THE UNDERWATER CENTRE

ROV Pilot Technician Course

The three week ROV Pilot Technician Course commences with an introduction to ROVs detailing the different types and classes of ROV, giving the student some insight into the world of ROVs, concentrating particularly (but not exclusively) on systems working in the offshore Oil and Gas industry. Again, system and environment safety are the starting point for lectures.

Some students think that a good ROV pilot technician is someone who can pilot an ROV well. In reality, the flying of ROVs is only a small part of the skills needed by an ROV pilot. Whilst good hand-to-eye co-ordination and spatial awareness are essential qualities, they tend to be acquired with time ‘on the stick’ i.e. flying. What really makes a good ROV pilot stand out is the ability to identify and remedy faults and defects that occur on the ROV system quickly. This does not mean we do not let students get ample flying time logged. Our aim is to ensure that students obtain about 8 hours each in real ‘live’ ROV flying within 40 hours (5 days) working as part of an ROV team (maximum 4 persons per team). This will include typical duties such as co-piloting, video and dive logging, sonar operation, radio comms control, inter-team communications (liaising with second ROV team, scuba dive team, surface supplied dive team, NDT dive team, wet-bell dive team, saturation dive team). We do not use ROV simulators. During the flying time with each class, difficulties will occur – either with snagging of tethers, failure of systems, entanglement, poor visibility, strong currents. Part of the learning process will be how to deal correctly with these common difficulties. For this, there is no substitution for real-life situations.

The course runs through the differences between various ROV systems and the vast majority of components and systems common to all. Lectures will go into detail on the many varied parts common to all ROVs with real examples and components available to study whenever possible. Components will be examined and throughout, reference will be made to the fault finding and trouble-shooting process giving students an insight into the thought processes and things to look for when trying to resolve problems with ROVs.

After the fundamentals of physics for flying ROVs, the course goes into much more detail on how to deal with the real life practicalities of keeping an ROV flying and flying well. We will be looking at different methods of setting up and operating an ROV to improve the ROV performance and reduce the likelihood of problems occurring with the ROV system. This will include hints and tips on how to get the best from whichever systems you are flying.

The course then moves on to the wide variety of sensors and tools that are now fitted to ROV systems, with particular emphasis upon acoustic sensors including the navigational sonar systems. A number of flying exercises will include search and recovery (using ROV manipulators and other methods), sonar mapping exercises, site survey exercises, zero visibility flying exercises, controlled tether buoyancy, and flying using (LARS) and Tether Management System (TMS).

Throughout, all flying exercises will be conducted as if carried out for real with students being required to provide commentary whilst flying, maintaining a full and complete video and written log for which assessments will also be carried out. There will also be practical repair exercises including a re-termination of damaged umbilical together with subsequent pressure testing and then ‘megger’ testing of repaired conductors.

Part of the lectures will also include looking at three-phase electricity. We shall look at the advantages for use and the additional hazards incumbent with three-phase electricity. This will include looking at three-phase motors and generators, starting three-phase systems including soft-start and star-delta wiring, three phase switch gear and phase control and switching.

The third week of the course moves on to look at hydraulic systems including why such systems are well suited to ROVs, designing and interpreting hydraulic circuit diagrams, stripping down, inspecting and servicing hydraulic components and considering care and maintenance of the same. Where possible, components will be provided (either good or faulty) for students to strip down and rebuild which hopefully helps to de-mystify the world of hydraulics.

Students should bring with them a pair of safety boots and foul weather gear since some days will be spent outside getting dirty mobilizing and stripping down ROVs. Overalls are provided.

THE UNDERWATER CENTRE

ROV WEEK 1

1. ROV work overview
    a. Semi-subs
    b. Drill ships
    c. Pipe laying barges
    d. Cable laying barges
    e. Fixed platforms
    f. Vessels of opportunity
    g. ROV/ Dive support vessels
    h. Heavy lift barges
    i. Jack-up Rigs
    j. ROV work (small scale)
    k. Diver support
    l. Trenching/ pipe laying
    m. Examples of launch & recovery systems LARS
    n. Pipeline inspection
    o. Example work-class tooling packages

2. Introduction to ROVs
    a. Why use ROVs
    b. Classes of ROVs
    c. Class I ROVs (with examples)
    d. Class II ROVs (with examples)
    e. Class III ROVs (with examples)
    f. Class IV ROVs (with examples)
    g. Class V ROVs including AUVs (with examples)

3. Main ROV components
    a. Transformers (step-up/ down and isolation)
    b. Surface control unit (SCU)
    c. Hand controller/ console
    d. Manipulator controllers
    e. Master/ slave manip controllers
    f. Main ROV components (overview)

4. Safety
    a. Overview of offshore/ ROV hazards
    b. Electrocution
    c. Working at sea
    d. Lifting (manual/ mechanical)
    e. Explosive atmospheres/ hazardous areas
    f. Working with divers
    g. Nature of the Sea
    h. Hydraulics
    i. Passive & Active protection systems
    j. Isolation
    k. Double Insulation
    l. Line Insulation Monitors

