

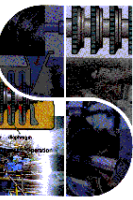
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Turret and Mooring Systems Design

Chapter 3

Turret Mooring System

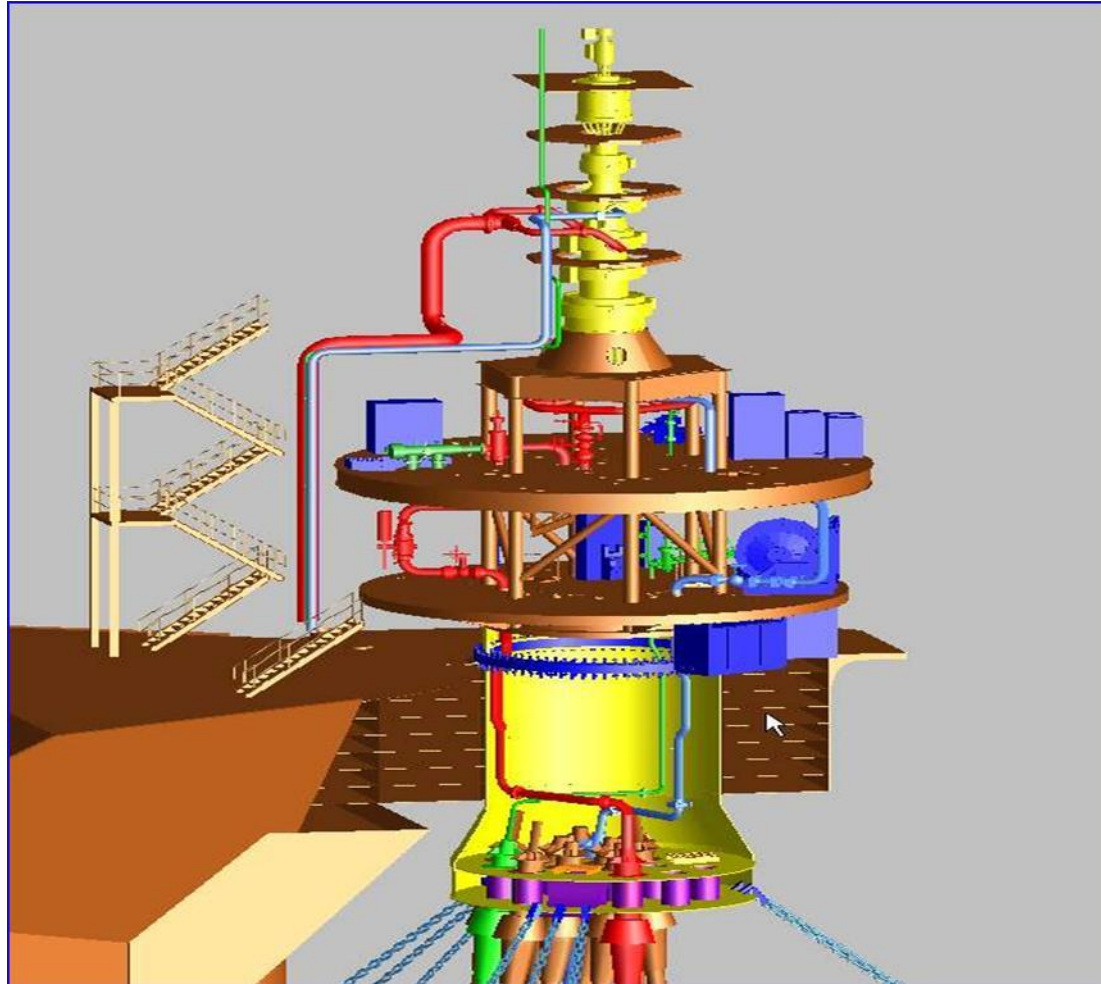
- Mooring turret is unique FPSO feature
- Serves three purposes:
 - » Anchors vessel at geo-stationary position
 - » Allows vessel to weathervane
 - » Provides conduit for fluid transfer
 - Subsea reservoir infrastructure to topside processing plant



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Turret Overview

Courtesy of SBM

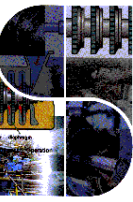


Turret Selection

- Factors which affect the choice:
 - » Sea states
 - » Number of subsea risers
 - » Water depth
 - » Number of anchors
 - » Converted tanker or new-build vessel
 - Propulsion

Turret Design

- Three types of turret mooring systems
 - » External
 - » Internal
 - » Submerged
- Each type can be sub-divided into:
 - » Disconnect type
 - » Permanent connect type

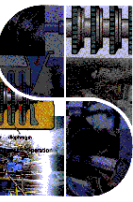


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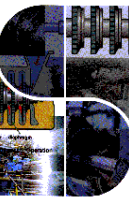
Disconnectable External Turret

Courtesy of SBM



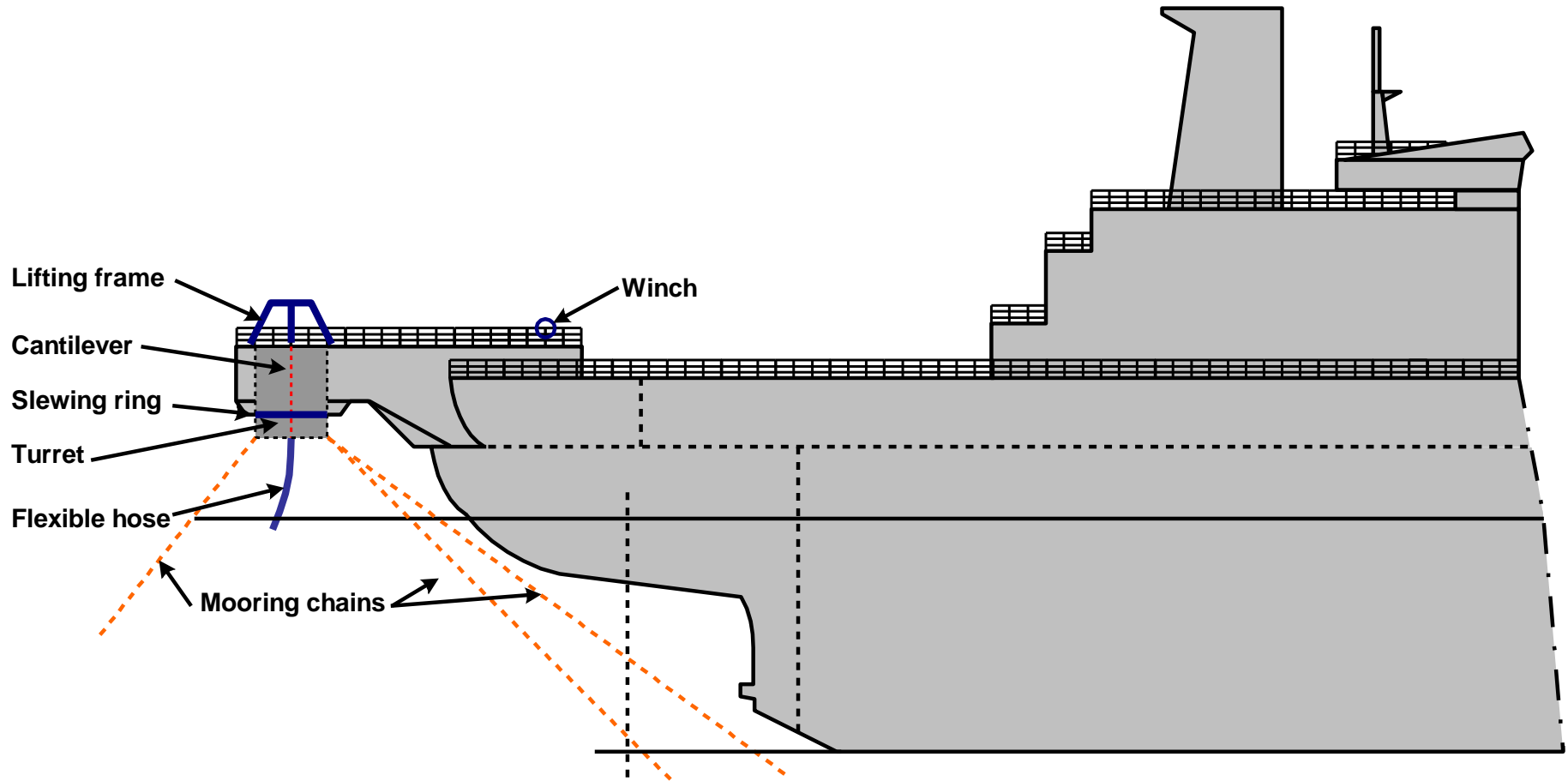


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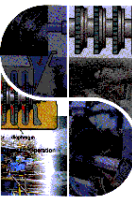


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External Permanent Moored



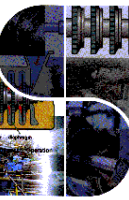
External Turret Permanent Mooring



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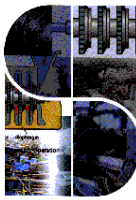
External Turret - Permanent Moored



