2H Offshore is a global engineering contractor specialising in the design, structural analysis and integrity management of riser and conductor systems used in the drilling and production of offshore oil and gas. Our capability and experience covers all types of risers, from shallow water fixed platform conductors, to drilling and production risers used in ultra-deep water.

**Intelligent Methodology**

At the core of our business is the expertise and experience to calculate and understand the response of dynamic offshore structures. Dynamic analysis in itself can present many complex challenges and these challenges are further compounded by the non-linear effects often seen in riser systems. This ability and understanding is supported and tempered by multi-discipline engineers through whom we deliver complete designs at both global and component level.

**Global Service**

Recognising the need to work closely with our clients, 2H now has offices in a number of the major offshore oil centres of the world including London, Aberdeen, Houston, Kuala Lumpur, Rio de Janeiro and Perth. Our offices are set up to enable seamless operation across all locations, sharing resources, capability and experience. This provides a common resource pool of over 170 engineers, enabling us to accommodate large projects and adapt quickly to changes in workload.

**Highly Qualified Team**

Engineering of riser systems requires strong analytical skills and considerable practical ability to accommodate the many interfaces. 2H employs a team of high quality, highly qualified engineers across a range of disciplines to meet the demands of our work. We are committed to training and continued professional development of our engineers to ensure they have a rounded capability, not just focused on risers. We have good staff retention and a growing number of engineers with over 10 years riser engineering experience, some having over 20.

**Proven Track Record**

Our clients include field operators, installation contractors, drilling contractors, engineering contractors and equipment vendors. We have the experience and capability to manage and implement major detailed design projects for operators and installation contractors, while our continuing provision of engineering support to equipment vendors is testament to our strong understanding of riser equipment and ensures our ongoing awareness of the latest equipment design challenges.
Areas of Expertise

Our business falls into two primary categories, Drilling, Completion & Workover and Production & Export. Engineering of the risers used in each area of activity has many similarities in terms of the skill sets and experience required to conduct the work, but each area has many unique characteristics requiring specific experience and knowledge of the equipment and operations involved. The scope of each area of activity and overlaps that occur are illustrated below.

Drilling, Completion & Workover

- Marine drilling risers
- Jack-up risers
- Subsea well conductors
- Completion & workover risers

Production & Export

- Surface BOP drilling risers
- FPS dry tree production risers
- Fixed platform well conductors
- Jack-up production risers
- Steel catenary risers
- Freestanding hybrid risers
- Flexible risers
- Umbilicals
Our day-to-day activities in well construction and servicing cover all types of risers used in dry and wet tree well construction, from shallow to ultra-deepwater:

**Drilling Risers**
- Conventional MODU low pressure risers
- High pressure surface BOP

**Well Conductors**
- Fixed platform wells
- Subsea wells
- Conductor supported minimum facilities platforms (CoSMOS)

**Completion and Workover Risers**
- Shallow water dual bore
- Deepwater monobore

The responsibility for design of equipment in well construction and servicing operations is spread between the operator, drilling contractor and equipment vendors. 2H provides support to all of these parties independently, but more importantly, ensures that the interaction between all parts of the system is properly addressed.

**Scope of Services**

2H provides a wide range of activities in the evaluation of fitness-for-purpose and operability of drilling risers, well conductors, completion and workover risers:

- Riser stack-up and tension optimisation
- Operating envelopes
- Riser installation and retrieval analysis
- Disconnect and recoil analysis
- Hang-off analysis
- DP vessel drift-off analysis
- Vessel mooring system analysis
- Rig move riser analysis
- Wellhead and conductor sizing and strength assessment
- Wellhead fatigue – first order and VIV
- Subsea stack-up weak point analysis
- Conductor-casing interaction analysis
- Casing and conductor installation
- Seismic analysis
- Wear analysis
- Completion/landing string operations analysis and operating envelopes
- Riser monitoring, data processing and response assessment
- Operating manuals
Challenges and Recent Developments

While 2H conducts numerous projects that support routine operations, new challenges are continuously arising that stretch our ability and further our experience. A selection of the challenges and developments we are seeing in the design of the risers used in well construction and servicing operations are given below.