5. Electrical installation in adverse/ hazardous areas
    a. Adverse/ Hazardous environments
    b. Risks & Injury

   c. Classification of Hazardous Areas
   d. Zoning
   e. Safe Areas
   f. Zone 0
   g. Zone 1
   h. Zone 2
   i. Explosion protection methods for different Zones (with examples)
   j. ROV shack Zone protection systems
   k. Temperature classes
   l. Gas Groups

6. Buoyancy and drag
   a. Definitions
   b. Vehicle buoyancy/ design requirements
   c. Reasons for Positive buoyancy
   d. Reasons for Negative buoyancy
   e. Reasons for Neutral buoyancy
   f. Umbilical/ tether buoyancy
   g. Drag effects
   h. Deep water deployment
   i. Combinational/ mixed buoyancy techniques

7. Launch Techniques
   a. Live boating
   b. TMS deployment
   c. Top-hat TMS
   d. Garage TMS
   e. Umbilical winch
   f. Latch-lock systems
   g. Launch considerations

8. Pressure vessels, seals & connectors
   a. Pressure
   b. Pressure vessels
   c. ‘O’ ring seals
   d. Care of ‘o’ rings
   e. Oil filled vessels
   f. Compensators
   g. Filling oil filled vessels
   h. Underwater connectors
   i. Care of connectors

9. Electric Thrusters (1)
   a. Types of motors
   b. Controls
   c. 3-phase AC induction motor
   d. DC permanent magnet motors
   e. Brushless DC
   f. Thruster layouts
   g. Thruster maintenance & faults
   h. Shaft seals
   i. Crane seals
   j. Spring seals

k. 'V' seals
l. Thruster drive/ control boards

10. Video & lighting
    a. Video picture
    b. Video signal (line signal)
    c. Camera types (CCD, SIT, SDA)
    d. Video transmission
    e. Balanced line drivers/ receivers
    f. Pan & Tilt
    g. Lights (care & maintenance, positioning)

11. Sensors
    a. Compass
    b. Pressure/ depth
    c. Altimeter
    d. Water ingress
    e. CP probes (contact/ proximity)

12. Sonar systems
    a. Navigational sonar
    b. Main controls
    c. Interpreting image
    d. Profile scanning sonar
    e. Side scan sonar
    f. Forward looking fixed head sonar

13. Tracking Systems (HPR)
    a. Long baseline
    b. Short baseline
    c. Ultra Short Baseline (USBL)
    d. ROV beacons
    e. Hydraphones
    f. Typical systems/ displays

Friday – Week 1 written examination (pass mark 65 %)
Risk Assessment for week 2 & 3 operations
Thereafter, students are required to complete a practical soldering exercise and cable splice. The cable is thrown into the sea (40m x 40m area) to be searched-for and recovered and then tested in weeks 2/ 3). The cable must be waterproof and all joints complete when tested using megger. This is an assessment.
Students are also required to complete a Student Workbook detailing the studies they have completed. The Workbook forms part of the evidence portfolio to be created for the purposes of external verification and inspection by the Scottish Qualifications Authority (SQA). This, together with the written tests and practical exercises/ assessments, provides a traceable proof of study and competence that are subject to outside verification and audit.

ROV WEEK 2
Alternating days with Monday, Wednesday and Friday comprising ROV flying and Tuesday and Thursday in the classroom studying.

1. Electricity – basic principles
    a. Electrical safety
    b. Legislation
    c. Voltage, current, resistance, Ohm's Law
    d. Resistors, series/ parallel, colour codes
    e. Power
    f. Inductive loads on ROVs
    g. Capacitance (in umbilicals)

2. Power supplies
    a. DC power supplies
    b. Transformers
    c. Half-wave rectifier
    d. Bridge rectifier
    e. Centre tapped full wave rectifier
    f. Smoothing capacitors
    g. Voltage regulators
    h. Switch-mode power supplies

3. AC Theory
    a. AC waveforms
    b. Generating AC (single phase, 3-phase)
    c. Resistors in AC
    d. Capacitors in AC (capacitive reactance)
    e. Inductors in AC (inductive reactance)
    f. Impedance and problems with video/ signals
    g. Power factor
    h. 3-phase AC
    i. Star-delta starting

4. High Voltage Electricity

5. Multiplexers
    a. Overview
    b. Telemetry transmitters/ receivers
    c. Surface control electronics
    d. Vehicle control electronics

6. Solenoids, relays and motors
    a. Solenoids
    b. Relays
    c. 'No-volt' release systems
    d. Free-wheel diodes
    e. Motors (2)
    f. 3-phase AC induction
    g. Balanced load
    h. Fault finding
    i. Starting
    j. Star/ delta

k. Electronic soft start
l. Speed control
m. Universal motors – series/ shunt
n. Two pole/ four pole
o. Stepper motors

7. Control systems
   a. Feedback loops
   b. Proportional systems
   c. Dither
   d. Dead band
   e. Hunting
   f. Hysteresis
   g. Pulse-width modulation

