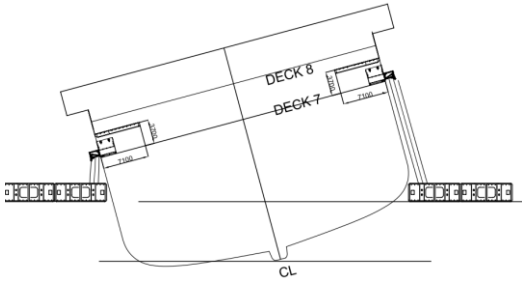
- At least two rescue boats are needed, one on each side.
- Combined lifeboats / rescue boats can be used; this can be used to increase the life saving capacity; for example, 60 persons.
- On a RoPax, at least one of the rescue boats has to be a fast rescue boat.
- Fast Rescue boat cannot meet the requirements of lifeboat.

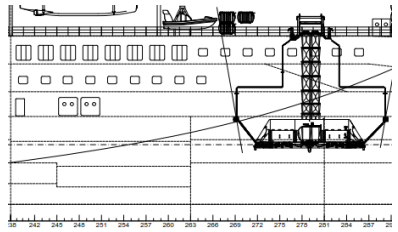


Life Rafts

- Either ”regular” davit launched life rafts; or
- MES (Marine Evacuation System)
- As with lifeboats, location of life rafts / MES should be such that they can be launched in heeled and trimmed situation.
- Life rafts to be installed so that they will float free if ship sinks.



