

TEXAS A&M UNIVERSITY  
GALVESTON CAMPUS.

## INTRODUCTION TO THE MARITIME INDUSTRY

# 3. Types of Vessels and Cargo Markets



MARA 205

Professor: Dr. Jean-Paul Rodrigue



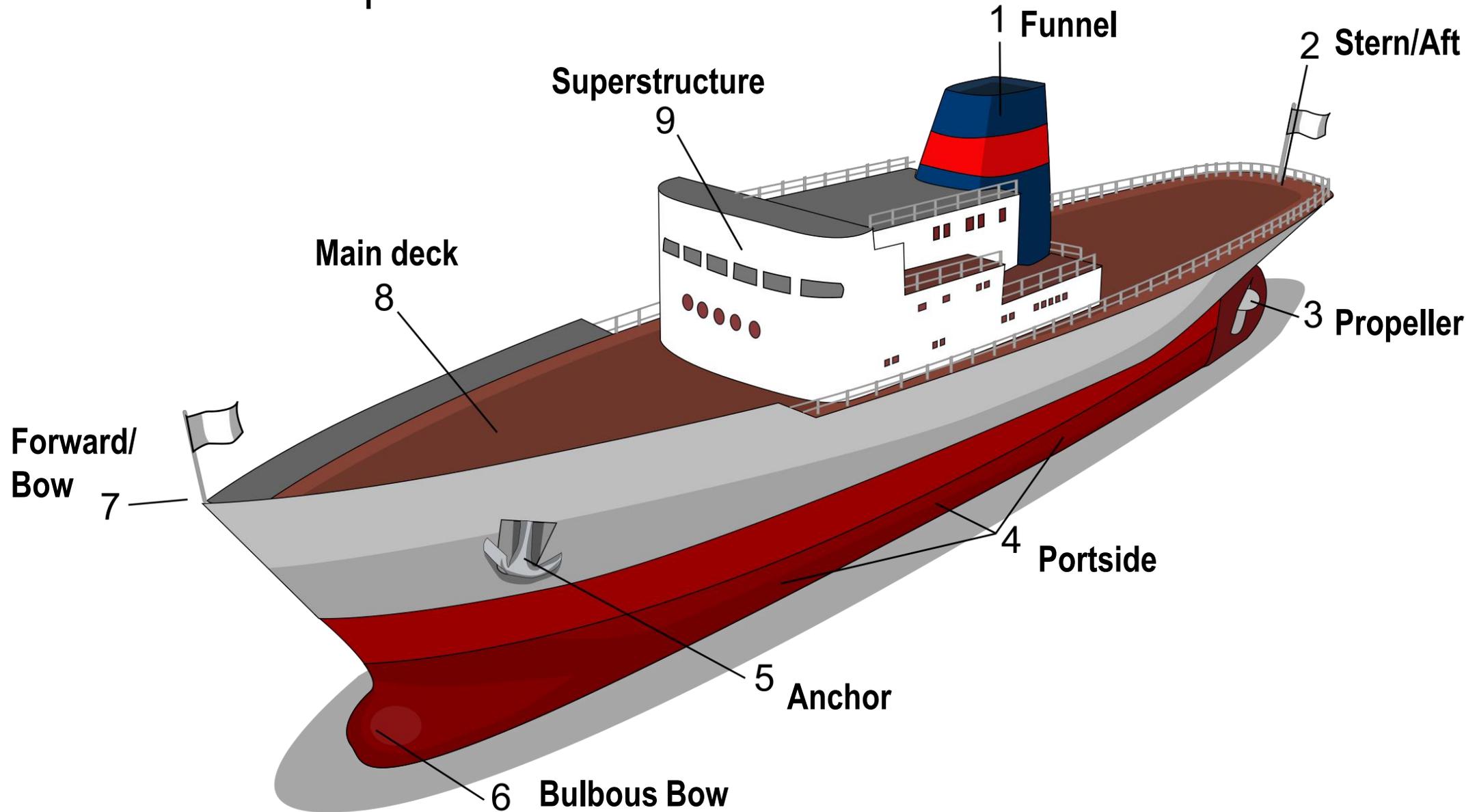
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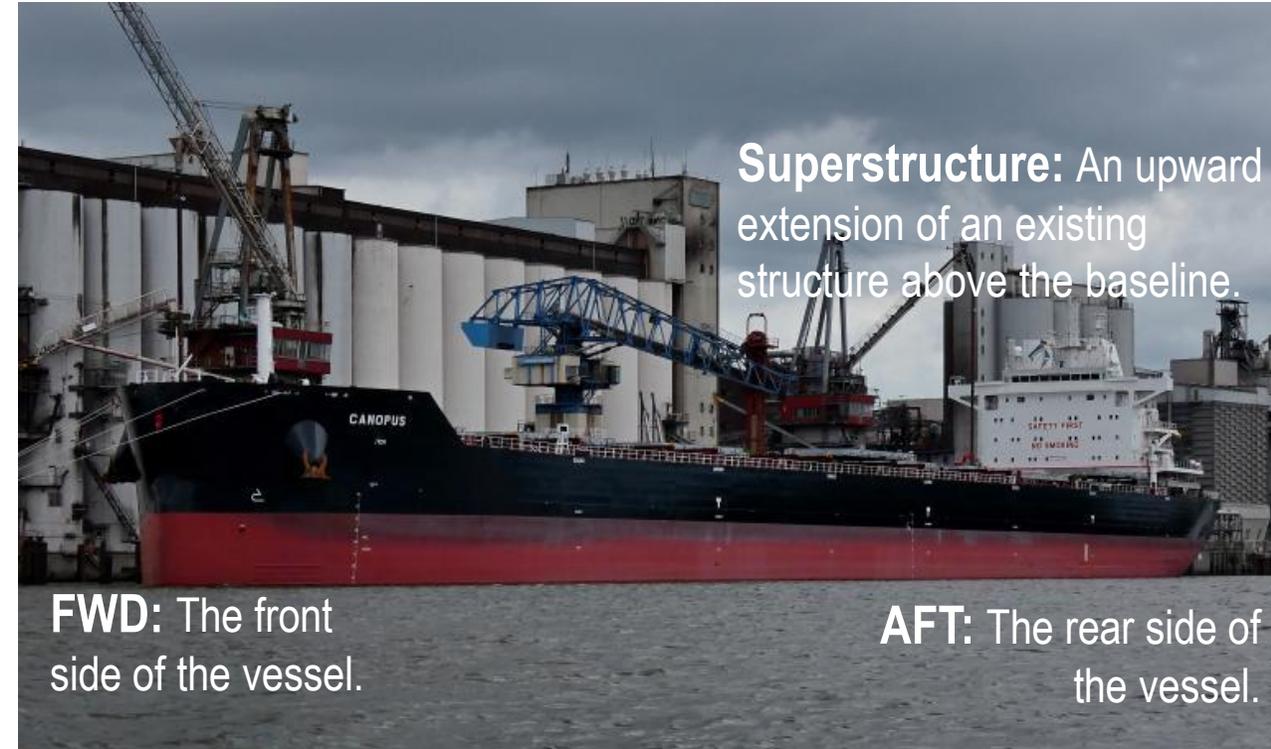
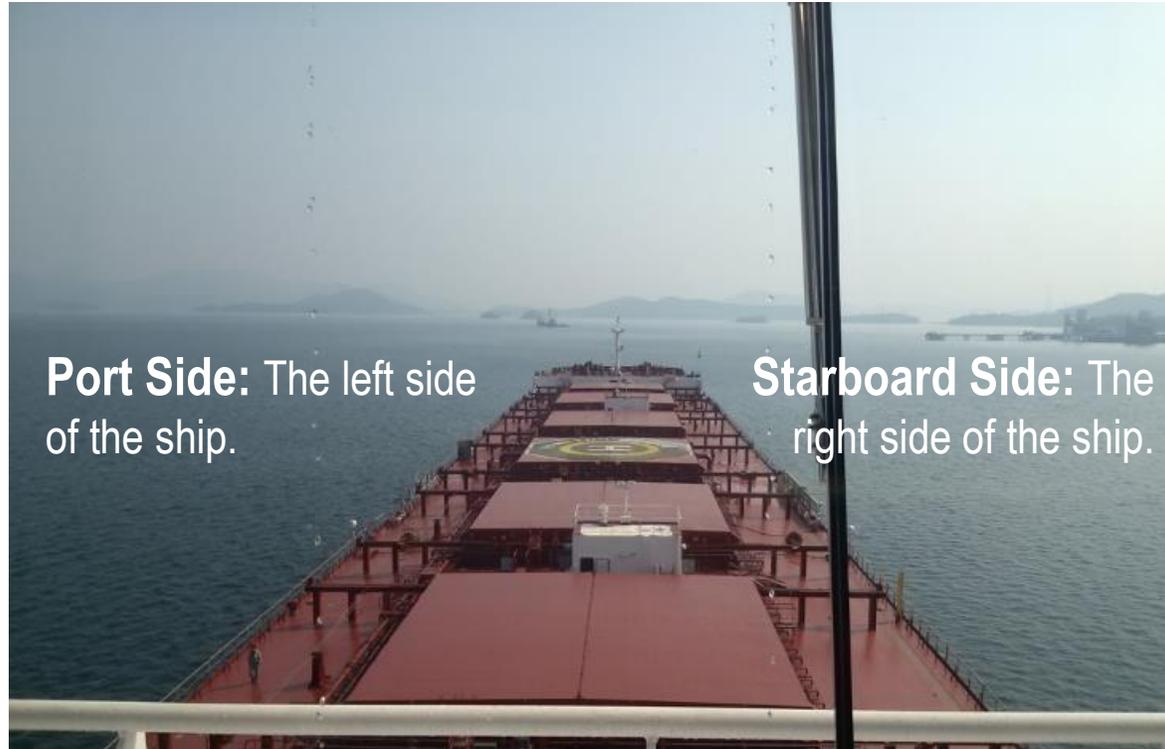