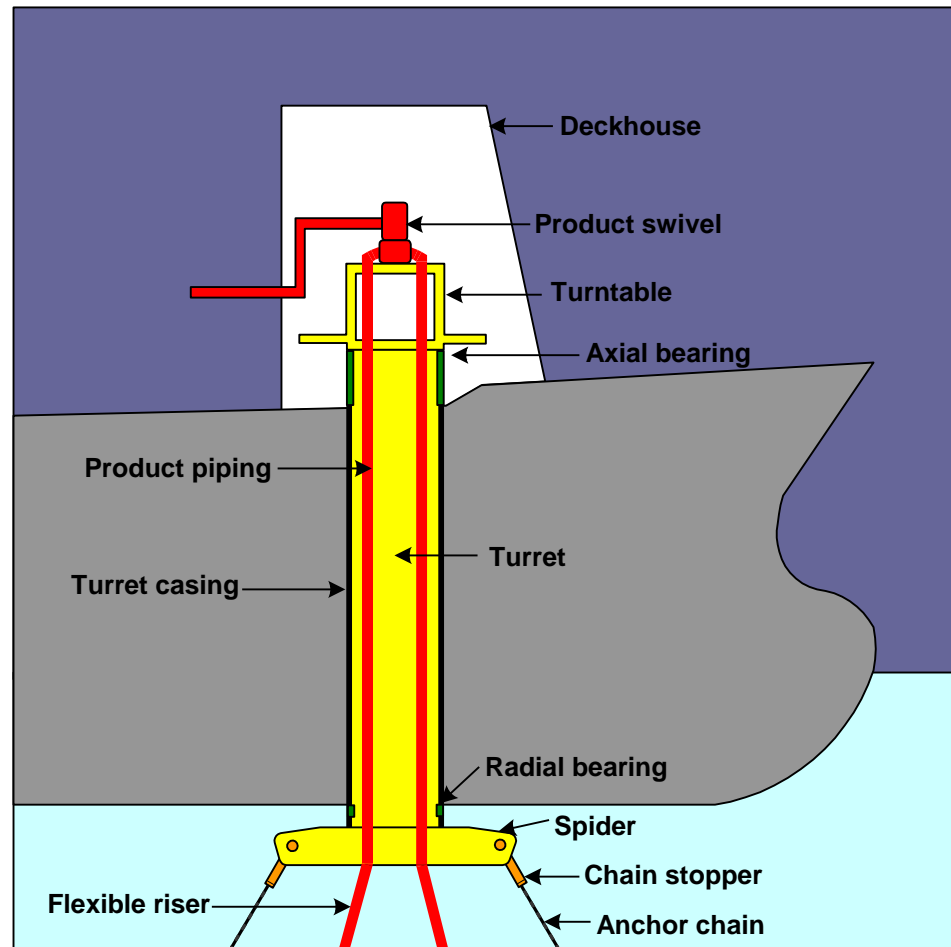
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Courtesy of SBM

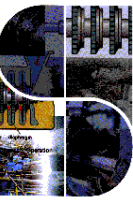
Internal Permanently Moored Turret



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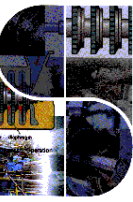
Internally Permanently Moored Turret



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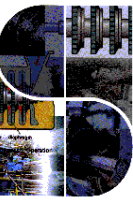
Maersk Curlew FPSO Turret - 1996



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Courtesy of SBM





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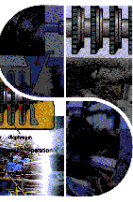
Maersk Curlew FPSO

Courtesy of SBM



FPSO Anasuria

Turret Manifold Decks

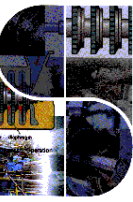


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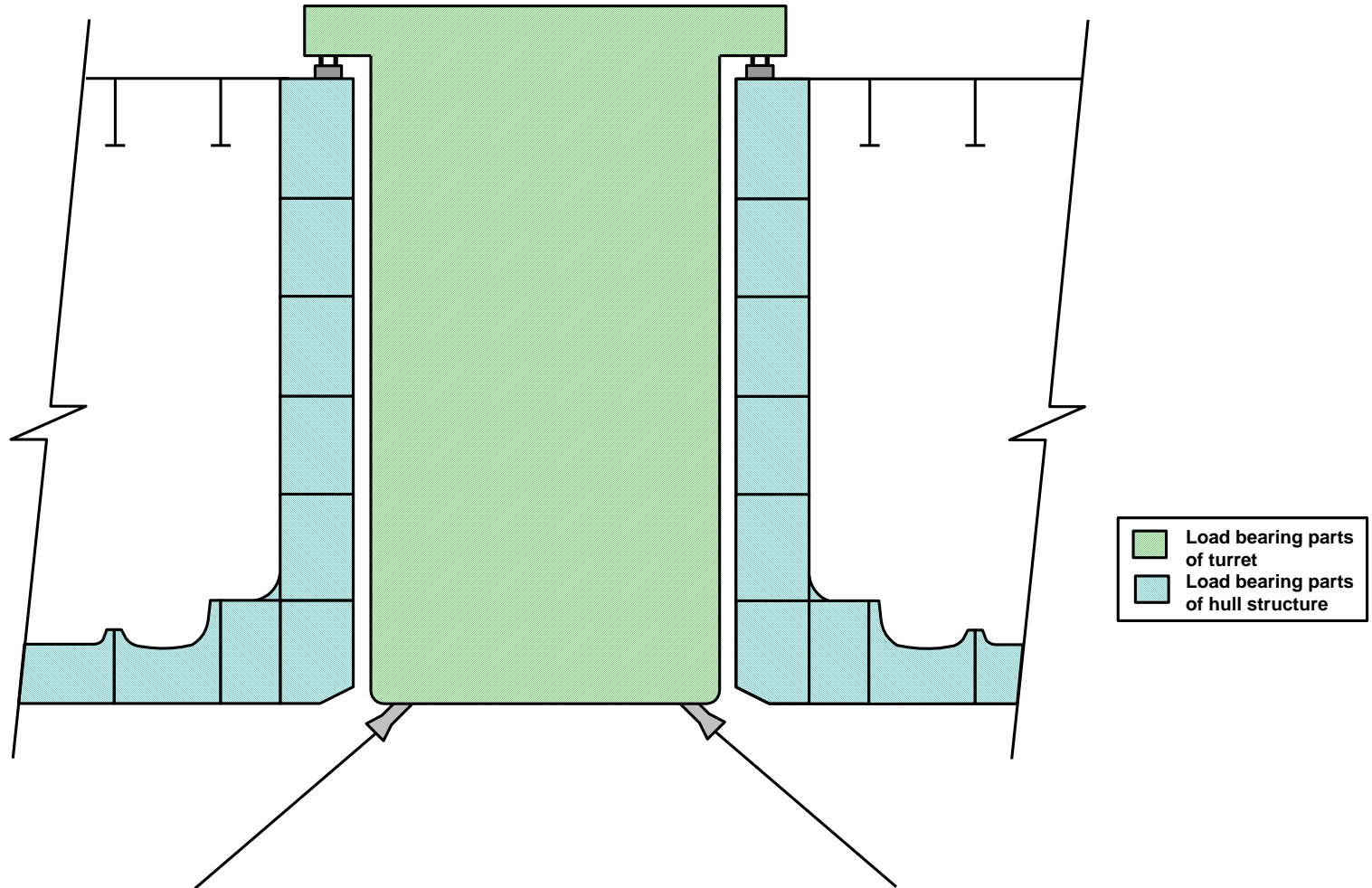
Courtesy of SBM

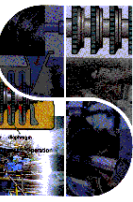


Large Diameter Internal Turrets

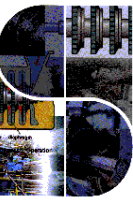


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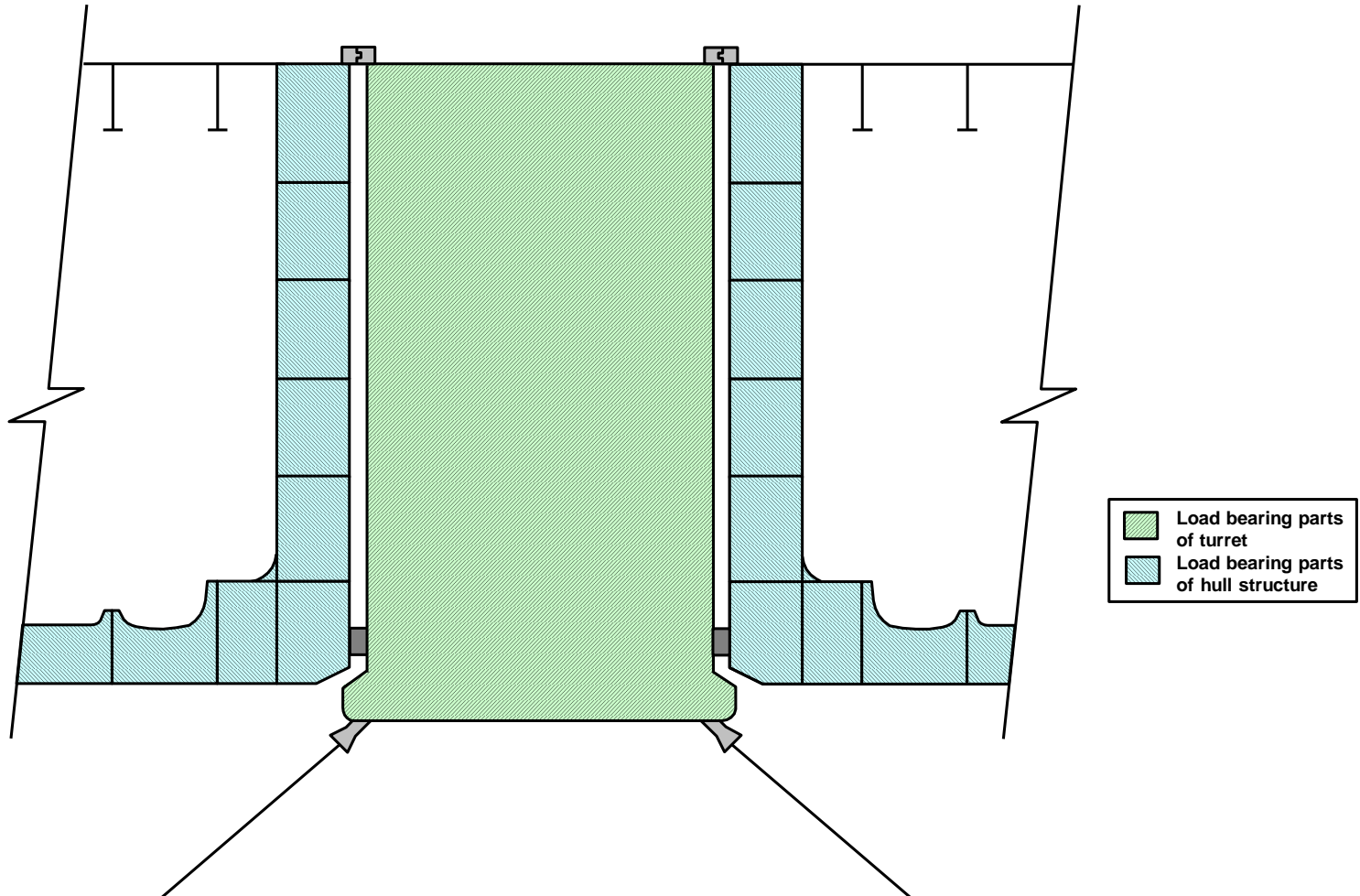




