

KNOWLEDGE AND SKILL GUIDELINES for ROV TECHNICIANS

Introduction to these Guidelines

Working as an ROV technician can be a challenging, yet very satisfying, career. These individuals must be resourceful, good at solving problems, and technically oriented, and they must be skilled at working closely with many different people.

The range of tools and equipment ROV technicians use is vast – including both general ship-board equipment and what is used on the ROV itself. These include A-frames, cranes, and winches; hydraulic motors and pumps; sampling devices; video equipment; electric motors; and fiberoptic transmitters and receivers.

As is common with many marine technical positions, people who do generally the same set of tasks may have widely different job titles. ROV technicians may be called ROV pilots; mechanical, electrical, or systems technicians; pilot, co-pilot, or pilot technician; or some type of supervisor.

Background training is essential, and the types of courses desired or required are as varied as the tasks ROV technicians perform. These courses might include English and/or technical writing, algebra and trigonometry, hydraulics, basic hand tools, electronics, and computer skills.

The ROV technicians who participated in MATE's workshops broke down their major responsibilities into six general job functions: operating equipment, piloting the ROV, performing maintenance/repairs on equipment, maintaining communications, using seamanship skills, and integrating system modifications. Some of these areas are quite specific to ROVs, whereas others involve more general marine-related technology skills. For example, seamanship skills involve basic rigging and survival skills. The different types of equipment an ROV technician is expected to operate include cameras, acoustic positioning systems, sonar, manipulators, and launch and recovery systems.

Personal characteristics of an ROV technician

The workshop participants felt that the following personal characteristics describe a good ROV technician:

- Skilled at solving problems
- Resourceful
- Open-minded
- Skilled in multiple areas
- Compatible with others

- Able to work in adverse conditions
- Possessing spatial awareness
- Happy to work in the ocean environment
- Skilled at working in teams
- Able to be away from home
- Able to communicate well
- Disciplined
- Able to think innovatively
- Skilled at systems troubleshooting
- Tolerant of “getting dirty”
- Cross-trained
- Willing to do all sorts of tasks (even tasks “beneath you”!); a good attitude
- Skilled at working with people

Tools and equipment typically used

- A-frame
- Knuckle boom crane
- TMS (tether management system)
- Constant tension winch
- Motion compensated winch (ram tension winch)
- Traction winch
- Still, video, SIT (silicon intensify targeting), and digital cameras
- Video monitors
- Sonar (imaging, low resolution, high resolution)
- Lasers
- CTD (conductivity, temperature, density)
- Bathythermograph (CTD and altimeter, depth)
- Core samplers (sampling and other collection devices)
- Acoustic Doppler recorder
- Altimeter
- Acoustic positioning system (responders, transponders, pingers, homers)
- Manipulators (robotic arm)
- Flow meters
- pH probes
- Methane sensors
- Electric motors
- High-voltage transformers
- Hydraulic motors and pumps (HPU – hydraulic power unit)
- Hydraulic valves (solenoid – digital - and servo – analog – infinite control over flow and pressure)
- Test equipment (electronic, TDR – time domain reflectometer and OTDR – optical time domain reflectometer, oscilloscope, multimeter, megohmmeter, amp meter, power meters)

- Fiberoptic splicing equipment
- Computers (PCs, Unix, Windows-based programs, DOS) and peripherals (sonar, camera adjustments, sensors, valves, vehicle monitors) (interfacing between computers and other hardware)
- Gyros
- Ground-fault monitors (interrupt and detect)
- Electrical power distribution systems (“big power”)
- Fiberoptic transmitters and receivers
- Telemetry systems
- Serial communications (used in computer field and have application in ROV technology)

Job titles

- ROV technician
- ROV pilot 1, 2, 3 (senior), and chief
- Mechanical technicians 1,2, 3, and senior
- Electronics technicians 1, 2, 3, and senior
- Mechanical technician 1, 2, and 3
- Electrical technician 1, 2, and 3
- Systems technician
- Handling system operator
- Pilot
- Co-pilot
- Pilot technician
- ROV maintenance technician
- Supervisor
- Trainee