# A. Parts of a Ship

# Basic Parts of a Ship

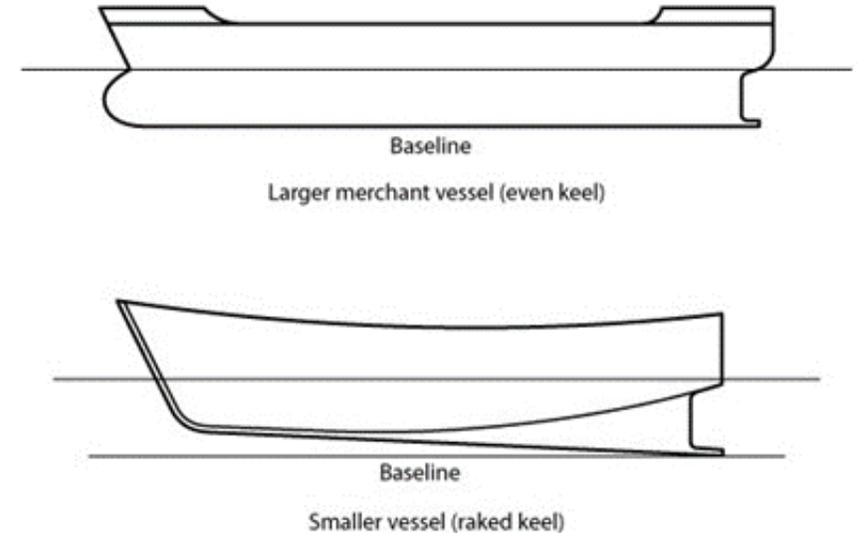


# Basic Parts of a Ship

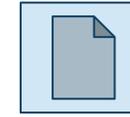


# Vessel Measurements

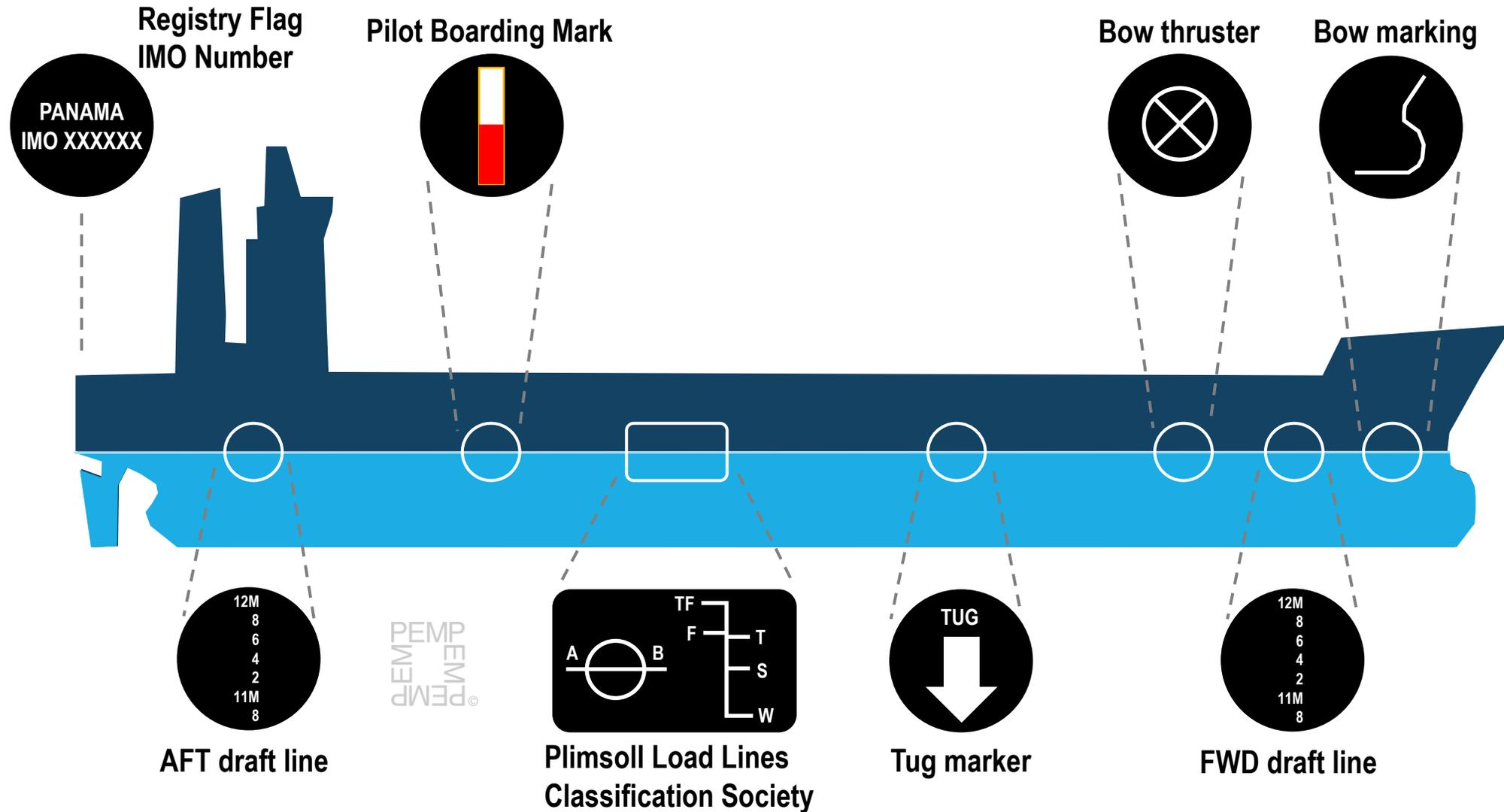
- Baseline
  - A line in the longitudinal plane of symmetry of the ship's hull parallel to the designed summer load waterline.
- Summer load line
  - The waterline up to which the ship can be loaded, in sea water, during summer when waves are lower than in winter.
  - Usually marked by a different paint color (red) below the load line.
  - Red because the paint contains copper, an anti-biofouling component.



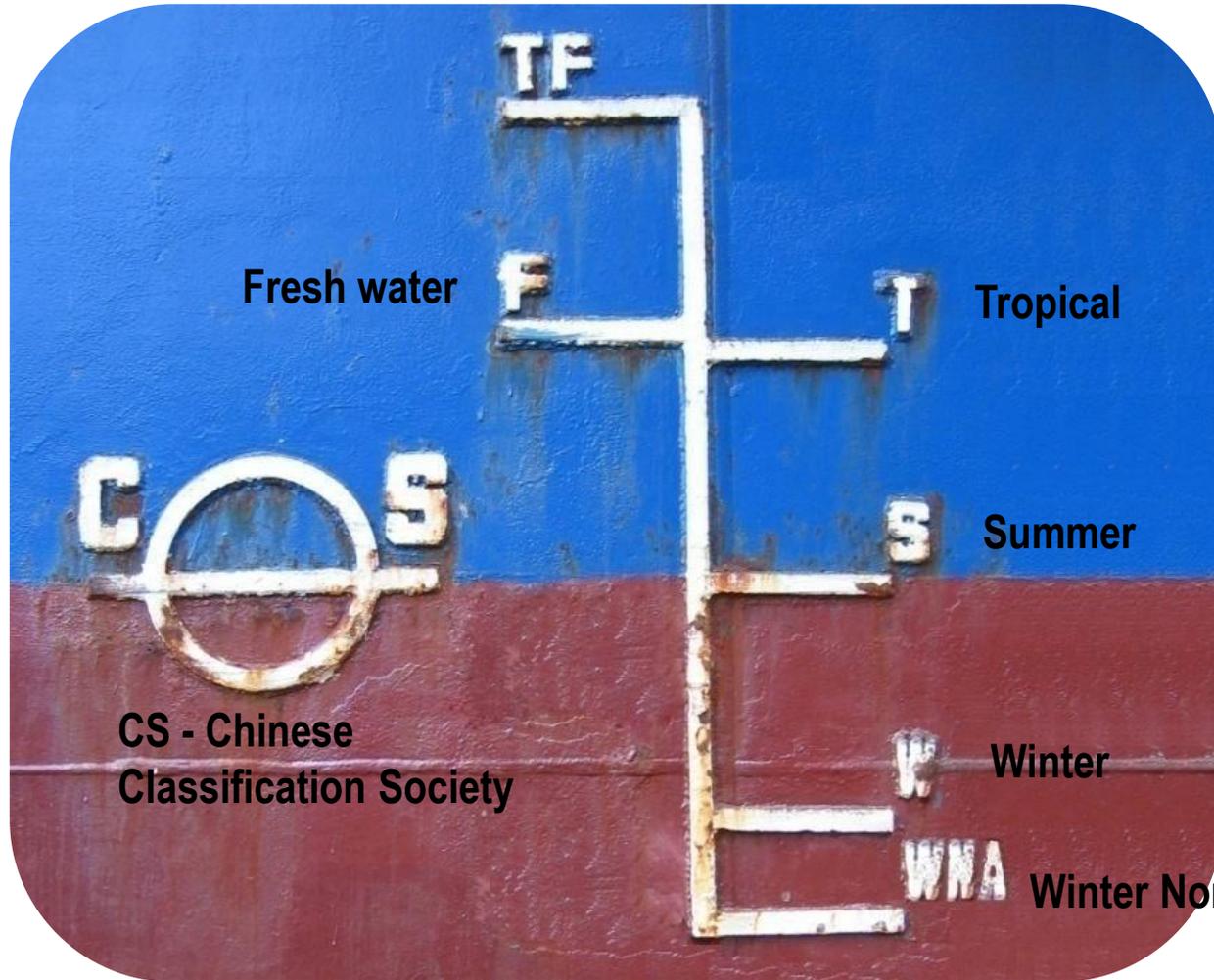
# Common Ship Hull Markings



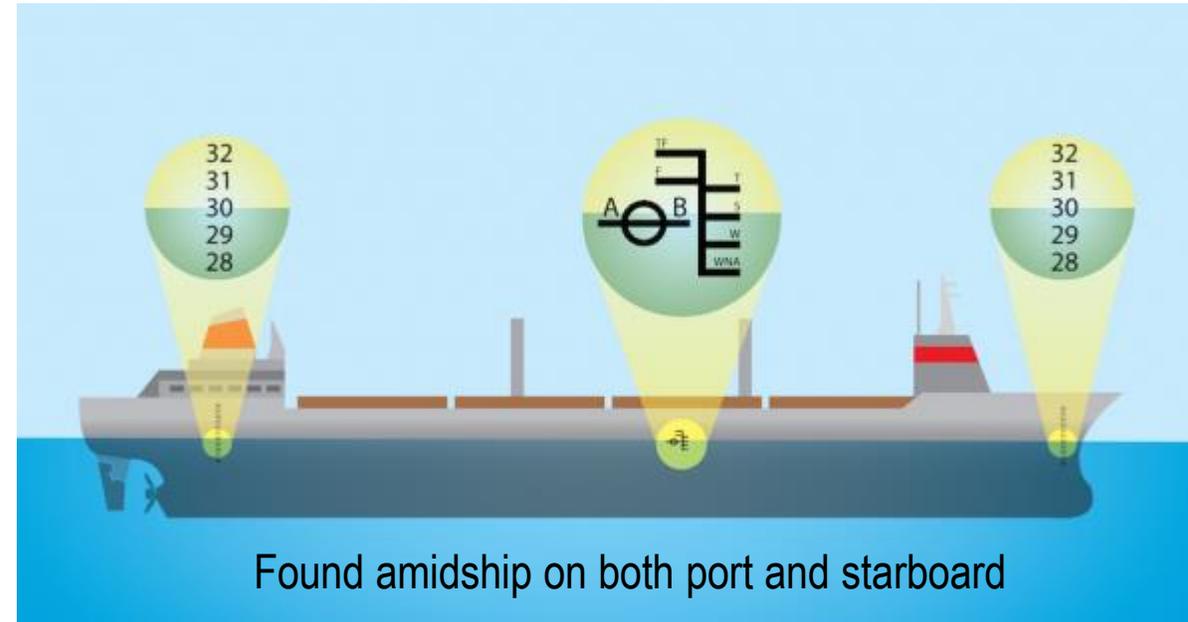
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# Plimsoll Mark - Load Lines

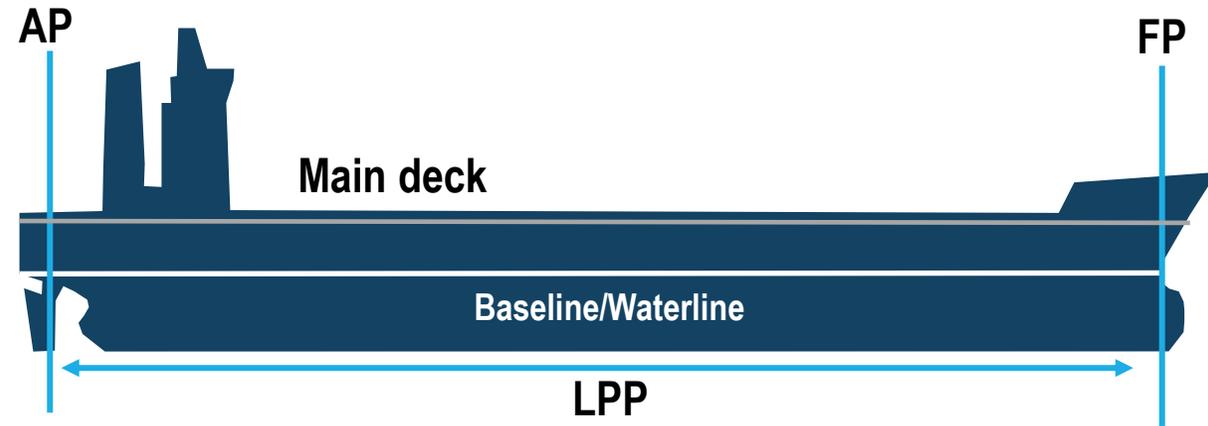


The Plimsoll Mark and Load Lines indicate how heavily a ship can be loaded.



