Subsea trees

Proven systems for easy installation and reliable operation in all water depths and operating conditions
Subsea trees

Subsea trees are complex configurations of valves and other components, installed at the wellhead to monitor and control production flow, and manage gas or fluids injection. Valve orientations can be either vertical with production tubing suspended in the wellhead, or horizontal with production tubing suspended in the tree. Design and materials are determined by operating conditions and physical environment of each specific well – with key factors including pressure, flow, temperature and water depth. Water depth has the most significant design implications because it determines operating pressure, structural integrity requirements and type of topside vessel involved.

GE Oil & Gas solutions

GE Oil & Gas designs subsea tree systems for every water depth in the offshore industry – including the technologies that enable moves into deeper waters and more challenging environments. Our current capabilities include depths of 0-3,000 m and reservoir shut-in conditions of 350°F and 15,000 psi.

We have supplied more than 1,200 tree systems over the last 40 years, with a current installed base including every major production basin worldwide. Our proven portfolio covers all applications from shallow-water, single-well satellites to major deepwater developments; from low-pressure reservoirs with artificial stimulation or lift, to high-pressure high-temperature (HPHT) applications.
Pushing subsea boundaries
GE Oil & Gas has an extensive range of subsea trees to suit a wide variety of oil and production challenges. These trees can be provided individually or as part of an integrated EPC package covering full field development. Our latest range of shallow, medium and deepwater (S, M & D-Series) trees all draw from GE’s structured engineering approach to maximize manufacturing efficiency, quality and consistency across the product portfolio and enable faster delivery cycles and improved reliability.

Innovation Now
GE Oil & Gas is a leading supplier of advanced solutions for the entire oil and gas industry – from drilling and production, LNG, pipelines and storage to industrial power generation, refinery, petrochemicals and pipeline integrity solutions. Drawing on the whole of theGE global organization, from Healthcare to Aviation, our products continue to reach higher levels of reliability, availability and efficiency. As the industry faces continually greater challenges, we believe technology is key to overcoming each one – safely and efficiently. We are committed to providing “Innovation Now” – and paving the way for a bright future in oil and gas.

Quality & reliability
In today’s high-risk projects where equipment availability and environmental protection is paramount, there is no room for failure. Nowhere are the challenges greater than in subsea applications. GE Oil & Gas draws experience from a massive installed base built up over the last 40 years. We work closely with clients to monitor progress and continually find new ways to increase the quality and reliability of our products.

Environmental health & safety (EHS)
All our facilities and personnel operate to the highest standards. We employ rigorous test, audit and review procedures in everything we do – minimizing risk at all stages of our product and service life cycles from development to ongoing operating support. We have received many customer and independent agency awards for our EHS performance, and we are extremely proud of every one because safety is something we take seriously in all aspects of our business.

Compliance & governance
In a time of rigorous regulation and enforcement, strong compliance and governance processes are more important than ever for global organizations. Merely having internal policies is not enough. Companies must devote significant attention and resources to ensure such rules are embedded in employees actions every day.

For more than 125 years, GE has demonstrated an unwavering commitment to performance with integrity, and we have built a worldwide reputation for lawful and ethical conduct. We go beyond simply obeying the law – we embrace the spirit of integrity. Our integrity policy, The Spirit & The Letter helps ensure that our employees conduct our affairs with unyielding integrity. Processes are in place for executive and employee accountability, training, continuous improvement, and an open reporting environment to set the tone for a culture of integrity everywhere, every day and by all our employees.
S-Series

Shallow-water solutions

Our S-Series trees are designed to maximize safety and efficiency for jack-up drilling operations in water depths up to 100 m and operating pressures up to 10,000 psi.

Designs are based on an in-depth understanding of environmental challenges including weather, sub-surface currents, poor visibility, and fishing interaction. Key advantages include smaller size, fisher-friendly wellhead protection structures, and an innovative barrier philosophy that removes the need for a separate tree cap.

Our designs also enable lowest-cost installation, with deployment using standard offshore jack-up drilling rigs and no need for major modifications.

VetcoGray SVXT™

Our latest award-winning vertical tree has an enhanced, integrated master valve block design that reduces overall size and weight – a minimum 20% lighter and 30% shorter than our traditional tree-on-mudline (TOM) systems. With 20 years of proven in-field experience around the world, our TOMs are widely considered the industry benchmark for harsh shallow-water environments.
Our latest horizontal tree is designed to increase tubing size and integrates the latest GE Oil & Gas technologies to deliver high performance and lower installation and operating costs. Building on the heritage of our traditional horizontal systems, the VetcoGray SHXT can be run with a high-pressure riser for fast and more efficient installation of the completion.
M-Series

Medium-depth solutions

Our M-Series trees have served the industry for over 15 years in water depths of 100 - 750 m with installation from semi-submersible drilling rigs. They are designed to accommodate guideline drilling and completion techniques, but can also be run guidelineless using vessels of convenience for installation. The designs are suitable for template and over-trawlable protection structures in heavy fishing areas.