Subsea Wellhead and Conductor Systems
Wellhead and conductor system fatigue has become an increasing concern due to extended use of existing wells, larger BOP and LMRPs and use of risers in more diverse locations. 2H pioneered the approach of integral riser and conductor system analysis and routinely conduct wellhead system fatigue assessments. This work is backed by experience gained in monitoring, often provided by our sister company Pulse Structural Monitoring, and data evaluation from more than 20 drilling programmes that provide invaluable insight into the behaviour of critical components.

HP Surface BOP Risers
High pressure surface BOP drilling offers an attractive approach for exploration drilling in many areas where high specification deepwater vessel availability is limited. 2H has been responsible for evaluation of HP drilling riser operability for the Far East and West Africa and the design and implementation of a system in a water depth of over 2000m offshore Indonesia for Total.

Jack-Up Riser Systems
Jack-ups are being developed to drill in greater water depths and for higher pressure wells than previously achieved. 2H has had close involvement in the drive to use jack-ups in water depths of over 100m and at pressures of over 10,000psi. Together with sister companies Claxton Engineering and SRP, 2H has been at the forefront of the evaluation and implementation of these new systems.

Jacket Platform Conductors
Extended use of fixed platforms in brownfield developments presents the challenges of operation with equipment degradation (corrosion of the conductor and surface casing and loss of centralisers), new surface equipment arrangements and limited documentation resulting through change of ownership. 2H provides analysis of these systems to evaluate ongoing integrity and, together with our sister company Claxton Engineering, implements remedial measures where needed.

Completion and Workover Risers
2H works closely with equipment suppliers to develop workover and completion risers to meet the demands of deeper water and heavier completions. We have had major involvement in the qualification of tool joint and casing couplings that meet the increased design demands and provide repeatedly reliable performance long term.

Conductor Supported Minimum Facilities Platforms (CoSMOS)
Conductor pipes used in shallow water well construction provide a means of supporting the surface equipment needed for dry tree production. 2H has designed a number of conductor supported minimum facilities platforms for use with up to 9 wells in water depths up to 38m.
Production & Export

Our expertise in production and export risers includes most combinations of vessel type and riser that have been implemented to date.

- Steel catenary risers (SCRs) – simple, lazy wave
- Top tensioned risers (TTRs) – single, multistring
- Freestanding/hybrid risers – single pipe, pipe-in-pipe and bundle (FSHR, SLOR, COR)
- Flexible risers (bonded, unbonded), umbilicals
- Semisubmersible, TLP, Spar, FPSO, FDP, and jack-up platforms

Being independent of any manufacturing or installation capability, we can engineer production and export risers as a main contractor, sub-contractor, part of an integrated project team or in the capacity of a certification and verification agent (CVA).

Project Involvement

Our involvement with many production and export risers often begins with feasibility assessment and concept evaluation to determine what risers work with what vessels. This extends in many cases to detailed design, construction and installation support through to operation. Typical activities we conduct during the different phases of project progression include:

Concept Design and FEED
- Riser feasibility assessment and concept evaluation
- Riser sizing, vessel and field layout
- Preliminary analysis and engineering

Detailed Engineering
- Detailed design of the complete system and individual components
- Material selection, coating and corrosion protection design
- Equipment specifications and qualification
- Interface management

Fabrication and Installation Support
- Procurement management
- Fracture mechanics analysis (ECA)
- Fatigue qualification and testing
- Installation engineering and analysis

Integrity Management and Monitoring
- Inspection planning
- Monitoring system design
- Dynamic data processing
Key Projects

Chevron Big Foot TLP, Top Tension and Steel Catenary Riser Detailed Engineering and Procurement Management
The combined conditions of deep water (1600m), large number of risers (15 production, 2 HP drilling) and high pressure (10,000psi) present considerable challenges in the design of this system, which is due for installation in 2013.

