Subsea Xmas Trees
Vertical or Horizontal
Implications / Issues for Insurers

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Topics - Vertical v Horizontal XT

- Evolution of subsea xmas trees
- Technical comparison / differences
- What can go wrong?
- Repair scenarios
- Issues for Insurers
Oil & Gas Xmas Tree - Definitions

1. The set of valves, spools & fittings connected to the top of a well to **isolate**, **direct** and **control** the flow of wellbore fluids

2. The control valves, pressure gauges, and chokes assembled at the top of a well to **control** the flow of oil and gas after the well has been drilled and completed

3. Integrates with wellhead as the well is prepared for service (production or WI)
Basic Xmas Tree Features

- Tree cap and gauge
- Tree adapter
- Swab valve
- Production wing valve
- Surface choke
- To production facilities
- Upper master valve
- Lower master valve
- Tubing-head adapter
- Production string

Kill wing valve
Kill wing connection
Surface (Dry) Xmas Trees
Subsea Xmas Trees - Main Developments

- Integrated valve block
- Subsea chokes
- Chemical injection facilities
- Instrumentation
- Diverless ROV tooling & technology
- Deepwater
- High pressure / high temperature
- Metallurgy - CRA
- Protection
- Thermal insulation
Subsea (Wet) Xmas Trees
Deepwater Drill Centre with Subsea XT}

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Subsea Xmas Tree Packages
VXT / HXT Technical Comparison / Differences

- Configuration
- Installation equipment
- Installation sequence
- Repair sequence
- Capex - procurement / installation
- Opex – remedial action / repairs
- Project planning - operating philosophy
Configuration

SPOOL TREE

CONVENTIONAL TREE

DEBRIS CAP
WIREFLINE PLUG
TREE CAP
TUBING HANGER
TREE BODY
WELLHEAD
ISOLATION SLEEVE

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Configuration Options

- Modular SpoolTree Christmas Tree
- Modular Dual Bore Tree
Subsea Xmas Tree Intervention Equipment
Typical Subsea Well Construction Sequence

**Vertical Xmas Tree**
1. Spud well. Drill top hole
2. Run BOP stack on marine riser
3. Drill to TD. Run & cement liner
4. Run downhole completion & tbg hanger
5. Install temporary barriers
6. Recover BOP stack
7. Deploy & test xmas tree
8. Remove temporary barriers
9. Connect flowline jumpers & flying leads
10. Flow test well
11. Recover intervention package
12. Run xmas tree cap
13. Commission well from platform
14. Install protective cover

**Horizontal Xmas Tree**
1. Spud well. Drill top hole
2. Deploy BOP stack on marine riser
3. Drill to TD. Run & cement liner
4. Install temporary barriers
5. Recover BOP stack
6. Deploy & test xmas tree
7. Redeploy BOP stack on marine riser
8. Remove temporary barriers
9. Run downhole completion & tbg hanger
10. Test completion and interfaces
11. Flow test well
12. Install TH plug and internal tree cap
13. Connect flowline jumpers & flying leads
14. Recover intervention string
15. Recover BOP stack
16. Commission well from platform
17. Install protective cover
# Typical Xmas Tree Replacement Sequence

<table>
<thead>
<tr>
<th>Vertical Xmas Tree</th>
<th>Horizontal Xmas Tree</th>
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<tbody>
<tr>
<td>1. Recover protective cap</td>
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<tr>
<td>2. Recover tree cap</td>
<td>2. Deploy BOP stack on marine riser</td>
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<tr>
<td>3. Deploy intervention package</td>
<td>3. Deploy intervention string</td>
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<tr>
<td>4. Install barrier plugs (min 2)</td>
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<tr>
<td>5. Disconnect flowline jumper &amp; flying leads</td>
<td>5. Unlatch down hole completion</td>
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<tr>
<td>6. Recover damaged xmas tree</td>
<td>6. Circulate to remove hydrocarbons</td>
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<tr>
<td>7. Deploy &amp; test replacement xmas tree</td>
<td>7. Recover completion &amp; tubing hanger</td>
</tr>
<tr>
<td>8. Remove temporary barriers</td>
<td>8. Possible mill out of packer</td>
</tr>
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<td>9. Connect flowline jumpers &amp; flying leads</td>
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<td>22. Commission well from platform</td>
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</table>
Examples of Thru Horizontal Tree Completions

Diagram showing various components and dimensions:
- 9 5/8" SM25Crw
- 7" SM2535
- 13 3/8" Gauge
- 9 5/8" SM25Crw
- Nido Carbonate

Diagram labels include terms like "Tubing Hanger," "Cross Over - Relancing," "Flow Coupling," and "Landing Nipple."
**Cost Comparison**

- Purchase costs similar - varies according to spec and market conditions. Typically US$1-3mm
- Installation costs similar order of magnitude.
- Replacement cost of horizontal xmas tree up to 10 times vertical xmas tree.
  - VXT can be replaced using drill rig or specially equipped DSV with lightweight intervention package. Typically US$5-10mm + mob / demob
  - HXT requires use of drill rig to run BOP stack and recover completion. Typically US$15-60mm + mob / demob
DSV Xmas Tree Replacement

FMC’s Light Well Intervention operating on Island WellServer
Vertical v Horizontal Selection

- Based on operating philosophy and economics
- A horizontal xmas tree is more suited to an application where there is a higher probability the well will be recompleted or worked over during its service life.
- Horizontal xmas trees should only be used when there is an extremely low probability that the tree itself will be recovered for any reason during its service life.
- If horizontal xmas tree design is selected
  - The Operator should invest in QA / QC to minimise problems with unproven technology.
  - The completion design should not be over complicated and include a latch to aid recovery.
Typical Incidents Resulting in Claims

All xmas trees
- Manufacturer error
- Installation damage
- Mechanical damage dropped or dragged objects
- External / internal leaks
- Erosion
- Component failure

Horizontal xmas trees
- Tubing hanger / xmas tree interface susceptible to damage from debris in BOP stack / riser
  - Damage to tubing hanger and / or xmas tree
- Inadvertent unlatch of landing string and/or tubing hanger
  - Damage to tubing hanger and / or xmas tree
  - Possible oil spill or well control incident
Scenario 1
Scenario 1 Spare HXT - Diagnostics
PWV Valve Block Machine Error
Seal Tite Repair Solution
Bridge Seal Repair Solution
Scenario 2
Scenario 2
Scenario 2 - Damage
Scenario Damaged HXT Bore
Scenario 3 Debris Damage
Xmas Trees - Implications Issues for Insurers

• Most incidents occurring during offshore construction or start up phase
• Additional hazards / risks with HXT
  – Intervention / service tools less proven
  – Exposed to offshore construction hazards risks for longer period
  – XT / tubing hanger interface sensitive to debris
  – Higher risk of inadvertent hydrocarbon release
• HXT repair costs much higher than VXTs. Do policy declared values make provision for full cost of repairs?
• Additional provisions to mitigate HXT (&VXT?)risks
  – QA/QC, performance / integration testing, risk assessment
  – Warranty surveys
  – Contingency plans (e.g spare XT set)
• Discovery & maintenance period considerations