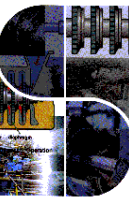
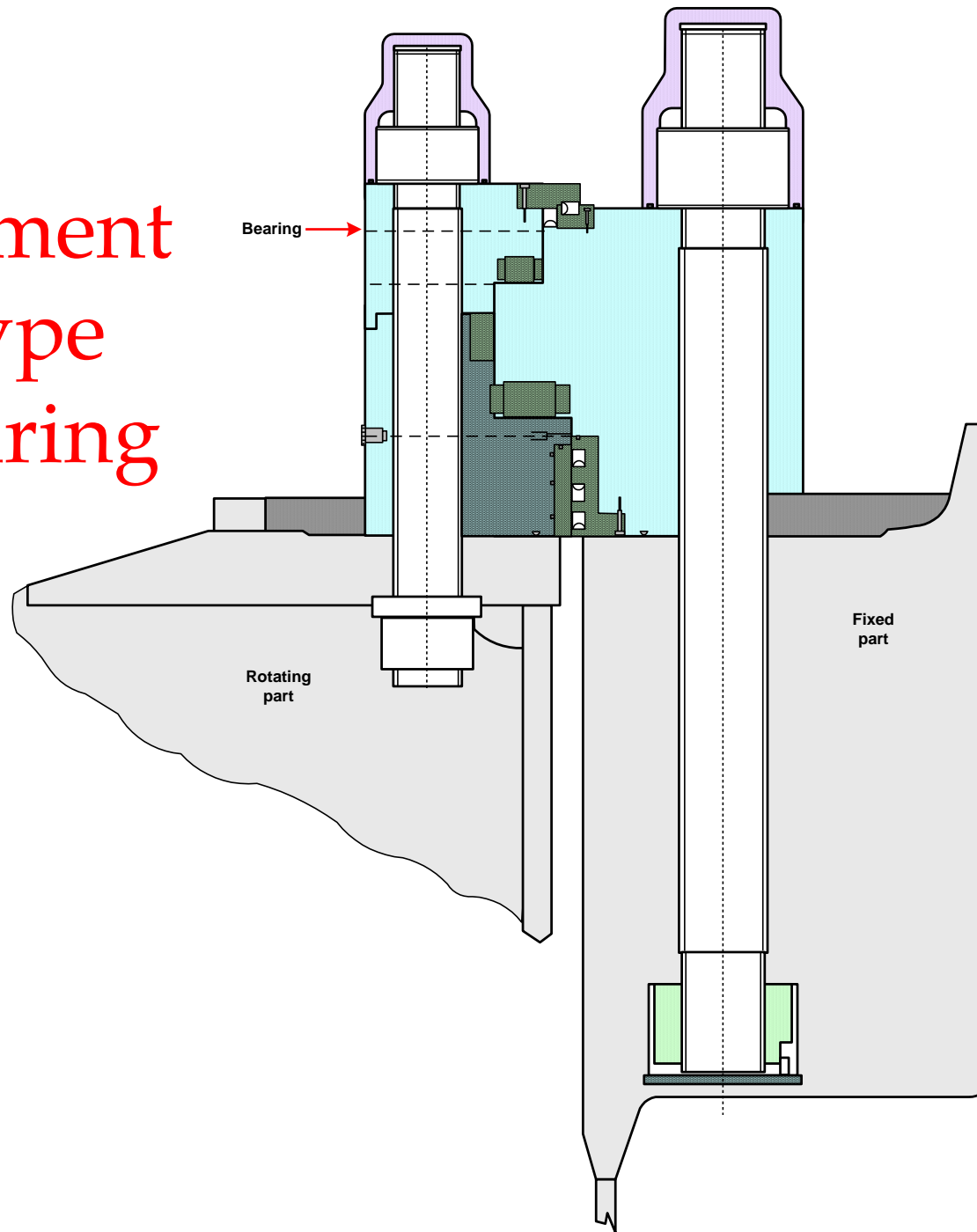
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Small Diameter Turrets

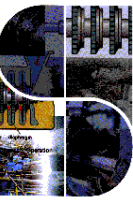


General Arrangement Roller Type Slew Bearing



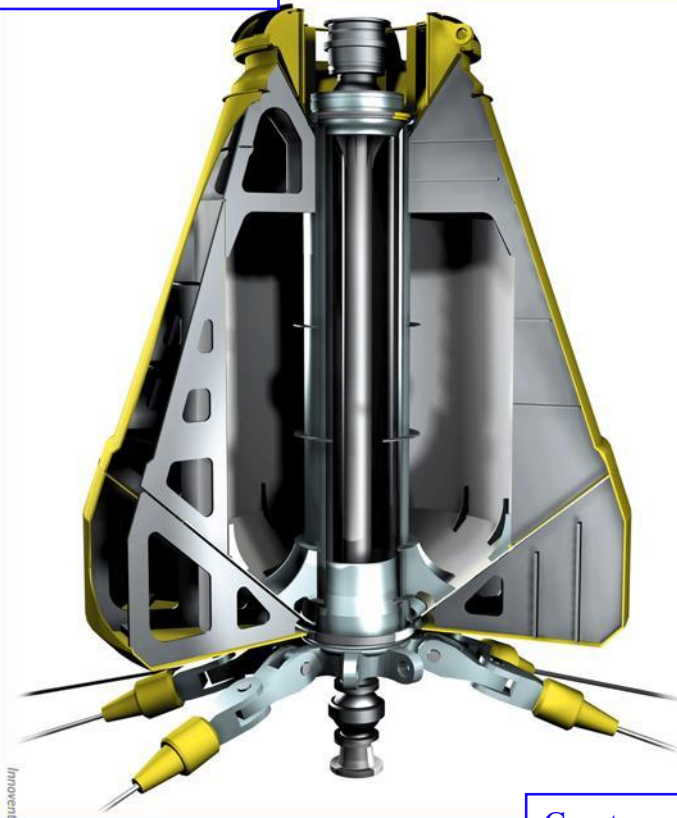
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Internal (Submerged) Disconnect Turret



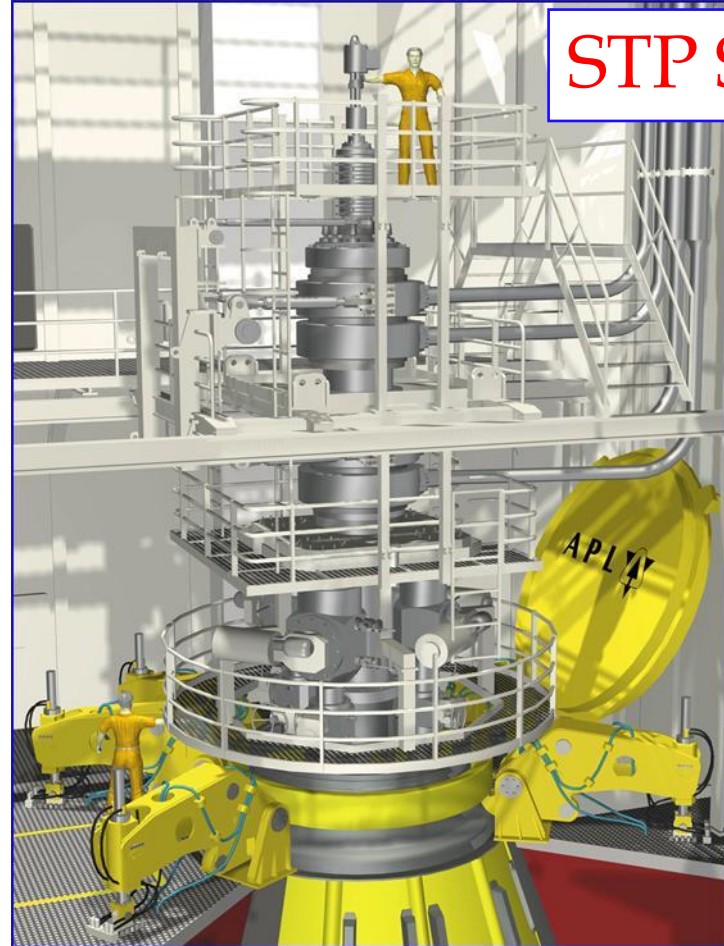
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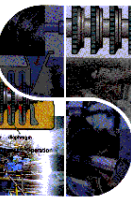
STP Buoy



Courtesy of APL

STP Swivel

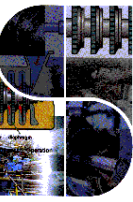




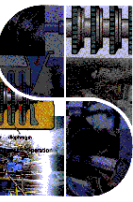
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Submerged Turret

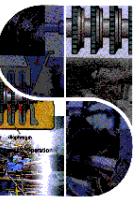




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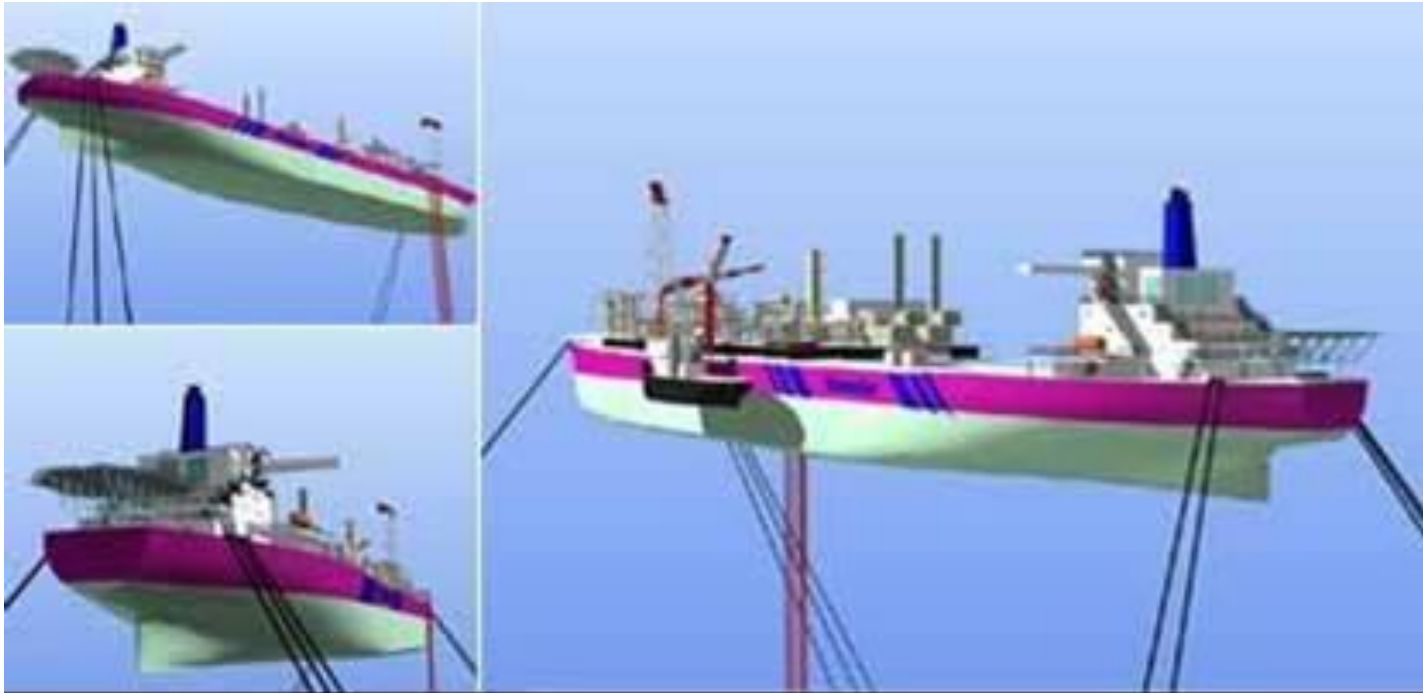


