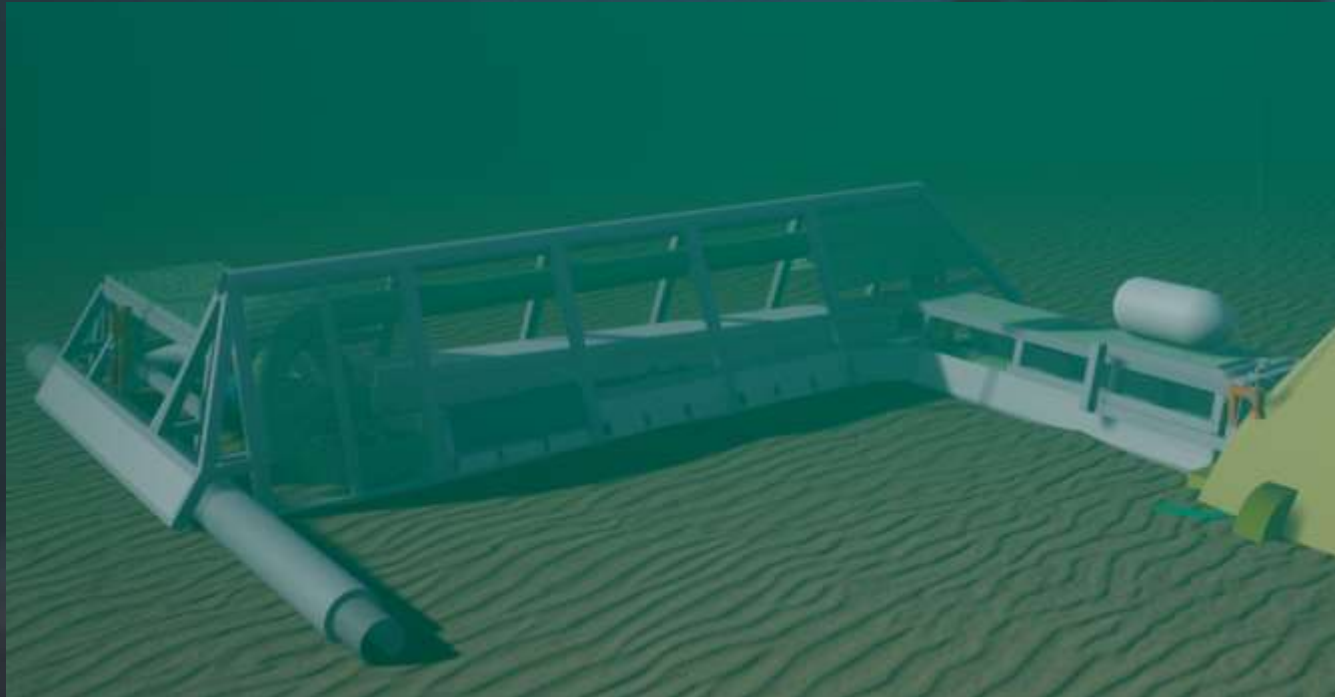


# The Delta STING Concept Spool Installation - Tie-in & Protection - Next Generation System



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- In Line Tee to Spool to Template
- The STING to Platform Interface
- The STING Structure, its Features
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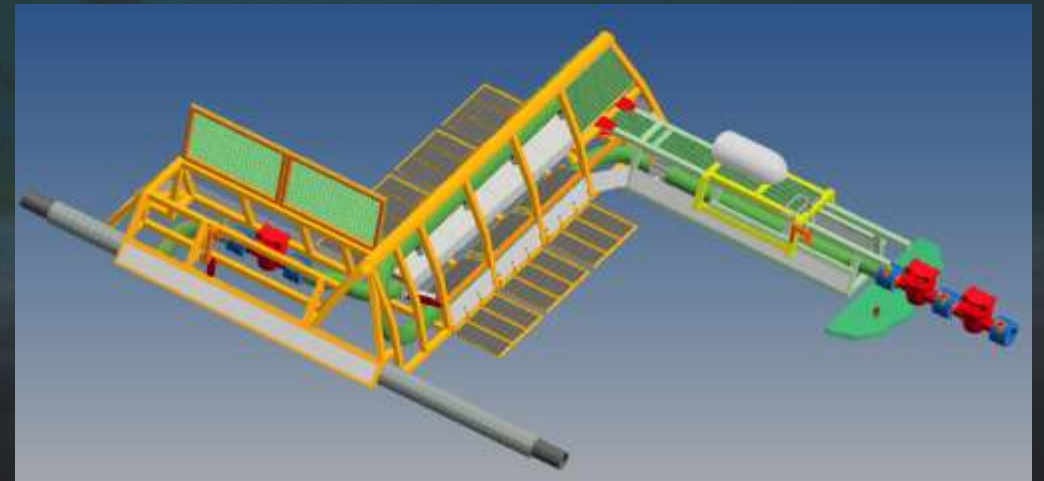
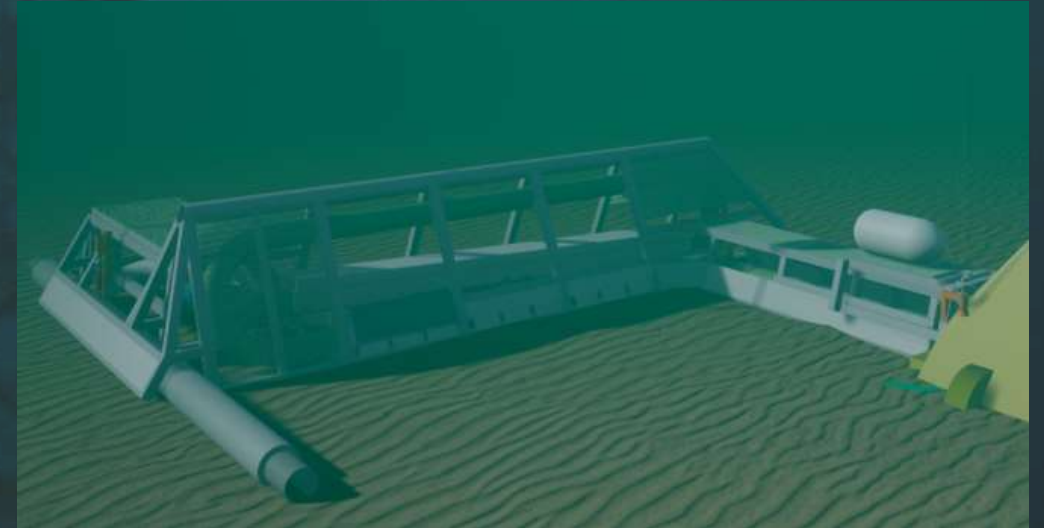
## STING System Advantages

- No spreader
- Can be stacked on deck
- Simplified sea fastening
- Allows use of smaller vessels
- Reduced tie-in forces & moments
- Inclusion of spool pipe supports and vibration damping devices to cater for operational induced vibrations, slugging, hammering effects etc.
- The protection structure => tailored to its operational environment
- Reduced strength & size requirement to tie-in porches
- Metrology data may be significantly reduced, even omitted
- Applicable for all spools



## STING System Advantages

- Significant cost saving potential
- Accommodates all known tie-in systems
- Easy and fast recovery at end of field life
- Size reduction is in the range up and beyond 60% compared to a similar Z-shaped spool
- Geometry provides superior flexibility
- Can integrate valves, wye-pieces, PLRs, vertical and horizontal connectors etc.
- The system frame acts as an artificial seabed with a controllable friction coefficient
- Spool can be pre loaded within the frame to allow further expansions to be catered for
- The frame can include a number of aids, as hydraulic strokes, hydraulic doors / hatches etc.





## In-line Tee to Spool to Template

- Direct connection to in-line tee
- Allow inclusion of PLR into the integrated frame structure
- Allow high expansion capacity due to its 3 D configuration
- Allow inclusion of valves with the spool pipe supported off the structure
- Allow inclusion of wye-piece assembly
- Allow umbilical routing in structure
- Integrated spool installation frame
- Integrated spool protection
- Allow simplified AUV access
- Allow AUV storage



## The STING At Platform Interface Riser base off-take

- Direct connection of spool to pipeline end manifold
- Allow high expansion take up with a small footprint close Platform
- Inclusion of ESV/riser base / spool in an integrated unit
- Allow inclusion of valves and wye-piece take-off
- Allow direct connection to flexible riser
- Allow protection /take-off to Umbilical distribution unit if preferred

- Pipeline connection
- Riser Connection
- 3D Spool
- Valves & Wye-piece
- Integrated Controls

