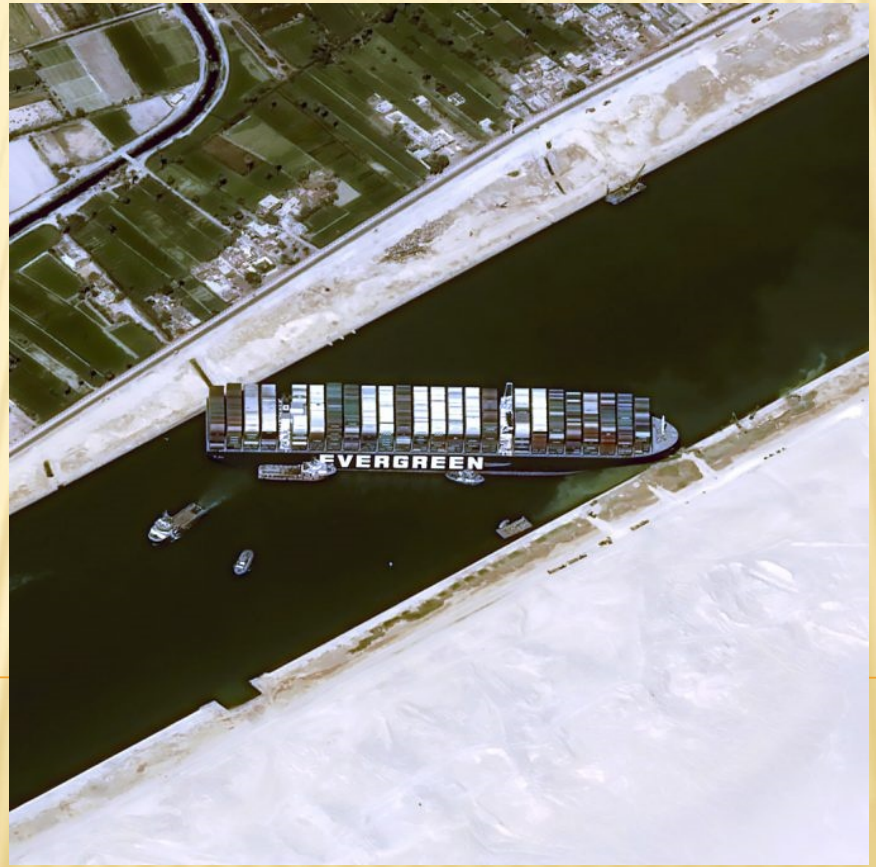
SAILING OVER TROUBLED WATER



Stephen Li

- A Background of the incident and Nautical Terms
- B Navigational safety in Suez Canal Transit
- C Pilotage of ships, their duties and liabilities

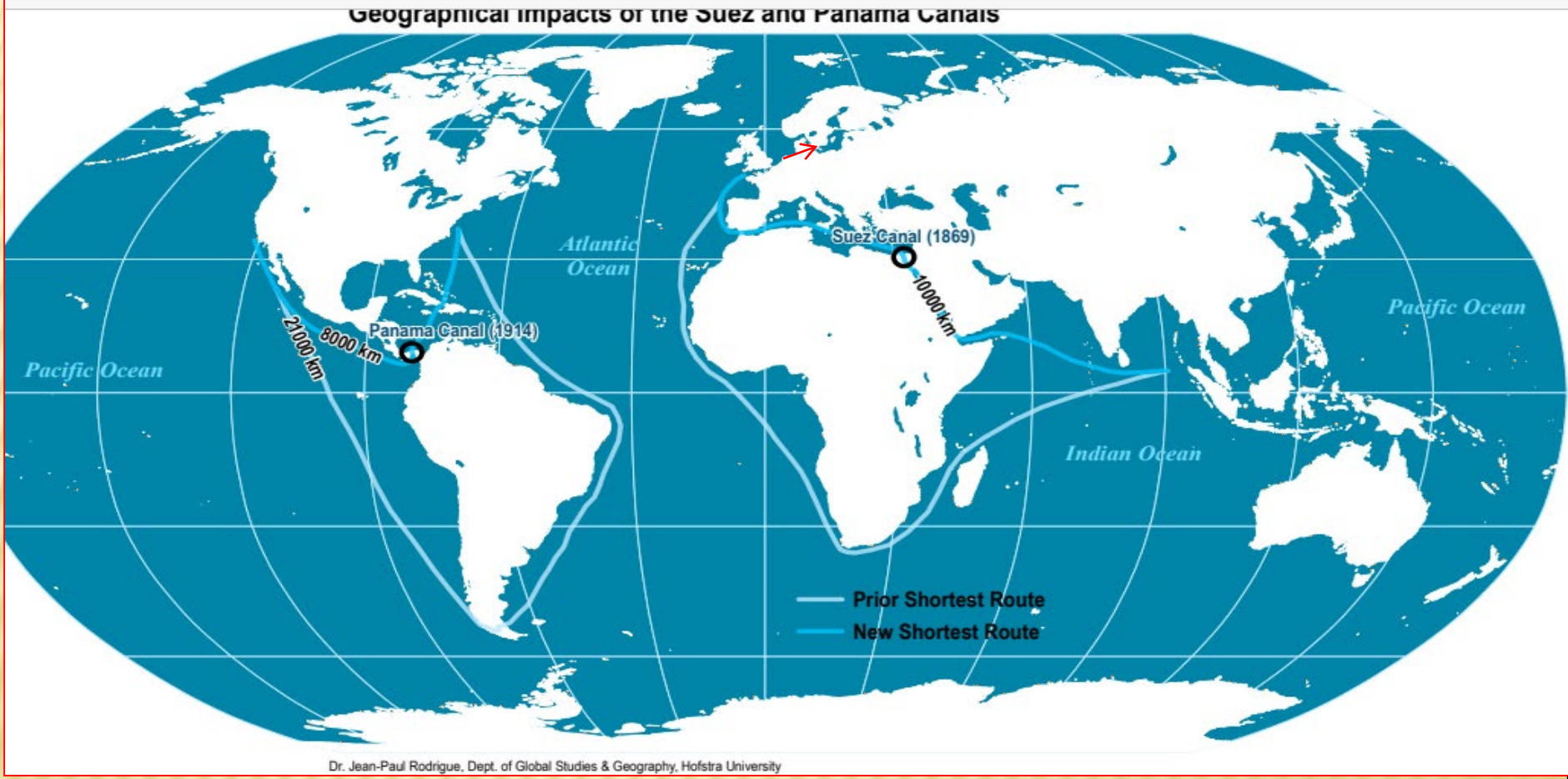
GROUNDING OF M.V. “EVER GIVEN”

- Between 23 and 29, March 2021, the Suez Canal was blocked for six days after the accidental grounding of m.v. Ever Given, a Golden Class 20,000 TEU container ship, on the morning at about 0744 local time of 23 March.

- The 400-metre-long (1,300 ft) vessel was buffeted by strong winds, and ended up wedging itself across the waterway, bow and stern stuck in the canal bank, which prevented other vessels from passing through that part of the Suez Canal.

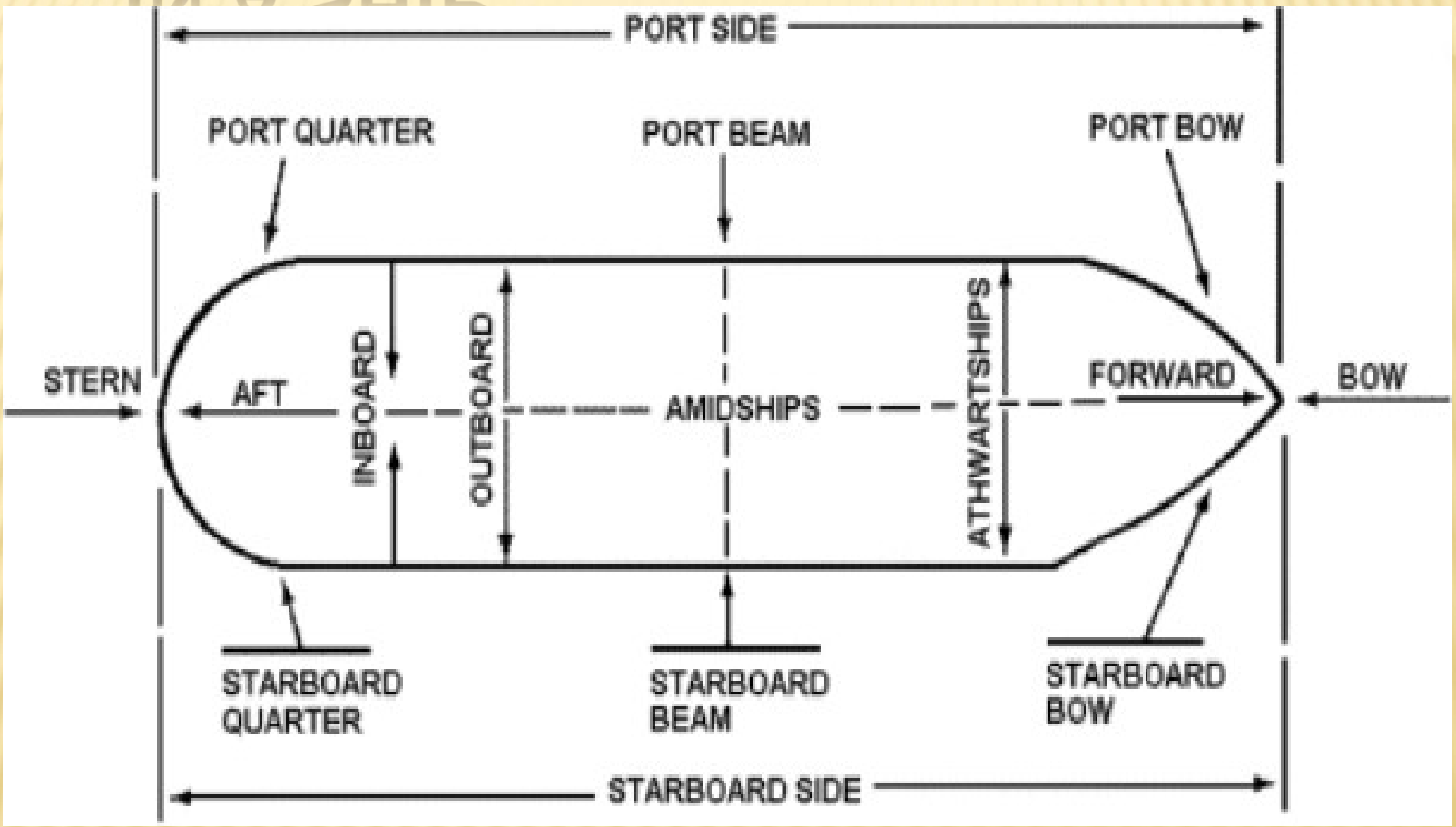
- .