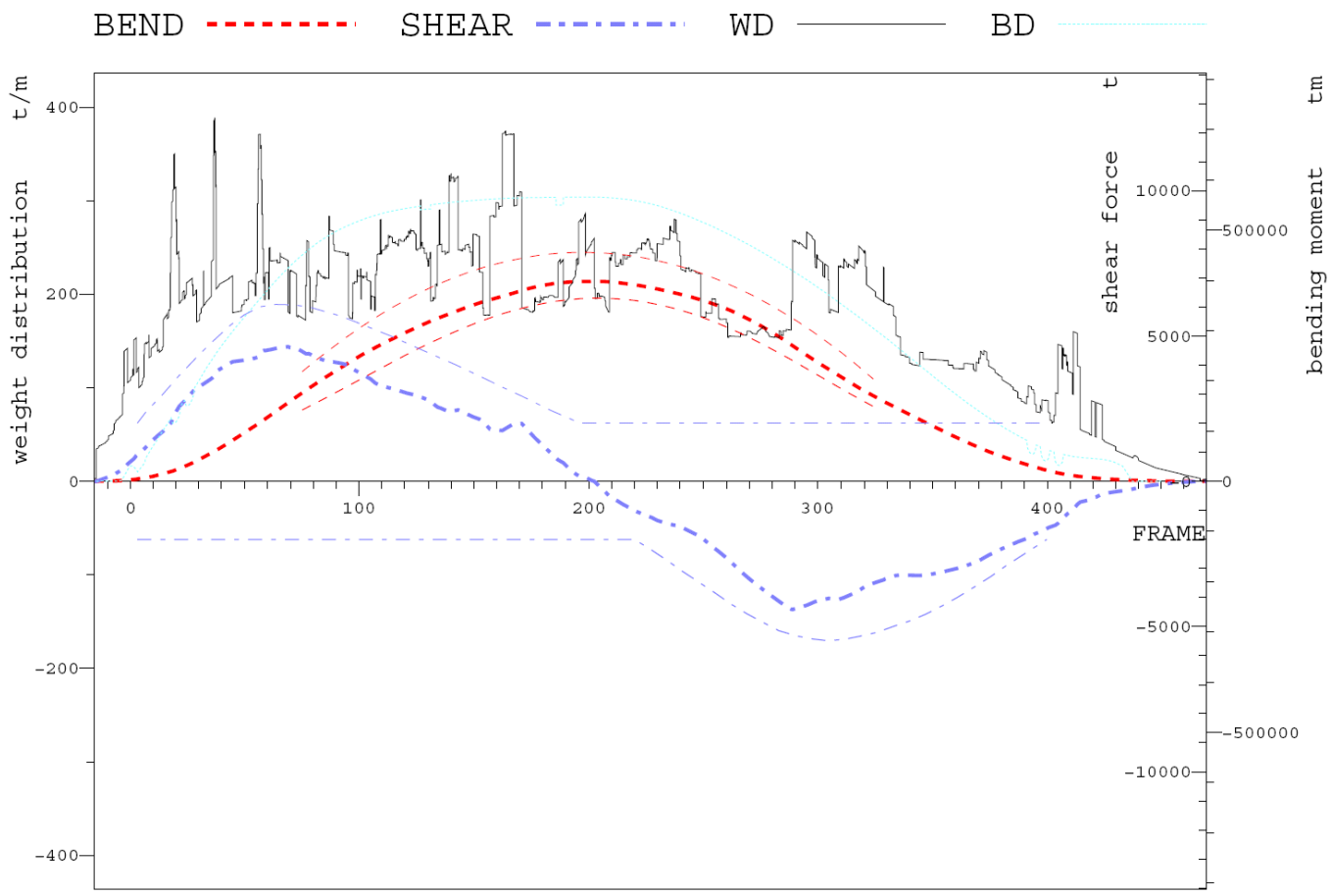




Structures, Vibrations, Noise

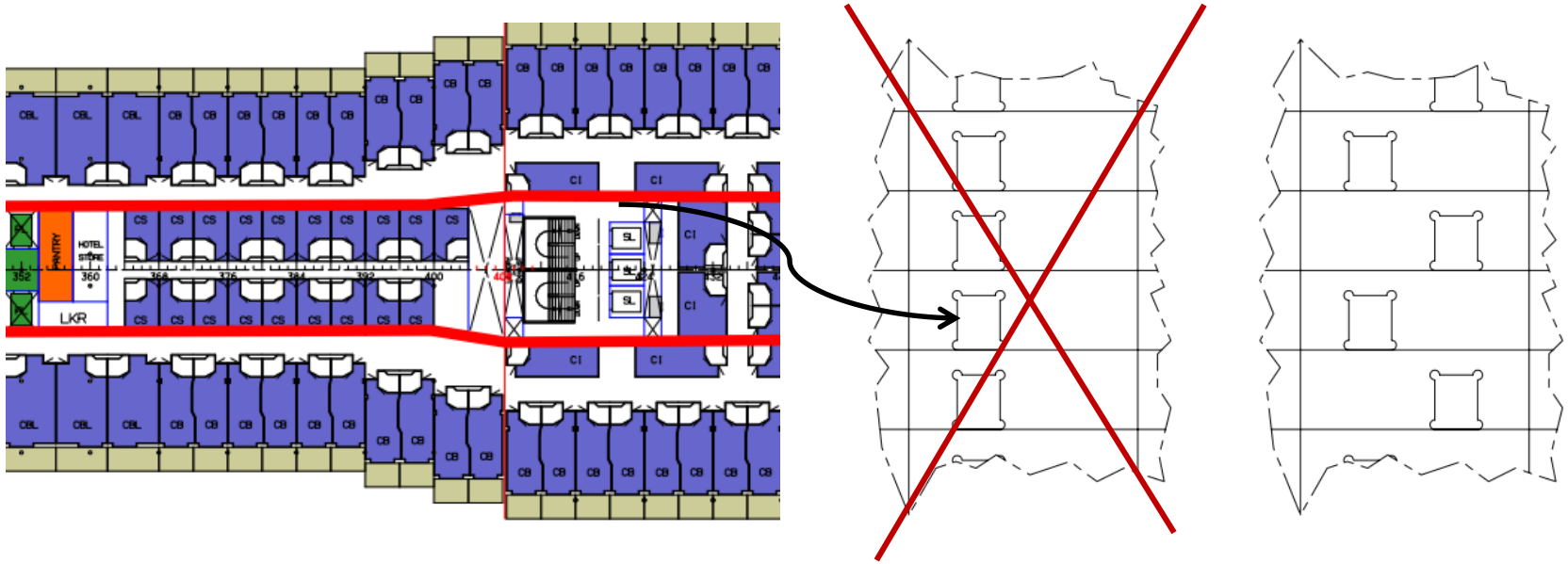
Longitudinal Strength

In operation the shear forces and bending moments in all loading conditions have to stay within limits.



