nanoUmbilical
Workshop

Need for Lightweight Umbilicals

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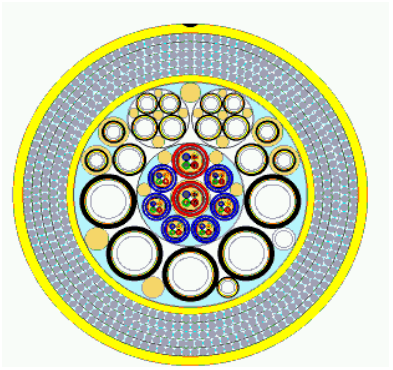
AGENDA

- Umbilicals
- Offshore hosts & arrangements
- Dynamic umbilicals
- Power cable umbilicals
- RPSEA Initiative
- Cable & umbilical comparisons
- Installation
- Possible applications
- Conclusions

What is an Umbilical ?



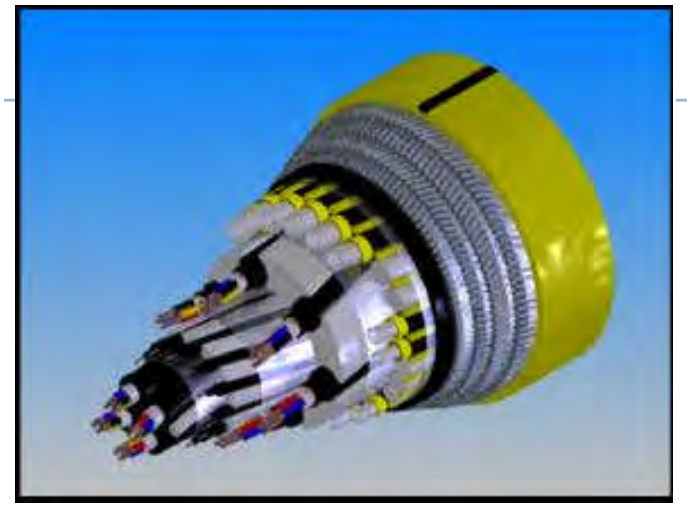
- **Umbilical**
  - **A number of functional components contained within a flexible package.**

    Typically the flexible package comprises of a thermoplastic extruded layer, surrounding a bundle of functional components which are assembled together in a compact structure. The flexible package may also be armored or contain tensile/weight members.

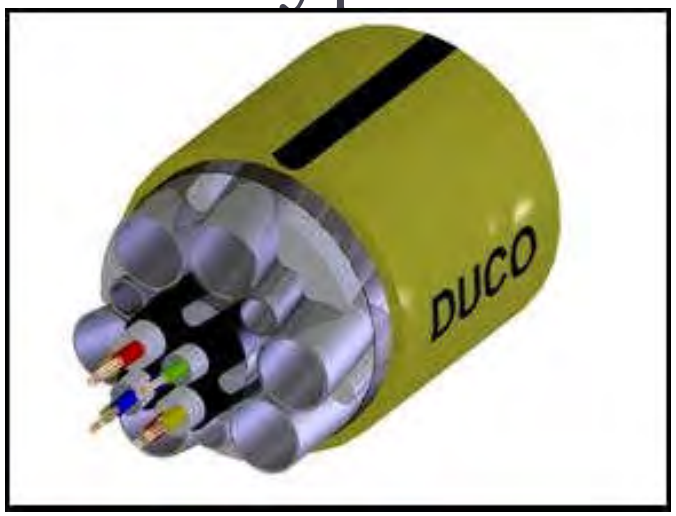
    Not a line to transport recovered hydrocarbons !

- **Functional Components ?**
  - Components included within the umbilical which are required to fulfill the system operational needs, such as :-
    - **Hoses / Tubes**
    - **Electrical and Optical Fiber Cables**