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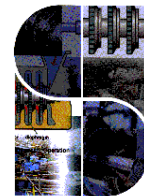
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Spread Moorings



Courtesy of Bluewater

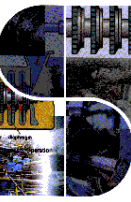
Bow Anchoring for Spread Mooring



ESD



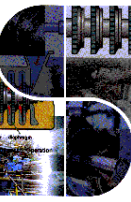
Courtesy of BP Angola



Jacket or Tower Mooring



Courtesy of SBM

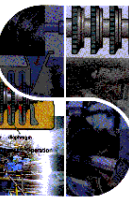


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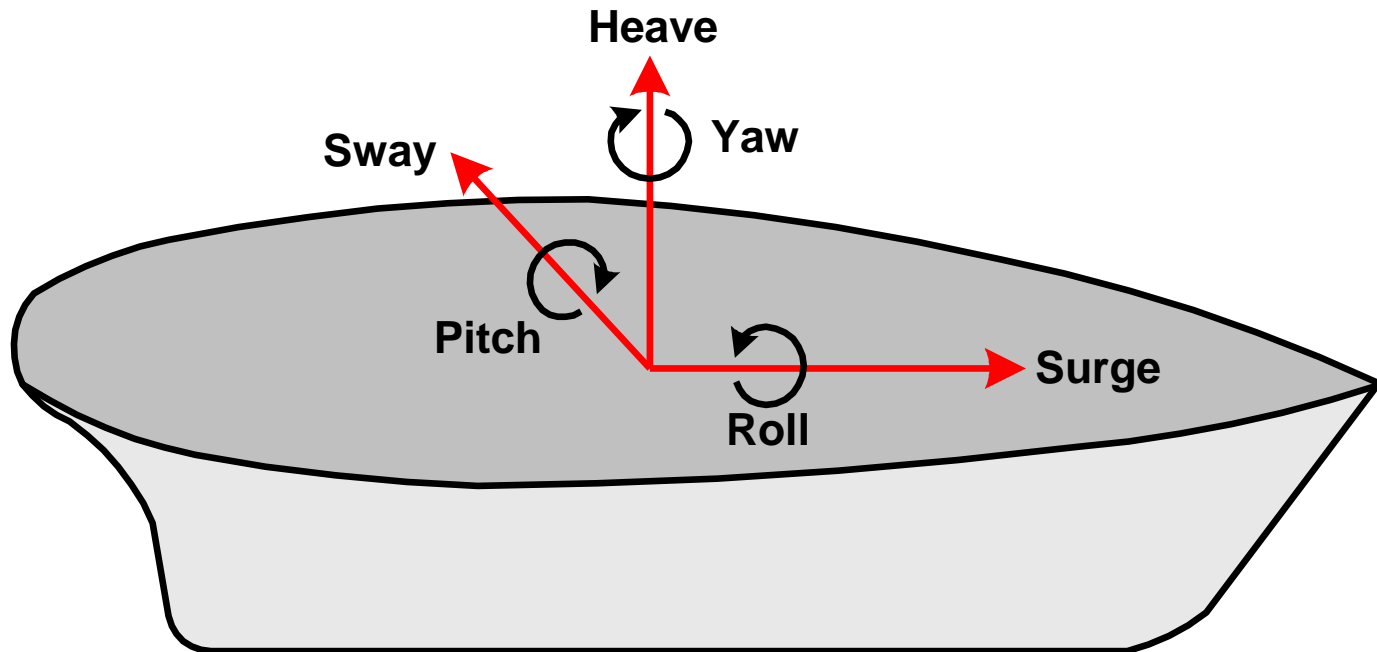
Tower Mooring



Courtesy of SBM



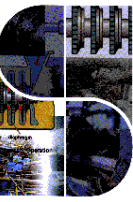
Ship's Motion



Vessel Motion across the Sea Surface

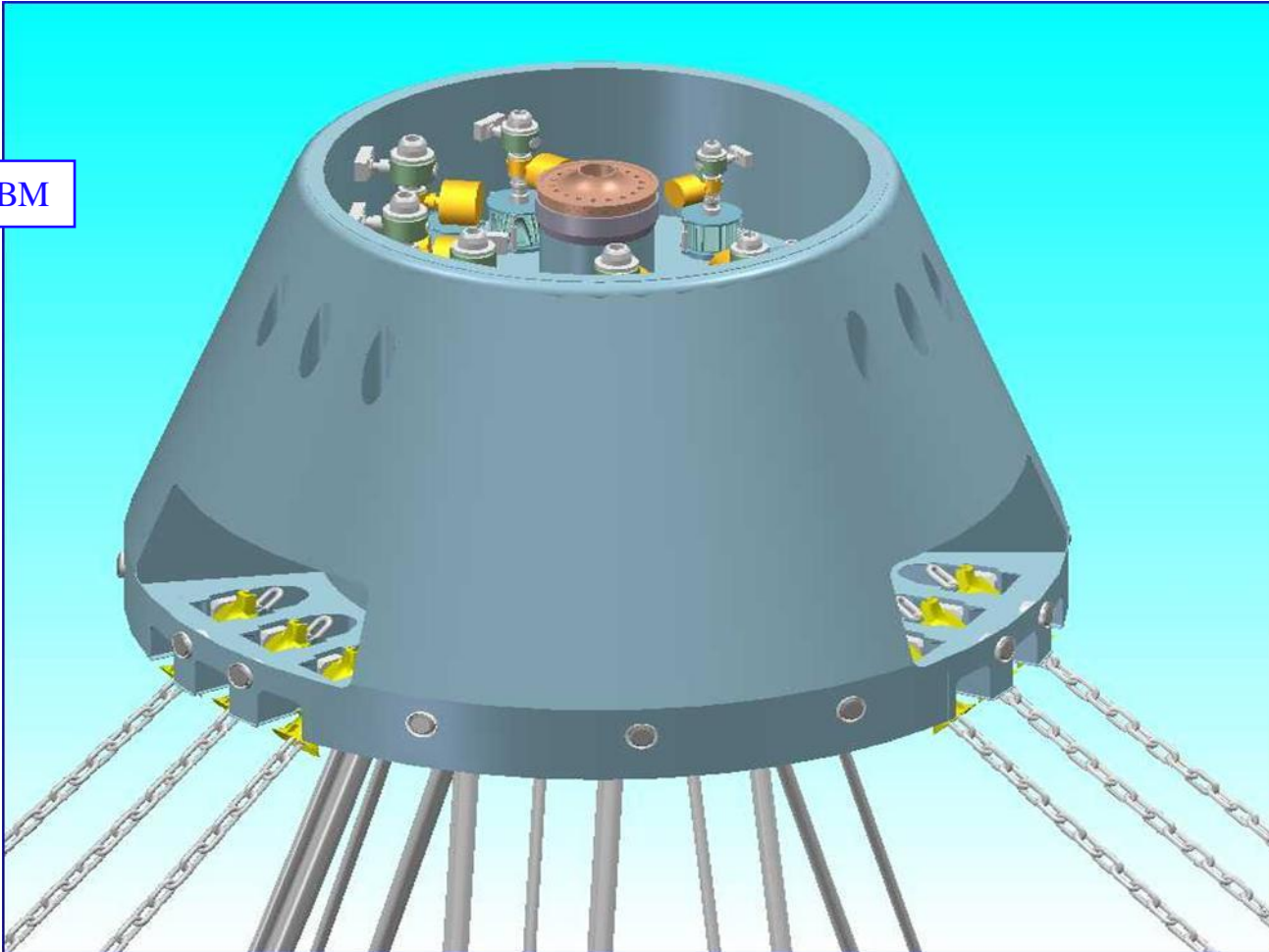


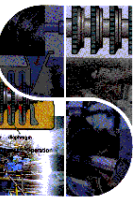
- Based on the period
 - » Short period motion due to waves
 - 6 to 20 seconds typically
 - » Longer period due to wind and wave
 - Can be several minutes
 - This is weathervaning
- Mooring forces increase with motion
 - » In other words the rougher the seas the greater are the mooring forces
 - More or stronger anchors