Basic courses desired or required

- English/technical writing
- Math
- Algebra
- Trigonometry
- Physics (basic, non-calculus)
- Basic hydraulics (“certificate level”) “Paul Munroe hydraulics puts on a great course” (Buck) 16 hours class; Sons ub - 40 hours (5, 8-hour days) class and lab Basic electronics (AC/DC, digital, analog “certificate level” – one year) Cleveland Electronics Institute (correspondence course); Sonsub – two-week, 80 hour course Field experience (internship, summer course)
- Basic hand tools course
- Marine instrumentation/marine technology and general applications
- Intermediate electronics (fiber optics)

- Emphasis in electronics OR hydraulics
- Basic computer skills (e.g., word processing, Excel, spreadsheets, databases)

Future trends

- Technicians will be less dependent on flying skills; the ability to do repairs will be more important
- Individuals will need to adapt to new technology (e.g., mouse-driven movements)
- Between hydraulics and electronics there will be more focus on electronics (it's easier to teach hydraulics to an electrician than vice versa)
- New advancements will be more electronics-focused
- Magazines – *Sea Technology*, *Ocean News*
- The industry will continue to grow (e.g., Sonsub building ten subs in the next five years, the oil industry routinely going to 5,000 ft. and going down to 7,000 ft.)
- “Oxygen” - project laying fiberoptic cable
- There will be fewer, but larger, companies (Sonsub; Oceaneering; Canyon Offshore; Stol Comex, which bought out AOD)
- ROVs will become larger because they will be required to do more and more work (not necessarily because they're going deeper)
- “A ton (2,000lb) of thrust” – 6,000lb payload (Jim Lewis)
- 100 shaft horsepower at sub useable
- Fiberoptic telemetry systems will be used more often
- Salary range – entry level \$30,000 or above, 2-year 40-50, 5-yr up to 6 figures (Sonsub in Houston); major overtime!!!

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Workshop Participant List

Workshop Coordinator: Deidre Sullivan

Workshop Facilitator: Chaire Denise

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Monterey Peninsula College, Monterey CA

Panel of ROV Technicians

Jim Lewis	Sonsub International
Wayne Barber	Sonsub International
Buck Reynolds	Monterey Bay Aquarium Research Institute
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Knowledge and Skill Overview Chart for Remotely-Operated Vehicle (ROV) Technicians

Job description: Individuals who operate and maintain ALL aspects of an ROV, its ancillary equipment, and its integration into the ship or rig

JOB FUNCTIONS	TASK AREAS					
A. Operate equipment	A1 Operate vehicle functions	A2 Operate cameras (video and still)	A3 Operate acoustic positioning system	A4 Operate sonar	A5 Operate manipulators (robotic arms)	A6 Operate LARS (launch and recovery systems)
B. Pilot the ROV	B1 Evaluate environmental conditions and hazards	B2 Dock/undock from TMS (tether management system)	B3 Navigate the ROV			
C. Perform maintenance/repairs on equipment	C1 Maintain/repair electronics	C2 Maintain/repair hydraulics	C3 Maintain/repair mechanics	C4 Use test equipment	C5 Calibrate and align equipment	C6 Perform general housekeeping
D. Maintain communications	D1 Maintain good customer relations	D2 Coordinate/integrate with ship's crew	D3 Coordinate/integrate with fellow crew members	D4 Write reports	D5 Maintain records	
E. Use seamanship skills	E1 Perform basic rigging	E2 Possess working knowledge of survival skills				
F. Integrate system modifications (Advanced skills)	F1 Design, build, and interface electrical systems	F2 Design, build, and interface hydraulic systems	F3 Maintain technical documentation	F4 Design and construct mounting systems		

