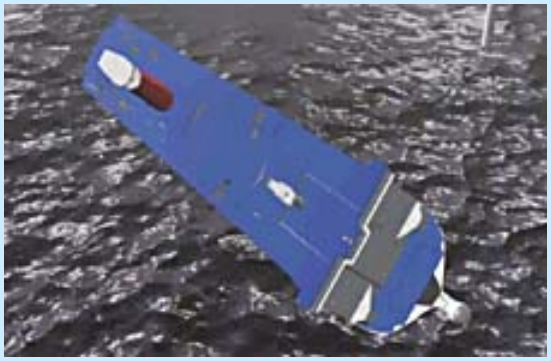
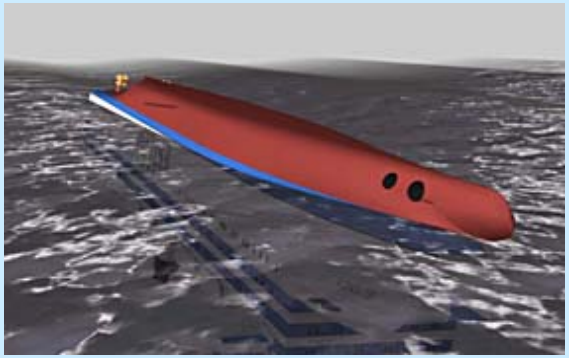
Effects of Weight and Stability





Lesson topic 3.4

Enabling objectives

- Determine the trim and heel of the vessel and recommend actions to correct the condition
- Record damage control messages
- Select terms and abbreviations associated with stability and buoyancy