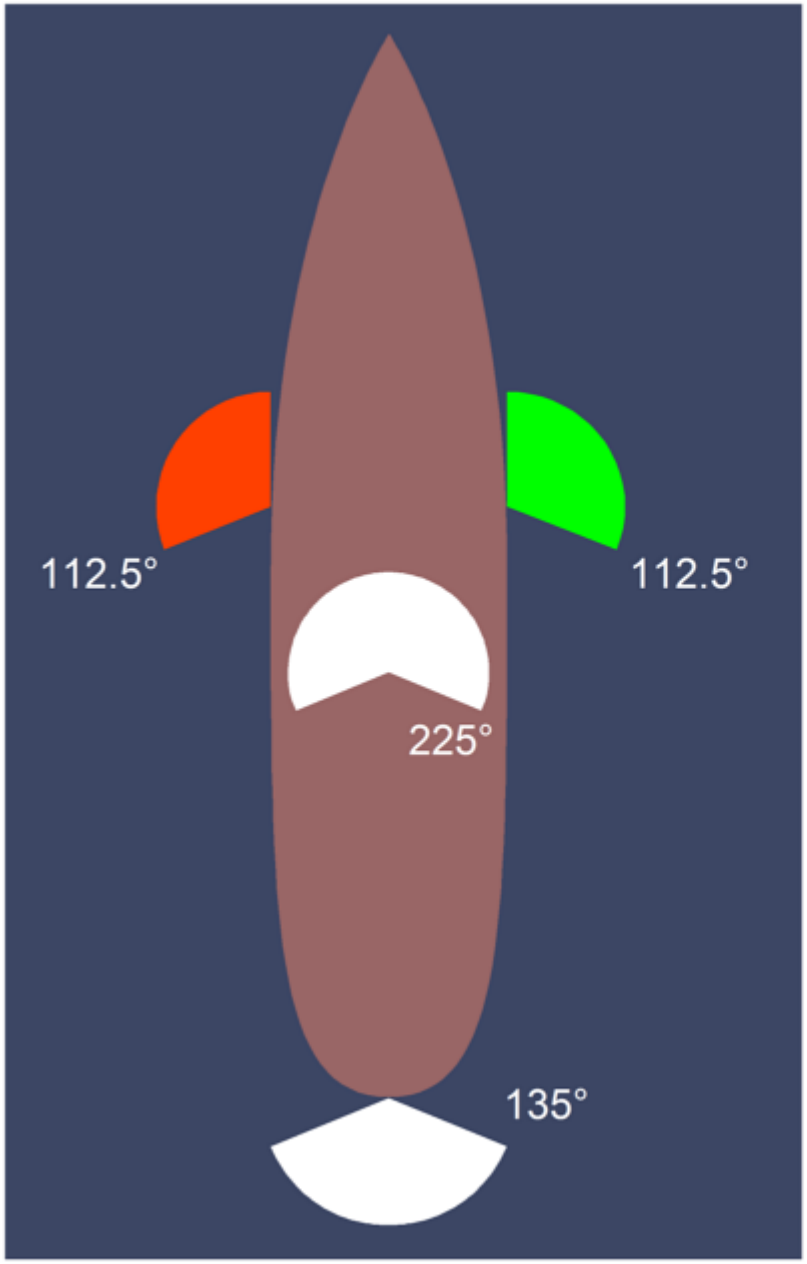
- The Suez Canal is one of the world's busiest trade routes, and the obstruction had a significant negative impact on trade between Europe and Asia and the Middle East. On 28 March, at least 369 ships were queuing to pass through the canal. This prevented an estimated $9.6 billion worth of trade.
- On 29 March, *Ever Given* was re-floated and moved to the Great Bitter Lake for technical inspection, The Suez Canal Authorities allowed shipping to resume from 19:00LT (17:00 UTC)

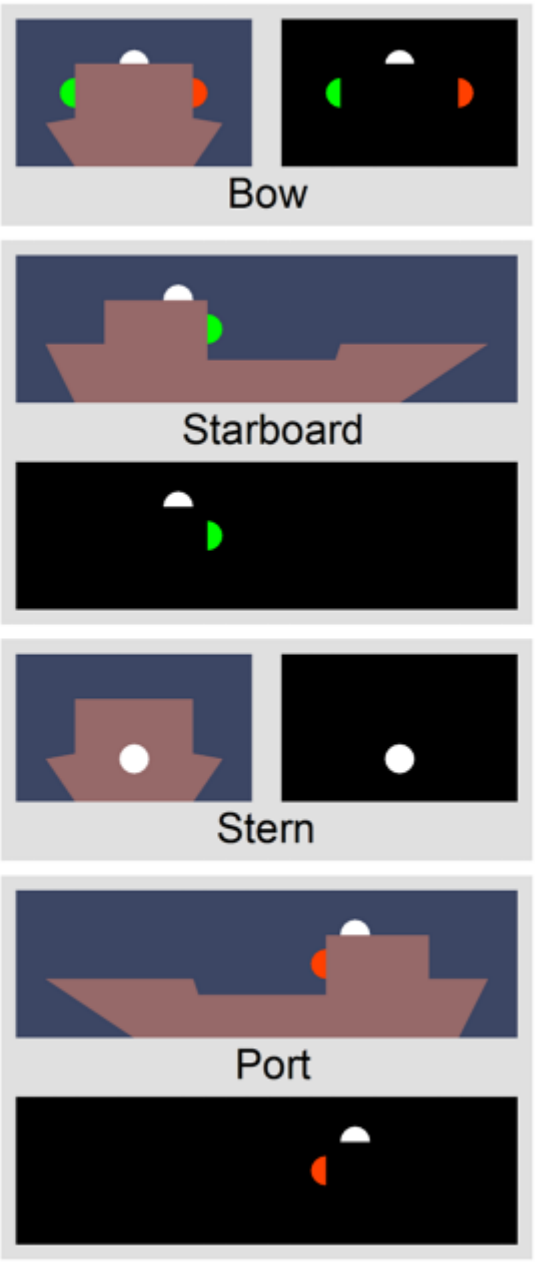

Geographical Impacts of the Suez and Panama Canals
Atlantic Ocean
Pacific Ocean
Pacific Ocean
Indian Ocean
Suez Canal (1869)
10000 km
Panama Canal (1914)
8000 km
21000 km
Prior Shortest Route
New Shortest Route
Dr. Jean-Paul Rodrigue, Dept. of Global Studies & Geography, Hofstra University