8. Connectors and cables
   a. Choosing cables
   b. Care of long cables
   c. Considerations when choosing connectors
   d. Environment
   e. Care of connectors

9. Op amps
   a. Overview
   b. Comparators
   c. Inverting amplifier
   d. Non-inverting amplifier
   e. Summing amplifier
   f. Non-inverting buffer

10. Transducers
    a. Linear displacement
    b. Angular displacement
    c. Angular velocity
    d. Pressure
    e. Water Ingress
    f. Temperature

11. Optical fibres
    a. Overview
    b. Safety
    c. Advantages/ disadvantages
    d. Fibre versus cable attenuation
    e. Snell's law, refraction & reflection
    f. Critical angle and Total Internal Reflection
    g. Fibre optic construction
    h. Laser transmitters/ receivers
    i. Modulation systems
    j. Step-index fibre
    k. Graded-index fibre
    l. Single-mode fibre
    m. Fibre optic sliprings
    n. Fibre repairs

o. Time-domain reflectiometer

Monday

In addition, ROV flying will commence with a safety induction tour of our pier site. Issuing of overalls and PPE. Emergency procedures, muster points, fire drill procedures, alarms, electrical isolation points identification, spill kits, First Aid stations, Dive Station locations. VHF and walkie-talkie procedures. Boat operations review. Overview of Hi-Ab Crane LARS safety and operation. Overview of LARS A-frame safety and operation.
Classes are then split into two groups of 4 to then work on one of our Saab Seaeye Falcon ROVs within their own dedicated ROV shack and LARS.
Toolbox talk, review of Risk Assessment for each group.

In two groups, Pre-dive ROV checks with emphasis on students undertaking all maintenance/ repair.
Launch procedure with roles allocated for students – one in shack monitoring LIM & ROV, one operating LARS, one controlling tag-line, one managing tether (with roles exchanged during two week period).
Then, dive operations begin – Overview of controls, LIM, sonar, recording/ editing (DVD Hard-drive) system, walkie-talkie procedure, video and dive logging.
Familiarisation with flying, station keeping, docking and un-docking ROV in cage. Close-quarters accuracy of flying. Each student is observed whilst flying and advice/ corrections given.
Students are allocated roles of 1. Pilot; 2. Co-pilot and data logger; 3. Tether manager; 4. All other duties including diagrams, mapping, tea/ coffee, and any other miscellaneous duties (affectionately referred to as 'dogs-body'). Each student takes turns at each role in rotation. This allows us to fly continuously during the day and allow breaks for students when convenient.
At end of day, post-dive checks, washing vehicle in fresh water, collection and filing of logs, clean shack in readiness for next team. De-brief.

Wednesday

Now, students required to act on own initiative to put their training into practice with instructors observing/ intervening when necessary. Toolbox-talk then students are required to prepare vehicle and systems for launch.
Once launched, activities will depend upon proficiency of pilot – if more practice on vehicle required, then simple navigation – if student better, then commence tour of site. Finding ship-wrecks near-by. Using sonar to find and measure objects – 10m 24" pipeline, concrete cube, NDT test station, armoured tanks x 2. For some, we move on to diver observations (when safe to do so).

Friday

Early start with Week 2 written test – then ROV practical for remainder of day.
Standard start-up protocol then teams split so that one team can start working with voice commentary, data logging and sketch diagrams of underwater structures in a co-ordinated team exercise. This is a practice for the assessment inspection and reporting on the NDT structure (a mock up of a section of a jacket)
The second team will be planning and executing a search of a barren area of seabed where the cable splices were randomly thrown. This requires each team member to fly to a grid section of seabed, verify position using sonar, and then search and map this grid. The students will move from grid to grid over a 40m x 40m area in 5m squares. By the end of the exercise, all cable splices will be found and mapped. This information is then passed to the other group to then find each cable splice

using co-ordinates given. The students are then left to use the manipulator to recover the splice. Return to the pier site and place the splice on a suspended mid-water hook. Precise control and spatial awareness are required. Once the splice is on the hook, this can be recovered and cut open and tested using a megger.

ROV WEEK 3
Comprising ROV flying Outcome Assessments
ROV Flying usually takes place on Tuesday and Thursday with Classroom lectures and practicals on alternate days.

<u>Monday & Wednesday</u>
Classroom lectures

1. Hydraulic Safety
2. Hydraulic principles
3. Pressure and flow
4. Hydraulic oil and properties
5. Contamination & failure
6. Hydraulic pumps (general) and specifications
7. Cylinders and force (general)
8. Hydraulic motors (fixed and variable displacement)
9. Connectors
10. Valves (basics)
11. Solenoid and Servo valves
12. Valve packs
13. Pressure relief valves
14. Pressure reducing valves
15. Filters (HP, LP)
16. Seals
17. Conductors
18. Semi-rotary actuators
19. Cylinder design and performance
20. Hydraulic Systems
21. Hydraulic practical assessments

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