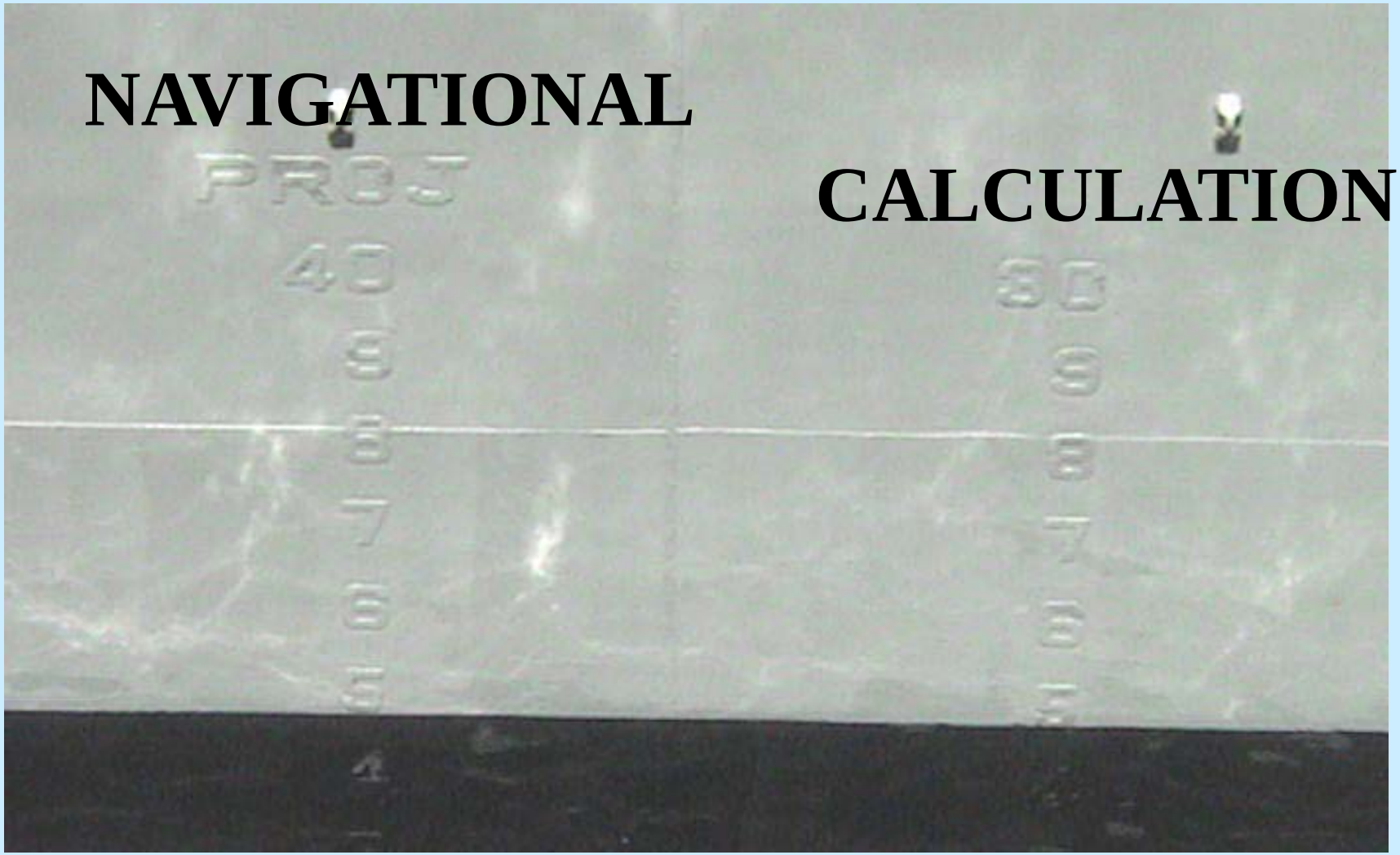
Shipboard draft marks

- Roman numerals, (calculation marks)
  - Used for measuring draft of the vessel from keel to waterline
  - Determines displacement
  - Numerals are 3 inches in vertical projected height
  - Read at bottom of mark for whole feet
  - Read at bottom of horizontal bar for 1/2 foot
  - Bar is 1 inch wide

Shipboard draft marks

- Arabic numerals, (navigational drafts)
  - Used to indicate operating drafts
  - Projections, if any, below the keel
  - Numerals are 6 inches in vertical projected height
  - Read at bottom of mark for whole feet
  - Read at top of mark for 1/2 foot
  - Used primarily by ship's navigator

Shipboard draft marks



Shipboard draft marks

- Limiting draft mark
  - If exceeded, ship's ability to survive damage or heavy weather is jeopardized
  - Located near draft numerals or amidships
  - Decision to exceed mark rests with the CO of the ship
- Internal draft indicators
  - Installed in larger ships
  - Draft can be read using remote draft gauge in DC Central

Clinometers

- Hermetically sealed glass tube containing liquid which is mounted on a calibrated board
- Installed at vital stations
- Most accurate under static conditions (fixed angles of Heel or List)
- Four types, (A, B, C, and E)
- Types A and B are used to determine trim
- Types C and E are used to determine heel or list

Clinometer

Definitions of Terms Associated with Ship's Stability

- Buoyancy
  - Tends to force the object back up out of the water
  - Upward force is equal to weight of water which the object displaces
- Reserve buoyancy
  - Volume of the watertight portion of the ship above the water line
- Displacement
  - The weight of the volume of water displaced by the hull, Weight of the ship.

Definitions of Terms Associated with Ship's Stability

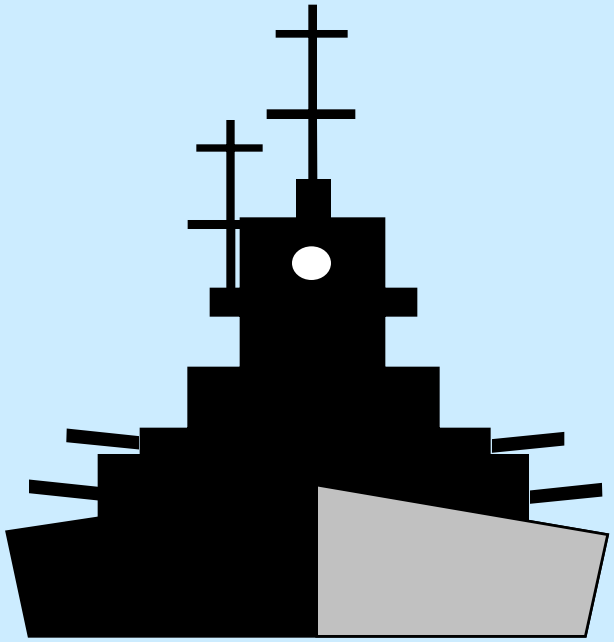
- Stability
  - Tendency to remain or return to an upright position
- Center of Buoyancy
  - Upward force acting in a vertical line through the center of the volume displaced
- Center of Gravity
  - Force of gravity (weight) of the ship's structure and contained load acts vertically downward

Principles of stability

- Floating body is acted on by two forces
  - Gravity
  - Buoyancy
- Objects exist in three states
  - Stable
  - Neutral
  - Unstable