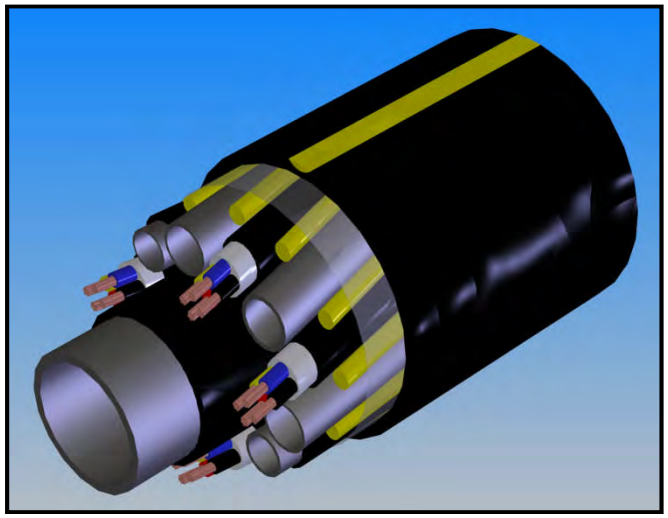
DUCO Umbilical Types



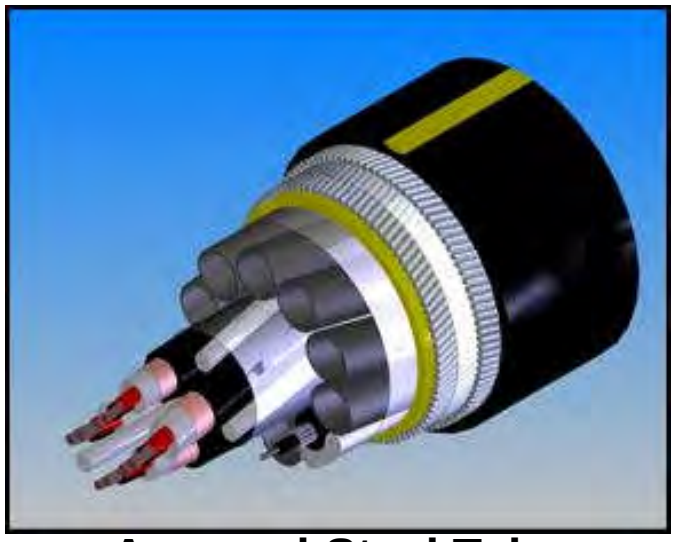
Thermoplastic Hose



Steel Tube

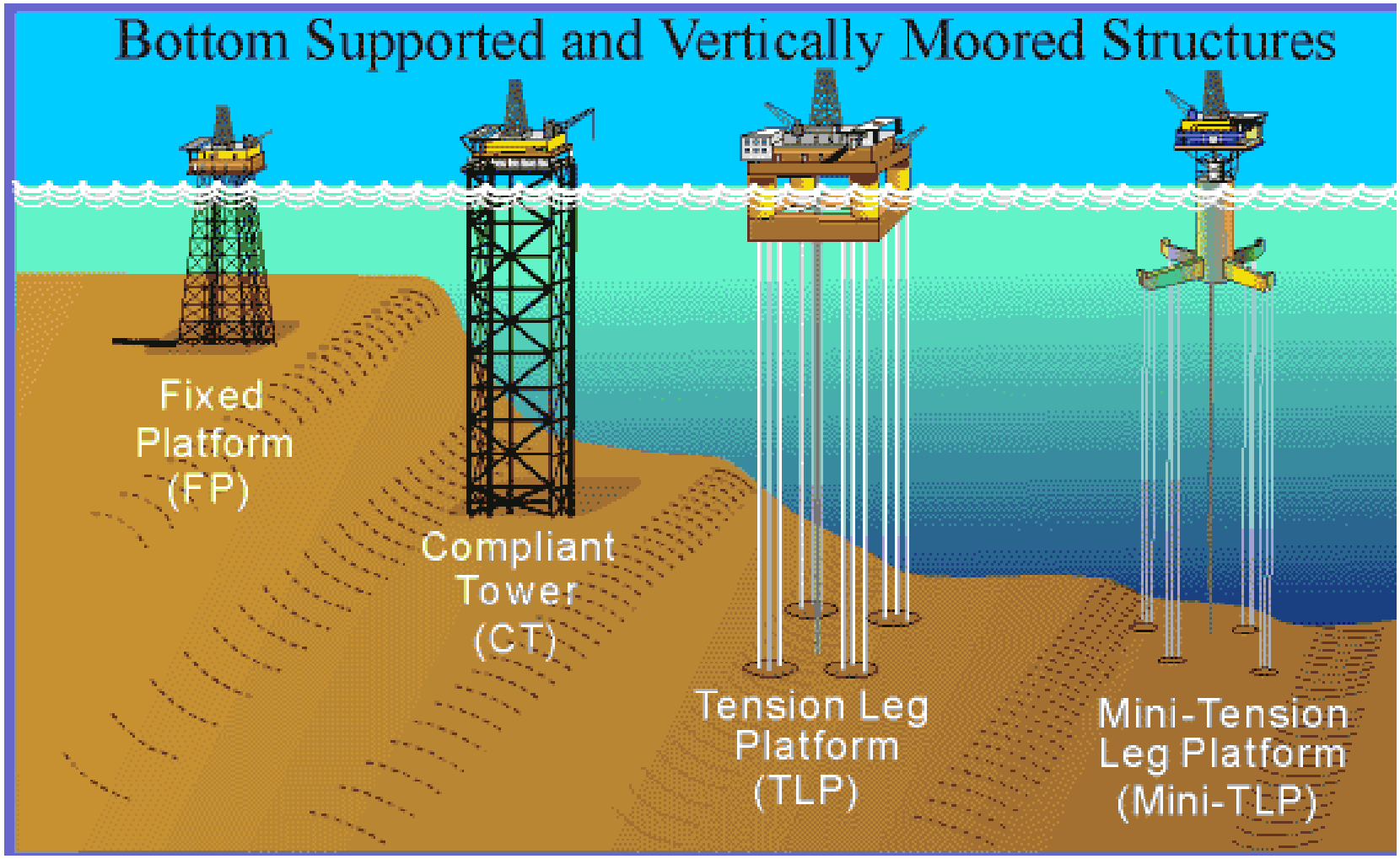


Large Central Tube



Armored Steel Tube

Offshore Host's – Rigs, Platforms & Vessels



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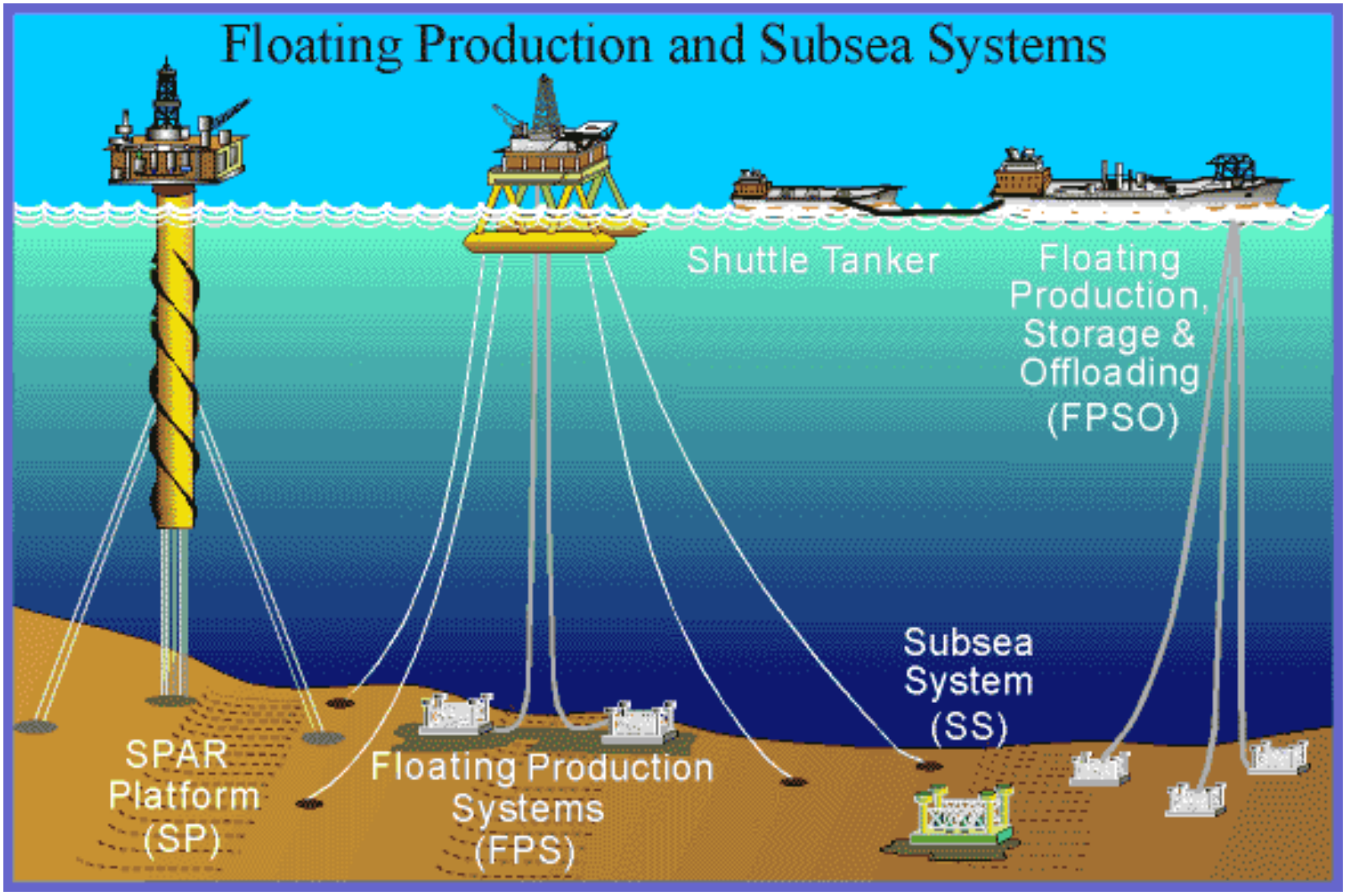
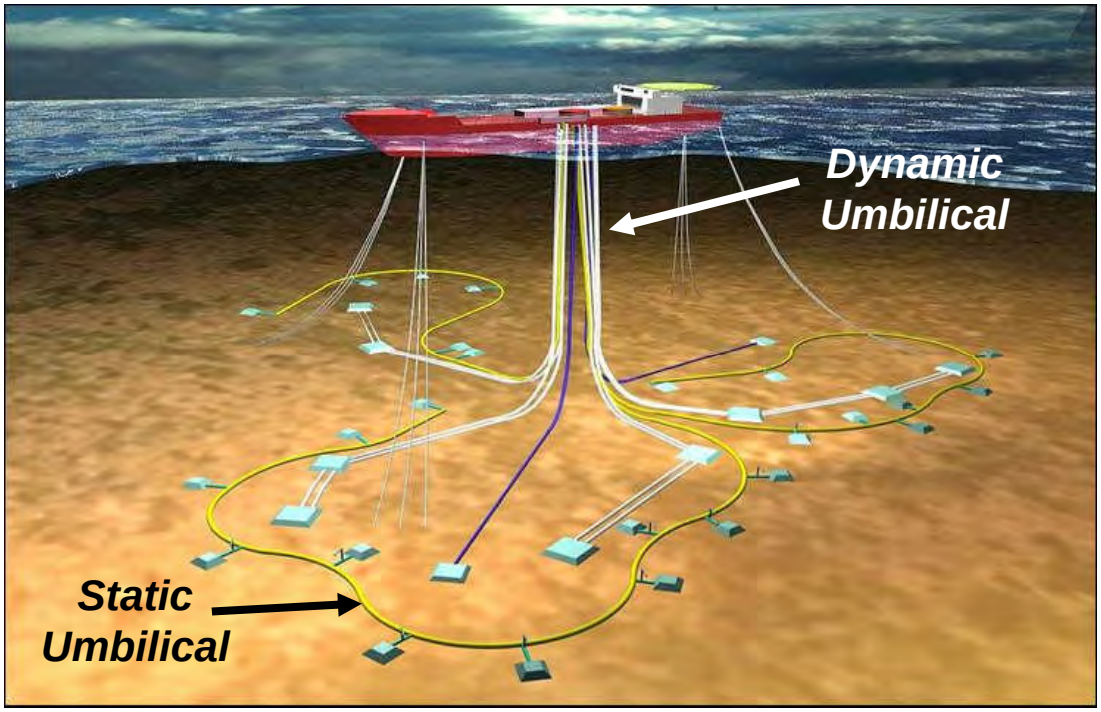


System Arrangement

- Supply and control link to sub-sea equipment

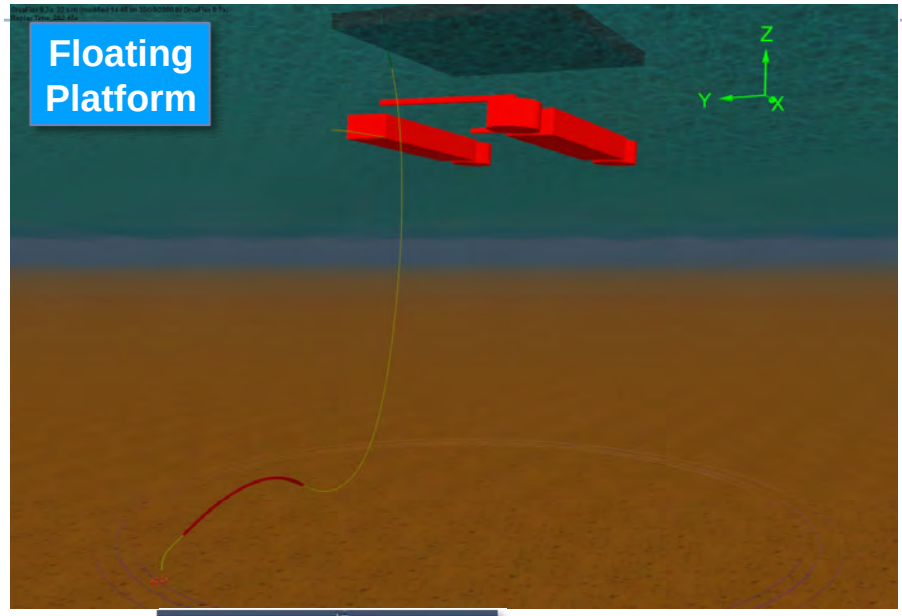
- Design Criteria
  - Static
    - Mechanical
    - Thermal
    - Electrical
    - Hydraulic
    - Environmental
      - Seabed stability
  - Dynamic

    (in addition to static)
    - Environmental
    - Vessel motion
      - Dynamic motion & fatigue

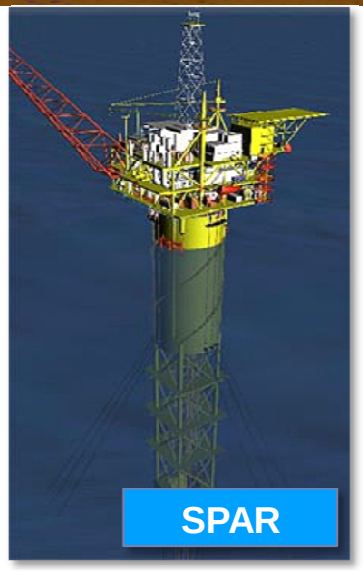


Dynamic Umbilical Considerations

- Shallow Water
  - Installation
    - Low topside tension
    - High dynamic wave motion
  - Design considerations for static and dynamic applications are most different.