Heerema - BP Block 31 Angola PSVM FPSO Freestanding Riser Detailed Design
In water depths up to 2030m these risers are amongst the heaviest freestanding risers installed to date. 2H’s involvement included the detailed design of 9 single line hybrid risers (SLORs), follow on engineering to resolve manufacturing and fabrication problems, and installation supervision.

Chevron Tahiti Riser Systems Concept Evaluation and CVA
2H was involved from very early in this project to evaluate feasibility of the production and export riser options for use with different platform types. During detailed design and construction, 2H acted as CVA to verify that the engineering, fabrication and installation of the risers was carried out in accordance with GoM design requirements. 2H also worked with our sister company Pulse Structural Monitoring on the design of an online instrumentation system for the project.

BP GoM Riser, Flowline and Subsea Integrity Management
2H is responsible for the integrity management of all subsea equipment including trees, manifolds, flowlines and risers on BP’s deepwater developments in the Gulf of Mexico. This includes 8 different developments with 4 different platform types (including spar, TLP, semi) and 6 different riser types (including production TTR, SCR, LP drilling, HP drilling).

BP Thunder Horse Concept Evaluation and SCR Detailed Design
Our involvement in this project began with a number of studies to evaluate the feasibility of using TTRs with a spar and freestanding risers for export, as well as assessment of the fatigue response of SCRs to the severe environmental conditions found in the field. During detailed design, 2H was responsible for the engineering and analysis of the production SCRs, which include some of the deepest and highest pressure risers of this type installed to date.

Saipem - Exxon Kizomba Freestanding Riser Detailed Engineering
Prior to execution of the project, 2H developed the freestanding single pipe and pipe-in-pipe riser arrangements through studies for various operators and the DeepStar JIP. During project execution, 2H conducted detailed analysis and engineering of the freestanding risers under contract to Saipem.

Freestanding Containment Riser Design and Procurement Management
2H was responsible for design and installation of 2 containment risers deployed in the Gulf of Mexico using threaded riser pipe. The first riser was installed within 7 weeks of project kick-off.
Engineering Services

2H has a track record of delivering high quality engineering and is continually advancing engineering design and analysis methods to meet increasing design challenges. Our specialism in risers and associated dynamic structures means that we routinely provide a range of different engineering evaluations:

- Strength assessment – normal operating, extreme and abnormal conditions
- Fatigue – wave induced, vortex induced vibration (VIV), vessel induced motion (VIM)
- Component finite element analysis – strength, sealability and stress concentration factor (SCF) analysis

The many ways in which offshore structures are adapted for use in different locations means that many non-routine situations arise that we are called upon to evaluate.

Analysis and Engineering

Rigid Jumper Engineering
Whilst we conduct jumper engineering as part of riser design, the rigid jumpers from flowlines to manifolds and trees can also be subject to significant dynamic excitation from current loading, slugging and loading from the riser during workover.

Fatigue Qualification and Testing Management
We provide product development and research, devise and manage test programmes for the qualification of welded, threaded, flanged or any other types of mechanical connections.

Installation and Transportation Engineering
We design lifting equipment and installation aids, and develop operating limitations for transportation and installation.

Coupled Vessel and Vessel Analysis
We evaluate the coupled dynamic behaviour of connected vessels for situations such as tender assist drilling operations.

Coupled Riser and Mooring System Analysis
For smaller structures such as offloading buoys, the interaction between riser, mooring and floating body is substantial. 2H conduct dynamic response assessment of such systems using an integrated approach. Similarly, we consider the interaction between risers and mooring systems, which can be significant in the response of drilling vessels subject to a failed mooring line.

System and Component Failure Analysis
We have conducted a number of projects to assess the response of failed riser systems including global behaviour following failure initiation and root cause analysis of failure in seals, connectors and other components.