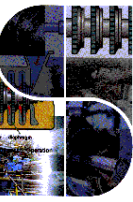
Mooring Chain Table

Courtesy of SBM

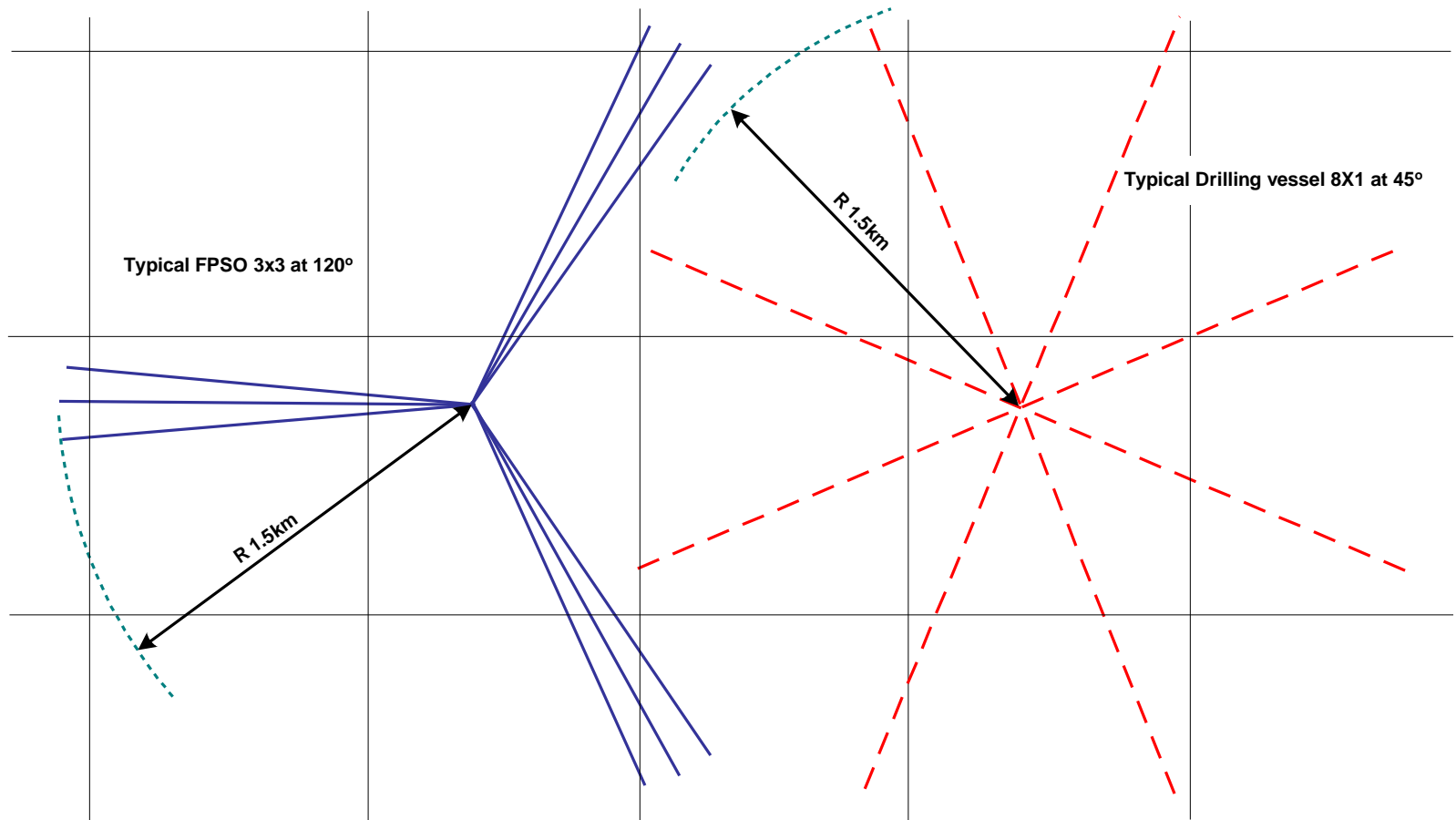


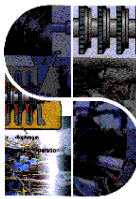


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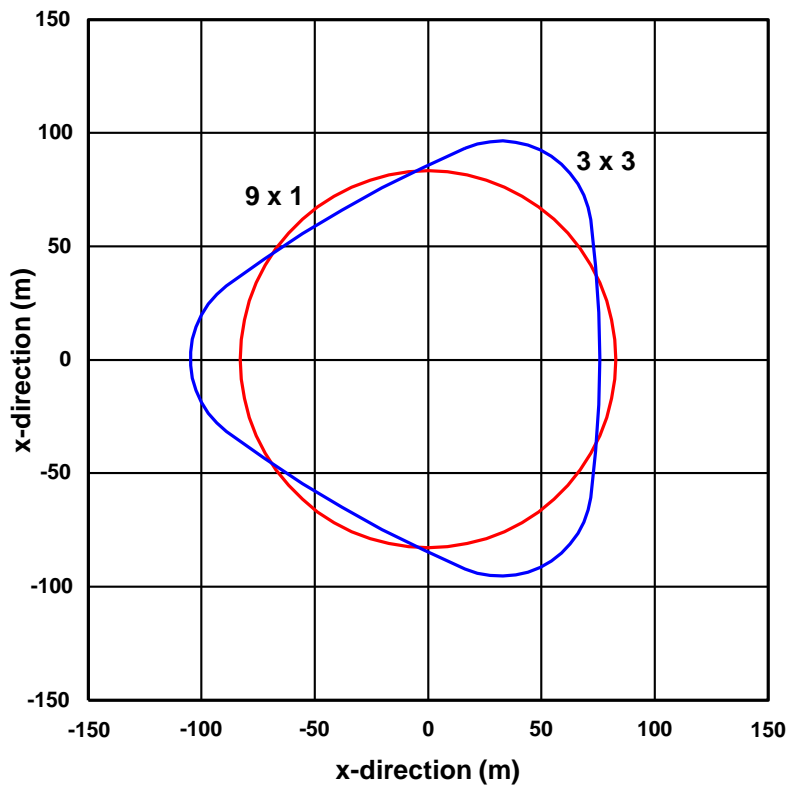
FPSO Mooring Spreads



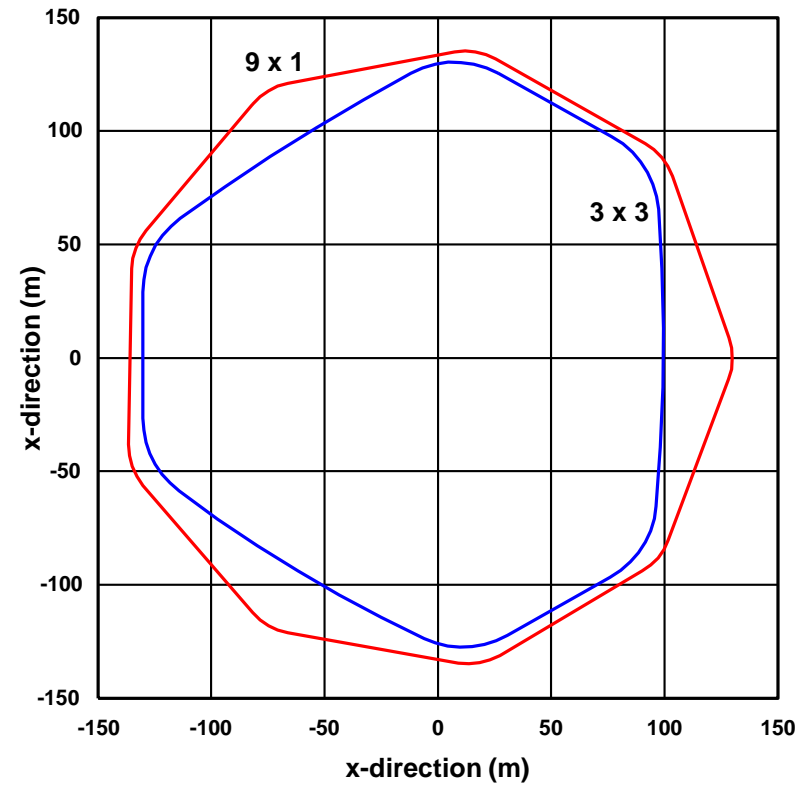


Offset Envelopes

Intact Mooring System

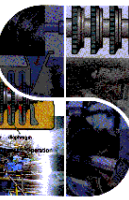


Anyone Line Damaged Mooring System

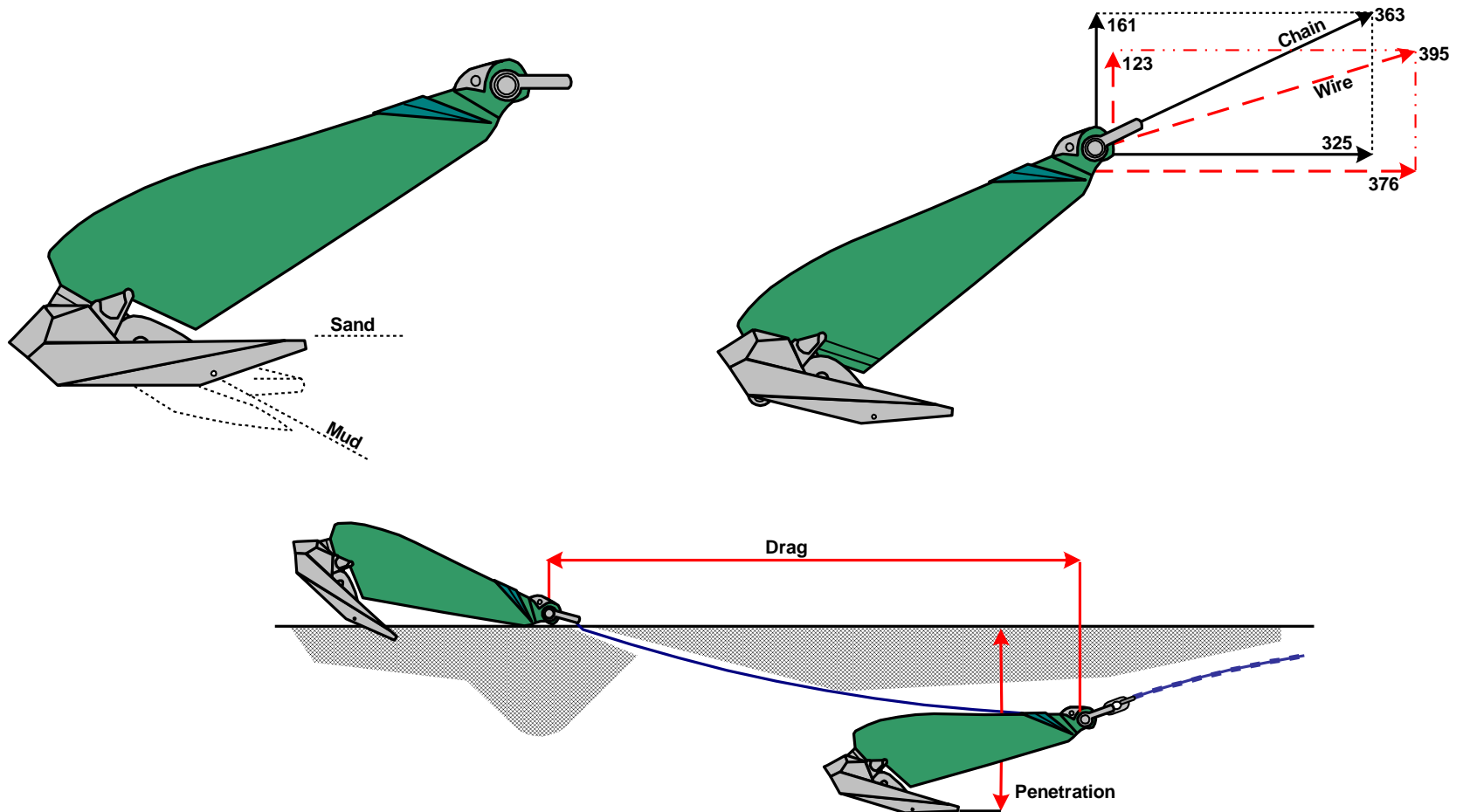


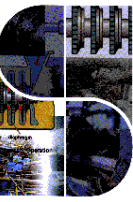
Anchoring Systems

- Three most common systems used to anchor tail end of mooring system to seabed are:
 - » Anchors
 - » Driven anchor piles
 - » Suction anchor piles