- Nautical Terms

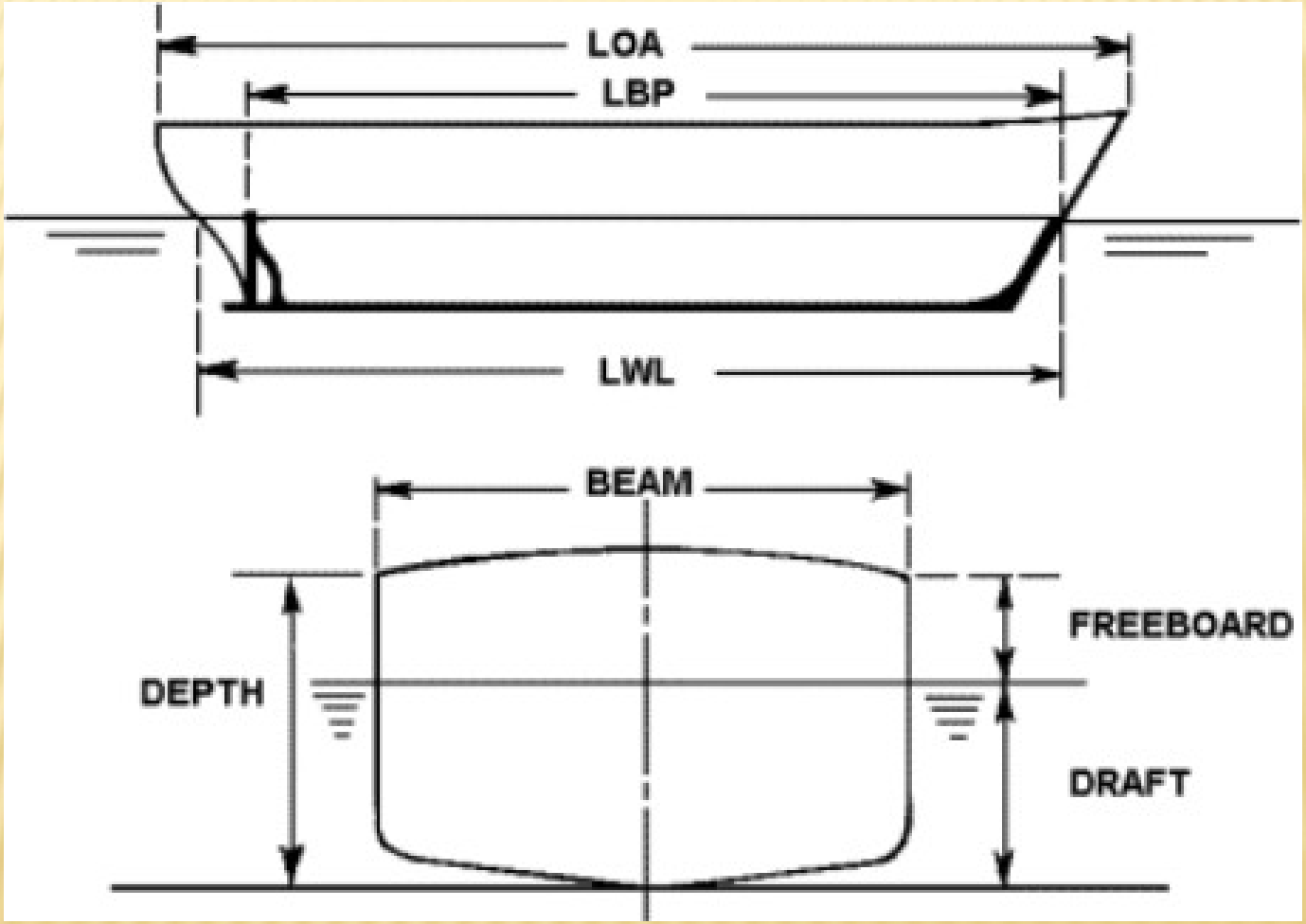
LOCATIONS AND DIRECTIONS IN A SHIP




112.5°
112.5°
225°
135°


Bow
Starboard
Stern
Port

TERMS RELATED TO HULL



TERMS RELATED TO A SHIP

Superstructure

Hull

MEASUREMENT OF SHIPS

- **Displacement**
  - This is the actual weight of the vessel measured by weight in tons of water she displaces when loaded with fuel, water, stores and crew.
- **Deadweight Tonnage (DWT)**
  - This a measure of the weight of the cargo, passengers, crew, stores, fuel and water which the ship can carry when floating at her summer load draft.

MEASUREMENT OF SHIPS

- **Net Tonnage (NT)**

  – This is a measure of space that can be used to carry passengers and cargo (earning space).

- **Gross Tonnage**

  - This a measure of the total internal volume of a ship, excluding some spaces such as wheelhouse, galley, radio room etc.

  – Gross and Net Tonnage are defined by International Tonnage Convention.

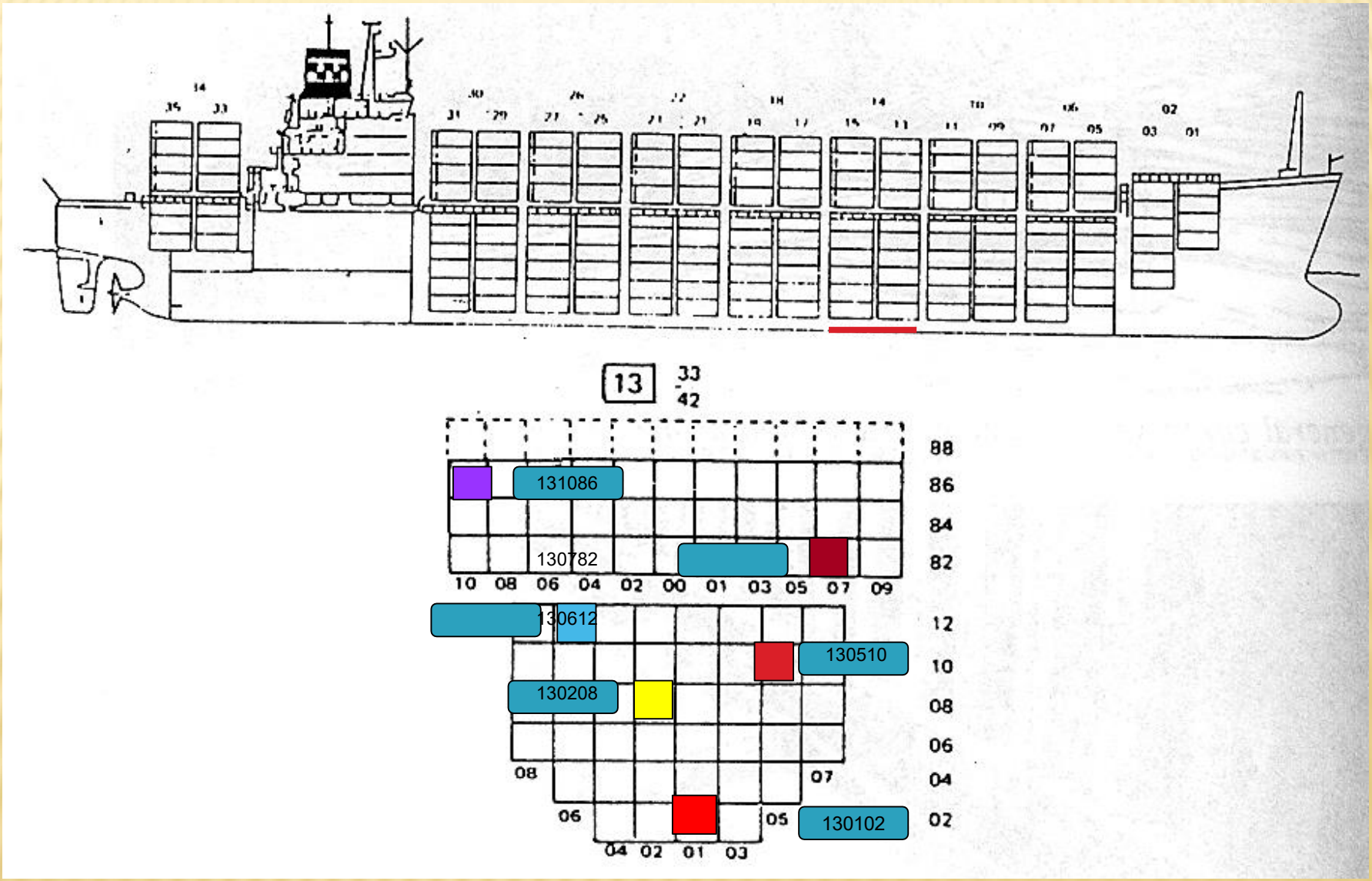
CONTAINER LOCATION (BAY ROW TIER)

- Stowage plan or Bay plan of containers in 3 dimension coordinates

- Bay: From Ford to Aft
- FEU-even number 02, 04 (Forty Feet Container)
- TEU-odd number 01, 03 (Twenty Feet Container)

- Row: From Centreline to
- Starboard side - odd number
- Port side – even number

- Tier: From bottom of hold upward
- only even number – 02, 04…
- From deck – 82, 84…


13
33
42
88
86
84
82
131086
130782
10 08 06 04 02 00 01 03 05 07 09
130612
12
130510
10
130208
08
06
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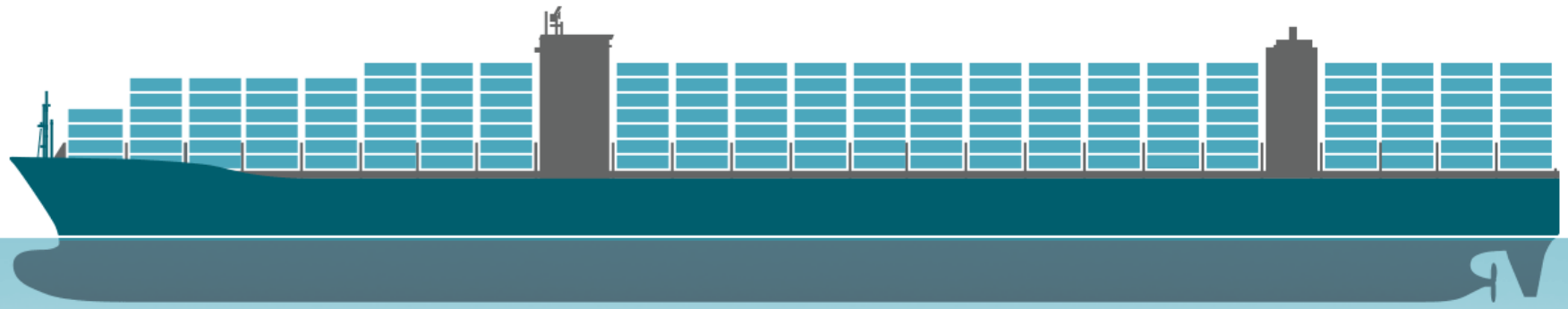
07
04
06
05
02
130102
04 02 01 03