Field Measurement Data Processing
We have developed a wide range of data analysis methods to enable reliable processing of the vast quantity of data that can come from monitoring of dynamic offshore structures, and provide clear explanation of response.
Design and Analysis Tools

Current practice for response evaluation and design of risers, conductors and other dynamic structures requires the assessment of tens and possibly thousands of load cases. To deliver the volume of analysis and specialist outputs needed for complete system design, 2H has developed a suite of processors to complement commercially available software. Some of the key tools we use in our day-to-day activities are listed below.

- FLEXCOM – riser analysis
- ORCAFLEX – riser analysis
- ANSYS – analysis of complex riser problems and component finite element analysis
- SACS – structural analysis and code checks
- SHEAR7 – vortex induced vibration analysis
- VIVA – vortex induced vibration analysis
- FLUENT – computational fluid dynamics
- CRACKWISE – fatigue crack growth and unstable fracture analysis
- WADAM - vessel motion analysis
- SOLIDWORKS – 3D drafting
- AUTOCAD – 2D drafting
- 2HSIZE – riser sizing to different design codes
- 2HFAT – spectral fatigue analysis
- 2HRNFLW – time domain fatigue analysis using Rainflow cycle counting
- 2HCRAK – unstable fracture and fatigue crack growth
- 2HBUOY – buoyancy tank sizing and code checks
Experience & Innovation

Our History

2H has been at the forefront of riser and conductor technology since 1993, identifying and developing configurations to meet ever evolving industry demands, particularly those due to increasing water depth and design pressures.

1993  2H Offshore Engineering Ltd. founded in Woking, UK
1993  First contract won - BP/Statoil riser envelope study 400-1500m
1994  2H conducted all drilling and completion and pipeline and umbilical lay analysis for Schiehallion
1995  First Cameron contract - Schiehallion completion riser
1997  STRIDE SCR JIP commenced (4yrs, $4M)

1998  2H Offshore Inc. founded in Houston, USA
1998  2H awarded Girassol riser bundle detailed analysis
1998  BP awarded 2H technical achievement award for bundled hybrid riser design development
1998  First 2H INTEGRIpod™ riser motion sensor developed and deployed on Allegheny
1999  Spar riser tensioner technology study, later used on Holstein
1999  2H Offshore acquired by UWG (now Acteon)
2000  Pipe-in-pipe riser JIP (RIPIPE) established
2000  Threaded Riser and Flowline (TRF) JIP started – led to SLOR and COR freestanding risers
2000  Awarded Thunder Horse HPHT SCR detailed design
2000  2H wrote AMJIG deepwater drilling riser guidelines
2001  Awarded Kizomba A & B SLOR detailed analysis with Saipem

2002  Detail design of deepest TTR’s (Dominion Devil’s Tower)
2003  2H Offshore Projetos Ltda founded in Rio de Janeiro, Brazil
2003  Largest diameter SLOR FEED (Petrobras PS1/52 – 18 in.)
2005  Awarded GoM riser integrity management contract by BP
2006  Awarded Cascade Chinook conception engineering
2006  Grouped SLOR™ developed
2006  Chevron Tahiti on-line riser and flowline monitoring system awarded
2007  Total HP drilling riser design for Donggala, Indonesia (Sedco 601, 2000m)
2007  First HP drilling riser for a FPDSO (Murphy Azurite)

2008  2H Offshore Engineering Sdn Bhd founded in Kuala Lumpur, Malaysia
2008  UWG combined into 2H Offshore bringing shallow water conductor and CoSMOS capability
2008  Heerema BP Block 31 Angola PSVM freestanding riser detailed design
2009  Chevron Tahiti riser and flowline monitoring system comes online and OTC Spotlight Award received
2009  MOORASSURE mooring line monitoring system installed for SBM
2010  Aberdeen office opened
2010  2H developed an innovative containment riser for GoM oil spill
2010  2H Offshore Engineering Pty founded in Perth, Australia
2011  Chevron Big Foot TLP riser design and procurement
Technical Papers

A measure of the technical challenges that 2H have met successfully is the many papers that have been written by 2H engineers. We have published over 150 technical papers on subjects including novel riser concepts, analysis methods and field monitoring and data evaluation. Our papers can be downloaded at www.2hoffshore.com.
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