All M-Series trees are trimmed with VG300 valves qualified for temperatures from -20 to 350°F. They are available for 10,000 and 15,000 psi applications, with 5", 6" and 7" production bores as standard.

The M-Series is equipped to interface with the ultra-reliable VetcoGray ModPod subsea control module with the award wining SemStar5" subsea electronics module with field-proven availability in excess of 99.5%.

VetcoGray MVXT™

This traditional guideline vertical tree has been used extensively in all mature offshore basins around the globe. It is highly compatible with various types of drilling fleets and provides wide flexibility in field development planning. Designed for both cluster and or template applications, with or without electro-hydraulic subsea control module, the VetcoGray MVXT can be installed directly onto the completed wellhead to enable early drilling/completion of the well.
VetcoGray MHXT™

Our guideline horizontal tree is well established in offshore developments around the world and is compatible with 18¾" drilling systems. The tree design allows for installation of the tubing hanger directly into the tree master valve block and eliminates the need for an open-water completion riser. The VetcoGray MHXT comes in two modes: HT1 with a single crown plug in the tubing hanger and a separate internal tree cap; and HT2 with two crown plugs in the tubing hanger. These designs can be used in both cluster and template configurations and can be supplied with a standard control pod interface.

Proven track record

To date, GE Oil & Gas has installed over 500 M-Series trees in offshore basins around the world. The trees are qualified to meet the most rigorous international standards for subsea products – API, ISO and Norsok – and they utilise standard, proven VG300 master valve blocks and H4 connectors. The M-Series line is designed for diverless installation and connection to flowlines and umbilicals using our HCCS connection systems. All trees have options for oil, gas, water injection and ESP applications and are supplied with proven diverless installation and maintenance tools.

Great flexibility & support

The M-Series includes a full set of rental tools to minimize capex for small field developments and allow greater flexibility in planning developments and budgets. The tools can be deployed to any location to meet operational needs and provide complete capability for well intervention and maintenance. Rental tools are generally available "to suit project schedules" and are fully supported by our Global Services department and experienced field support engineers.
After 40 years of delivering subsea trees with field-proven reliability and availability, GE Oil & Gas has the experience to answer the industry’s toughest questions.

Since one size does not fit all applications, how do we deliver field-specific products that are efficient and reliable?

We use a structured or modular approach to engineering and manufacturing – standardizing common components used in all of our trees, and identifying application-specific areas for custom engineering. Our portfolio is organized in S, M, and D-Series structured frameworks based on operating depths and functional requirements. This approach enables our application engineers to quickly define tree specifications for each project – improving efficiency, quality, and delivery cycles across the product range.

How do we address the different installation/completion requirements within this structured approach?

Each of our S, M, & D-Series trees is available in horizontal and vertical options. The base model is then augmented with either Standard, Enhanced, Gas Lift or Water Injector production specifications – each of these designs has a standardized set of master forgings defined for maximum functionality.

How do we address the increasing need for shorter lead times?

The base case delivery schedule is eight months for a standard tree. Every tree in each of the series has been designed from an optimized master block forgings as standard and a predefined maximum set of peripheral functions. These functional requirements have been maximized in the base case design so that in many cases there is more capability in the base case design than is needed, and those functions not required are blanked. This helps to reduce engineering and maintains the short delivery cycle.

How do we address the ever-increasing Smart Well requirements?

Our tubing hangers are designed to maximize downhole functions from the outset. Those not required are blanked off. For example, our D-Series trees accommodate up to nine hydraulic and two electric downhole penetrations – either of the electric penetrations can be swapped out for fibre-optic connectors.

How do we address reliability and availability of its trees?

We use a spectrum of in-field performance data and in-house testing to perform complete analyses and diagnostics regimens to ensure reliability of the entire tree system. We use GE materials coating technology to reduce wear and friction on our new range of gate valves and accelerate lifetime tests (ALT/HALT) of our control systems. All trees are designed to accommodate our standard VetcoGray ModPod and SemStar5™ electronics module – which can communicate with our SmartCenter for remote monitoring and data collection to optimize and improve the performance of your field.
How do we address the ever-increasing needs of flow assurance in deep water?

Each of our M and D-Series tree designs allows for insulation options in the base case. During the project’s systems engineering phase, the required insulation thickness is determined and verified against the required cooldown times to prevent hydrates. We have maximized chemical injection points and erosion monitoring along the production bore to allow flexibility in flow assurance solutions. GE is also participating in a Joint Industry Project (JIP) focused on verifying industry specifications for applying and inspecting insulation materials to ensure consistency.