GOLDEN CLASS CONTAINERS

MV Ever Given



Length: **400m**

Speed: **22.8 knots**

Built: **2018**

Gross tonnage: **219,076**

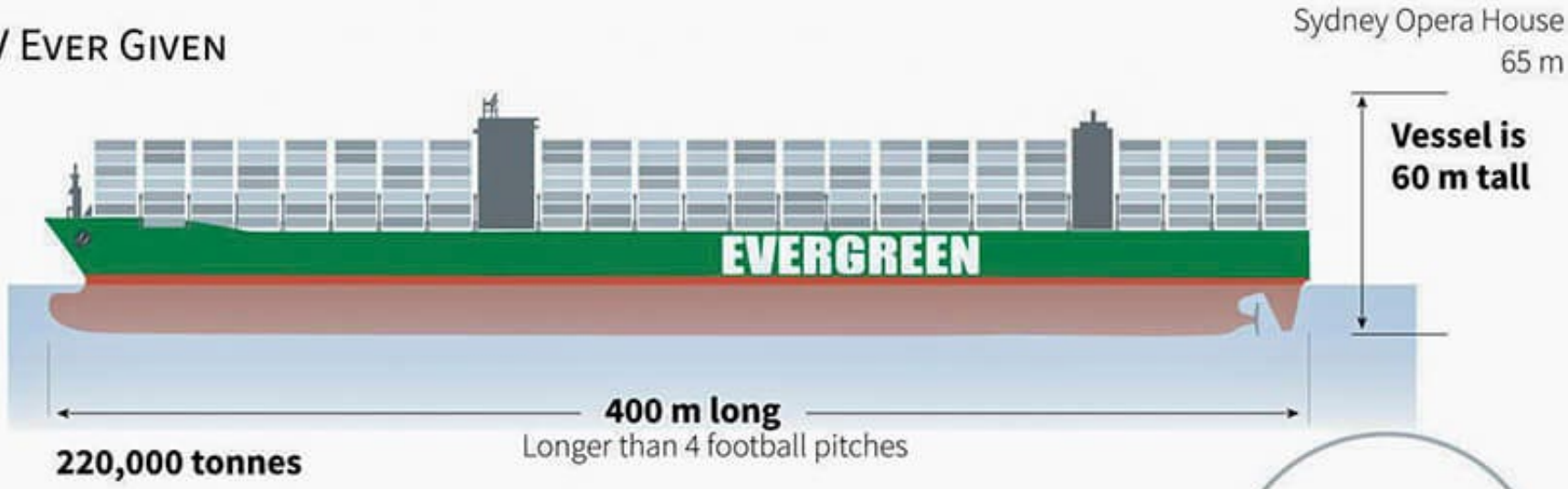
Source: ShipmentLink

BBC

MV Ever Given and the Suez Canal

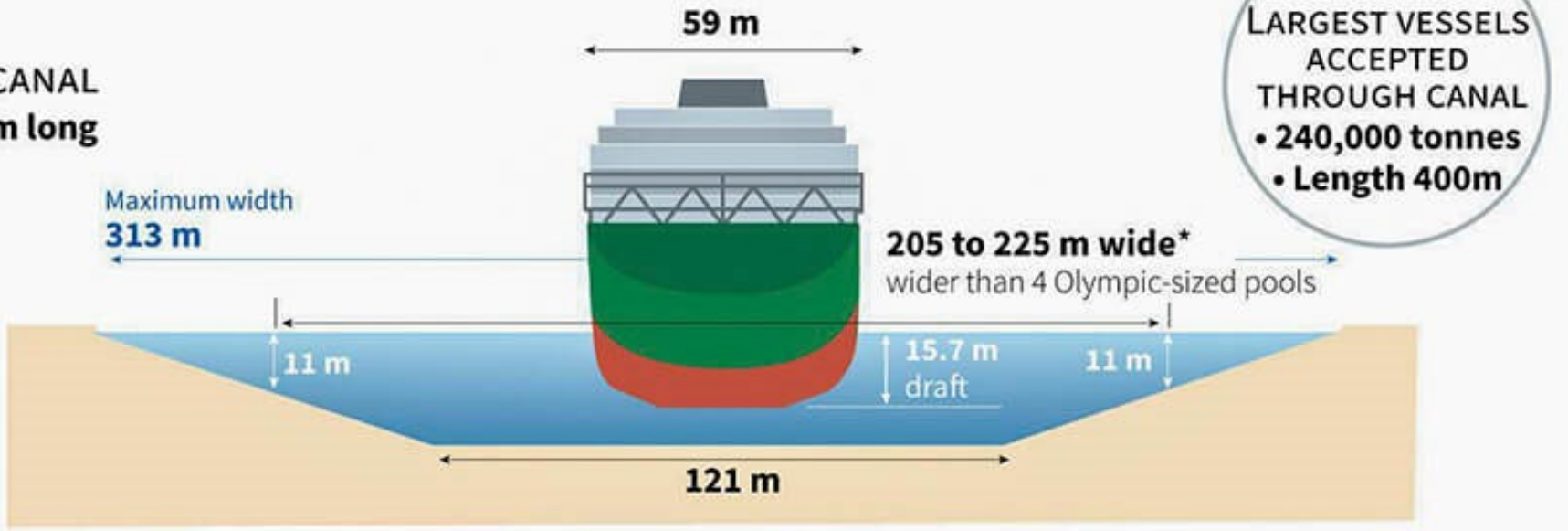
The huge container ship of the Evergreen Marine Corporation has blocked the canal

THE MV EVER GIVEN



SUEZ CANAL

193.3 km long



LARGEST VESSELS ACCEPTED THROUGH CANAL

- **240,000 tonnes**
- **Length 400m**

Sources: fleetmon.com, Suez Canal authorities, Vessel finder

*at a depth of 11 metres

AFP


EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
EVERGREEN
COSCO
COSCO
APL
GREEN

Ever Given anchored for safety checks

BBC

POSSIBLE CAUSES OF ACCIDENT

- The causes of this incident are still under investigation by the Suez Canal and other Authorities
- One of the allegations was the strong side wind causing the ship to set towards the bank
- We will look at the movement of Ever Given shortly before it grounded

WINDAGE AREA OF LARGE CONTAINER SHIP

- The windage area of a vessel or offshore structure is the area that is exposed directly to the wind. As is obvious, this is the area of all items above the waterline. This will include:

- Area of Freeboard - Part of the hull/offshore structure above the waterline

- Area of deck containers (about 8 – 10 tier height of deck containers)

- Calculating the windage area is required when we need to know the wind forces acting on the vessel.
- The formula for wind force calculation on any structure is:
- Wind Force = Pressure x Area exposed to the wind direction


CAI
APL
TRITON
CMA
MAGELLAN
EVERGREEN
EVERGREEN
EVERGREEN
EVER
COSCO
COSCO
tex
CMA CGM
OOCL
COSCO SHIPPING
COSCO SHIPPING
EVER GIVEN

RULES OF NAVIGATION IN SUEZ CANAL

- Art 54 of the Rules of Navigation states the transit speed in Suez Canal of a container ship is 16km/hour (8.6 knots)

- In general, steering a ship is more challenging than driving a car. Unlike the tires of a car that grip the surface of the road, a ship will have no brake as a car does.
- Ships are at the mercy of wind, currents and interaction in shallow water, not always moving in the direction they're pointed. Owing to the large momentum it is difficult to make corrections quickly when they veer off-course.

MOVEMENT OF EVER GIVEN BEFORE GROUNDING – MAX SPEED WAS 13.7 KNOTS

VIDEO-2021-03-29-22-58-02.mp4

The swinging between starboard side and portside banks of the Canal had already started.


23 Mar 2021 05:43:14 UTC
23 Mar 2021 07:43:14 EET
00:01:37
EVER GIVEN
SOG: 1.0 Knts
HDG: 31.0°
COG: 291.5°
ROT: 5.1°
After the last wide swinging movement the Ever Given runs aground.

- SOG

Speed Over Ground

was 13.7 knots (highest)

At 5.1 knots over

the canal transit speed

EXCESSIVE SPEED OF EVER GIVEN

- It is possible for the pilot to increase the speed of Ever Given as the ship set too much to the port side of the canal bank due to strong wind
- Increasing the speed might give quicker response of rudder in turning the ship's head back to the centre of canal as more water flowed through the rudder

- However when big ship is navigating at relative high speed in shallow and narrow waters, the large hull will induce greater squat and **bank effect (main contributing cause)** causing the vessel to veer off course and lose control.

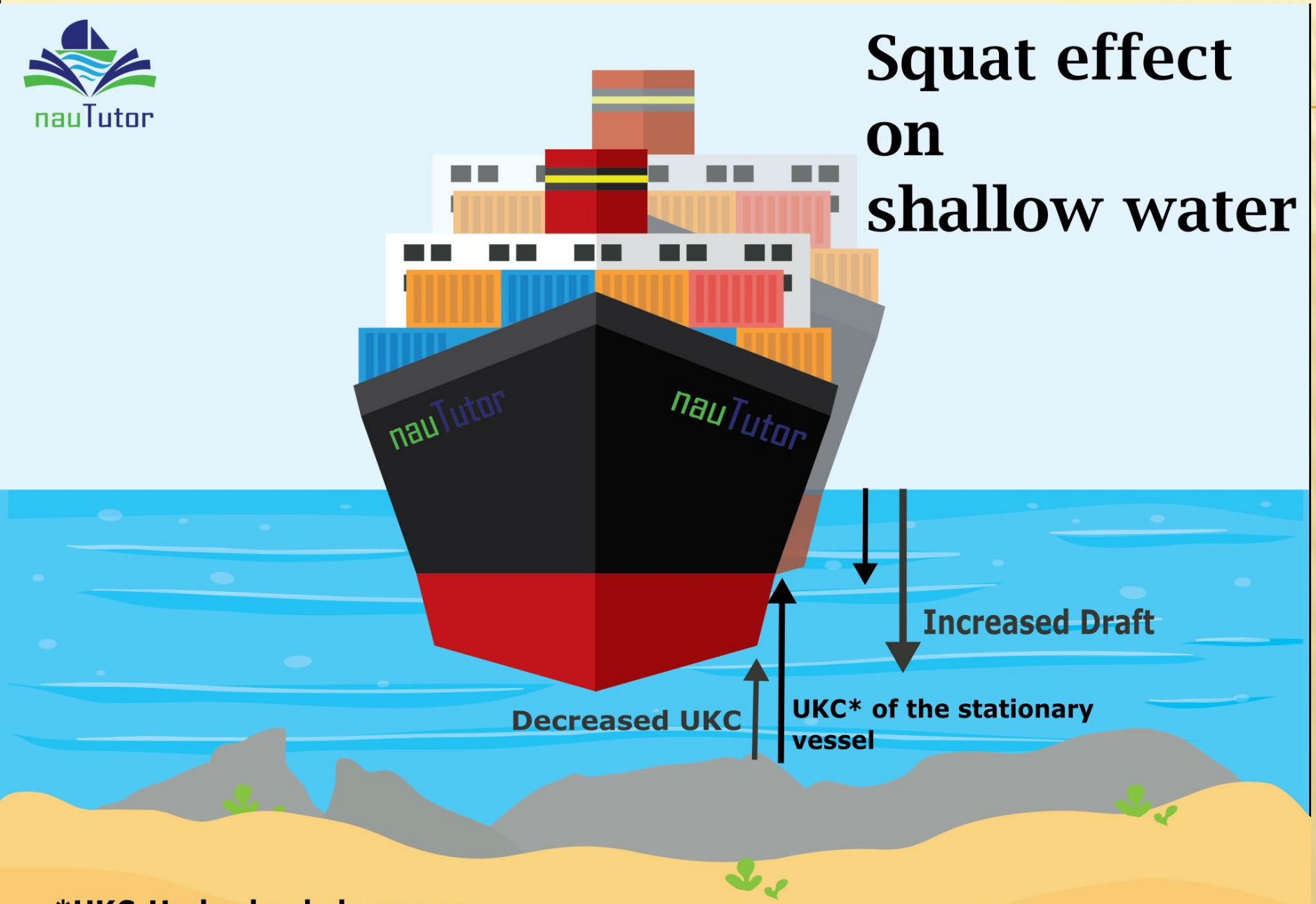
- It is unclear whether a lull in the wind or human error or something else was at fault for the initial westward drift, but once that happened the bank effect became the final nail in the sandy coffin, pulling the stern of the ship towards the western shore while pushing the bow away.