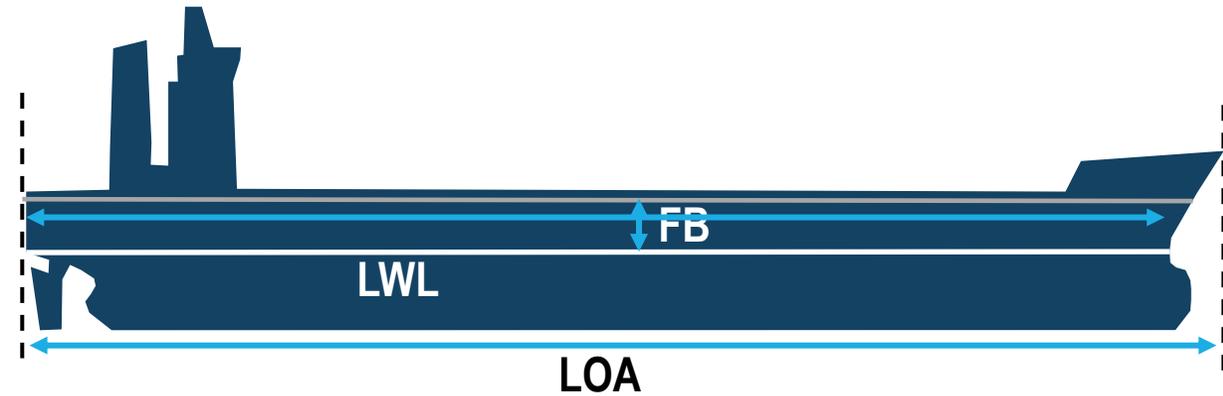
# Vessel Measurements

- Forward Perpendicular (FP)
  - The perpendicular drawn at the point where the bow of the ship meets the waterline while it floats at design draft.
- Aft perpendicular (AP)
  - The perpendicular drawn through the rudder stock (shaft).
- Length between Perpendiculars (LPP or LBP):
  - The longitudinal distance between the forward and aft perpendiculars.
  - Measured for steering capability.



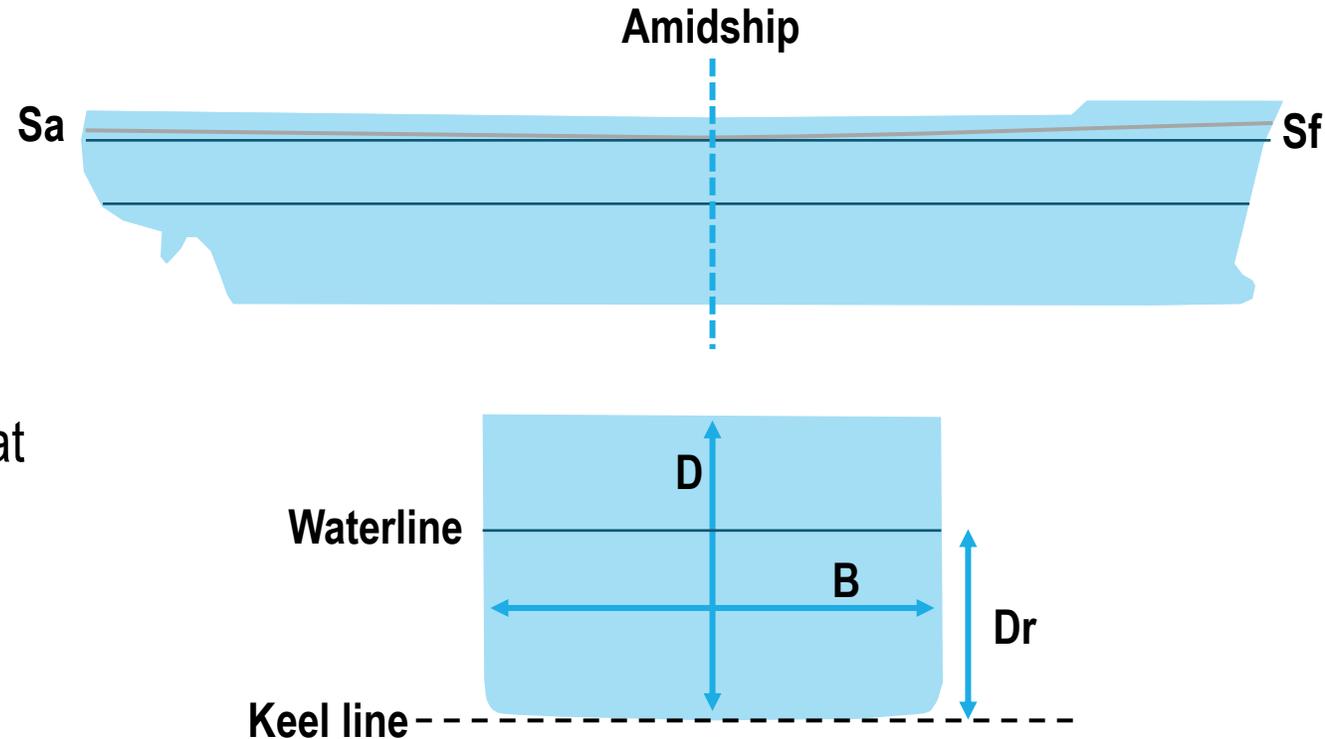
# Vessel Measurements

- Length of Waterline (LWL)
  - The length of the ship's hull intersecting the surface of the water.
  - Related to the water displacement.
- Length Overall (LOA)
  - The maximum length from the forwardmost point of the ship's hull to the aft-most point.
  - To fit locks and docking areas.
- Freeboard (FB)
  - The distance between the waterline and the main deck or weather deck of a ship.
  - Must be high enough to avoid potential deck flooding during rough sea conditions.



# Vessel Measurements

- Sheer ( $S_f$  &  $S_a$ )
  - A measure of main deck curvature.
  - Sheer forward and aft build volume into the hull and increase its buoyancy.
  - Keeping the ends from diving into an oncoming wave and slowing the ship.
  - Long ships tend not to have sheer.
- Beam ( $B$ )
  - The distance between the two sides of the ship at its greatest width (amidship).
- Depth ( $D$ )
  - Middle of length from the top of keel to the uppermost continuous deck at side.
- Draft ( $Dr$ )
  - Length from the top of keel to the waterline.
  - Important measure to access ports and canals.



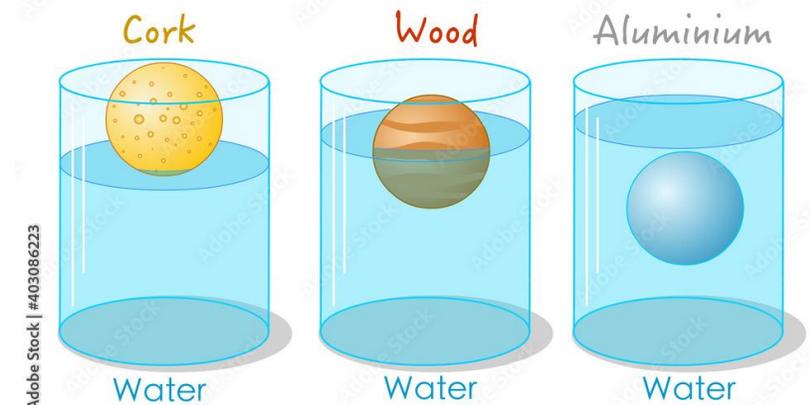
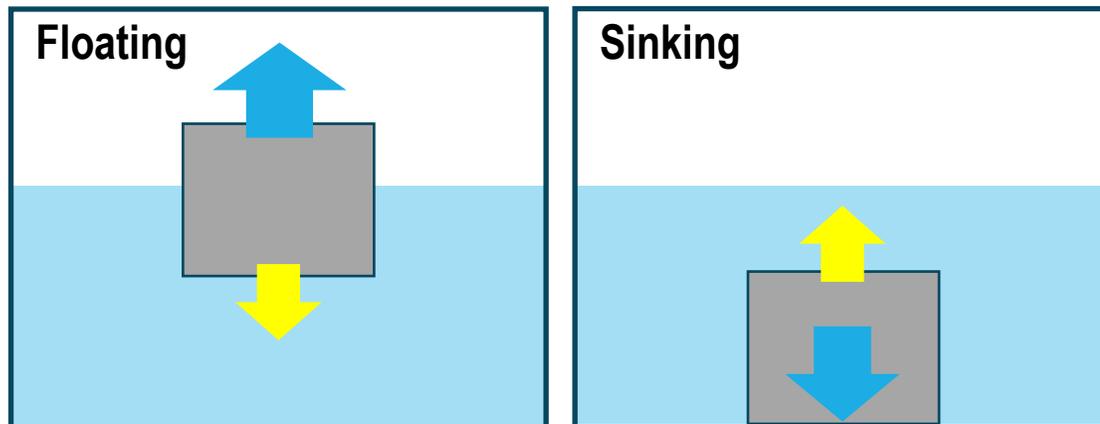
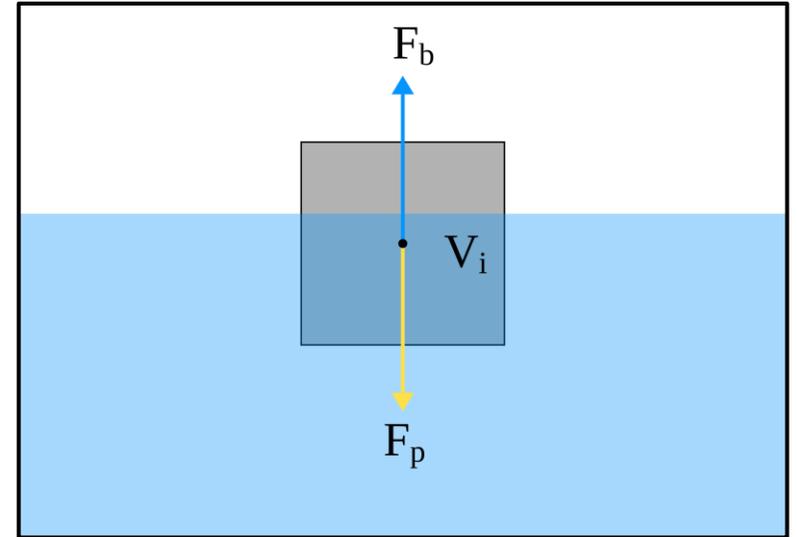
# MV Dali (Measurements)

<b>Length (LOA)</b>	299.92 m (984 ft)
<b>Beam</b>	48.2 m (158 ft 2 in)
<b>Draft</b>	15.03 m (49 ft 4 in)
<b>Depth</b>	24.8 m (81 ft 4 in)
<b>Freeboard</b>	9.77 m (32 ft 1 in)

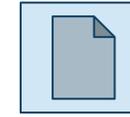


# Archimedes' Principle (Principle of Floatation)

- Archimedes' Principle (c. 246 BCE)
  - “Any object, totally or partially immersed in a fluid or liquid, is buoyed up by a force equal to the weight of the fluid displaced by the object.”
  - An object of weight  $F_p$  displaces a volume  $V_i$  that creates a buoyancy force of  $F_b$ .
- Principle of floatation
  - To float, an object needs to displace a greater weight of water than its weight.