How do we reduce customer installation costs?

Our portfolio of tooling and intervention solutions enables subsea trees to be installed from vessels of convenience and eliminates the need for installation risers. Tubing spools, trees and manifolds can be run on wire from field-support vessels rather than using the drilling rigs. Our PTP tool allows tubing plugs to be installed and retrieved through vertical trees by ROV rather than by wireline unit and riser.

How do we address the increasing requirement for downhole well maintenance?

Well maintenance is very expensive, especially in deep water, and can lead to production losses when vessels are not easily available. Besides our normal open-water workover riser solutions that allow well access from semisubmersible or drillship, we are developing light well riser intervention systems to allow frequent low-cost well access from vessels of convenience. This enables quicker and more frequent well access with wireline tools to maintain or enhance production at a fraction of the traditional cost.

How do we extend the life of mature fields and take advantage of newer technologies?

Mature fields present an ever-increasing challenge, especially in deep water where installation and maintenance costs are high. By anticipating future needs in the base case design, we have enhanced producer options for additional annulus monitoring and isolation, plus options for additional chemical/acid injection with minimal intervention. Our key control system components are designed to facilitate retrofitting newer versions of electronics and communication technologies when they are developed, thus keeping brownfields up to date. By anticipating these needs we can focus on higher recovery factors from subsea developments early in the development phase.

How do we ensure consistent quality of supply and service support in a global market?

GE has a strong culture of technology and service, as well as rigorous global sourcing systems and regional manufacturing capabilities to provide local content in the countries where our customers operate. We recognize that each project has unique needs that must be addressed, and that the corresponding solutions will be fundamental to the project’s success and long-term reliability. Our process controls in engineering, sourcing and manufacturing ensure quality and reliability in these areas – along with a global network of highly trained and experienced field service engineers who ensure that customers get the value they expect from us.
Our next-generation deepwater D-Series modular short-delivery subsea tree systems are engineered for up to 15,000 psi and 10,000 ft. They incorporate more than 25 years of design heritage and subsea experience – including the integral, field-proven VetcoGray ModPod control system powered by VetcoGray SemStar5™, our award-winning, open-architecture subsea electronics module.

The DVXT tree system is an adaptable base case tree solution capable of simple support vessel installation, whilst providing for the flexibilities to accommodate BOP on tree and Completion Riser system on tree. This unique design also accommodates a tubing head spool, and a tree direct onto wellhead option. A truly flexible structured system covering all operators installation methodologies.
Our D-Series systems provide high functionality, quality and reliable service in the industry’s most extreme operating conditions, with enhanced quality packages available as options to meet more unusual project requirements. A full range of pressure challenges are covered with three structured options:

- Standard production/injection (SP)
- Enhanced production (EP)
- Gas-lift production (GP)

Both the horizontal and vertical configurations are compact and designed to minimize rig and ROV operations for lowest installed cost. Shared features include:

- Optimized for flow assurance (hydrate and erosion prevention)
- 5 x 2” and 7 x 2” VG300 trimmed standard systems
- 10,000 psi standard (15,000 psi option)
- 10,000 ft water depth rating
- 8 downhole hydraulic and 2 electrical or 2 fibre-optic or combo
- 5.25 MM ft.lbf bending capacity
- Tree weight: 40 tonnes
- Tree footprint: 14 x 14 ft
- Delivered with standard service and quality package
- 8-month delivery cycle on standard units
- Integrated standard solution with controls

VetcoGray DHXT™

This highly flexible horizontal tree can be configured for water, gas or alternating injection. Its compact, lightweight design includes a flush top plate and extended mandrel for efficient BOP operation; multiple pressure, temperature and sand detection sensors; and a variety of features to minimize ROV intervention.
Large bore D-Series

These trees are specifically designed to address the challenges of deepwater gas developments – optimizing flow assurance, ensuring high well availability, reducing reservoir back pressure and enabling higher recovery factors through life of field.

Production bore sizes of 6\(\frac{3}{8}^\prime\), 7" and 7\(\frac{7}{8}^\prime\) are ideal for the larger completions now used in deepwater gas fields. The trees can be designed to either integral or non-integral chokes and multiphase flow meters to suit the specific requirements of each well.

D-Series non-integral flow modules

Designed to accommodate the choke and multiphase meter, these modules can be run with or separate from the trees.

The flow module ensures laminar flow through the meter to facilitate accurate metering of fluids. Modules can be tailored to specific flow-assurance needs including pressure, temperature and erosion sensors, chemical injection and metering. These facilities are all tied back to the VetcoGray SemStar5™ Control System for accurate, real-time monitoring of well conditions.

When the combined size of the tree and flow module exceeds 60 tonnes, the tree is provided in modular design to facilitate handling on the drilling vessel.