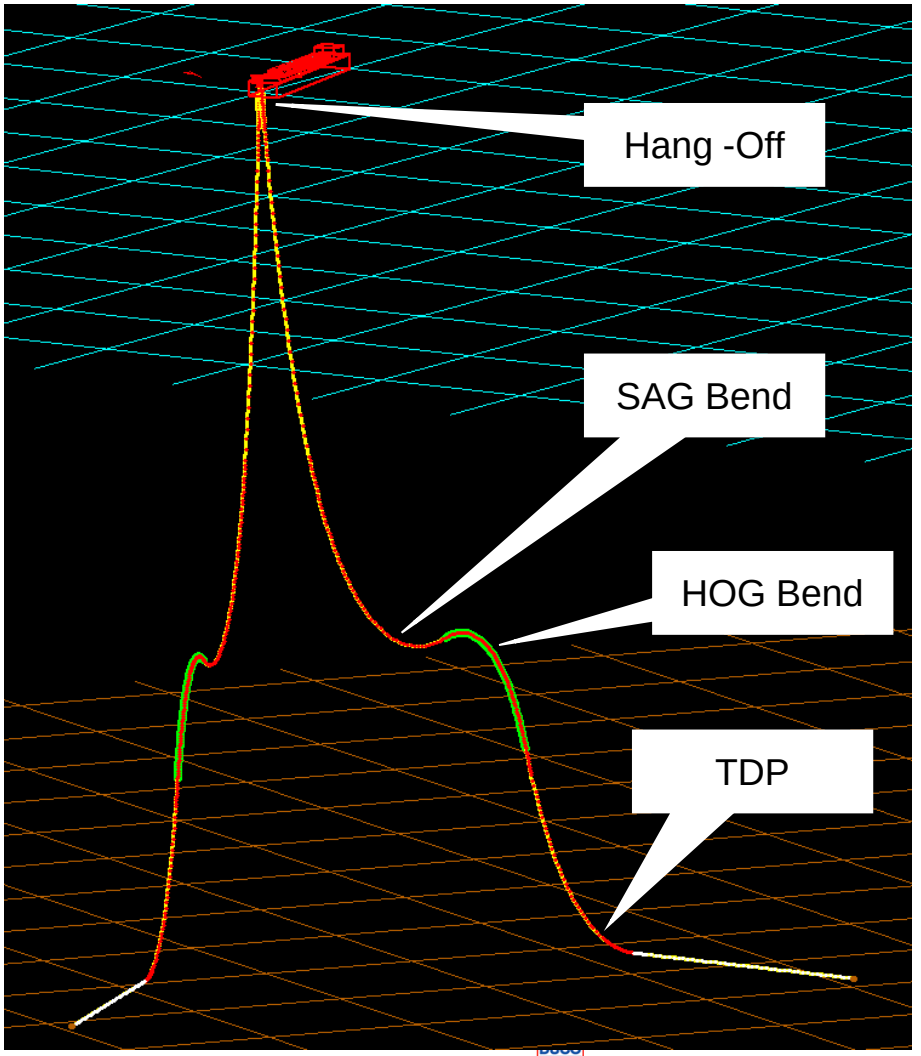


- Deep Water
  - Installation
    - High topside tension
    - Low dynamic wave motion
  - Differences between static and dynamic solutions may be more subtle