## The STING Structure & its features

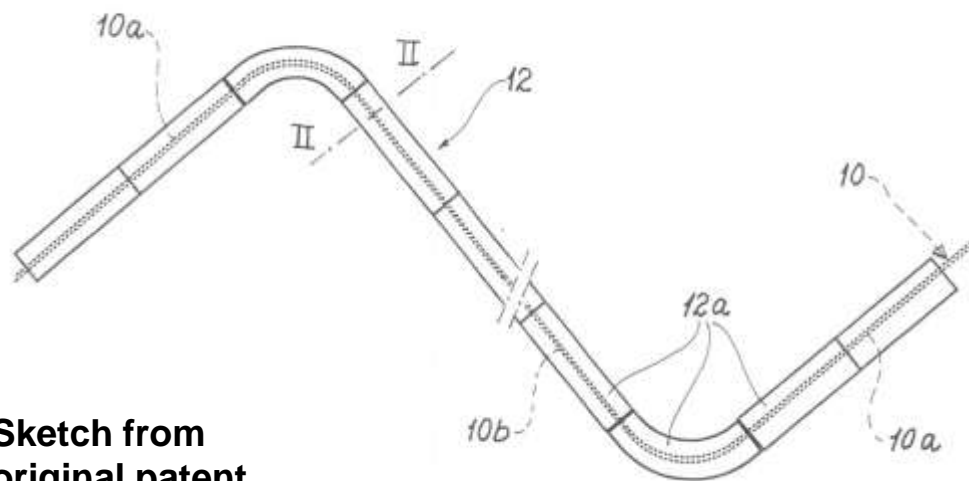
- Fabrication support from structure
- Load out support from structure
- Sea-fastening support from structure
- Installation strong beam with direct connection of lift rigging
- Long-term protection unit
- Limited rock dump
- Inclusion of parking or made accessible for ROV AUV.
- Easy Incorporation of movable hatches for access to included equipment
- Inclusion of Smaller openings for allowance of snake type of ROV / AUVs.
- Easy retrievability at end of field life



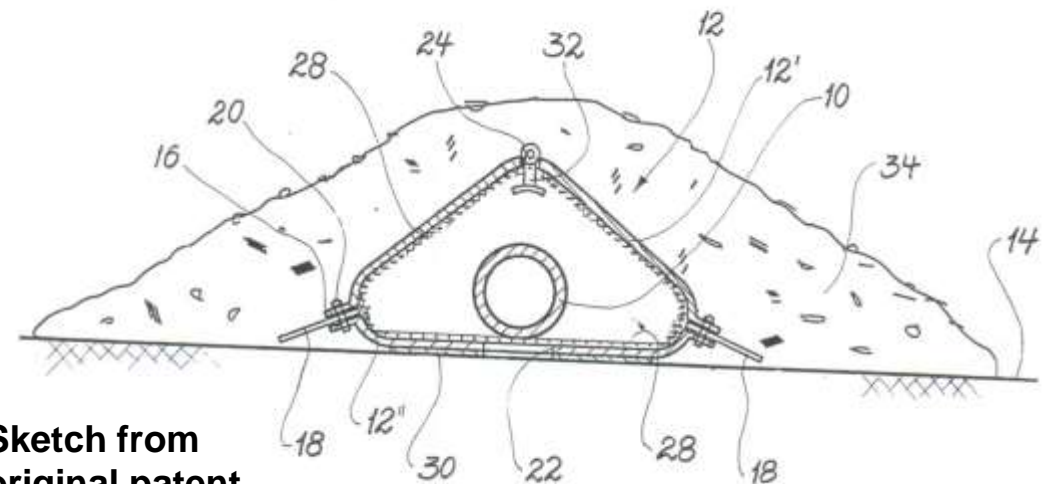


## System History IProS

- Late 1990-s our personnel developed a system and a method to integrate tie-in spools into a combined installation and protection system which was patented in Norway and in the US
- Further developed in 2000 assimilating a 3-D highly flexible spool system into the integrated protection system.
- A prototype unit was fabricated and located in Stavanger for a number of years to be displayed to potential clients