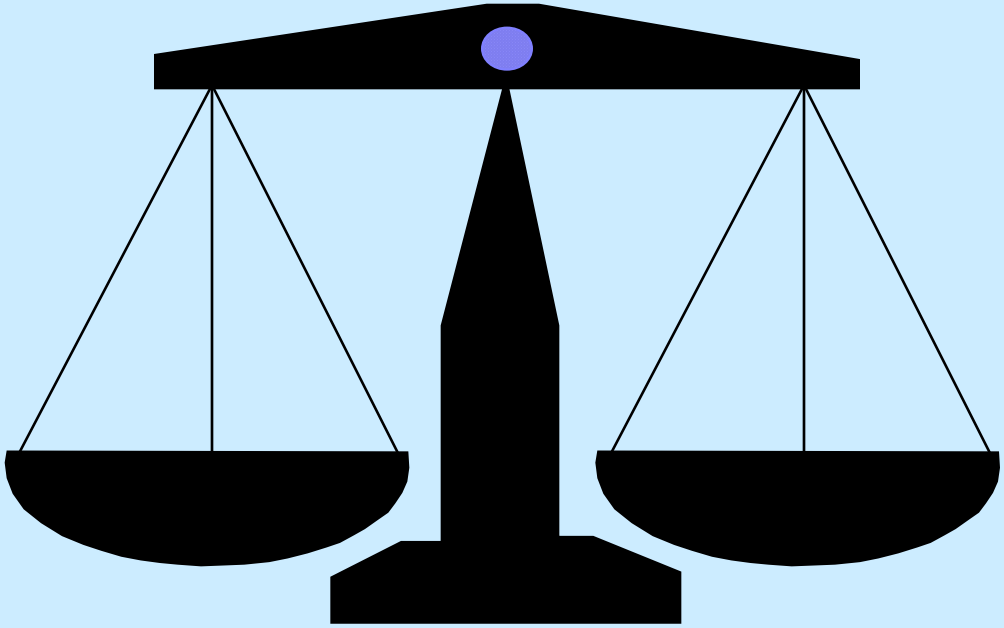
Forces Acting on Ship's Stability

- Centers of buoyancy & gravity must lie in the same vertical line
- Ship is disturbed from rest by
  - Wave action
  - Wind pressure
  - Turning forces
  - Recoil of gunfire
  - Impact of collision or enemy hits
  - Shifting of weights onboard
  - Additional/removal of off center weights



Forces Acting on Ship's Stability

- "Stable Ship" develops a tendency to right itself
  - Called a "Righting Moment"



Principles of Heel, Roll, List, and Trim

- Heel: Athwartships (side to side) inclination
  - Roll: Alternate Heeling from side to side
  - List: Permanent angle of Heel
  - The major cause of listing is off-center weight
- Trim
  - Distribution of weight so that the ship sits well in the water forward and aft
  - Determined by difference between forward and after draft

Effects of Weight on Ship Stability

- Weight additions, removals and shifts
  - The addition or removal of weight will always change the draft readings, and may effect trim, list and overall stability
- Causes of off center weight
  - Flooding in compartments off the centerline
  - Pumping liquids across the ship
  - The shifting of ammunition, cargo, or personnel, across the ship

Effects of Weight on Ship Stability

- Correcting for off-center weight
  - Shifting weights from the listed side to the high side
  - Jettisoning topside weights
  - Drain loose water
  - Suppressing free surface
  - More drastic measures, such as completely filling partially flooded spaces, require careful consideration and are usually a last resort

Free Communication with the Sea Effect (off centerline)

- Occurs when a compartment is partially flooded,
- Effect is increased as the ship rolls
- The movement of the water as the ship rolls exerts a strong, dynamic force on the bulkheads
- As more water is taken in, draft increases.
- Results in stability being greatly reduced

Ship's Flooding Effects and Liquid Load DC Diagram plate 1

- Flooding effect diagram
  - Flooding effect portion of this plate is to show the effect of flooded compartments on the ships stability
  - Compartments on the flooding effect diagram are color coded
    - Pink - Flooding of the compartment results in a decrease in stability
    - Green - Flooding of the compartment improves stability, even though free surface exists

Compartments on the flooding effect diagram are color coded as follows

- Yellow - Flooding of the compartment improves stability when completely filled, but stability is impaired when free surface exists
- White or Uncolored - Flooding of the compartment will have no appreciable effect on the stability of the ship

Ship's Flooding Effects and Liquid Load DC Diagram plate 1

- In the Flooding Effect part of this plate, the three numbers in the compartment represent
  - Center, compartment number(s)
  - Left upper, capacity in tons, S.W
  - Right lower, moment Ft. tons

Ship's Flooding Effects and Liquid Load DC Diagram plate 1

- Liquid load diagram
  - Tanks and voids that are fitted to carry liquids
  - In the Liquid loading part of this plate, the five numbers in the compartment represent
    - Center, compartment number
    - Left upper, capacity in tons, (filled with cargo)
    - Left lower, change in draft aft, (when flooded)
    - Right upper, list/degrees
    - Right lower, change in draft fwd, (when flooded)
  - Tanks are color coded to indicate use

Watertight integrity

- Maintained to keep the ship stable
- Flooding in spaces could result in change to
  - Buoyancy
  - Center of gravity
  - Displacement
- Maintain correct material conditions to avoid flooding & aid in fire/smoke containment

Summary and Review

- Shipboard Draft Marks
- Definitions of terms associated with ship's stability
- Principles of Stability
- Forces acting on ship's stability
- Principles of Heel, Roll, List, and Trim
- Effects of weight on Ship Stability
- Free Communication with the Sea Effect

Summary and Review

- Ship's Flooding Effects and Liquid Load Diagrams (Isometric Damage Control Diagram number One)
- Watertight Integrity