SQUAT / SINKAGE

Squat – Limited space around the vessel

-Water flow around the hull increases to allow the same water mass to pass
-Increased flow leads to negative pressure and downward vertical force (Bernoulli's principle)
-If the water flow can not increase the vessel speed will be reduced
-Squat affect the vessel when depth below keel is less than 10% of the vessel draft

Squat effect on shallow water

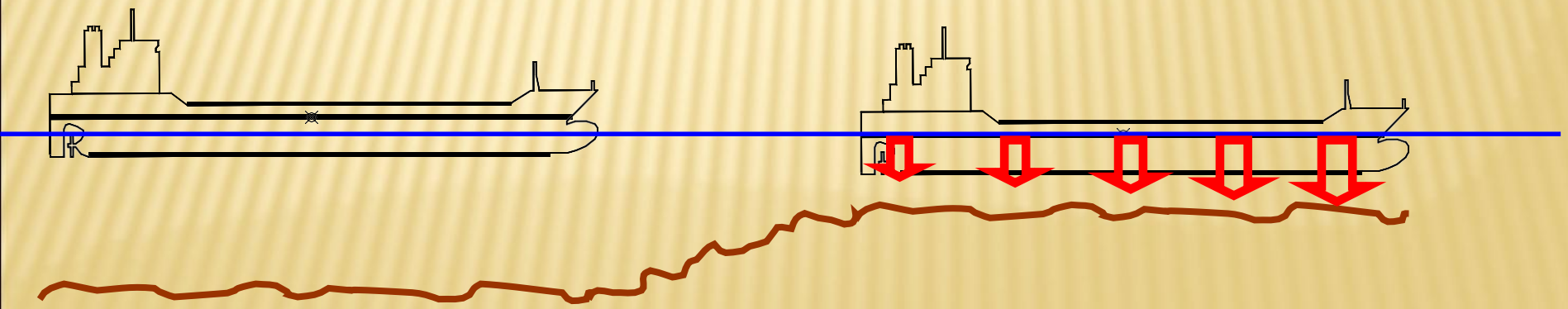


*UKC-Under keel clearance

SQUAT

A hydrodynamic phenomenon in which a vessel moving through shallow water creates an area of lowered pressure (due to Bernoulli's effect) causing the ships draught to increase.

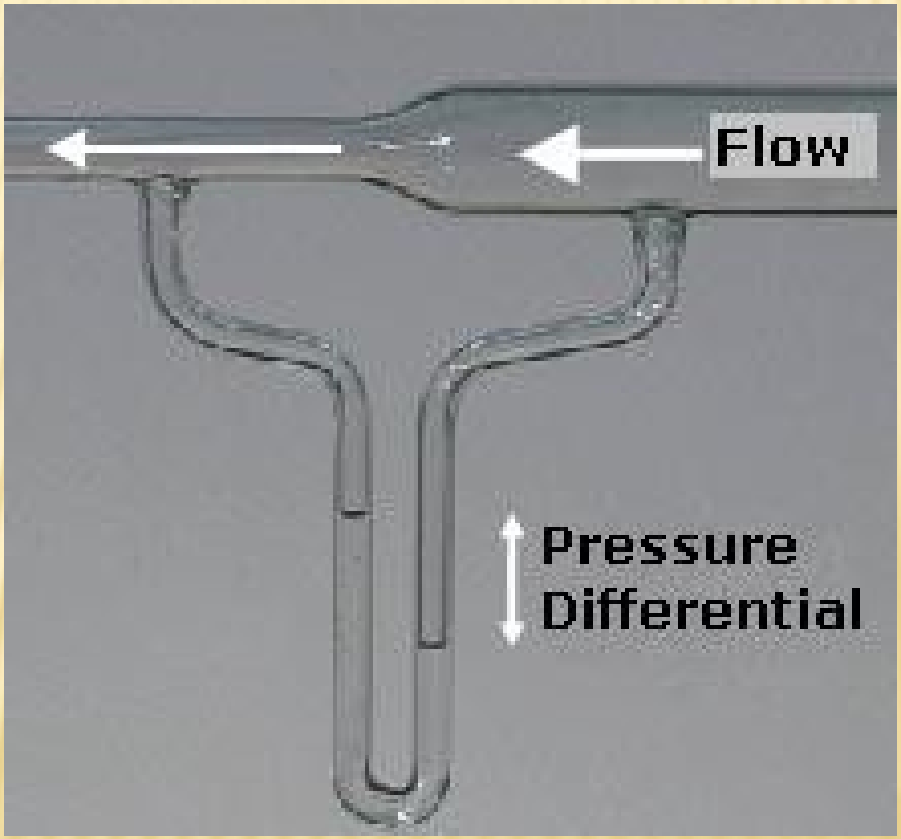
Squat effect results from a combination of (vertical) sinkage and a change of trim that may cause the vessel to dip towards the stern or towards the bow.



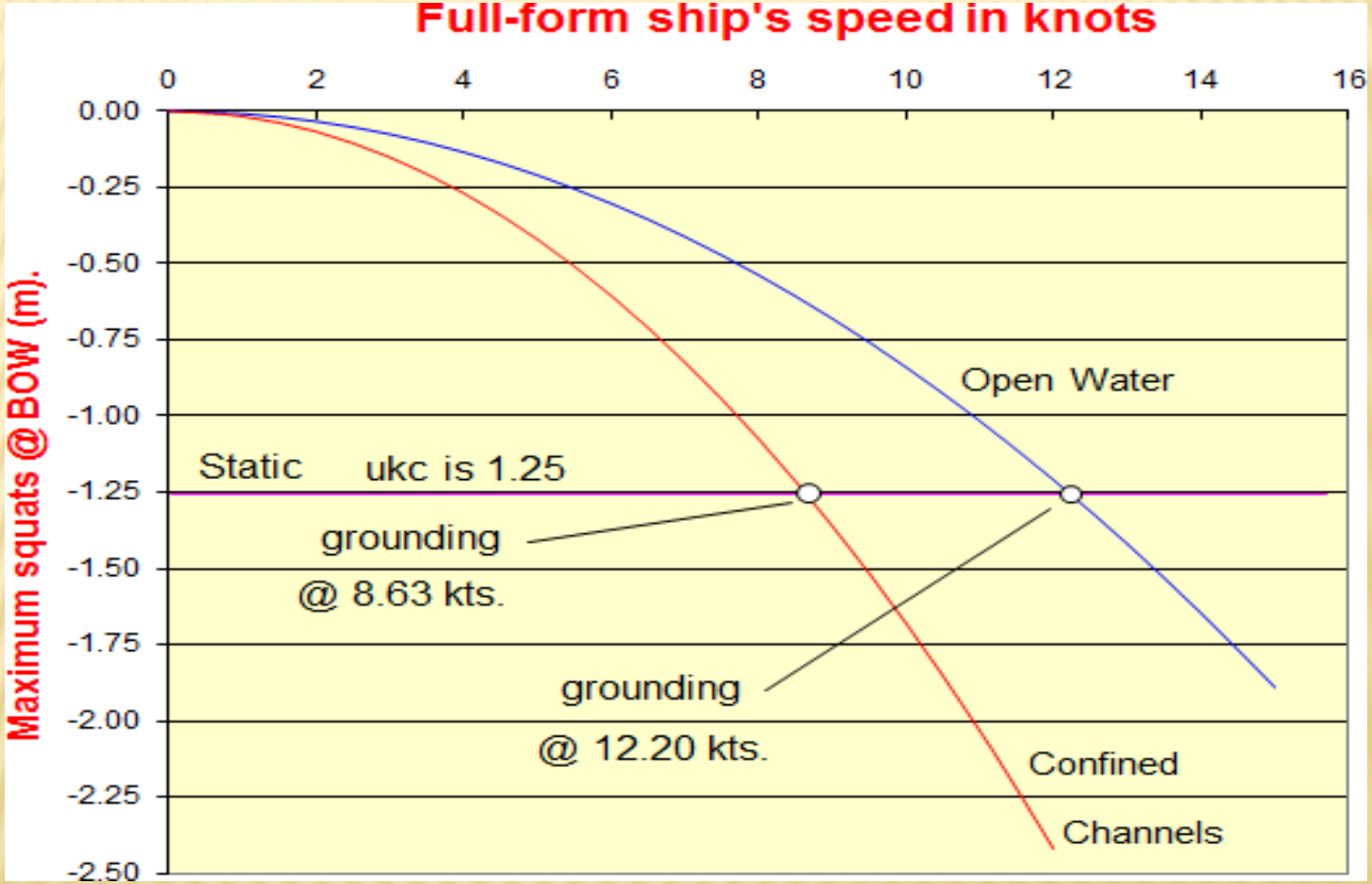
- Bernoulli's principle

- As displaced water travels under the hull of the ship from front to rear, it gets squeezed through a smaller area, causing the water to speed up and the pressure to drop. To compensate, the hull of the ship is pulled downwards towards the canal floor more strongly at the stern than at the bow, increasing the asymmetry of the "squat."