Sketch from  
original patent

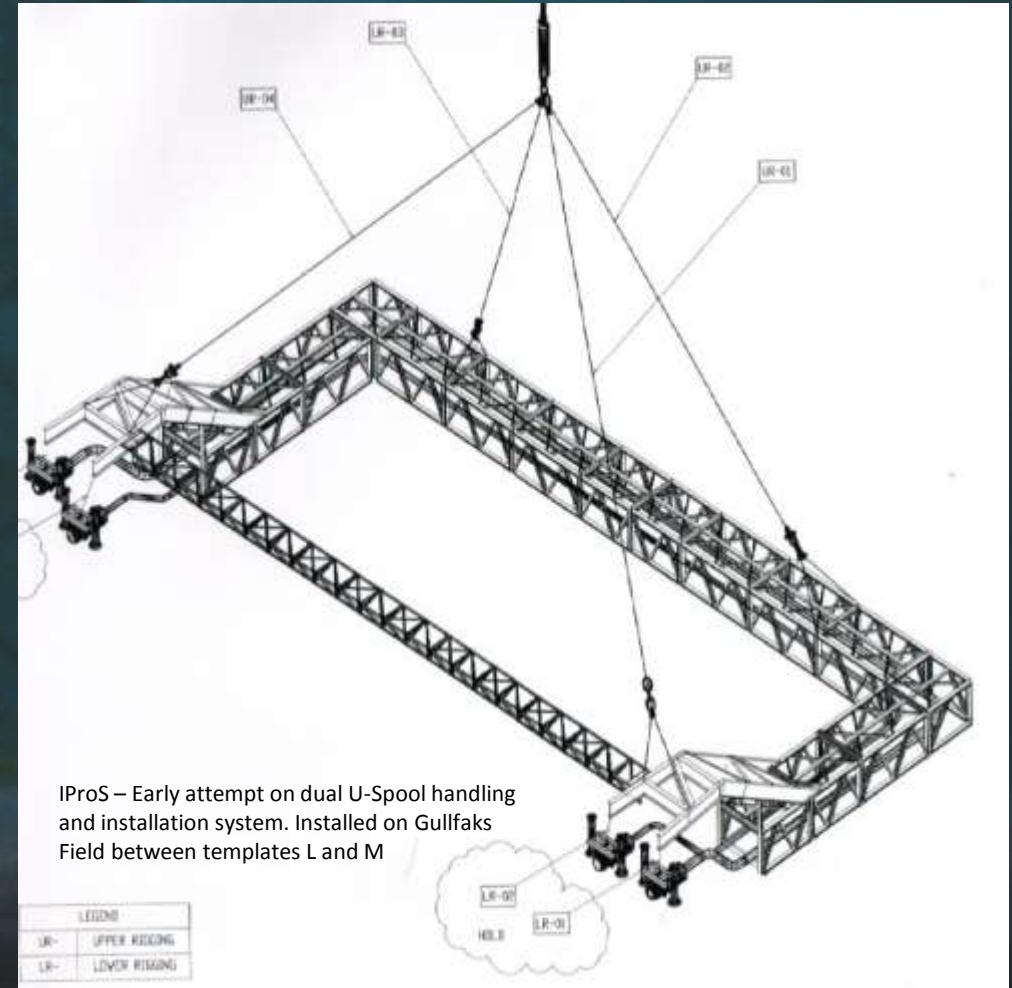


Sketch from  
original patent

## System History / Track Record

### IProS on Gullfaks South

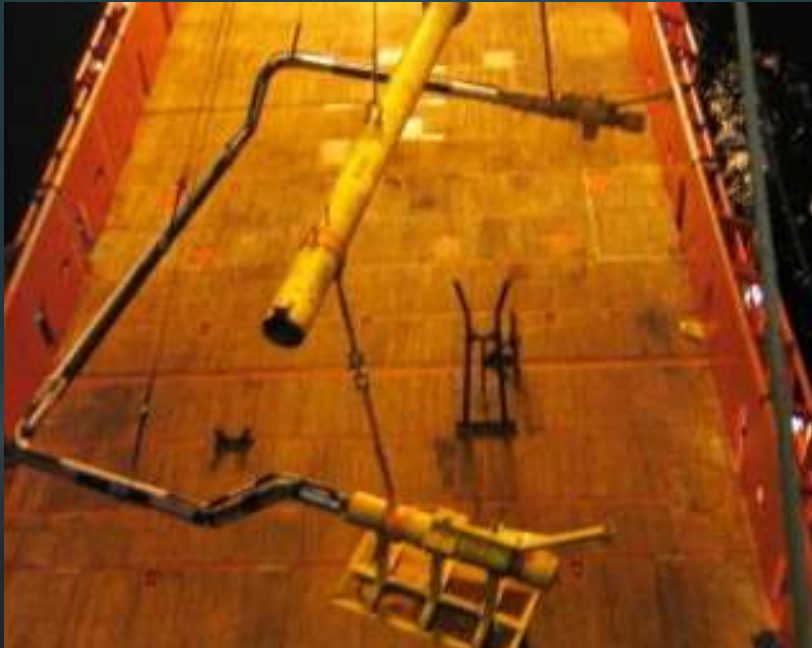
- A similar design was used by Rockwater in 1998-99 on the Gullfaks Satellites Project
- The frame => marine grade aluminium utilizing standard aluminium profiles
- Sideways stability and protection was provided by rock dump
- A number of designs were detailed, Z - shaped, L- shaped and U- shaped