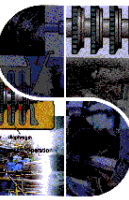


Anchor Behaviour



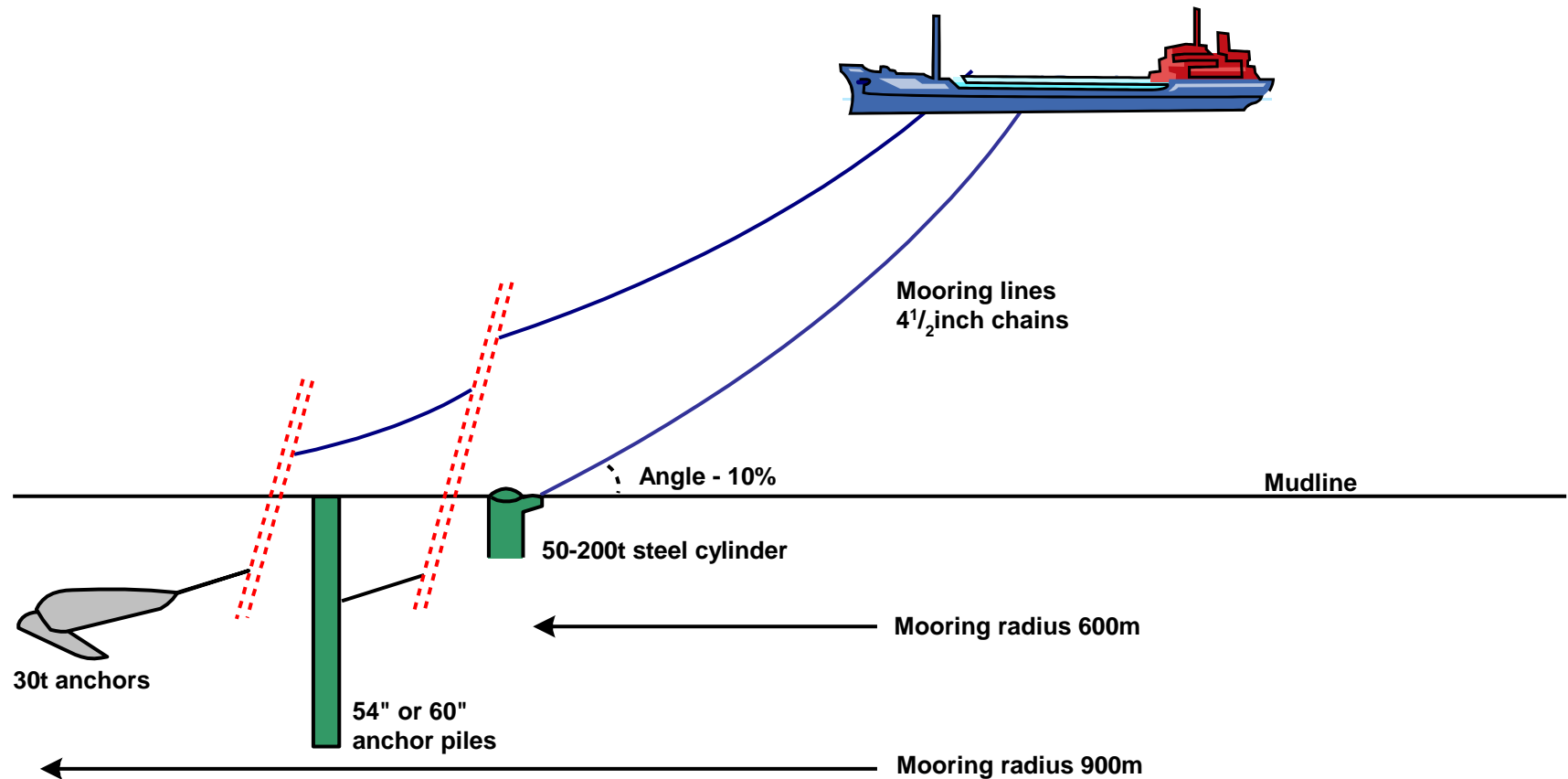


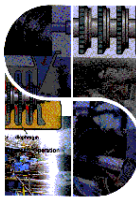
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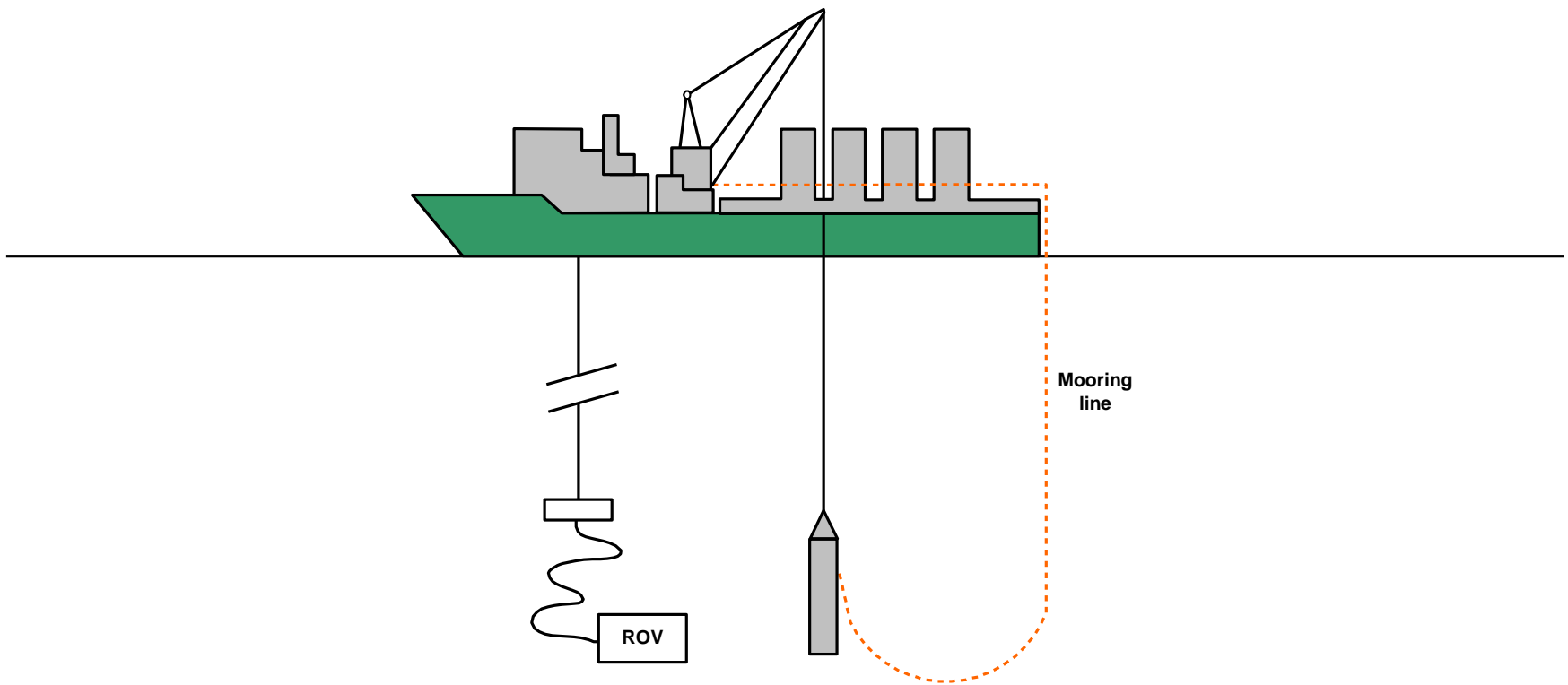
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Suction Anchors