Knowledge and Skill Guidelines for ROV Technicians

Critical work function A: Operate equipment

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
A1. Operate vehicle functions	<ul style="list-style-type: none"> • Vehicle is operated in a timely, safe, and successful manner. • Vehicle functions respond as expected. • Customers are satisfied. 	<ul style="list-style-type: none"> • Knowledge of vehicle systems • Ability to operate all vehicle functions (e.g., lighting, cameras, altimeters, depth transducers, vehicle controls, auto functions, hydraulic valves) • Basic knowledge of computers • Ability to use spreadsheets, word processing, and databases • Ability to use operating systems and OEM (original equipment manufacturer) software • Ability to comprehend hardware and software manuals
A2. Operate cameras (video and still)	<ul style="list-style-type: none"> • Desired images are obtained. • Images are clear. • The appropriate camera is used for the desired results. 	<ul style="list-style-type: none"> • Knowledge of and ability to operate cameras and video equipment • Knowledge of different camera types, including deck and tether management system (TMS), and their applications • Knowledge of video distribution systems • Knowledge of lighting and how it affects video images • Knowledge of environmental conditions (e.g., turbidity, sediment)
A3. Operate acoustic positioning system	<ul style="list-style-type: none"> • ROV arrives at destination in a safe and timely manner. • Customer items are positioned correctly. • ROV is tracked successfully. • Environmental parameters are measured correctly. 	<ul style="list-style-type: none"> • Ability to operate acoustic equipment • Knowledge of and ability to apply principles of acoustic positioning • Knowledge of OEM -specific acoustic equipment • Knowledge of environmental conditions (e.g., salinity, temperature) and how to measure these parameters (e.g., using XBTs)

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Critical work function A: Operate equipment (continued)

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
A4. Operate sonar	<ul style="list-style-type: none"> • ROV arrives at destination in a safe and timely manner. • Target is located correctly. • Obstacles are avoided. • Sonar is operated properly. 	<ul style="list-style-type: none"> • Knowledge of sonar (theory and equipment) and ability to select proper settings • Ability to interpret images • Ability to locate target(s) • Ability to recognize and avoid obstacles
A5. Operate manipulators (robotic arms)	<ul style="list-style-type: none"> • Desired manipulator task is completed safely and in a timely manner. • No collateral damage is sustained. 	<ul style="list-style-type: none"> • Ability to use manipulators and cameras • Ability to manipulate the position of the ROV • Ability to demonstrate hand-eye coordination and spatial awareness (3D interpretation of 2D images) • Knowledge of manipulator specifications • Ability to avoid collateral damage
A6. Operate LARS (launch and recovery systems)	<ul style="list-style-type: none"> • ROV is launched and recovered successfully (without damage to ROV and/or vessel). • Safety is maintained during launch and recovery. • Environmental conditions are measured and considered properly. 	<ul style="list-style-type: none"> • Ability to operate site-specific handling systems (e.g., winch and A-frame, knuckle boom crane) • Knowledge of and ability to implement all safety requirements • Ability to measure of environmental conditions and react properly

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Critical work function B: Pilot the ROV

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
B1. Evaluate environmental conditions and hazards	<ul style="list-style-type: none"> • Vehicle is deployed and recovered safely and without injury. 	<ul style="list-style-type: none"> • Knowledge of safe operating parameters (sea state limitations, weather, currents) • Knowledge of weather and currents • Ability to interpret sea state
B2. Dock/undock from TMS (tether management system)	<ul style="list-style-type: none"> • Dock/undock is successful. • ROV arrives safely and without damage. • Telemetry is maintained during operations. • All environmental factors are considered properly. 	<ul style="list-style-type: none"> • Knowledge of TMS • Ability to demonstrate hand-eye coordination and spatial awareness • Ability to measure environmental conditions and react properly
B3. Navigate the ROV	<ul style="list-style-type: none"> • ROV arrives at destination in a timely manner. • ROV arrives safely and without damage. 	<ul style="list-style-type: none"> • Ability to fly the ROV • Ability to demonstrate hand-eye coordination and spatial awareness • Ability to read charts and maps • Knowledge of longitude and latitude • Ability to use various mapping systems • Ability to read a compass • Ability to calculate vectors

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Critical work function C: Perform maintenance/repairs on equipment