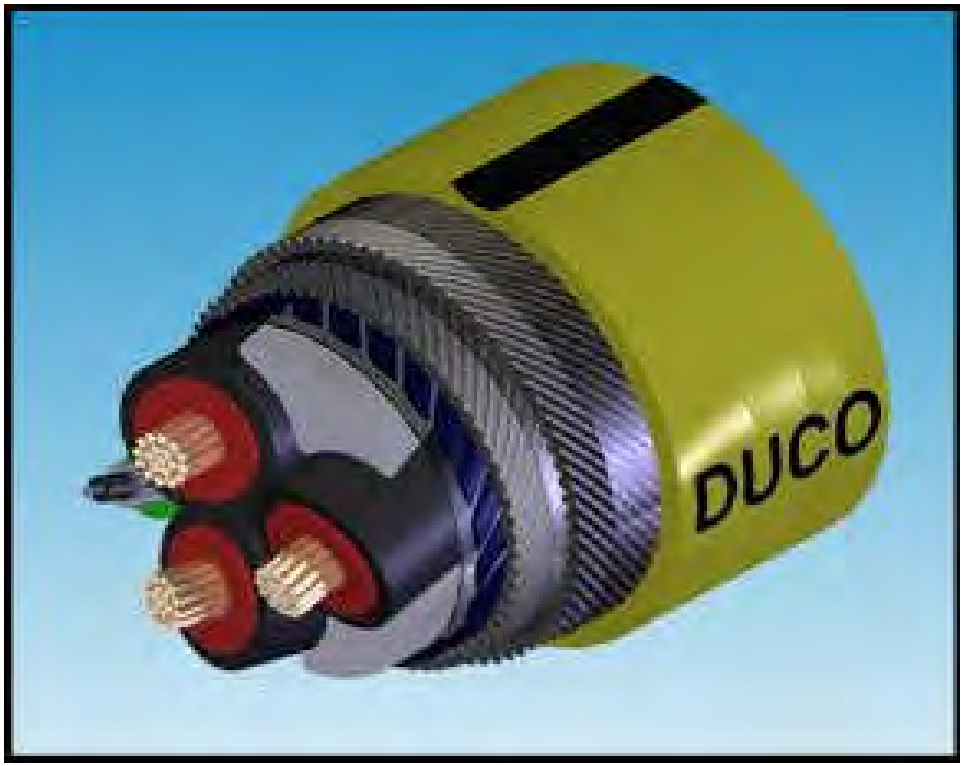


Dynamic Umbilical Configuration

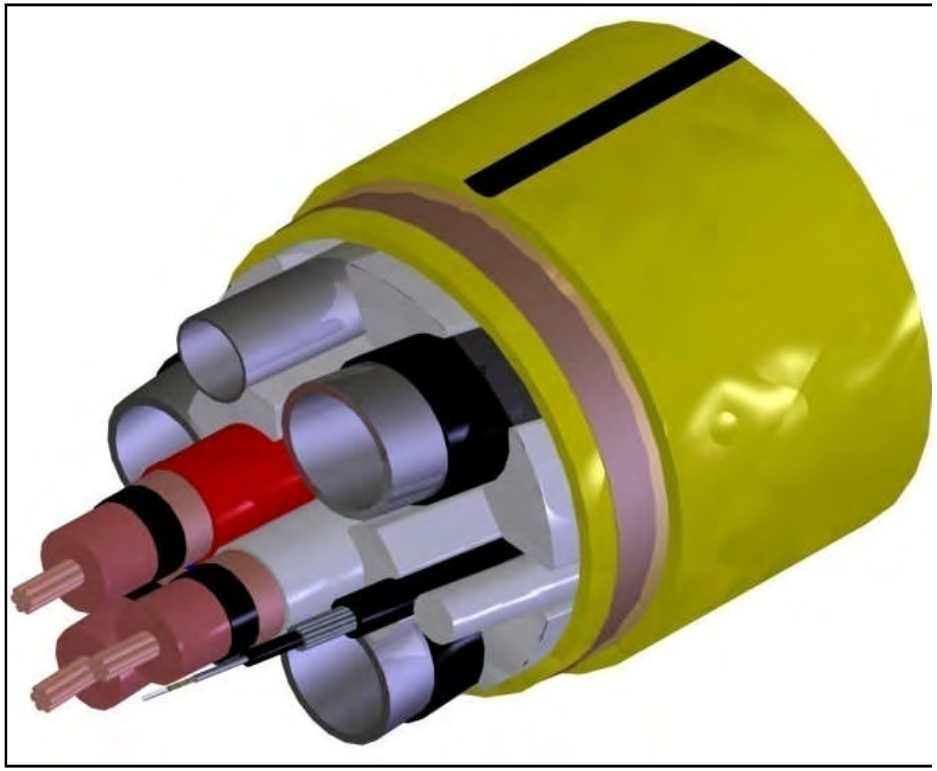
- Load variations assessed along the riser length; tension variations (self weight and dynamic effects) and curvature variations.
- Design assessed against various environmental return periods, e.g. FPSO ballast conditions, FPSO extreme motions and mooring line failure.
- Tension and curvatures assessed at Hang-off, Sag Bend, Hog Bend, and TDP



Power Cable Umbilicals



Power Systems / Coms



Utility

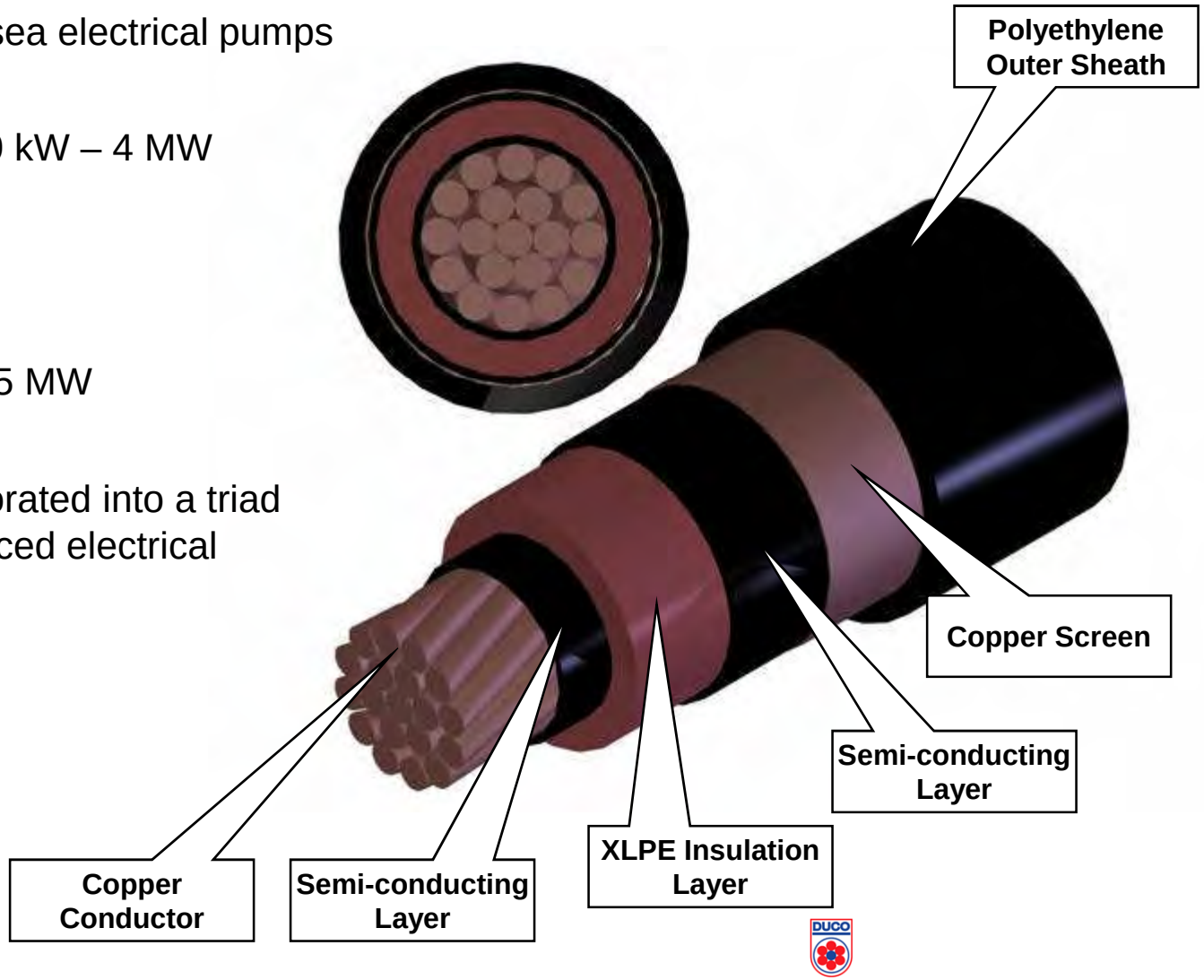
Increasing need to deliver electrical power subsea