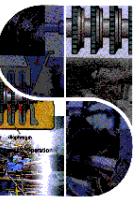


Launching Suction Anchors



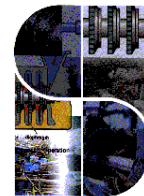
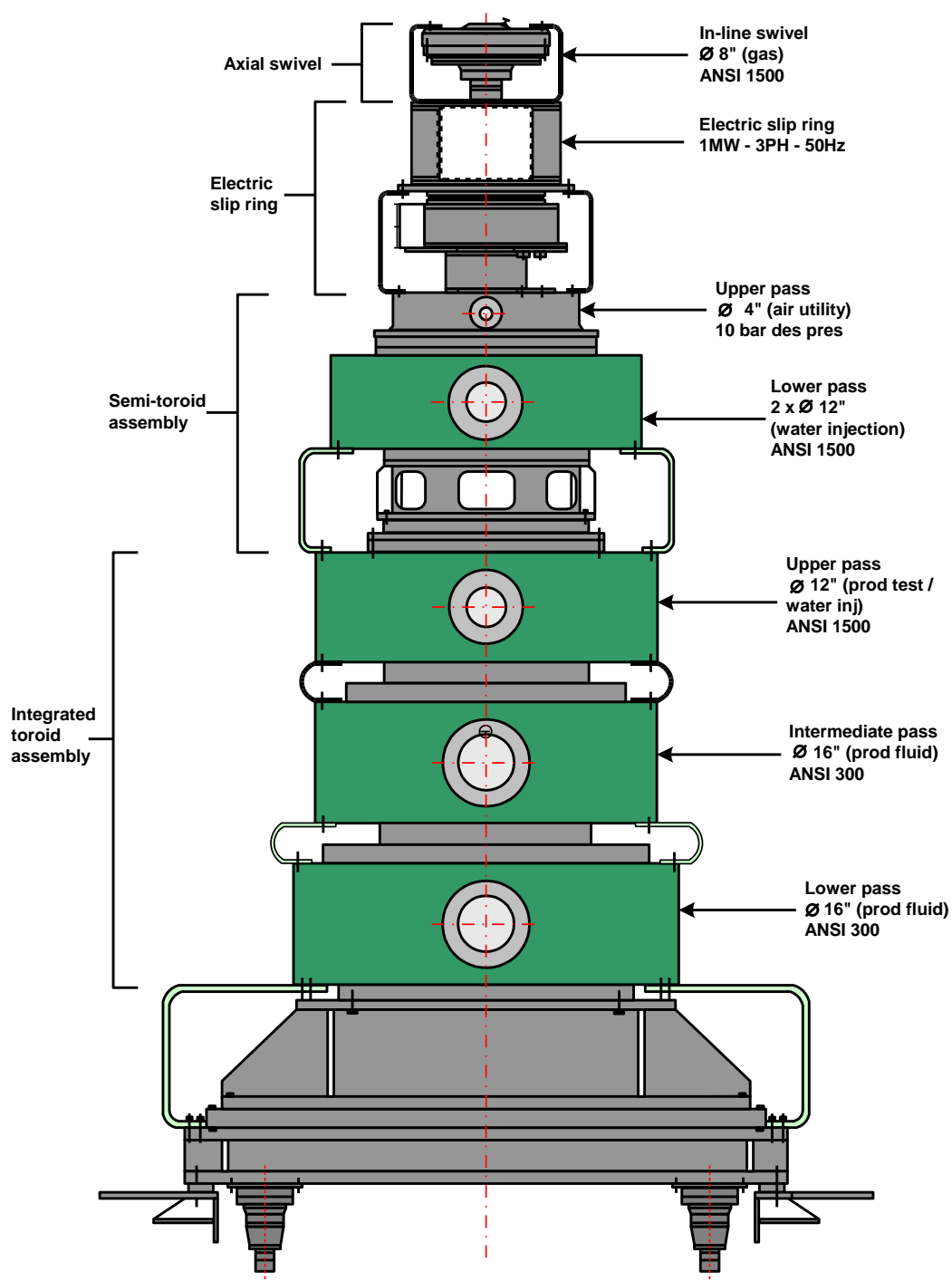
Swivel Stack Design

- A typical swivel stack consists of:
 - » Production
 - » Water Injection
 - » Export oil (to another platform or buoy)
 - » Gas lift / export
 - » Utilities including chemicals for subsea production
 - » Electrical swivel
 - » Gas Re-injection
 - » Signals



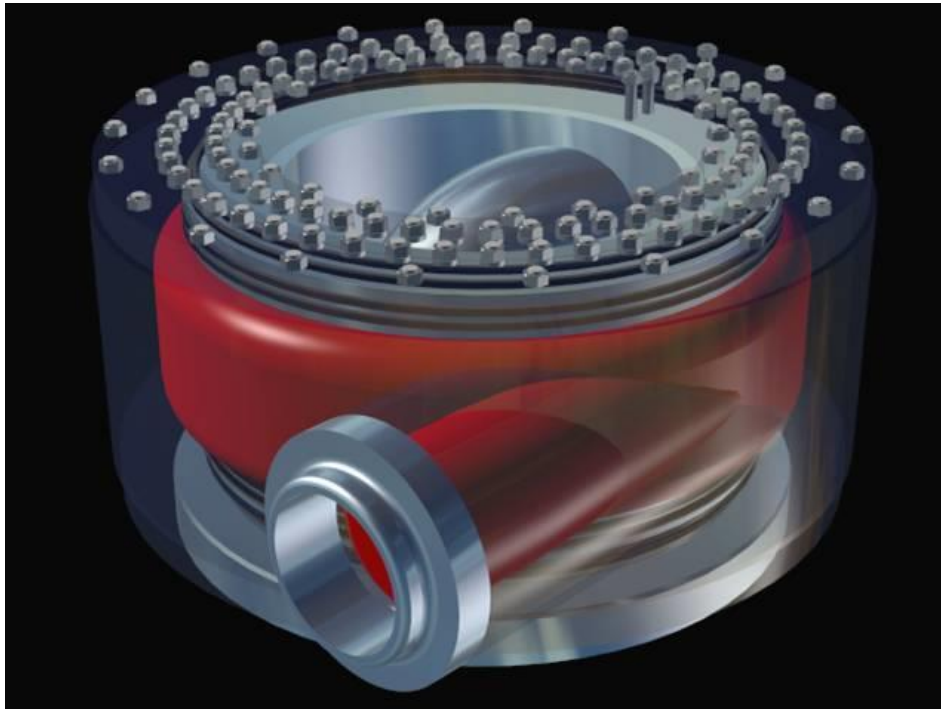
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Swivel Stack



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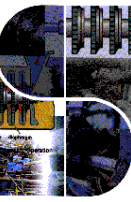
Toroidal Swivel Detail



Courtesy of Brown Brothers

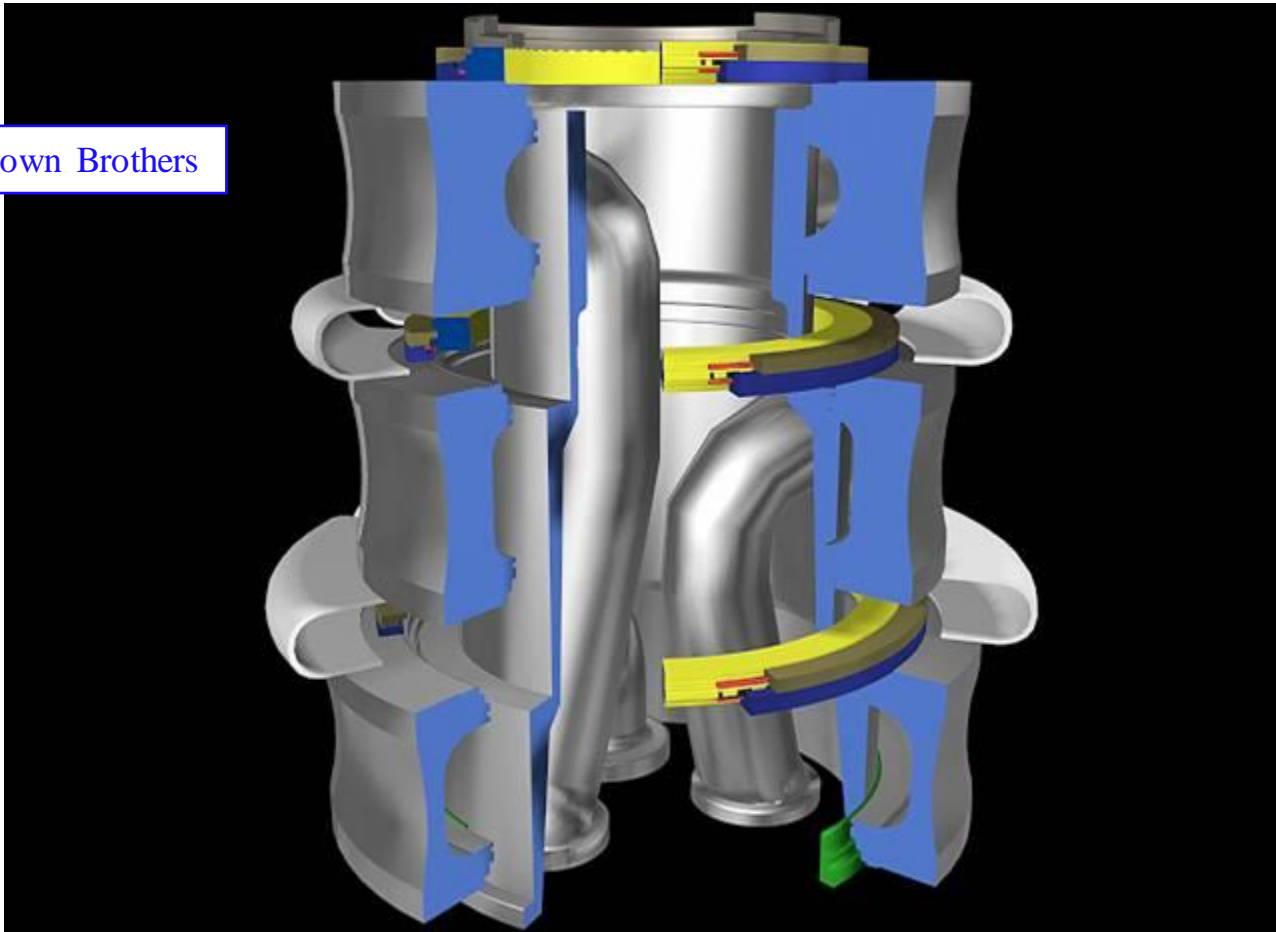
Multi- Path Swivels

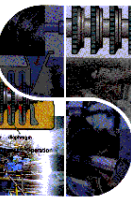
- Pipe diameters up to 20 inches
- Pressures up to 330 bar(5000psi)
 - » For liquid and gas
- 360° weathervane capability
- Turret may be positioned anywhere
- Can be installed on all turret designs
- Can withstand harshest environments