## System History / Track Record IProS on Stine

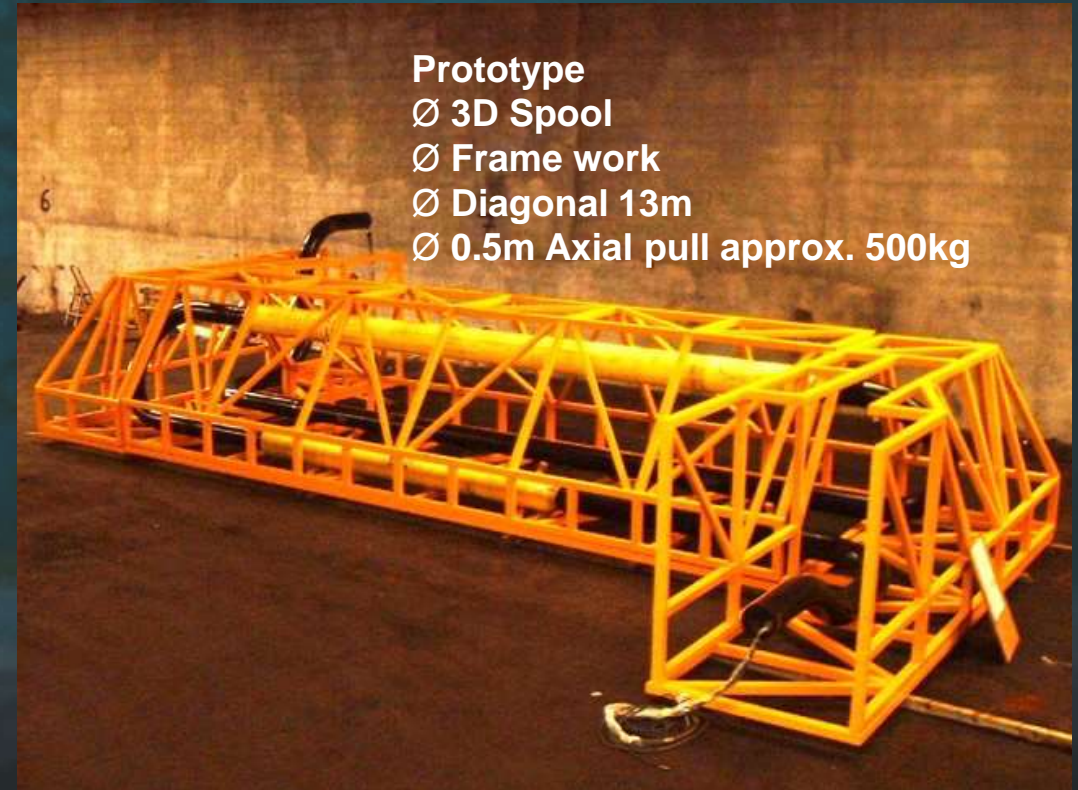
- U - spool system for use on the Dong operated Stine Field in 2003
- Spool with an overlaying protection structure made from GRP covers and standard GRP grating
- Final installation was with separate spool and cover lifts, rig capacity limitations
- The transport to field a supply vessel were each unit was lifted directly off deck and installed from the drilling rig



## System History / Track Record

### 3 D Spool

- 10" spool made from 13% Cr with 60mm Insulation for a design pressure of 345 bar and a pipe line expansion of 1,5meter was designed and fabricated in collaboration with Hermes Marine Services in 2001
- Location; Havelageret, Stavanger harbor area, tested and shown to potential customers, Statoil among others
- The unit was kept in storage for a couple of years and shown at request
- Proved extremely flexible - could be axially moved only by use of hand
- 600mm stoke => axial force approx. ½ ton
- Diagonal hub to hub distance of 13meter (Approx. 50%+ of similar Z - shaped spool)





## Future Inclusions

- Allows branch to spool connection
- No GRP cover for dropped objects
- Provide protection to top leg
- Provide protection of bottom legs
- May include seabed stabilization means
- Offshore metrology, welding and testing on vessel
- Offshore field joint at welded locations
- ROV operated hub adjustment
- Added expansion capability
- In-line tee simplification
- Can accommodate rock ingress into the structure while maintaining full expansion loop functionality

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