MV Electrical Power Cable

- Artificial Lift using subsea electrical pumps
  3 Phase power,
  Typically 6.6kV, 500 kW – 4 MW

- Platform to Platform
  3 Phase power,
  Typically >11kV, > 5 MW

- The cables are incorporated into a triad configuration for balanced electrical characteristics



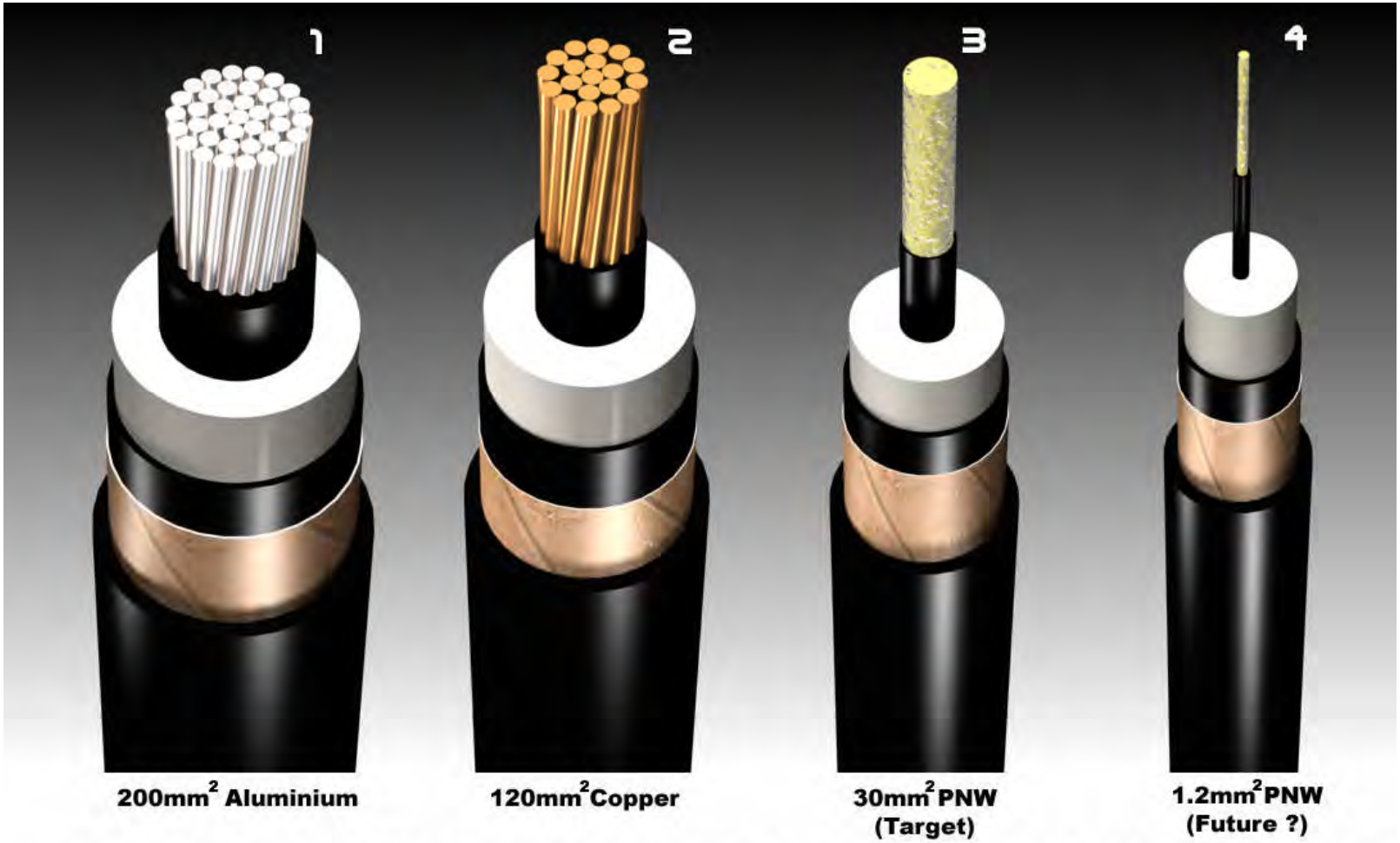
RPSEA Initiative

- The RPSEA goal is to provide an ultra-high conductivity wire that has the ability to carry at least 500 Amps at room temperature, and be half the diameter of a pure copper conductor carrying the same current at the same voltage.

- 120mm^2 copper conductor was selected as the reference for evaluation, based on relevant industry standards for the application. An aluminium cable of equivalent conductivity was also included for information.

- No consideration was given to voltage, so a typical system insulation rating of 12/20 kV was assumed for the purposes of any further analysis, with copper screen tapes applied.