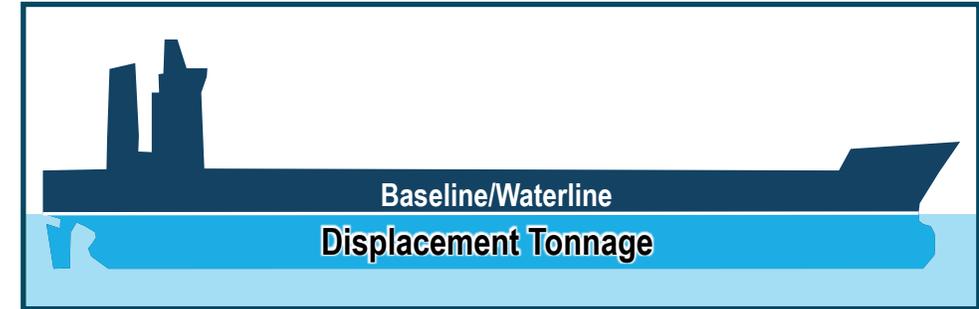


# Displacement and Tonnage

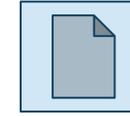


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- Displacement tonnage (D)
  - Total weight of the ship when fully loaded.
  - Measured by using the weight of the water being displaced, expressed in metric tons.
- Lightweight tonnage (L)
  - The total weight of the ship when empty.
  - Measured by using the weight of the water being displaced, expressed in metric tons.
- Deadweight tonnage (DWT)
  - Maximum weight that a ship can carry.
  - $DWT = D - L$ .
  - Expressed in metric tons and includes bunker and stores.

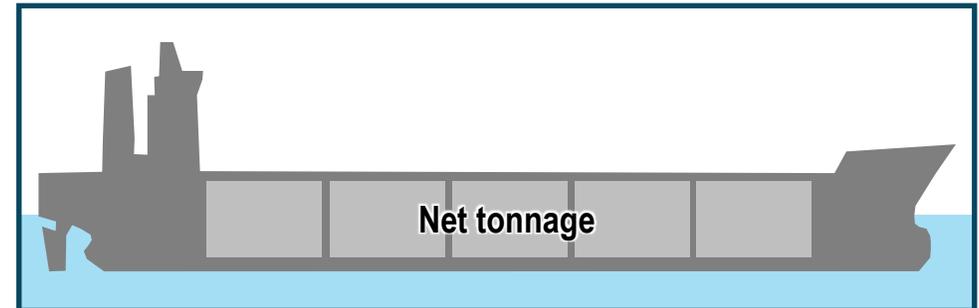


# Displacement and Tonnage

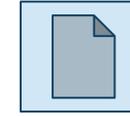


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- **Gross tonnage (GT)**
  - Total volume of a ship converted into tonnage.
  - Measured as volumes of all enclosed spaces and expressed in cubic meters.
- **Net tonnage (NT)**
  - Subtracting the volume occupied by the engine room and the space necessary for the operation of the ship (crew quarters, bridge, etc.) from the gross tonnage.
- **Gross register tonnage (GRT)**
  - Calculated in a specific way according to the country of registry.
  - To determine the fees that a ship will pay to use a canal (Panama GRT, or Suez GRT) or a port.



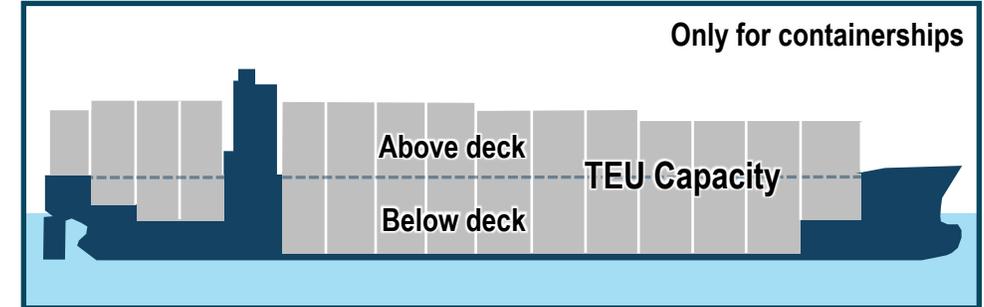
# Displacement and Tonnage



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- TEU Capacity

- Only for container ships or ships able to carry containers.
- Estimate of the volume in Twenty-Foot Equivalent Units that can be carried without impairing visibility or exceeding the baseline (waterline).
- Slot capacity (fixed): Total number of containers that can be put in the carried slots.
- Loadable capacity (variable): Total number of containers that can be loaded on a ship, based on its weight and stability limits.

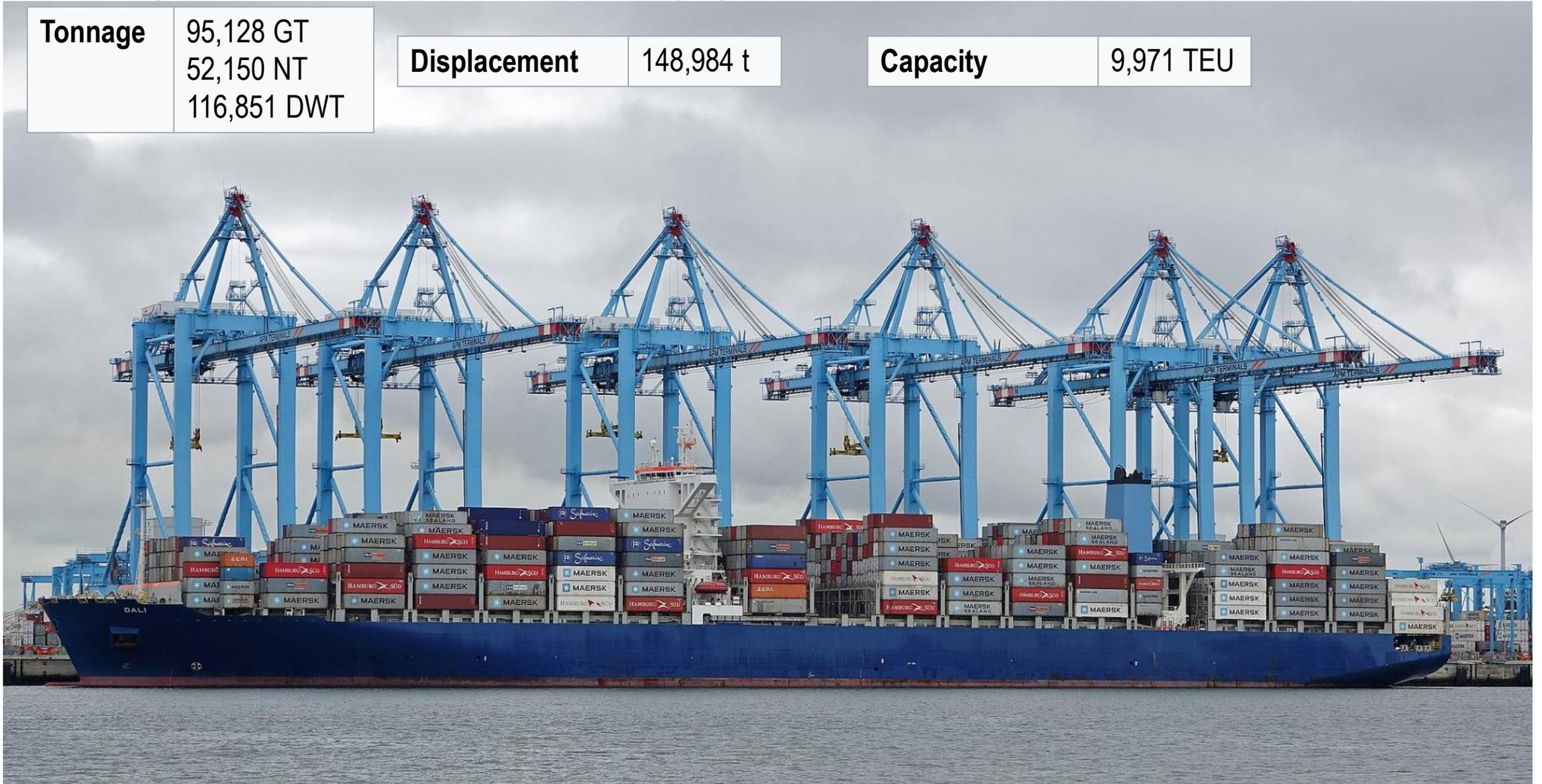


# MV Dali (Displacement and Tonnage)

<b>Tonnage</b>	95,128 GT
	52,150 NT
	116,851 DWT

<b>Displacement</b>	148,984 t
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<b>Capacity</b>	9,971 TEU
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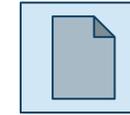
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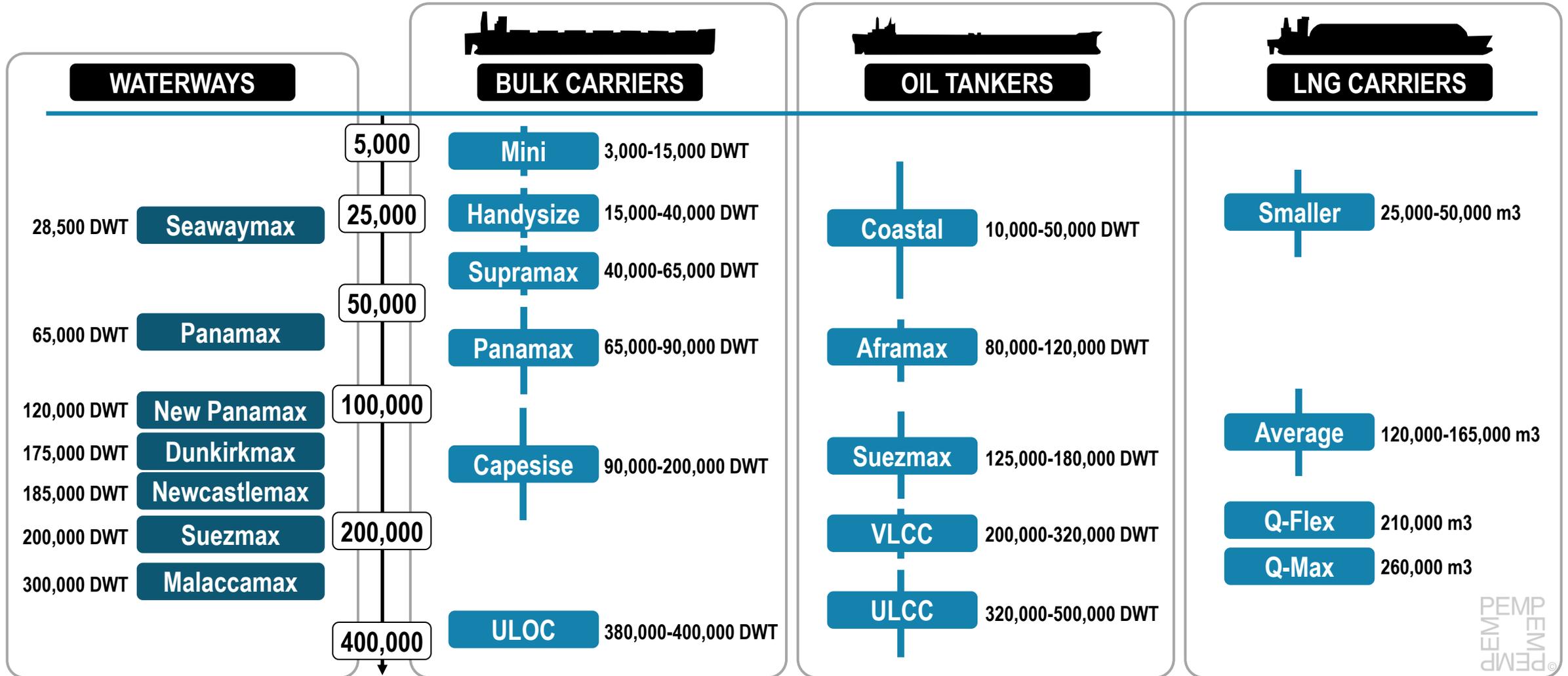


# B. Vessel Types

# Bulk Ship Classes



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# Most Commonly Used Vessel Categories

## PANAMAX

A ship of the maximum size that can enter the old locks of the Panama Canal. The locks are 110 feet wide, 1000 feet long.