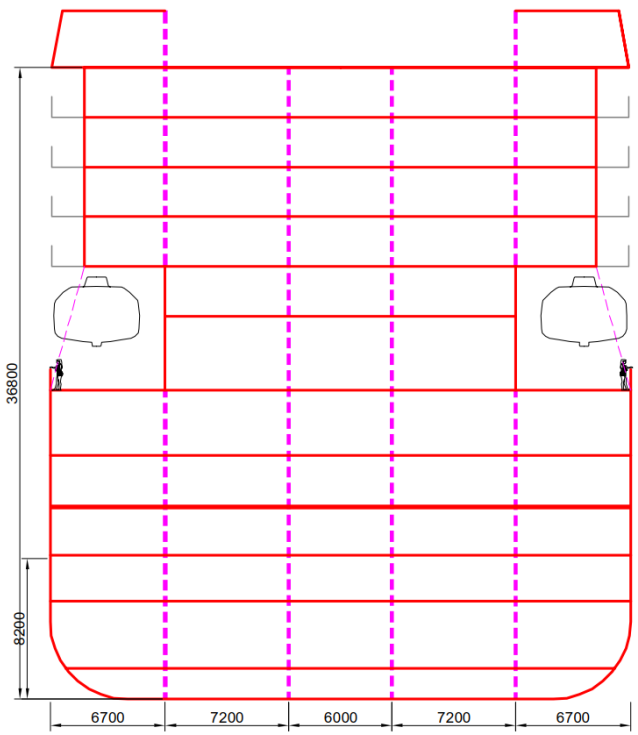
Longitudinal Strength

- There are several large cruise ships sailing with longitudinal strength problems, such as structural cracks and similar issues.
- The most important way to avoid these problems is good GA design, with nice continuous steel lines.
- Openings above each other in main structures should be avoided.