Comparison of MV Power Cables



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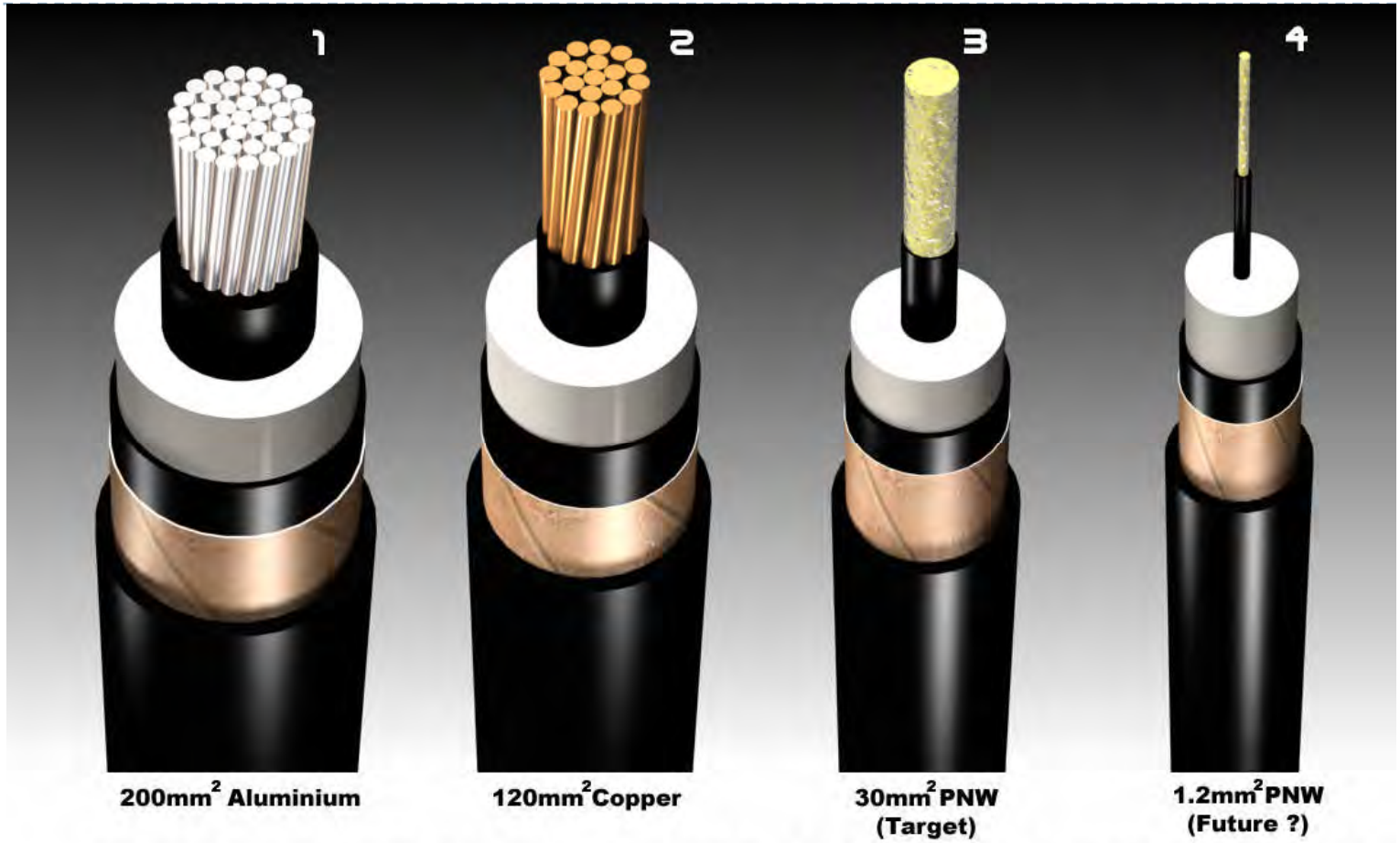


Diameter (mm)	38	33	25	19
Wt in Air (kg/m)	1.45	1.82	0.54	0.33
Wt in Water (kg/m)	0.29	0.96	0.03	0.02

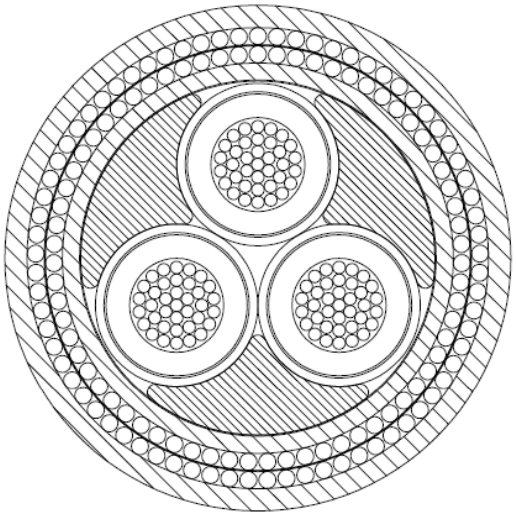
Power Cable Umbilical Design

- By assembling the various articles used in the comparison, into a ‘classical’ single power cable umbilical it is possible to compare the differences due to changes in conductor material alone.

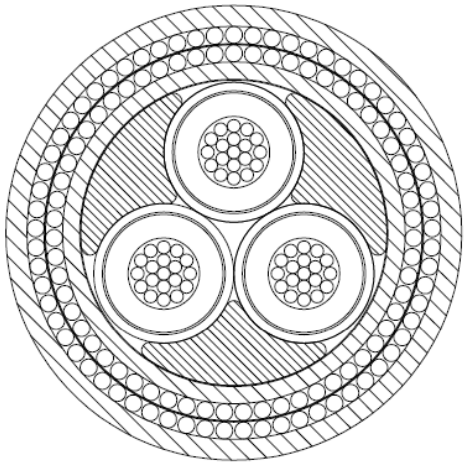
- In the classical design, steel wire (double layer for torque balance) armoring and standard sheathing thicknesses’ have been assumed.

Comparison of Power Umbilicals

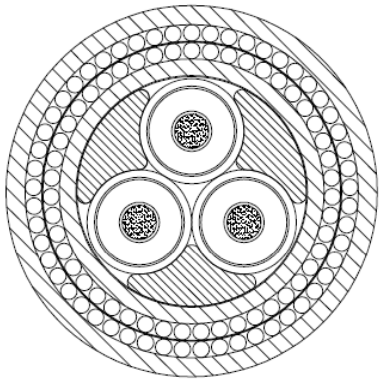
All structures are steel wire armored



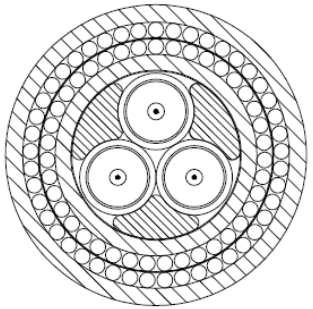
200mm² Al



120mm² Cu



30mm² PNW

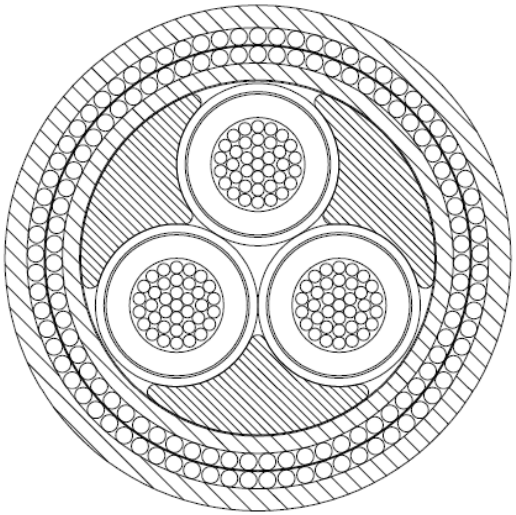


1.2mm² PNW

Dia (mm)	118	106	90	77
Wt (kg/m)	23.3	21.9	14.5	11.6
Wt (kg/m) in water	12.9	13.6	8.7	7.3