## AFRAMAX

A ship of 80,000-120,000 dwt, which is the AFRA standard (Average Freight Rate Assessment). Established to standardize contract terms with well-defined tanker ship capacity.

## POST-PANAMAX

A ship too large to enter the old locks of the Panama Canal. The expansion of the Panama Canal allowed to accommodate many post-Panamax ships.

## HANDYSIZE

A ship in the 10,000 to 50,000 dead-weight ton range. Common in small regional markets as they can operate in many ports.

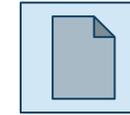
## SUEZMAX

A ship roughly 150,000 dead-weight tons, the maximum size that can fit through the Suez Canal.

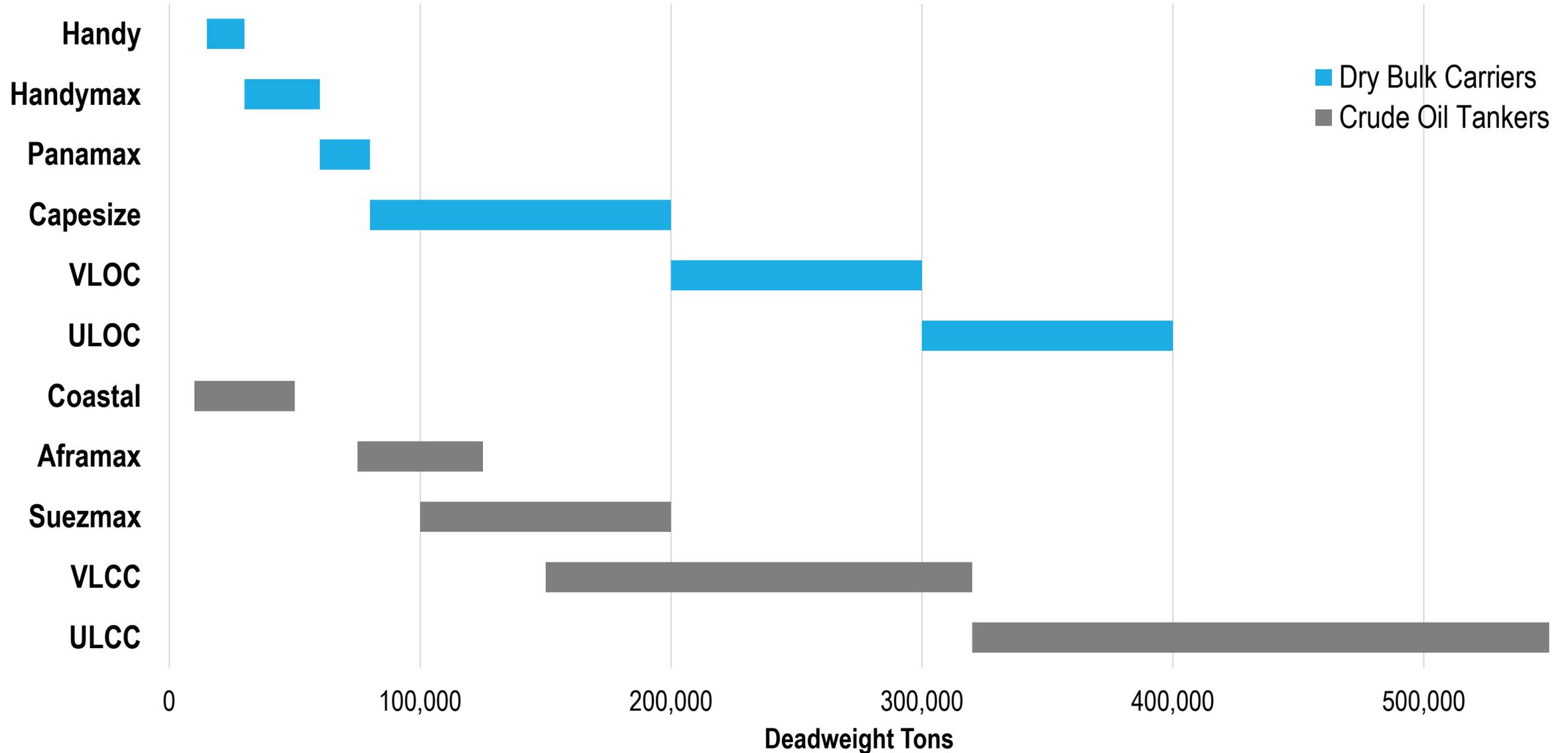
## CAPE SIZE

Large dry-bulk carriers of a capacity greater than 80,000 dead-weight tons. Relates to the ships that originally could not fit through the Suez Canal and had to go around Africa by way of the Cape of Good Hope.

# Vessel Size Groups



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# The Functional Specialization of Ships

- Functional specialization
  - Ships are designed for a specific function, which is carrying passengers or freight.
  - Some can have several functions (cargoes), while others are designed only to carry one type of cargo.
  - Ships exist because there is a market for what they can transport (derived demand).

**Container Ships**

**Roll-On/Roll-Off Ships**

**Break-Bulk Ships**

**Multipurpose Ships (Combination)**

**Crude Carriers**

**Product and Chemical Carriers**

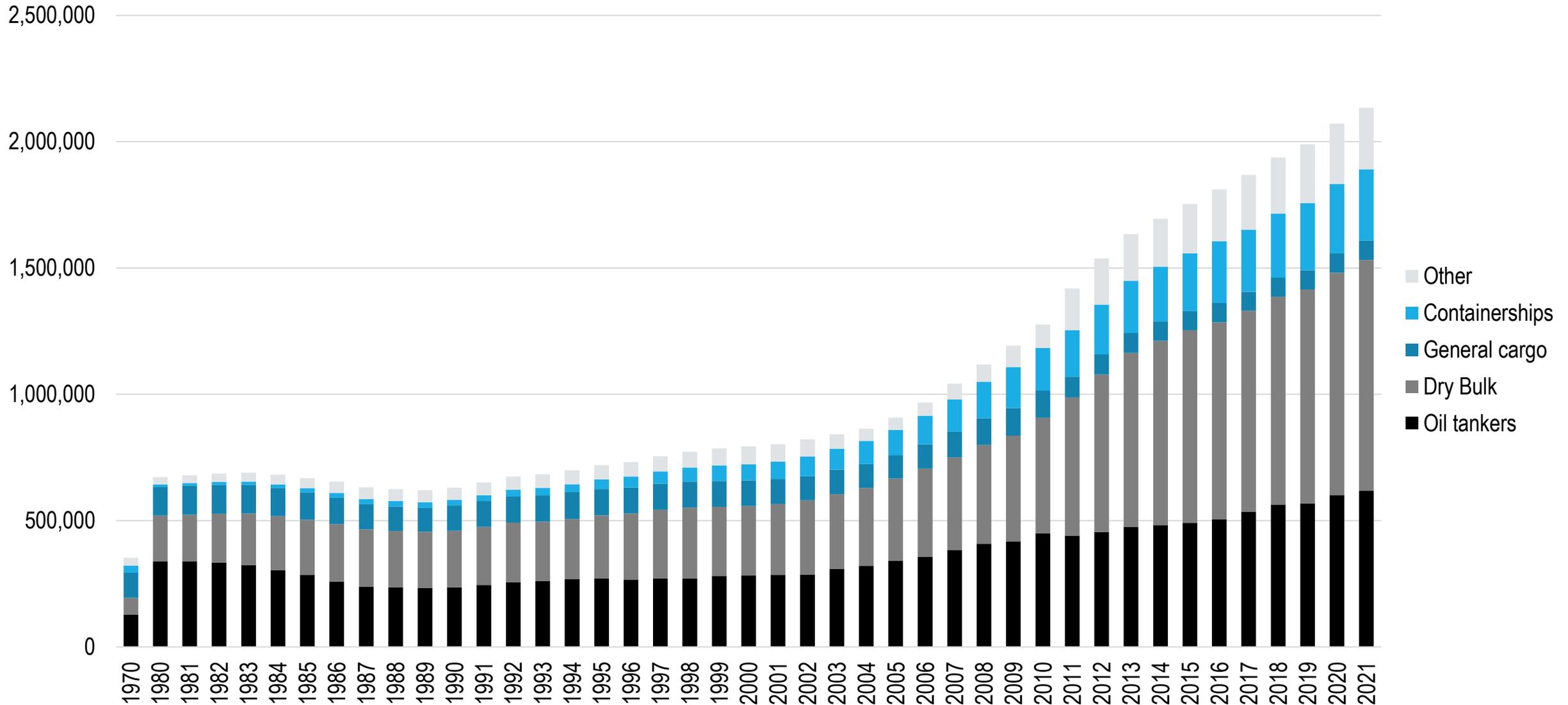
**Dry-Bulk Carriers**

**Gas Carriers**

# Largest Ships by Category

<b>Containership</b>	<p>Ever Ace (2021)</p> 	<p>LOA: 399.9 m Beam: 61.5 m Draft: 16 m TEU: 23,992</p>
<b>Ultra Large Crude Carrier</b>	<p>TI Europe (2003)</p> 	<p>LOA: 380 m Beam: 68 m Draft: 24.5 m DWT: 442,000 t</p>
<b>Ultra Large Ore Carrier</b>	<p>MS Ore Brazil (2011)</p> 	<p>LOA: 362 m Beam: 65 m Draft: 23 m DWT: 402,000 t</p>
<b>Cruise Ship</b>	<p>Wonders of the Seas (2022)</p> 	<p>LOA: 362 m Beam: 64 m Draft: 9.3 m Passengers: 5,734</p>

# World Tonnage by Cargo Vessel Type, 1970-2021 (in millions dwt)



# Passengers and RORO Vessels

## Passenger ferries

Carried across relatively short bodies of water in a shuttle-type service.  
Tend to be small and fast vessels, except for high volume markets (e.g. English Channel, Greek islands, Japan, Philippines).  
Many are RORO vessels.

## Cruise ships

Trips of various durations, usually over several days.  
Several amenities (restaurants, theaters, swimming pools, casinos).  
Usually very large capacity ships.  
Before air transportation, serviced by liner passenger ships, dominantly over the North Atlantic.

## RORO vessels

Roll on – Roll off  
Allow cars, trucks and trains to be loaded directly on board.  
The largest are the car carriers that transport vehicles from assembly plants to main markets.