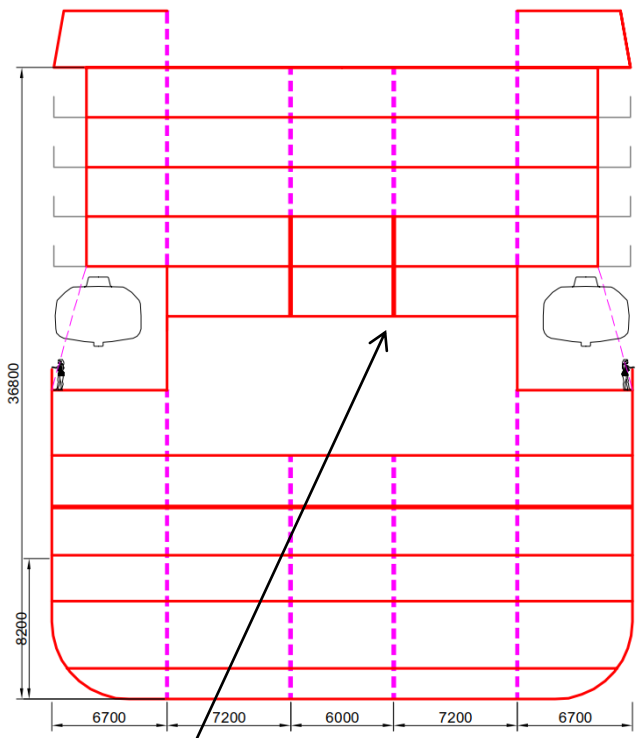


Removing or Relocating Pillars

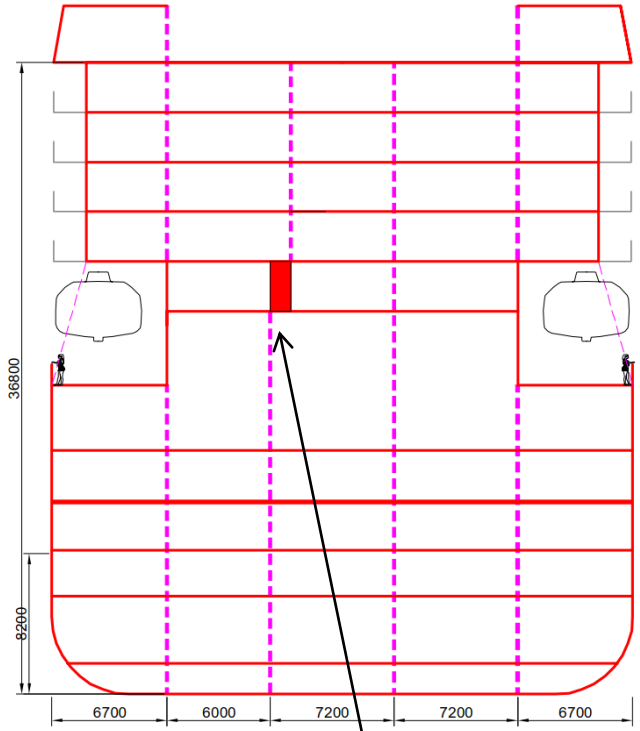
It is often possible to remove or relocate pillar, but it can mean lots of changes



NORMAL PILLAR SPAN
max. 7.2 m BETWEEN PILLARS



2 OR MORE DECKS OF LONGITUDINAL
BULKHEADS ABOVE REMOVED PILLARS



SHIFTING OF PILLAR LINE
NEEDS A BULKHEAD.

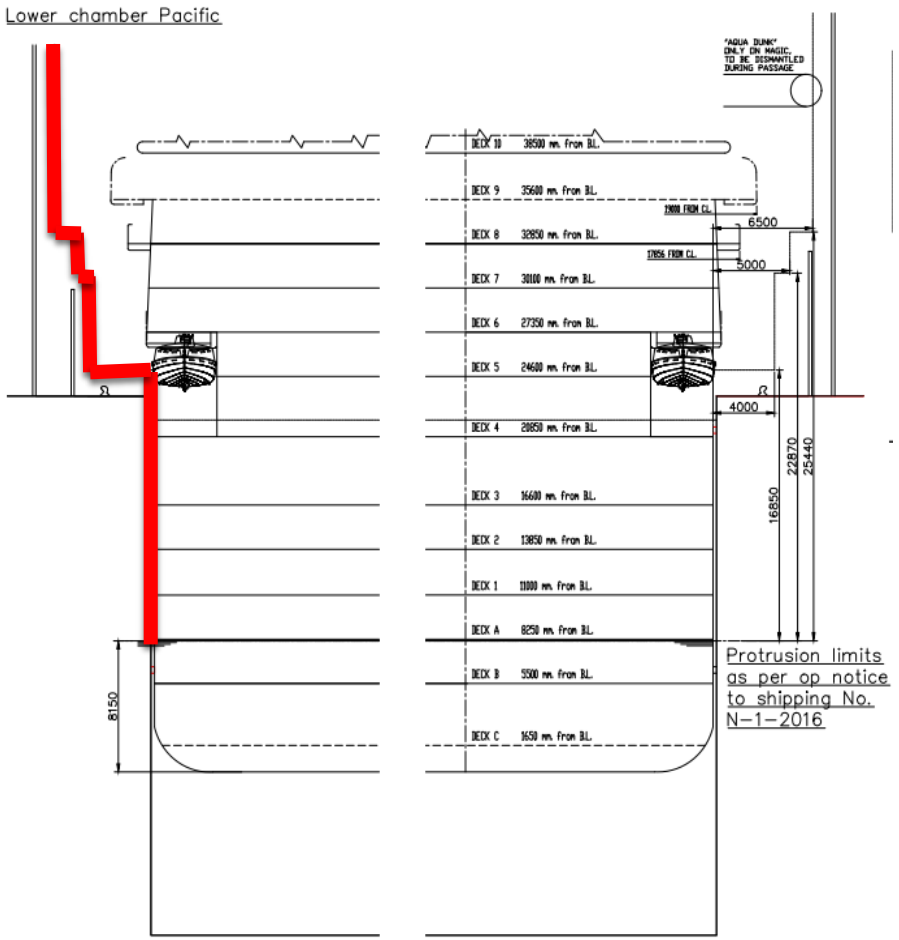
Other important SOLAS and other regulations