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
C1. Maintain/repair electronics	<ul style="list-style-type: none"> • Electrical safety is maintained. • Electrical failures are minimized. • Electrical systems demonstrate increased reliability. • Inspection is completed regularly, as per schedule. • Repairs are completed safely, correctly, and in a timely manner. • Diagnostic programs are used properly. • Measurement data are accurate. 	<ul style="list-style-type: none"> • Knowledge of basic electronics • Knowledge of electrical system safety (lockout, tagout) • Ability to inspect equipment (e.g., for corrosion, wear, damage, ground faults) • Ability to use diagnostic programs within the system • Knowledge of system layout • Ability to solder • Ability to replace faulty components
C2. Maintain/repair hydraulics	<ul style="list-style-type: none"> • Hydraulic safety is maintained. • Hydraulic failures are minimized. • Hydraulic systems demonstrate increased reliability. • Inspection is completed regularly, as per schedule. • Repairs are completed safely, correctly, and in a timely manner. • There are no environmental mishaps. • Diagnostic programs are used properly. • Measurement data are accurate. 	<ul style="list-style-type: none"> • Knowledge of basic hydraulics and principles • Knowledge of hydraulic system safety (lockout, tagout) • Ability to inspect equipment (e.g., corrosion, wear, damage, leaks) • Ability to use diagnostic programs (e.g., flow monitors) within the system • Knowledge of system layout • Knowledge of basic physics
C3. Maintain/repair mechanics	<ul style="list-style-type: none"> • Mechanical safety is maintained. • Mechanical failures are minimized. • Mechanical systems demonstrate increased reliability. • Inspection is completed regularly, as per schedule. • Repairs are completed safely, correctly, and in a timely manner. • Diagnostic programs are used properly. • Measurement data are accurate. 	<ul style="list-style-type: none"> • Knowledge of basic mechanics • Knowledge of mechanic system safety (lockout, tagout) • Ability to inspect equipment (e.g., for corrosion, wear, damage, proper lubrication) • Knowledge of system layout • Ability to construct small mechanical devices • Ability to use hand and power tools (e.g., drills, screwdrivers, micrometers) <p style="text-align: center;">*are 'lockout' and 'tagout' appropriate for all three task areas?</p>

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Critical work function C: Perform maintenance/repairs on equipment (continued)

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
C4. Use test equipment	<ul style="list-style-type: none"> • Test equipment is used properly to accomplish required task(s). • Tests are conducted in a safe manner. • Correct instruments are chosen for each task. • Test and measurement data are used to troubleshoot and resolve problems successfully. 	<ul style="list-style-type: none"> • Ability to determine the proper equipment for the test • Ability to operate various test and measurement instruments (e.g., oscilloscope, megohmmeter, TDR, OTDR, multimeter) in a safe manner
C5. Calibrate and align equipment	<ul style="list-style-type: none"> • Equipment and instruments function accurately within manufacturer's specifications. • Calibration and alignment procedures are followed. 	<ul style="list-style-type: none"> • Knowledge of equipment operations • Ability to calibrate and align instruments and equipment (e.g., CTD) per manufacturer specifications and procedures
C6. Perform general housekeeping	<ul style="list-style-type: none"> • Work environment is neat and orderly. • Cleaning materials are used, stored, and disposed of properly. • Hazardous materials are stored and/or disposed of properly. 	<ul style="list-style-type: none"> • Ability to maintain a clean and efficient work environment • Knowledge of sanitation and hygiene procedures • Knowledge of HAZMAT storage and disposal

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Critical work function D: Maintain communications

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
D1. Maintain good customer relations	<ul style="list-style-type: none"> • Information is recorded accurately and legibly. • Logs and other records are current, correct, and well-documented. • Customer is satisfied. 	<ul style="list-style-type: none"> • Ability to communicate verbal and written information clearly • Ability to solve problems • Ability to demonstrate good customer relations skills
D2. Coordinate/integrate with ship's crew	<ul style="list-style-type: none"> • Briefing accomplishes objective(s). • Miscommunications are minimal. • Hand signals are used properly. • Debriefing provides good, positive feedback. • Mission is successful. 	<ul style="list-style-type: none"> • Ability to conduct a briefing/debriefing (e.g., communicate mission and clarify terminology) • Knowledge of chain of command • Knowledge of ship's procedures • Ability to use hand signals