When working with the VetcoGray DHXT, an independent flow module allows recovery of the choke and/or multiphase meter without recovering the tree/completion. The flow module can be mounted on either the tree production base at the well or at the manifold, depending on field-specific requirements.
Pressure solutions for medium & deep water

Standard (SP)

Our standard production / injection trees are designed for rig flexibility and easy handling with a small deck footprint 15' W x 16' D x 12' H. All systems are fully qualified to industry standards.

**M-Series SP operating envelope**
- 15,000 psi (1,035 bar)
- 2,500-ft water depth

**D-Series SP operating envelope**
- 15,000 psi (1,035 bar)
- 10,000-ft water depth

**Key features**
- D-Series SP uses the familiar, industry-proven VG300 valve system – all primary valves are fail-safe close with linear ROV overrides; production side valves are 5¼" HH trim; annulus side valves are 2¼" EE trim
- The standard temperature class for the D-Series system is P-U (0 to 250˚F); testing is carried out to PSL 3 with 3G option, and options to 350°F are being qualified
- The tree top plate is maintained flush to ensure efficient BOP operations; an extended length mandrel can be provided
- Chemical injection is offered on both annulus and production bores
- The control system uses the independently retrievable VetcoGray ModPod control module, and the tree design incorporates multiple pressure, temperature and sand detection sensors; the sand detector is ROV retrievable
- Up to 9 hydraulic and 2 electrical or fibre-optic connections to downhole functions are incorporated in the standard system design
- For all of production choke on the SP system is a VetcoGray 4" Series 74, ROV insert retrievable design with temperature capabilities from -46 to 121˚C

Enhanced (EP)

Our enhanced production tree system offers increased functionality through an extended annulus wing block. This includes additional valves and sensors for improved annulus pressure management and options providing access for future well maintenance such as acid squeeze or other injection treatments with minimum intervention equipment. The EP controls package includes an option for the VetcoGray SemStar5-R remote DHPT or Smart Well canister.

Gas lift (GP)

This enhanced production tree system offers gas lift functionality. Additions to the standard system include gas lift choke, dual-bore flowline connector and additional sensors. Gas lift functionality has been designed into the SP structures so that minimal re-engineering is required to include this option.
GE has a strong legacy of subsea development around the world – over 1,200 subsea trees in more than 310 projects. In 40 years of innovation, we have achieved a number of industry milestones, including:

- First 15,000 psi subsea tree installed in the Gulf of Mexico
- Longest offset subsea production control system – 144 km from seabed to beach
- Deepest light well intervention at 1,130 m

This legacy, combined with our current technological capabilities enables GE Oil & Gas to provide creative and cost-effective solutions to the challenges facing the oil and gas industry. With an ever-increasing installed base of deepwater solutions, we continue increasing product reliability and availability – to help ensure a long future for this extremely demanding and crucial area of the global energy industry.

<table>
<thead>
<tr>
<th>Systems design meets all the following criteria</th>
<th>S-Series</th>
<th>M-Series</th>
<th>D-Series</th>
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<td>Configuration</td>
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A complete range of subsea production systems

Subsea Connection Systems
- Extensive range of subsea connectors and tooling systems
- Clamp, collet and mandrel connectors
- Diverless operation
- Qualified size range to 42 inches
- Single, dual and multibore configurations

Subsea Manifold Systems
Solutions for all project requirements
- HPHT & deepwater
- Cluster manifolds
- Template manifolds
- Integrated controls and HIPPS functionality
- Optimized installation

Subsea Controls & Informatics
- Over 30 years of experience and 1,000 modules operating worldwide
- Installations include the world's largest subsea tieback, the largest deepwater fields, large-bore gas delivery projects and high pressure/high temperature applications
- Portfolio includes ultra-reliable VetcoGray ModPod equipped with the award-winning SemStar5™ subsea electronics module for unrivaled flexibility and reliability

Subsea Power & Processing
Solutions to increase production rates and/or recovery from subsea wells
- Subsea gas-boosting systems - BlueC™ wet-gas compressor qualified for Ormen Lange
- Subsea separation and pumping systems - Troll C, the world’s first subsea separation system in operation
- Power-supply systems - surface, umbilical and subsea equipment with MECON Wet Mate and Dry Mate technology

Worldwide service capabilities
GE Oil & Gas continually invests in its network of world-class repair and service facilities in over 30 countries – with highly experienced and certified field service personnel strategically located to provide timely support in every region. We cover all aspects of supply and support with advanced tools, skills and solutions – wherever and whenever they are needed. We understand that true reliability must extend beyond the quality of any single product to the support provided throughout its service life. Our approach is based on dynamic monitoring, analysis and planning – to ensure effective application of technologies and efficient allocation of site-specific resources. Our people are knowledgeable, proactive and responsive, and know how to get the best major subsea service centers performance from our products.
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