BERNOULLI'S PRINCIPLE



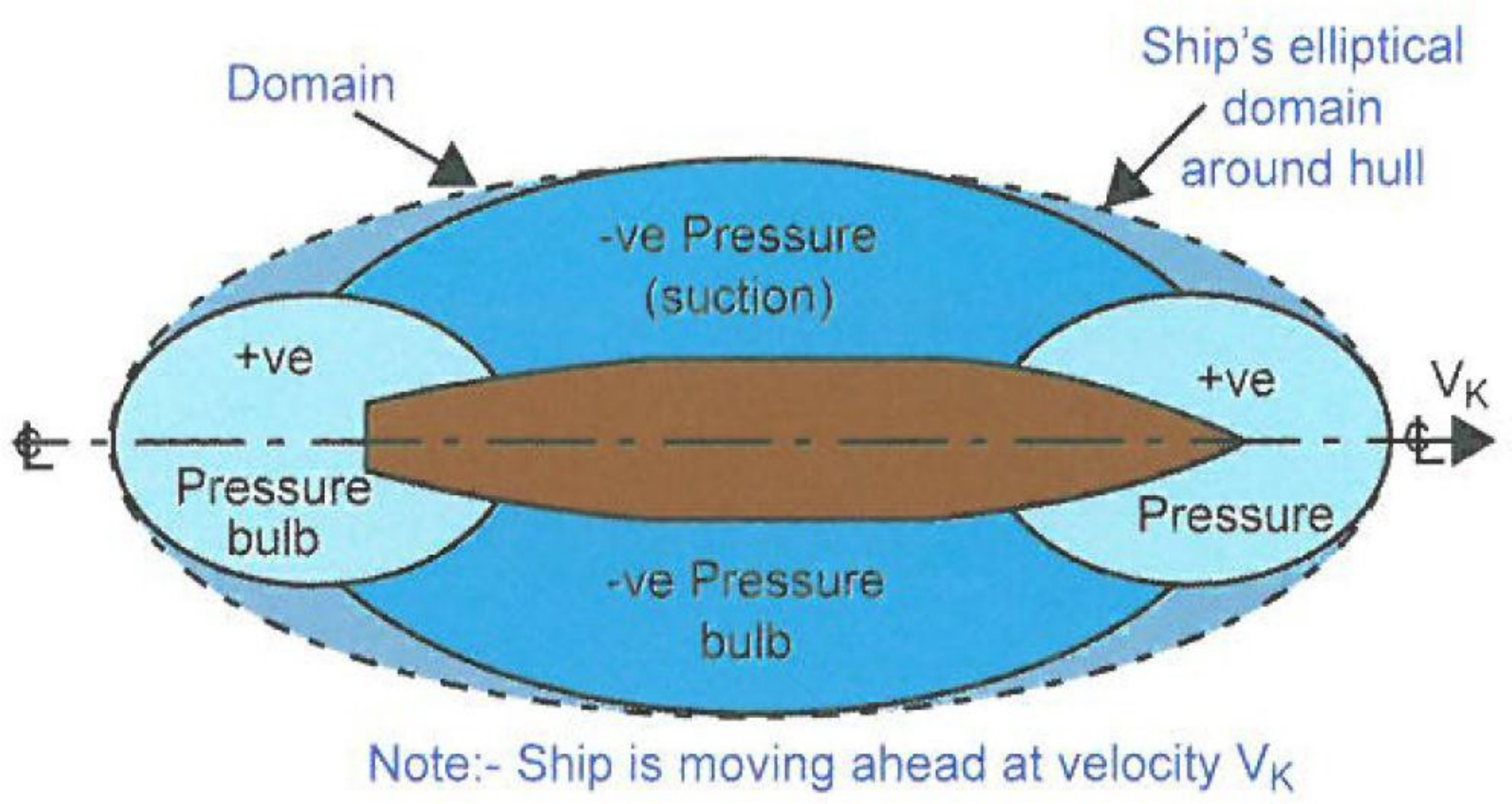
SQUAT IN OPEN WATER & CONFINED CHANNELS



BANK EFFECT WHEN SHIP NAVIGATES IN NARROW WATERS

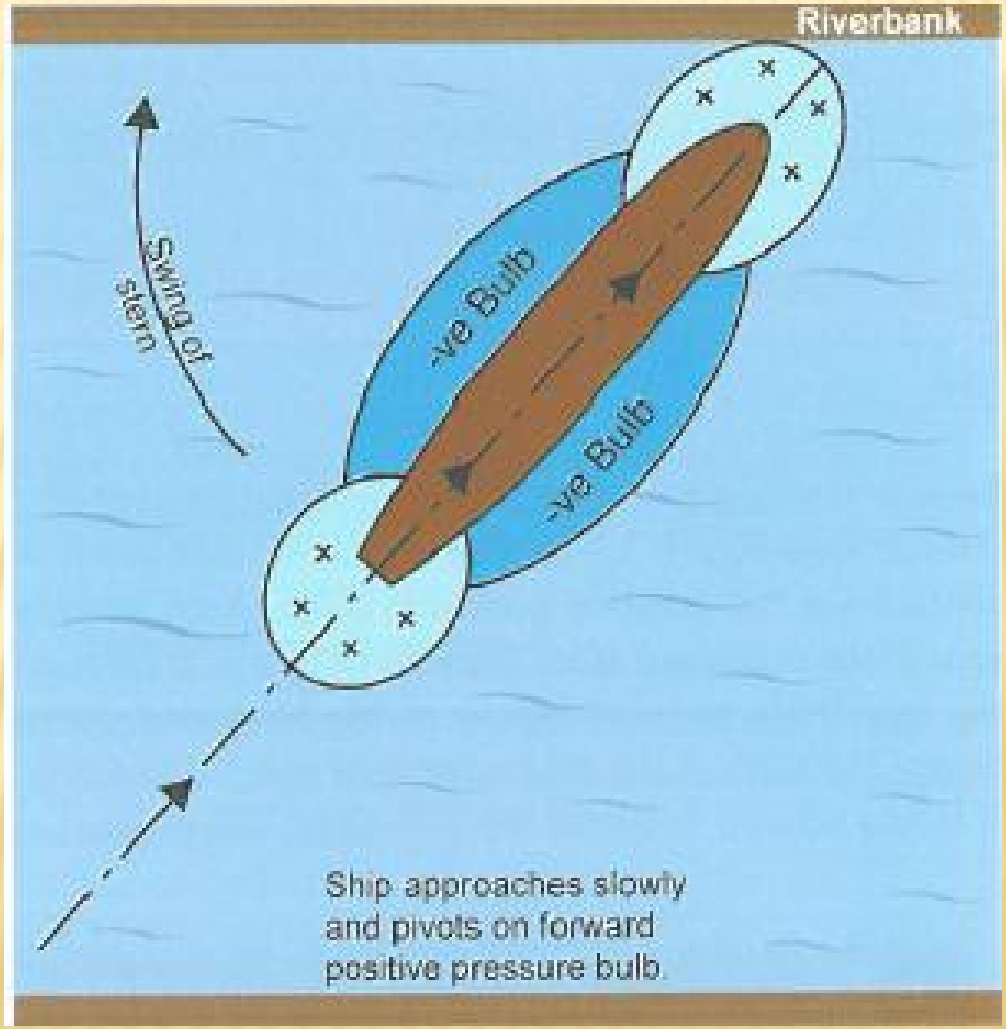
PRESSURE ZONES

PRESSURE DISTRIBUTION AROUND HULL - TOP VIEW



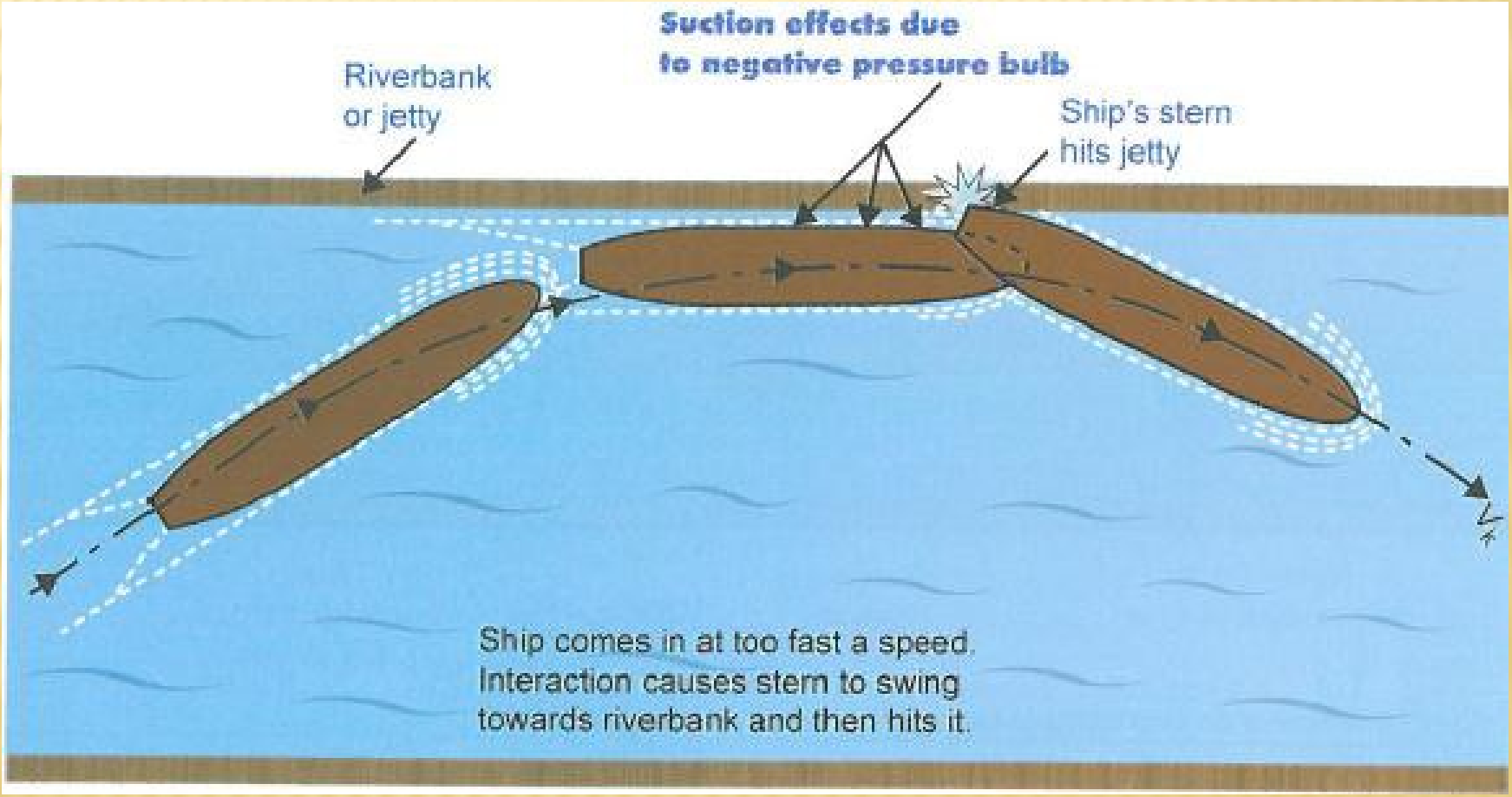
SHIP-TO-SHORE INTERACTION

APPROACHING A BANK



SHIP-TO-SHORE INTERACTION

THE BANK EFFECT CAUSED THE STEM OF EVER GIVEN TO SWING TO STARBOARD UNCONTROLLABLY



MEGA SHIPS PASSING SUEZ CANAL

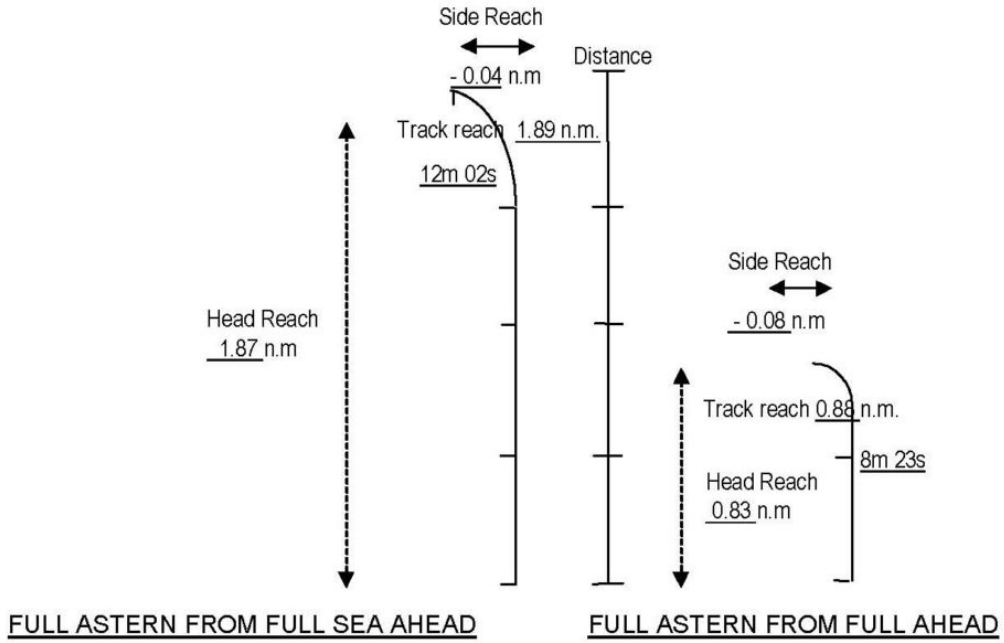
- As ships in transit become bigger, the margin for error when sailing through shallow waterways like the Suez Canal becomes much smaller.