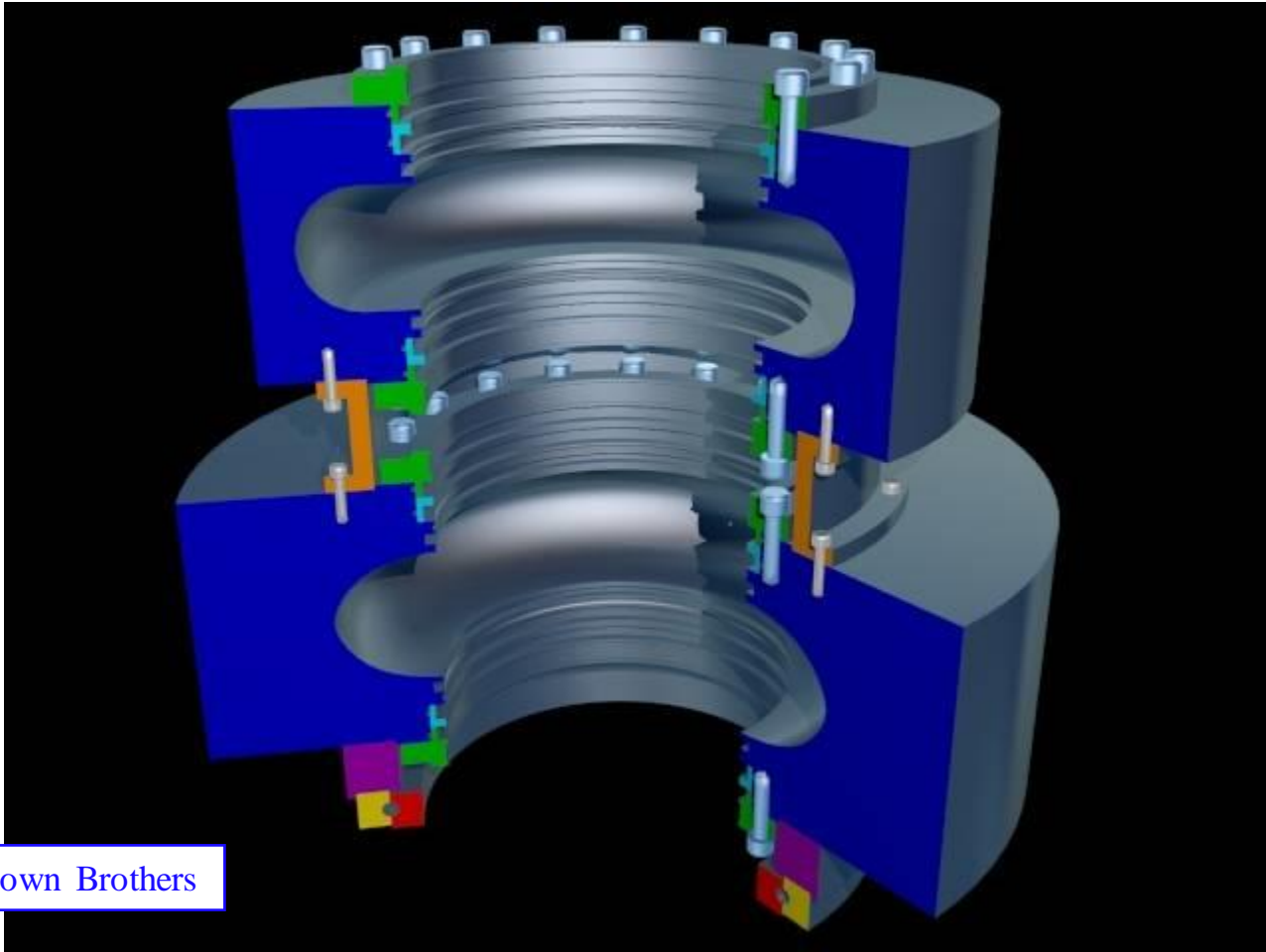
Swivel Stack Core

Courtesy of Brown Brothers



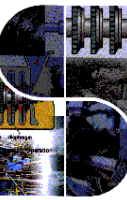
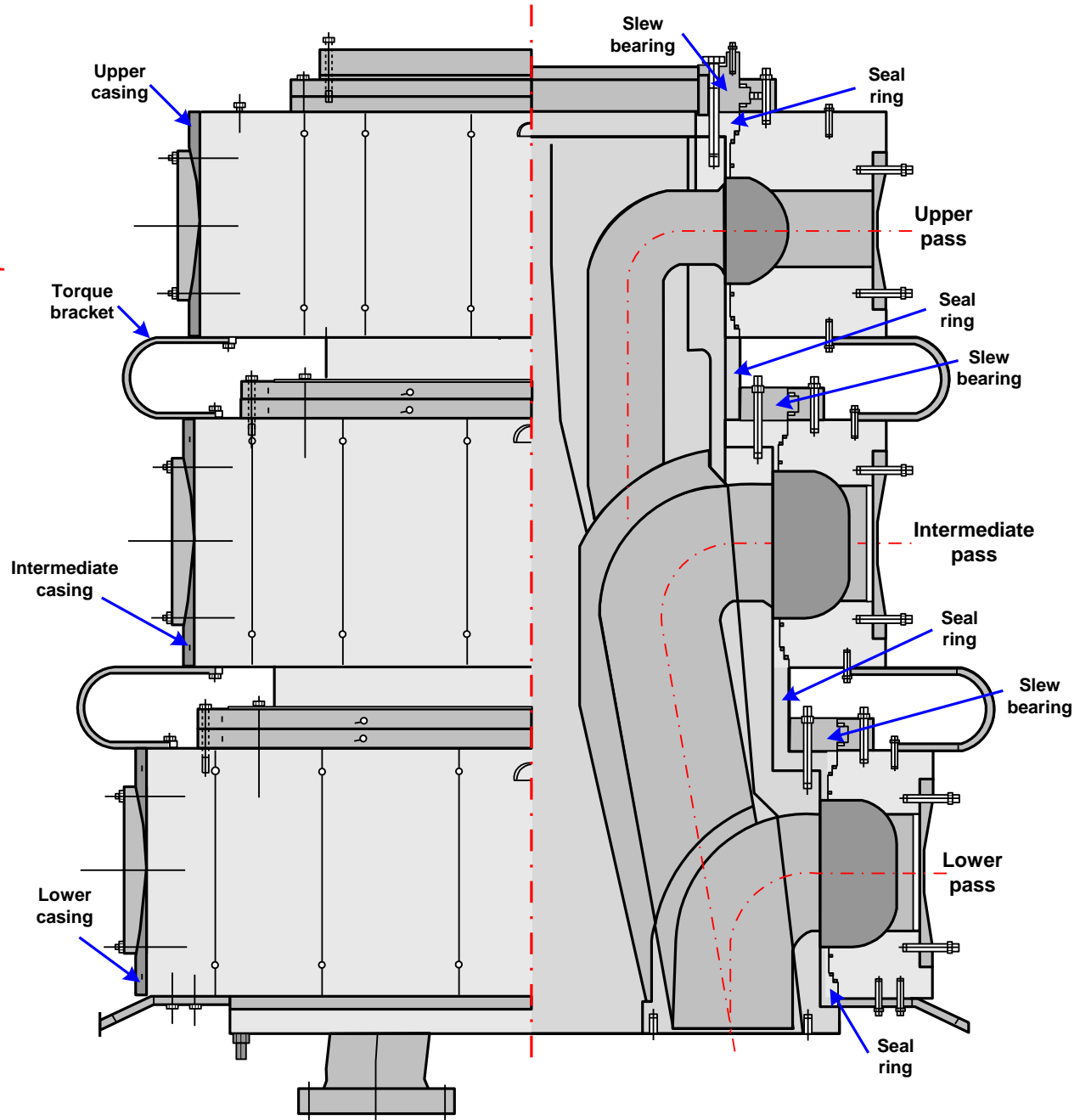


Swivel Outer Shells

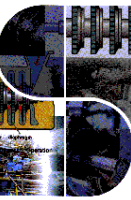


Courtesy of Brown Brothers

Toroidal Swivels

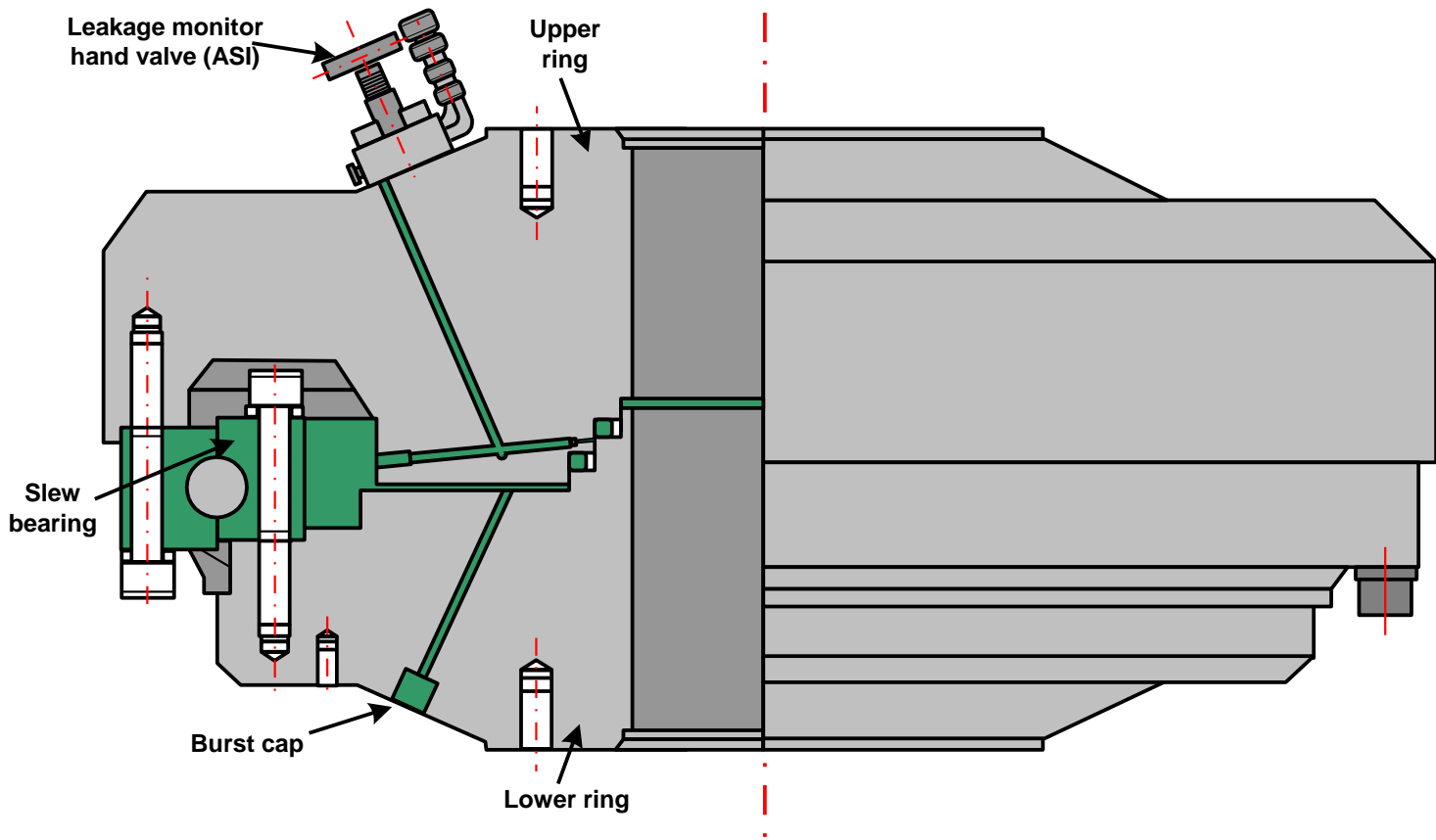


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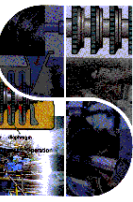
Axial Swivel



Swivel Stacks

Courtesy of FRAMO





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