Comparison of Power Umbilicals

Tension



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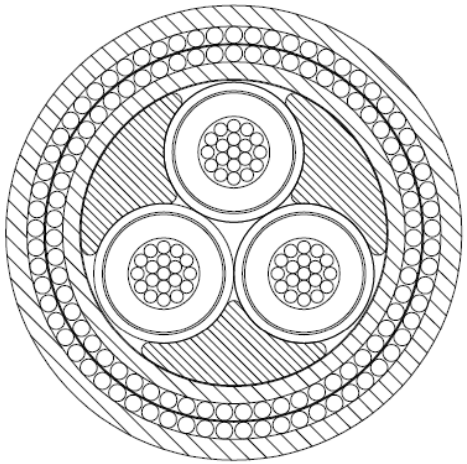

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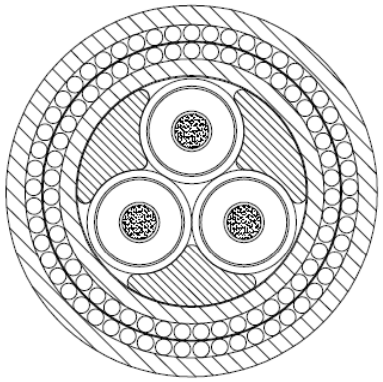
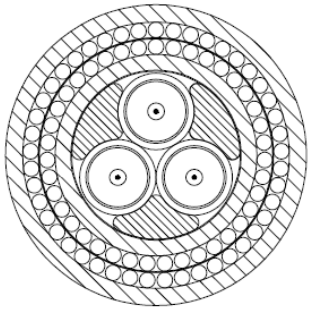


30mm² PNW



1.2mm² PNW

Top tensions during Installation at various water depths

Depth	Top tension in Tonnes			
3,000’	17	18	12	10
6,000’	34	36	23	20
10,000’	57	60	38	32

Strain Limitation

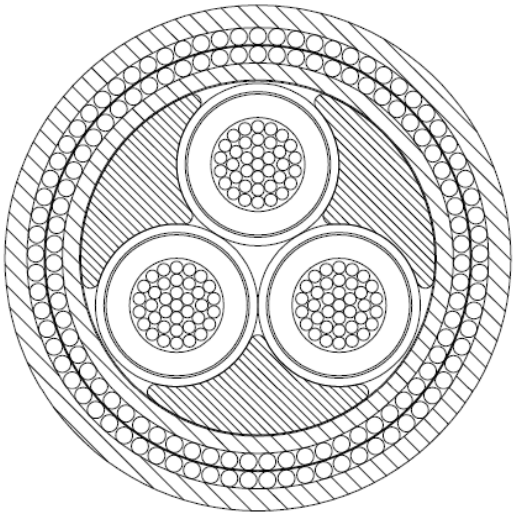
In a classical umbilical which contains double wire armoring, the amount of steel has to be significantly increased to limit conductor strain, for ever increasing water depth.

This tensile limit is governed by the strain on the conductor.

With a PNU conductor the effect of strain may not impose such limitations

Comparison of Power Umbilicals

Weight



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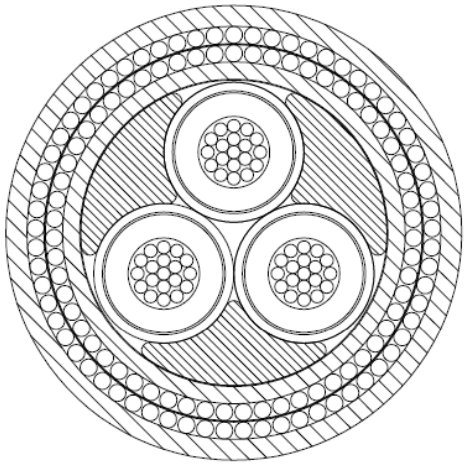

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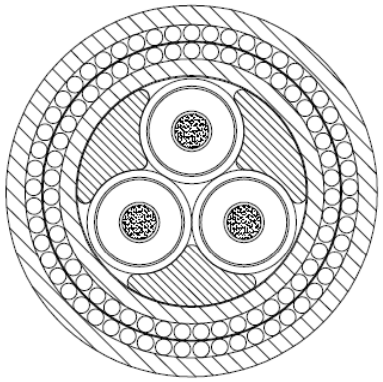
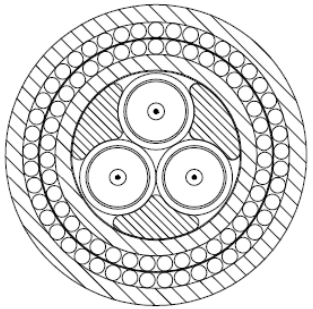


30mm² PNW



1.2mm² PNW

Total weight of product for variation of length

length	Total product weight in Tonnes			
10 miles	375	352	233	186
20 miles	750	705	466	373
30 miles	1125	1057	700	560

Electrical Performance

	120mm² Cu		30mm² PNU	
Distance miles	Volt drop %	Power MW	Volt drop %	Power MW
10	10	3.0	10	3.2
20	10	1.2	10	1.3
30	10	0.6	10	0.65

Operating voltage set at 11kV

With the reduction in cable size the Inductance decreases

More power could be delivered, however the electrical stress on the insulation has not been considered, and will increase with smaller conductor

Installation Vessels

For The Deep Blue	120mm^2 Cu	30mm^2 PNU
Length Capacity (km)	123 (76 miles)	186 (115 miles)

Increase in length capacity approximately 50% by weight.
Smaller umbilical OD, will also result in a reduction in the allowable bending radius and a reduction in product volume, i.e. easier to handle

Possible Applications

Conditions for which a lightweight umbilical can be favorable

	Umbilical Length	
Water Depth	Short	Long (>30miles)
Shallow	No	Yes To reduce weight
Deep > 3,000’	Yes To reduce top tension	Yes To reduce weight & tension

Conclusions

- Main impact on umbilicals containing large conductors
- By reducing in top tension, allows more tiebacks to host, but clashing may still be a problem
- Increase in length capacity for existing vessels and manufacturing equipment
- More vessels could be considered for installation, due to reduced tensioner size, smaller umbilical volume and greater allowable bending
- Limitations on conductor strain may be reduced
- Potentially more efficient use of electrical power
- Not promising for shallow water, and short step out