# Fast Ferry – Piraeus, Greece



# Cruise Ships at the Port of Cartagena, Colombia



**MEYER WERFT - Der Bau der Spectrum of the Seas (The making of the Spectrum of the Seas)**



# Massification in the Cruise Industry



## MODERN CRUISE SHIPS

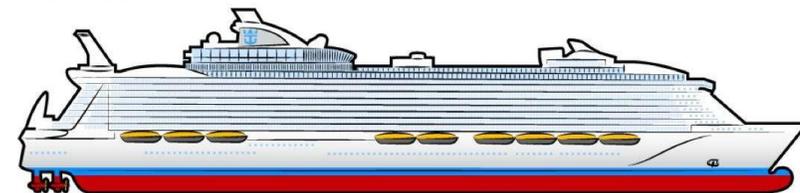


**TITANIC**      **AVG MODERN SHIP**      **SYMPHONY OTS**

<b>TONNAGE</b>	46,328 GT	113,524 GT	250,800 GT
<b>LENGTH</b>	883 ft	980 ft	1,198 ft
<b>HEIGHT</b>	104 ft	196 ft	230 ft
<b>DRAFT</b>	35 ft	27 ft	31 ft
<b>BEAM</b>	92 ft	119 ft	159 ft



<b>STATEROOMS</b>	840	1,401	2,805
<b>PASSENGER DECKS</b>	8	13	18
<b>PASSENGERS</b>	2,453	3,077	7,600
<b>CREW</b>	900	1,203	2,350
<b>MAX SPEED</b>	23 knots	29 knots	22 knots



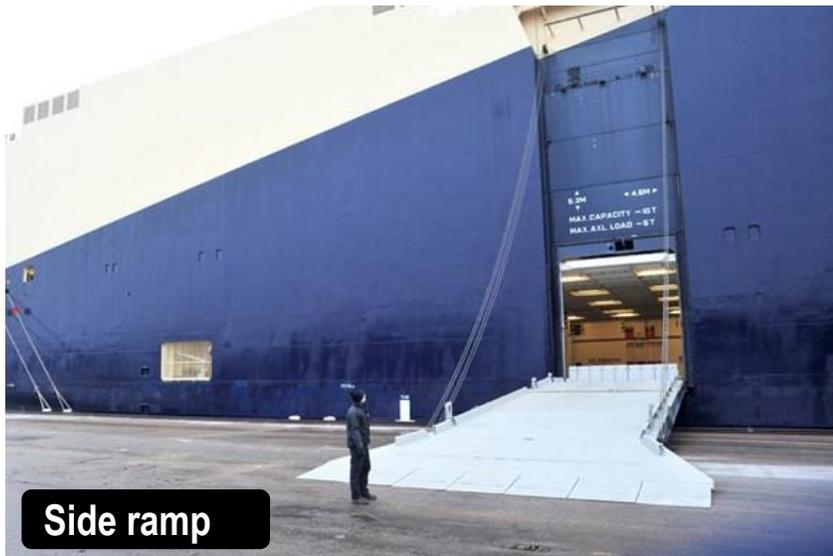
<b>COST (TODAY)</b>	\$400 M	\$820 M	\$2.0 B
<b>COST PER TON</b>	\$8.6k	\$7.2k	\$8.0k
<b>COST PER CABIN</b>	\$476k	\$585k	\$713k

# RORO Vehicle Carrier, Shanghai

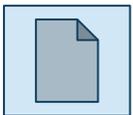


A roll-on/roll-off ship (with cargo loading ramps aft and starboard).

# Ramp Configurations on RORO Vessels



# Small RO-RO Cargo Ship (Stern Ramp)



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# Bulk and Break-bulk Vessels

## Bulk cargo

Freight, both dry or liquid, that is not packaged.  
Minerals (oil, coal, iron ore) and grains.  
Use of specialized ships such as oil and gas tankers.  
Specialized transshipment and storage facilities.  
Single origin, destination and client.  
Prone to economies of scale.

## Break-bulk cargo

Cargo packaged in some way (bags, boxes or drums).  
Numerous origins, destinations and clients.  
Before containerization, economies of scale were difficult to achieve.  
Dominance of the containership.

# Capesize Dry Bulk Carrier



# Handymax Bulk Carrier

A break-bulk (general cargo) ship, with a completely removable deck.

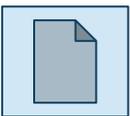


# Chemical Tankers

Tend to be a smaller size (5,000 to 35,000 DWT)



# Ultra Large Ore Carrier, the *Berge Stahl* (Bulk)



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# Ultra Large Crude Carrier (ULCC)



# Liquid Petroleum Gas Carrier (Bulk; Mostly Propane)



# Liquid Natural Gas Carrier (Bulk; Mostly Methane)



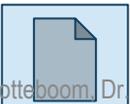
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# Reefer Ship (Break Bulk)



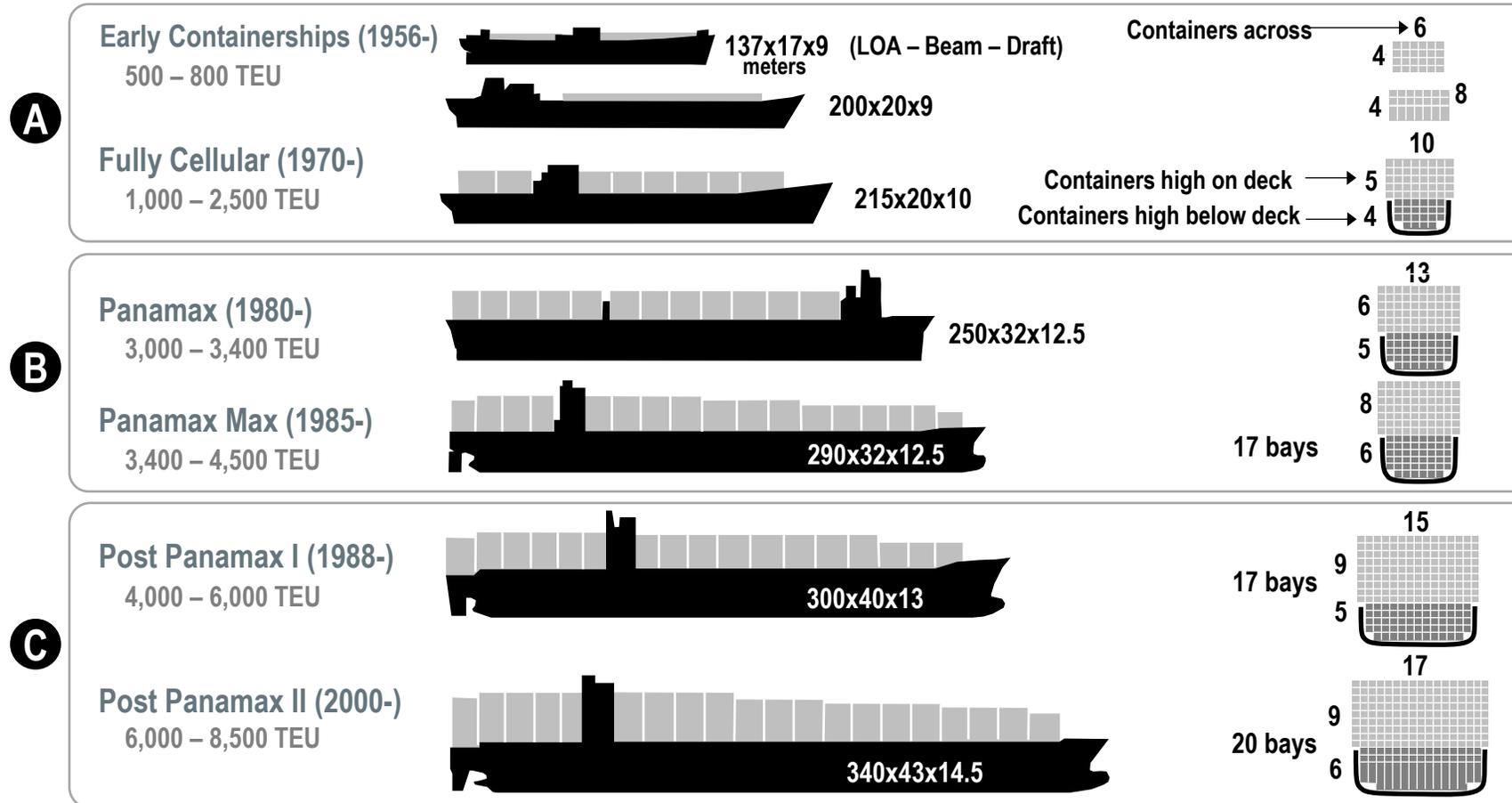
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# The Evelyn Maersk (Containership: break-bulk)