- Larger ships displace more water and have less of a gap between the hull of the ship and the walls and floor of the canal, increasing the squatting and bank effects and making the pilot's job even more difficult.


EVERGREEN

STOPPING DISTANCE OF A CONTAINER SHIP

Stopping ability



From full ahead sea to full astern

Initial rpm	Final rpm	Initial	Final	Track	Head	Side reach
123	-102	15.68	0.0 knots	1.89 n.	1.87 n.	-0.04 n.

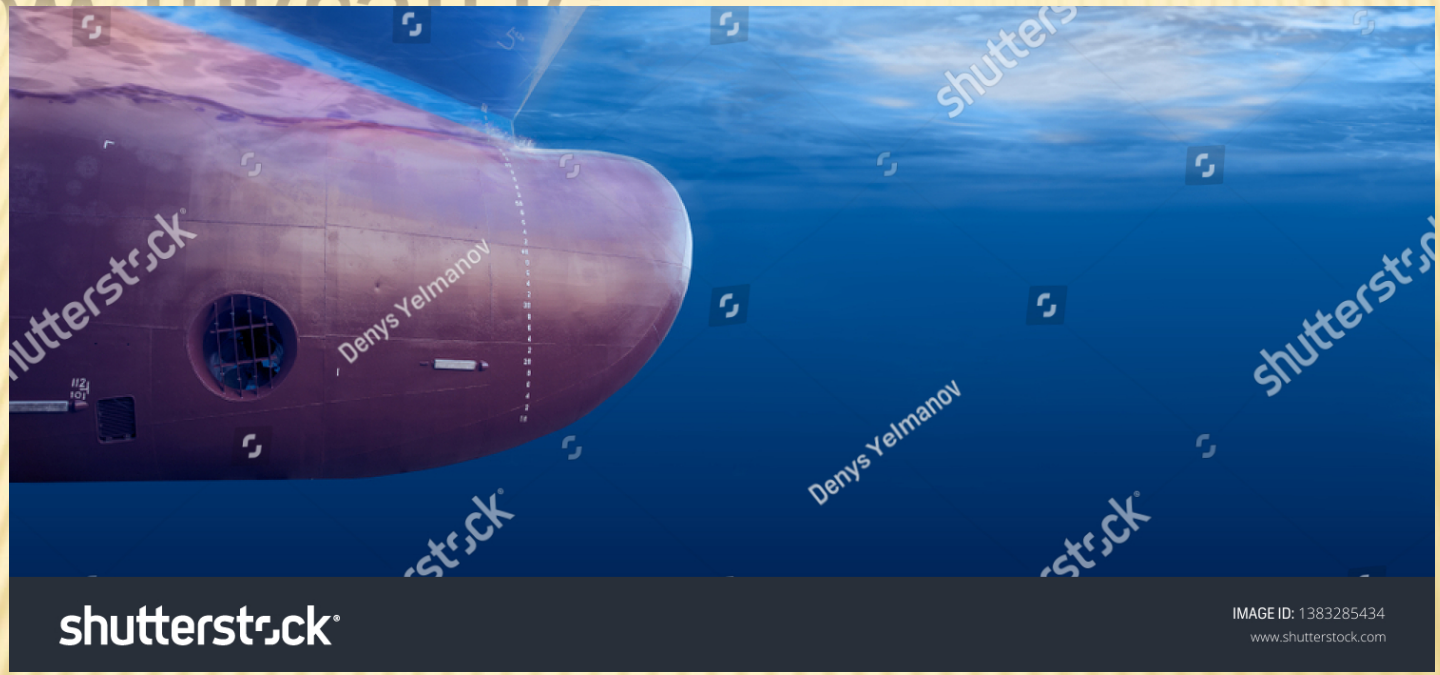
From full ahead to full astern

Initial rpm	Final rpm	Initial	Final	Track	Head	Side reach
102	-101	12.3	0.0 knots	0.88 n.	0.83 n.	-0.08 n.