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Critical work function D: Maintain communications (continued)

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
D3. Coordinate/ integrate with fellow crew members	<ul style="list-style-type: none"> • Team goals are accomplished. • Crew performance increases/improves. • Crew is content and happy. • Mission is successful. 	<ul style="list-style-type: none"> • Ability to focus on team goals • Ability to get along with fellow crew members for extended periods of time and in cramped quarters
D4. Write reports	<ul style="list-style-type: none"> • Records are current. • Information is recorded accurately and legibly. • Logs are current, correct, and well-documented. 	<ul style="list-style-type: none"> • Ability to write information in a clear and concise manner • Ability to format documents
D5. Maintain records	<ul style="list-style-type: none"> • Records are current. • Information is recorded accurately and legibly. • Logs are current, correct, and well-documented. 	<ul style="list-style-type: none"> • Knowledge of and ability to perform record-keeping • Knowledge of logs (e.g., pilot, maintenance, inventory, finance, video, customer)

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Critical work function E: Use seamanship skills

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
E1. Perform basic rigging	<ul style="list-style-type: none"> • Knots, gear, and rigging equipment are used properly. • Rigging is accomplished safely, correctly, and in a timely manner. • Items are moved or secured safely and without damage. • Hand signals are used properly. 	<ul style="list-style-type: none"> • Knowledge of rigging equipment (e.g., shackles, eyes, snatch blocks, bridles, slings) • Knowledge of and ability to tie knots • Knowledge of salvage gear • Knowledge of trigonometry • Knowledge of physics • Knowledge of deck safety • Ability to use hand signals
E2. Possess working knowledge of survival skills	<ul style="list-style-type: none"> • Personal flotation devices (PFDs) and survival suits are used properly. • Life boats are accessed and used properly. • CPR/first aid certifications are current. • Environmental concerns are addressed adequately. 	<ul style="list-style-type: none"> • Ability to use PFDs and survival suits properly • Ability to use life boats • Knowledge of CPR/first aid • Ability to assess environmental conditions and react properly

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Critical work function F: Integrate system modifications (Advanced skills)

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
F1. Design, build, and interface electrical systems	<ul style="list-style-type: none"> • Design and fabrication of electrical systems meet the intent of the project. • Electrical systems are built and interfaced properly (with other peripherals or pieces of equipment). • Instrumentation works and receives proper data. 	<ul style="list-style-type: none"> • Ability to design and fabricate electrical systems • Knowledge of serial communication (RS422, RS485, RS232) and ability to interchange (what? components? OR among what? protocols?) • Knowledge of analog signal data
F2. Design, build, and interface hydraulic systems	<ul style="list-style-type: none"> • Design and fabrication of hydraulic systems meet the intent of the project. • Hydraulic systems are built and interfaced properly (with other peripherals or pieces of equipment). • Circuitry is modified properly. • Operation of added equipment is successful. <p>(Does the term 'circuitry' make sense with hydraulics?)</p>	<ul style="list-style-type: none"> • Ability to design and fabricate hydraulic systems • Ability to add components and modify circuitry as necessary • Ability to read blueprints/schematics <p>(Does the term 'circuitry' make sense with hydraulics?)</p>

Knowledge and Skill Guidelines for ROV Technicians

Critical work function F: Integrate system modifications (Advanced skills) (continued)

TASK	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What ROV technicians need to know and/or be able to do in order to perform this task well
F3. Maintain technical documentation	<ul style="list-style-type: none"> • Documentation allows new personnel to understand changes. • Changes are communicated effectively. • Tools (e.g., CAD) are used properly. 	<ul style="list-style-type: none"> • Ability to maintain and update technical documentation • Ability to communicate effectively, both orally and in writing • Knowledge of CAD • Ability to create and print a schematic
F4. Design and construct mounting systems	<ul style="list-style-type: none"> • Design and fabrication of mounting systems meet the intent of the project. • Mounting system works. • Proper materials are used. • CAD is used properly. 	<ul style="list-style-type: none"> • Ability to design and fabricate mounting systems • Knowledge of CAD • Knowledge of proper materials to use