Waterway limits

- As vessels get larger, they can access less and less locations.
- Important air draught limits:
  - Suez: 68 m
  - San Francisco: 67 m
  - New York: 65 m (requires discussion with Authorities before passing)
  - Great Belt: 65 m (requires discussion with Authorities before passing)
  - Bosporus: 64 m
  - Hong Kong: 63 m
  - Panama: regular 57.91 m; case by case (in low water): 62.50 m
  - Tokyo: 52.8 m
  - Tampa: 45.4 m
- New Panama Canal
  - 366 x 49 x 15 m (Old 294 x 32 x 12 m)
- Great Lakes
  - 222.5 x 23.2
- Draught >9 m can be issue in many ports.
- Length >300 m can be issue in many ports.

Panama Canal

- Vessels going through Panama Canal have to be designed to meet the protrusion limits.
- Old and new canal have different limits, here new canal shown.
- Lots of other regulations, e.g.:
  - Bridge layout
  - Bollard location
  - Bollard capacity



ILO MLC 2006

- Maritime Labour Convention 2006, MLC 2006 (20.8.2012)
- Governs many aspects of seafarers' conditions, such as:
  - Minimum age, wages, hours of work, health care, food…
  - Accommodation and recreation facilities.

(f) in single berth seafarers' sleeping rooms the floor area shall not be less than:
  (i) 4.5 square metres in ships of less than 3,000 gross tonnage;
  (ii) 5.5 square metres in ships of 3,000 gross tonnage or over but less than 10,000 gross tonnage;
  (iii) 7 square metres in ships of 10,000 gross tonnage or over;

(g) however, in order to provide single berth sleeping rooms on ships of less than 3,000 gross tonnage, passenger ships and special purpose ships, the competent authority may allow a reduced floor area;

(h) in ships of less than 3,000 gross tonnage other than passenger ships and special purpose ships, sleeping rooms may be occupied by a maximum of two seafarers; the floor area of such sleeping rooms shall not be less than 7 square metres;

(i) on passenger ships and special purpose ships the floor area of sleeping rooms for seafarers not performing the duties of ships' officers shall not be less than:
  (i) 7.5 square metres in rooms accommodating two persons;
  (ii) 11.5 square metres in rooms accommodating three persons;
  (iii) 14.5 square metres in rooms accommodating four persons;

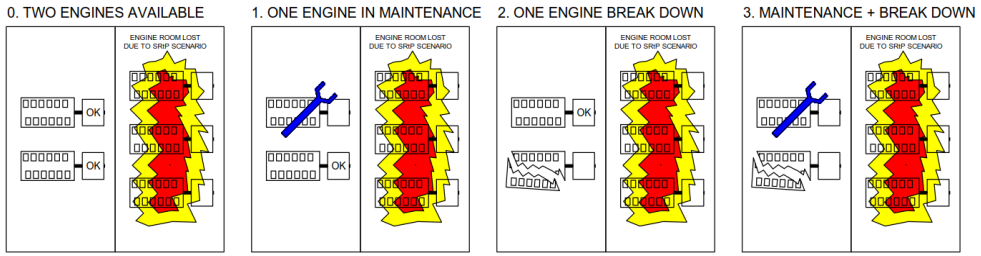
- *"The BMA will consider applications to include the floor area of en-suite sanitary facilities in the required total floor area of sleeping rooms, where it may be demonstrated that overall numbers of cabins in multiple occupancy will be reduced".*