Environmental conditions during Manoeuvring Trial

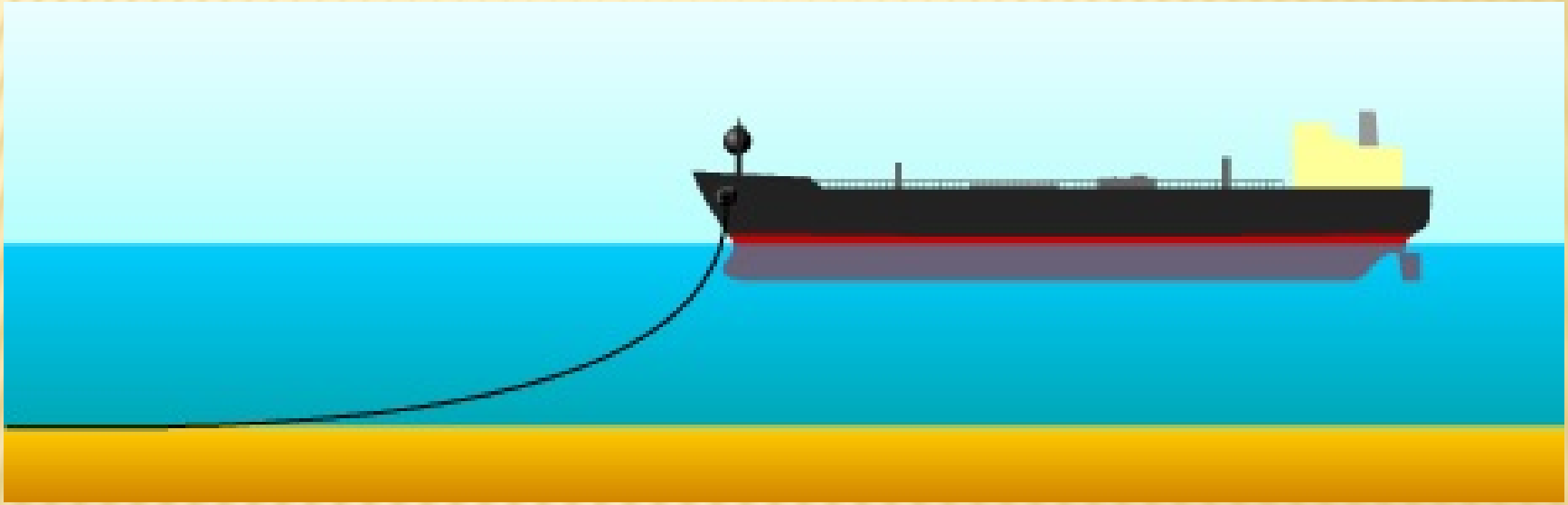
Wind Direction	Wind speed	Sea State	Depth of water
---	Calm	Calm	>10D

BOW THRUSTER?



A bow thruster will lose its effectiveness as a ship's speed increases. Depending on the hull and thrust tunnel design, thrust effectiveness can be lost at between 2 and 5 knots.

USE OF ANCHOR FOR EMERGENCY STOP



Movie - Master and the Commander – Using anchor to turn the vessel broadside to enemy warship to effect fire power, if the water is not too deep.

TUG ESCORT

LOCAL FORECAST ON HIGH WIND PREDICTION

- Gust prediction is an important element of weather forecasting services, yet reliable methods remain elusive.
- Peak wind gusts estimated by the meteorologically stratified gust factor model might be evaluated at various locations along the Suez Canal.
- Transit windows should be set for Mega ship transit

SAFE NAVIGATION IN SUEZ CANAL

- Conclusions:
- Strong wind could cause undesirable set and side movement to large ships
- Over speed in Suez Canal could cause Squat and Bank suction effect (normal operating speed is 8.6 knots)

- Suggestions:
- Local weather forecast on the possible encounter period of high wind (e.g. During hours of dawn or dusk)
- Arrange convoy for Mega ship transit – to set transit window period with less high wind probability
- Provide tug escort during the Mega ships transit
- Ship's crew to standby anchor at forward during transit

PILOTAGE


EVER GIVEN

WHAT ARE THE DUTIES AND LIABILITIES OF SUEZ PILOTS ONBOARD M.V. EVER GIVEN

- At time of grounding, two Suez Canal Pilots were onboard giving advices to the ship for canal transit.

PILOTAGE

- Pilots with local knowledge have been employed on board ships to guide vessels into or out of port.
- In addition to local knowledge and expertise, pilots are able to provide effective communication with the shore and with tugs, often in the local language.
- Pilotage is compulsory for all vessels entering or leaving Egyptian ports and for vessels transiting the Suez Canal

MASTER PILOT RELATIONSHIP

- The presence of pilot on board does not relieve the master or officer in charge of the navigational watch from their duties and obligations for the safety of the ship.
- Despite when pilot is on board, the master is always in command.
- The master and officers are under a duty to provide the pilot the fullest assistance including all navigational duties.

LIABILITY OF PILOT IN GENERAL

- Like any ports in the world, pilot will give navigation advices to the ship but they will bear no financial liability in case of collision or grounding accidents.

- The only exception is Panama Canal Pilots

RESPONSIBILITIES (ART 4) - SUEZ CANAL

- Pilot
- The duties of pilots commence and cease at the entrance buoys of Port Said and Port of Suez. He only gives advice on maneuvering the vessel, course to steer etc. He puts at the disposal of the Master his experience and practical knowledge of the Canal, but as he cannot know the defects or difficulties of manuverability for every vessel, **the responsibility falls completely upon the Master.**

- When on Canal or at its ports or roads, **owners, operators, and/or charterers of any vessel… are responsible for any damage and consequential loss** caused either directly or indirectly to herself or to Suez Canal Authorities properties or personnel or to obstruct navigation in the Canal.

LIABILITY OF PILOT IN HONG KONG

LIABILITIES – HONG KONG PILOT

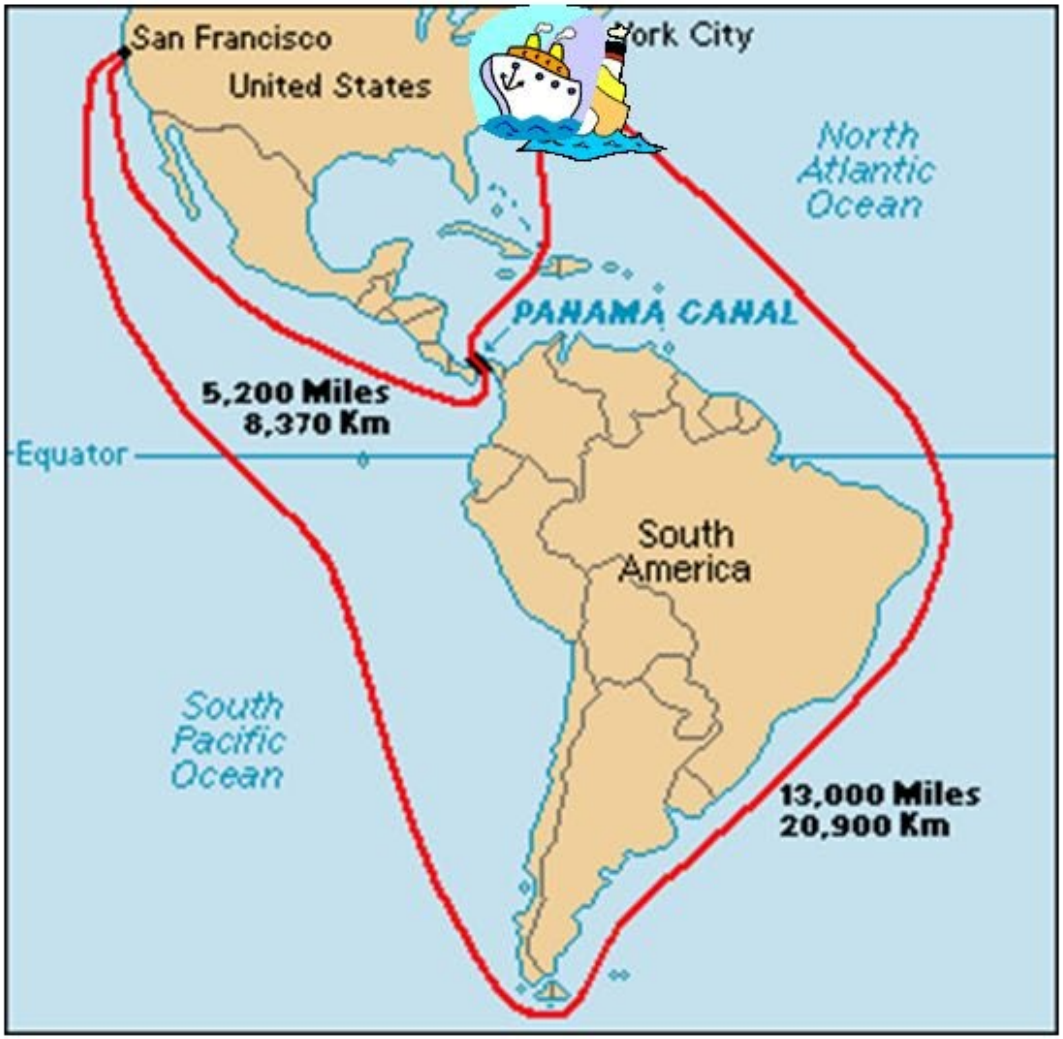
- Section 24A of the Pilotage Ordinance (Cap.84) (Hong Kong) provides that:

  "a licensed pilot shall not be liable in damages for neglect or want of skill on his part while piloting a ship for any amount exceeding in the aggregate **the sum of HK$1,000** and the amount of **pilotage dues payable** in respect of pilotage services rendered by him for that ship".

LIABILITIES – HONG KONG PILOT

- Thus, in a situation where an accident is caused by pilot error the owner or Master remains responsible for any loss or damage, neither the Director of Marine nor the Government have any liability and the liability of the licensed pilot concerned is limited to HK$ 1,000 (USD 129). This means, effectively, that the pilot is immune from liability.

The Panama Canal shortened the trip from the Pacific to the Atlantic by 7,800 miles.



http://static.howstuffworks.com/gif/willow/panama-canal0.gif

PILOTAGE IN PANAMA CANAL

- Pilotage through the Panama Canal is compulsory and carried out exclusively by Panama Canal Commission pilots (about 270 pilots). Unlike most ports of the world, Canal pilots do not act in an advisory capacity but take command over the vessel.

- It is possible to hold the Panama Canal Commission liable for accidents which occur during Canal transit and which can be attributed to actions of Canal pilots in command of the vessel. Claims procedures are ruled by the Panama Canal Act of 1979 with amendments and Code of Federal Regulations.


Suez Canal
Israel canal
plan
Haifa
WEST B
Jerusalem
Jordan
Israel
Cairo
القاهرة
New
Cairo City
مدينة القاهرة
Aqaba
Altubaiq
Natural
Reserve
Al Khanafah
Wildlife
Sanctuary
Tabuk
a shorter route, thanks to fees for Red Sea-Mediterranean transit falling due to Israel-Egypt competition.
MAHANOLOGY

Thank You