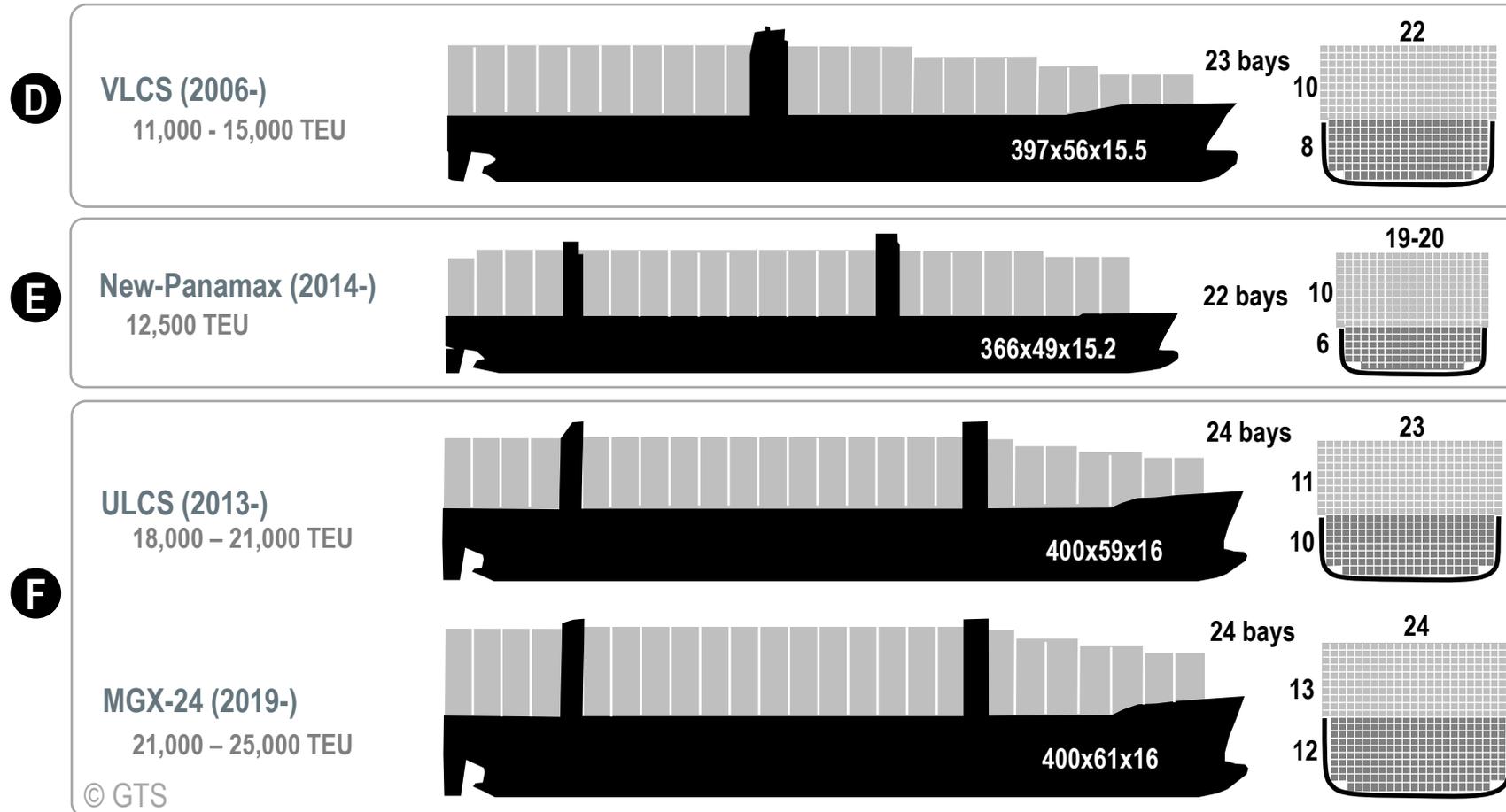


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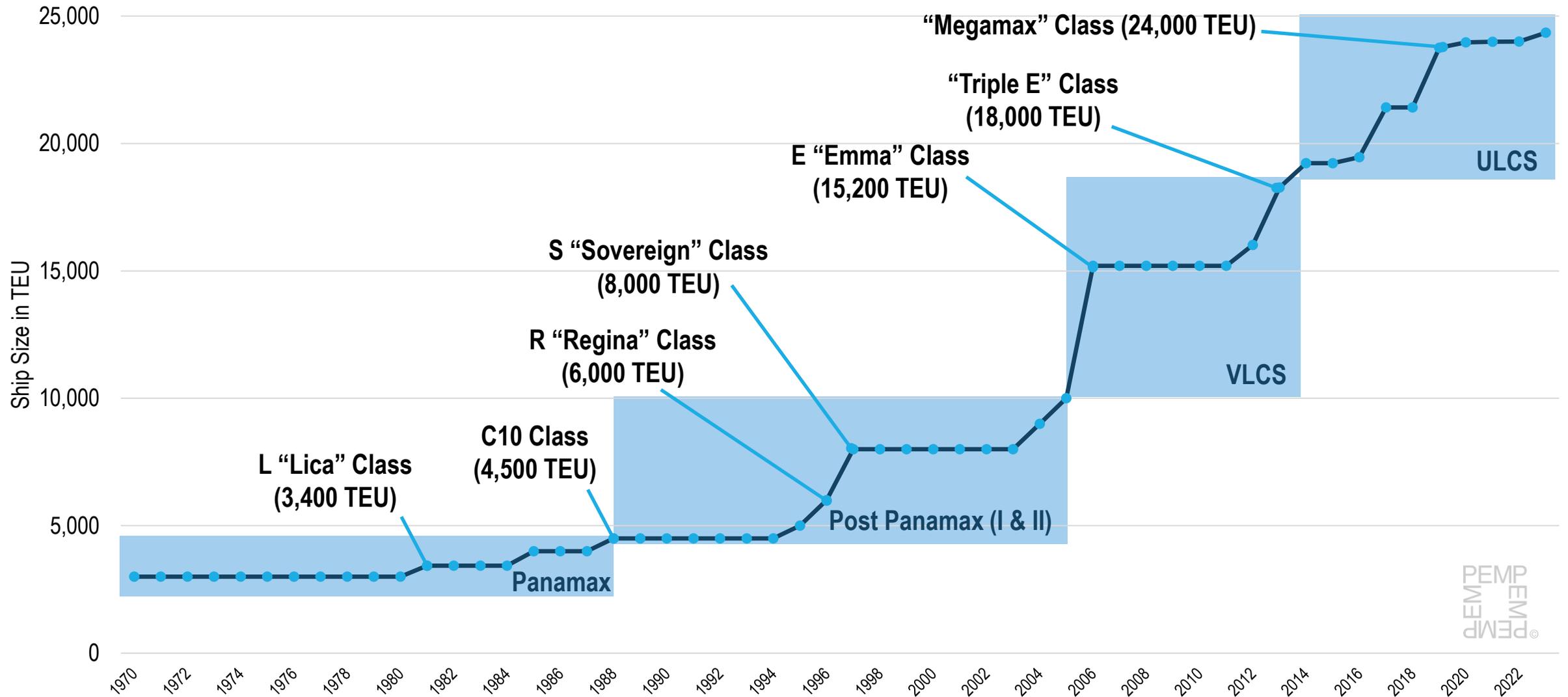
# Evolution of Containerships



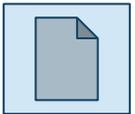
# Evolution of Containerships



# The Largest Available Containership, 1970-2023



# Stacked Upper Deck of a Containership



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# Multipurpose Vessel (Tramp)



# Laker Ship

A laker ship, for trade on the Great Lakes (mostly past the Welland Canal).  
Designed to fit the Soo Locks.



# Cable Laying Vessel





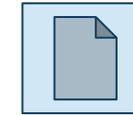
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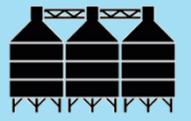
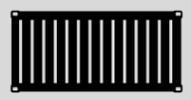
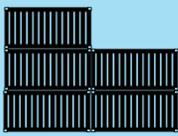


# C. Cargo Markets

# Mobility of Freight

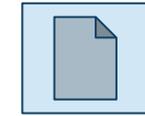


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	Weight	Storage	Fragility	Perishability
	<b>Ores</b> Heavy (0.83 g/cc)	 Piling	None	None
	<b>Grain</b> Heavy (0.83 g/cc)	 Silos	Low	Low
	<b>Petroleum</b> Heavy (0.88 g/cc)	 Tanks	None	None
	<b>Apparel</b> Average	 Warehouse	Low	None
	<b>Fruits &amp; vegetables</b> Average	 Temperature controlled warehouse	High	High
	<b>Containers</b> Average (15-20 tons)	 Stacks	Cargo dependent	Cargo dependent

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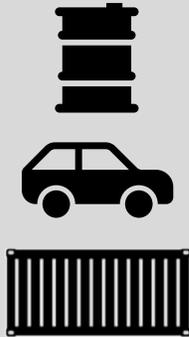
# Types of Maritime Cargo and Ship Types



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## GENERAL CARGO

Unitized Cargo



### Break Bulk



Drums, bags, pallets, boxes

Lift-on/lift-off (1.0 day average port time)

7% of tonnage

### Neo Bulk



Lumber, paper, steel, vehicles

Lift-on/lift-off, roll-on/roll-off (1.0 day average port time)

5% of tonnage

### Containerized



Containers

Lift-on/lift-off (0.9 days average port time)

13% of tonnage

## BULK CARGO

Loose Cargo



### Liquid Bulk



Petroleum, LNG, chemicals, vegetal oils

Pumps and pipelines (1.1 to 1.3 days average port time)

35% of tonnage

### Dry Bulk



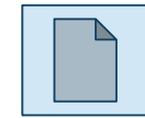
Coal, iron ore, grains, bauxite, sand

Grabs / suction and conveyors (2.7 days average port time)

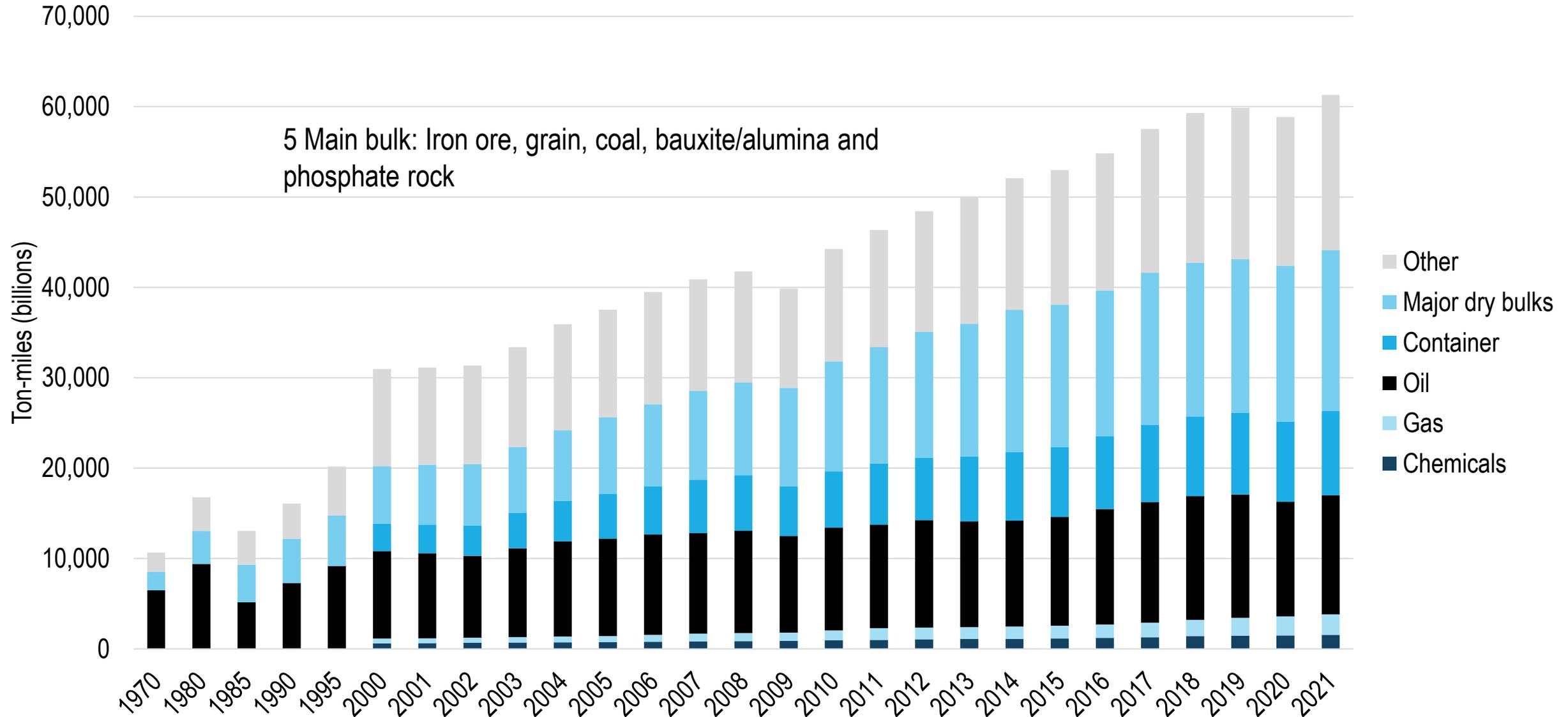
40% of tonnage

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# World Seaborne Trade by Cargo Type, 1970-2021



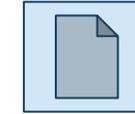
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# What is a Container?

- A standard metal box (ISO 668 standard)
  - 20-foot box of 20 feet long, 8'6" feet high and 8 feet wide (One TEU; Twenty Foot equivalent Unit).
  - 40-foot box (equals two TEU).
  - 40-foot 'high cube' box. 9'6" feet high (often counted as two TEU).
- Using common handling equipment
  - Moving between ships, railcars, trucks and barges.
- The container is a load unit
  - Can be adapted to carry different cargoes.
  - Standard: General dry cargo.
  - Tank: Liquid cargo (fuel and chemicals).
  - Reefer: Refrigerated cargo (food).

# The Benefits of Containerization



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## **TRANSPORTATION COSTS**

- Lower freight rates.
- Lower insurance rates.
- Minimal load unit.



## **INVENTORY COSTS**

- Lower storage costs.
- Lower packing and packaging costs.
- Faster inventory turnover.

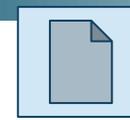


## **SERVICE LEVEL**

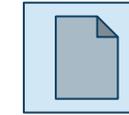
- Time reliability.
- Higher frequency.

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# Container Identification System



Read this content



Check digit calculator

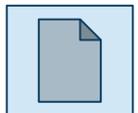
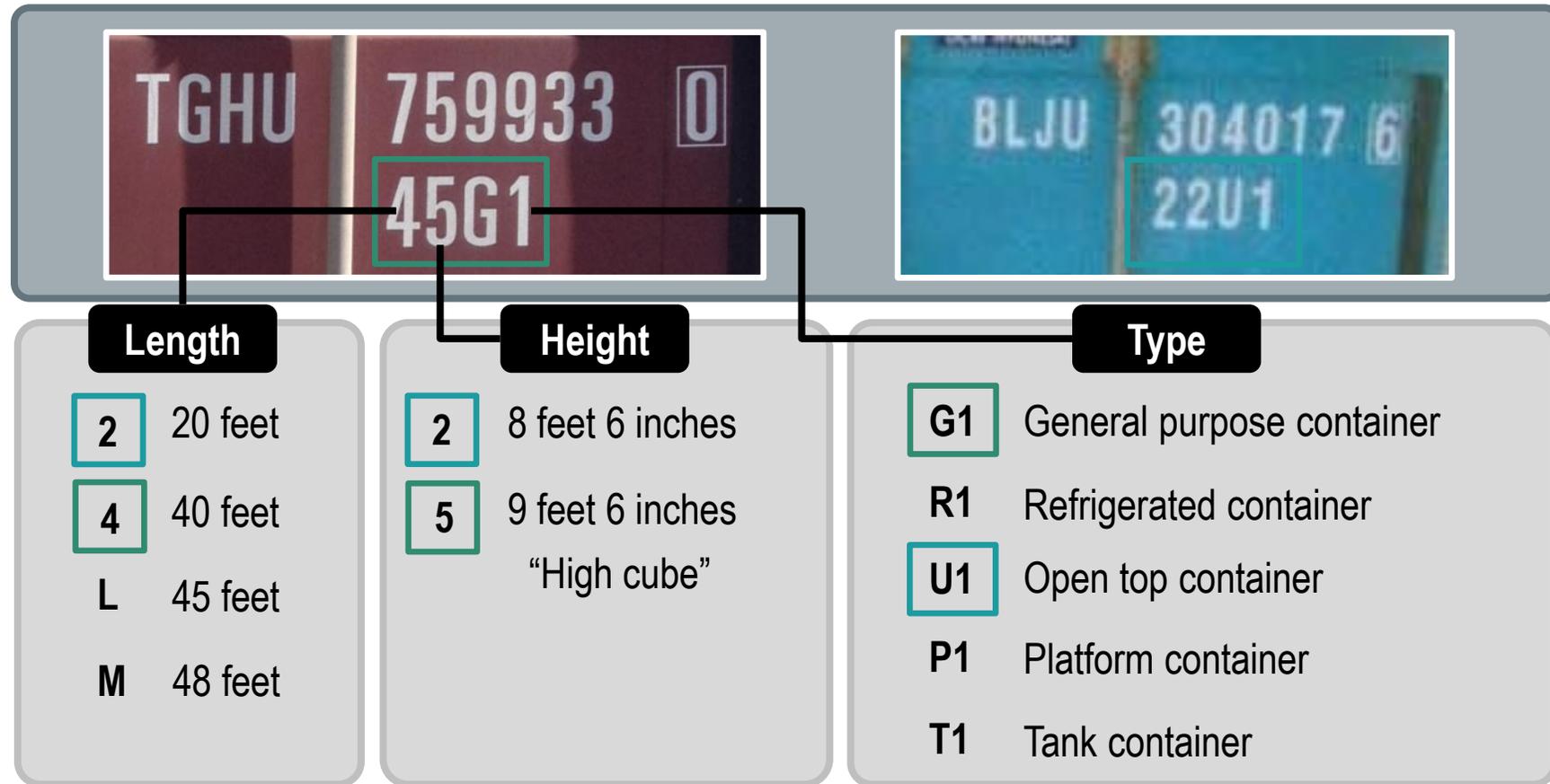