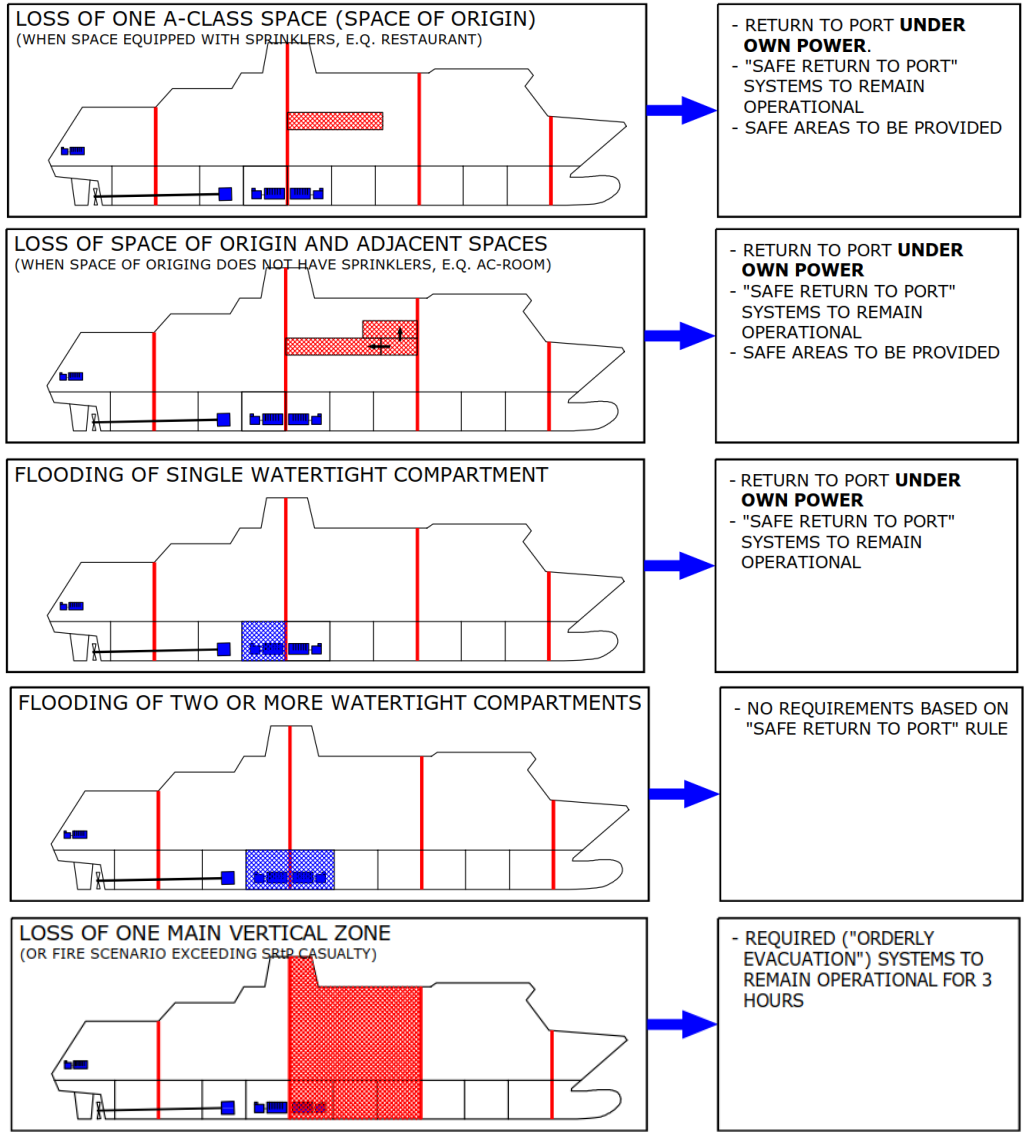
Safe Return to Port (SRtP)

SOLAS requirement for all passenger ships when length >120 m or when 3 or more MVZs.

After a casualty, there should be safe and habitable areas for persons onboard and propulsion to enable return to port without assistance.

- Vessel propulsion and essential services to be operational after casualty (fire or flooding) in any space or group of spaces within A-class boundaries.
- If space not protected by fixed fire fighting the fire casualty extends to adjacent space and space above (not to adjacent main fire zone)
- Required stores and bunker depends on actual operation, 1,000 nm range allows world wide cruising, 1,500 nm if Polar areas included
- Separate requirement for case where one MVZ is lost => Orderly evacuation (specified systems to remain operational for 3 hours





End

- If the rules are followed from the beginning, the end product will be much closer to the original intentions than otherwise possible.
- It may feel the rules limit the design freedom, but in the end almost everything can be done with clever design.
- Knowing the rules makes “bending” them easier. Often only small changes in design make an “illegal” design to a “legal” design.
- Rules change continuously, so continuous follow up – of at least the main rules – is important for anyone involved in ship design and operation.
- Rules can initially sound boring, but without knowing about them you will never be a good naval architect, or even an architect.

FORESHIP

AT THE SHARP END