- ① Owner Code (3 letters): TGH
- ② Product Group Code (1 letter): U
- ③ Registration Number (6 digits): 759933
- ④ Check Digit (1 digit): 0
- ⑤ Size & Type Code (4 digits/letters): 45G1

## Operational Characteristics

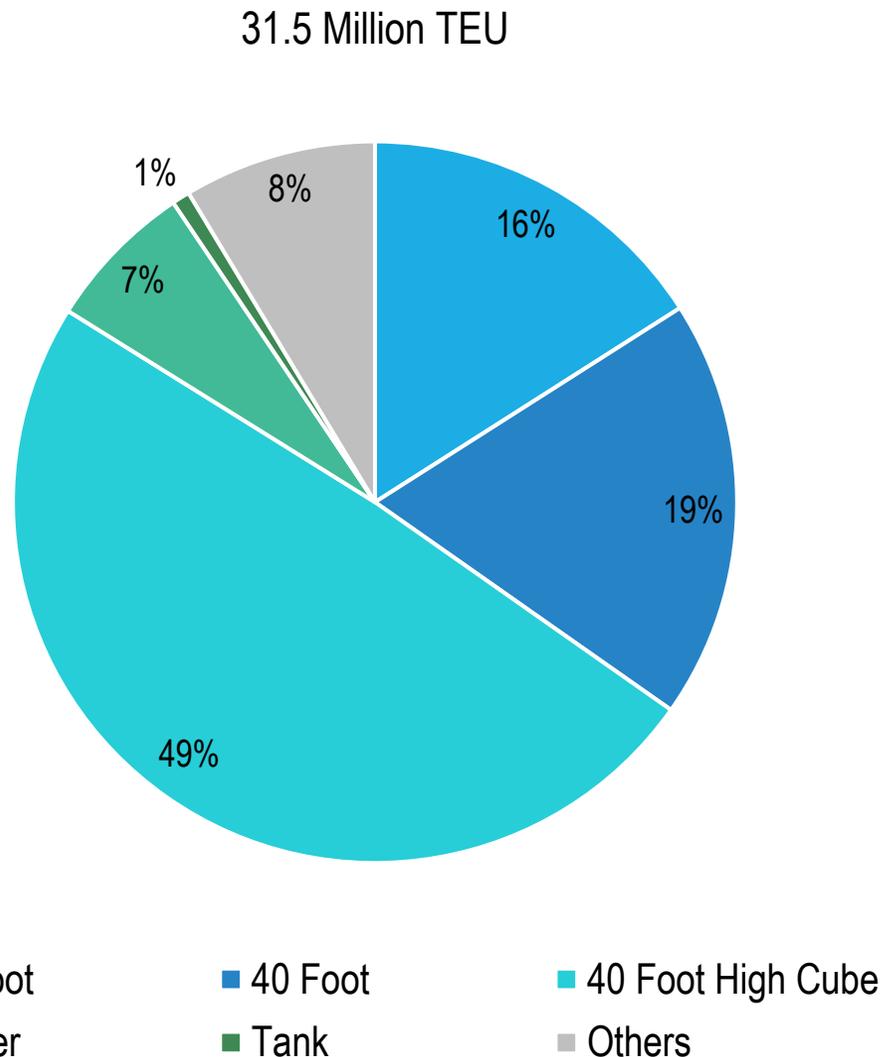
Maximum weight: 30,480 kg  
Container weight: 3,870 kg  
Payload weight: 26,610 kg  
Cubic capacity: 2,700 cubic feet

# Common ISO Container Size and Type Codes



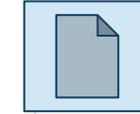
**Read this content**

# Composition of the Global Fleet of Containers, 2012

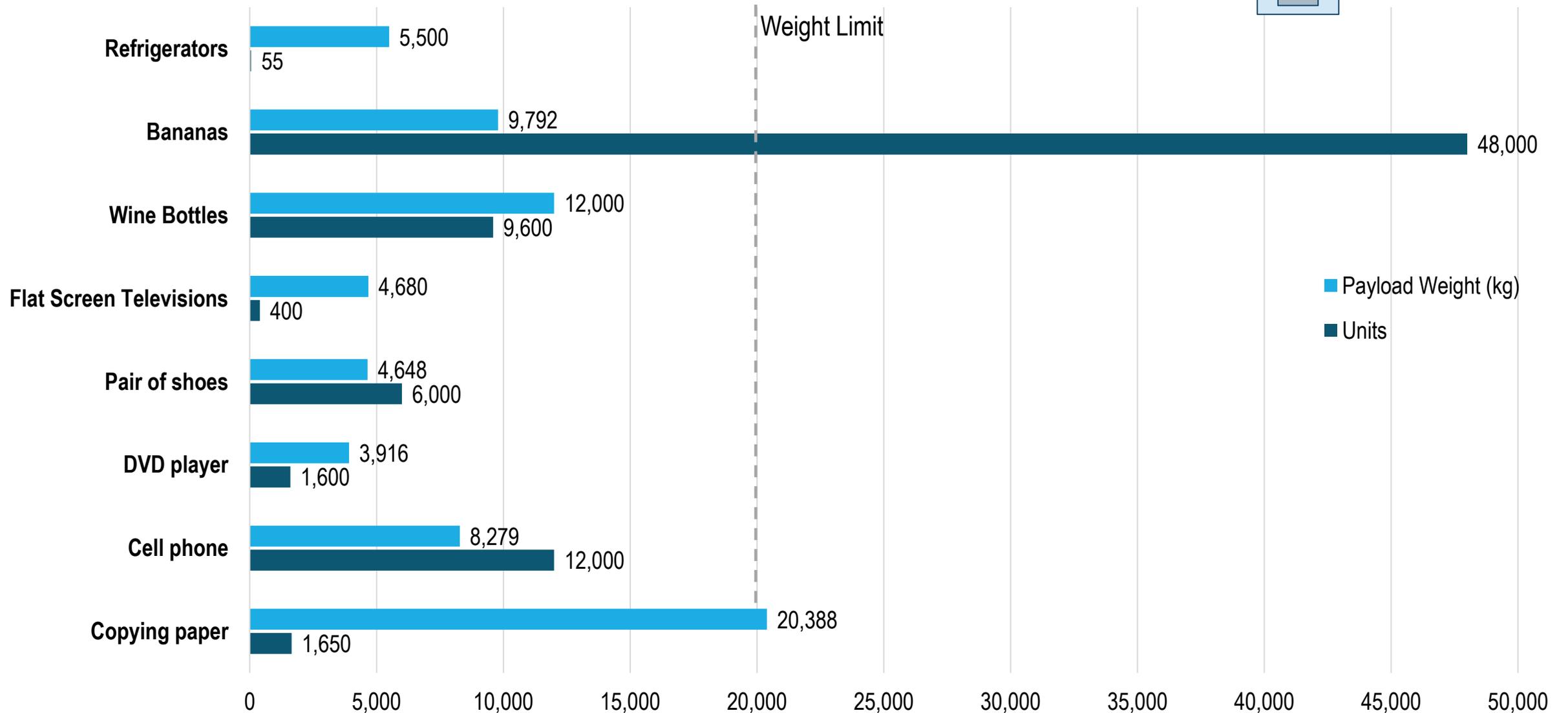


- 20 Foot Containers
  - Carry heavier goods.
  - Running out on weight before run out of volume.
- 40 Foot Containers
  - Carry more volume than weight.
- 40 Foot High-Cube
  - Highest volume available in maritime shipping.
- Reefer
  - Carry refrigerated goods.

# Number of Units and Weight of Standard Consumption Goods that Can be Carried by a 20 Foot Container



[Read this content](#)



# Palletized versus Floor Loaded Container

## FCL Palletized



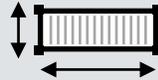
## FCL Floor Loaded



# Advantages of Containerization

## ADVANTAGES

### Standardization



ISO standard (modes and equipment). Unique identification number and size type code.

### Flexibility



Commodities, manufactured goods, liquids and refrigerated goods.

### Costs



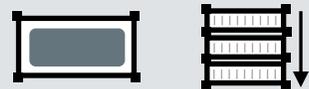
Low transport costs. Economies of scale at modes and terminals.

### Velocity



Fast transshipment operations. Low terminal turnaround times.

### Warehousing

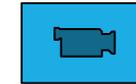


Own warehouse; simpler and less expensive packaging. Stacking capability.

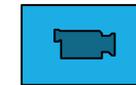
### Security & Safety



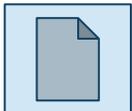
Contents unknown to carriers. Reduced spoilage and losses.



**How a container is made**



**Loading containership**



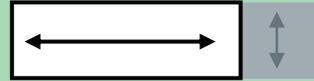
**Read section 4**

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# Drawbacks of Containerization

## CHALLENGES

### Site constraints



Large consumption of terminal space. Draft issues with larger containerships.

### Capital intensiveness



Container handling infrastructures and equipment are important investments.

### Stacking



Complexity of arrangement of containers, both on the ground and on modes.

### Repositioning



Divergence between production and consumption; empty repositioning. 20% of all containers.

### Theft and losses



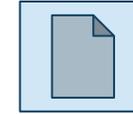
High value goods vulnerable to thefts, particularly between terminal and final destination.

### Illicit trade



Illicit trade of goods, drugs and weapons, as well as for illegal immigration.

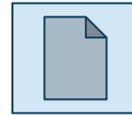
# Stacked 40-Foot Containers, Port of Yantian, China



[Read this content](#)



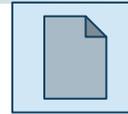
# Loading Coffee into Containers, Cartagena, Colombia



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# 40-Foot Containers Doublestacked on a Rail Car



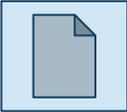
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# 40' Reefer Container



# 20-Foot Tank Containers



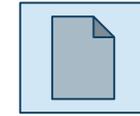
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# The Ultimate “Kegger”



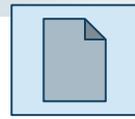
# Reuse of a Discarded Container (South Africa)



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# Containerized Housing Units, Le Havre, France



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# Containers used to fence the US/Mexico Border

