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INTRODUCTION

It is extremely important to strictly adhere to safety measures during the design, programming, and underwater use of subsea robots. These robots require special technical capabilities and safety precautions due to the demands of depth and water. These rules help to work safely with robots and are important for both safety and operational efficiency.

1. Pre-Dive Inspection

1.1 Ensure all components are fully charged.
1.2 Ensure that there are no entanglements in the propulsion systems and that the propeller operates normally without noise.
1.3 Ensure the camera's protective glass is clean, free of scratches or cracks, and without fogging inside.
1.4 Ensure the cable is securely connected and fastened with the metal cap.
1.5 Check that the cable is undamaged.

2. Precautions During Use

2.1 Device

- Do not throw the device into the water. Activate the thrusters after placing the device in the water.
- Stop the thrusters before removing the device from the water.
- Ensure the cable is securely connected and fastened with the metal cap.
- After use, cover the cable connection point with a protective cap.

2.2 Thrusters

- Avoid spinning the thrusters in the air.
- Do not touch the operating propeller.

2.3 LED Lights

- Do not look directly at the LED lights.
- Do not touch the LED lights during use.

2.4 Remote Control

- The remote control is not waterproof; protect it from water splashes during use.

2.5 Neutral Buoyancy Cable

- Maintain a safe distance from the cable to avoid entanglement.
- If the cable is entangled, first untangle it, then retrieve the device.

2.6 Battery

- The device has an internal battery; keep it away from direct sunlight, flames, heaters, or other heat sources.
- Monitor the current to protect the battery from swelling and failure. Swelling may occur if the minimum voltage drops below the permitted level. For example (3S LIPO min 11.1 V max 12.6V), if the battery voltage drops below 11.1 V during its operating life, the battery may fail.
- The use of swollen or failed batteries is prohibited.

3. Charging

3.1 The charging temperature range should be 0°-40°C (32°-104°F). The recommended temperature to extend battery life is between 20°-30°C (68°-86°F). Charging outside the temperature range can shorten battery life or damage it.

3.2 Ensure there are no flammable or explosive materials nearby during charging.

3.3 If the device has been brought from cold temperatures, wait for the battery to reach room temperature before charging.

4. Leakage Tests

4.1 All electronic parts, cable connections, and mechanical components of the robots must be insulated to operate in water. The robot's watertightness must be ensured. Specific leakage tests must be performed for each part and repeated at certain intervals.

5. Electrical Safety

5.1 Robots operate with electricity underwater, so there is a risk of short circuits and electric shock from electrical components. The electrical supply system must be insulated against water. Before submerging the robot in water, ensure that electrical connections are fully closed and insulated.

6. Depth and Pressure Resistance

6.1 Depth limits: Each robot must have a specific depth limit. If the depth limit is exceeded, the robot's mechanical structure may be damaged.
6.2 Pressure resistance: The metal and plastic parts of the robot must be resistant to water pressure. The casing must be made of materials that can withstand high pressures.

7. Temperature and Water Quality

7.1 Water temperature can affect the robot's electronic parts and battery. Chemical and biological substances in the water can damage the robot's parts. Therefore, water temperature and quality must be carefully monitored.

8. Post-Dive Maintenance

8.1 Cover with the protective cap (first ensure the cable connection point is clean and dry).
8.2 Rinse the device with fresh water and dry it, keeping it away from direct sunlight. 8.3 Check propellers and thrusters after each dive.
8.3 Regularly check the cable and replace it if damaged.
8.4 Store batteries in a safe environment and keep them at 50-60% for long-term storage.

9. Emergency and Accident Plan

9.1 Accident Monitoring System: The status of each system must be monitored before and during the robot's operation, and warnings must be issued in case of malfunction.
9.2 Spare Parts: Robot parts may fail during underwater operations. Spare parts must be readily available.
9.3 Intervention Protocols: In case of any accident or problem, operators must immediately apply the relevant procedures.

10. Kill Switch Process Steps

10.1 Connection to Control System: The kill switch mechanism is activated via control software or a physical button.
10.2 Automatic Safety: If the robot's condition is at risk, the kill switch can be activated automatically.

10.3 Intervention in Hazardous Situations: The kill switch is activated to prevent electrical and mechanical malfunctions.

10.4 Physical and Programmatic Kill Switch: The kill switch can be activated with both a physical button and a programmatic command.

10.5 System Safety Restoration: After the kill switch is activated, the robot's condition must be checked, and appropriate tests must be performed for safe restoration. 10.6 Engineering Safety: The kill switch mechanism must comply with engineering standards.

10.6 Automatic Intervention: Autonomous features of robots must be integrated with safety systems.

10.7 Testing and Verification: The kill switch and other safety mechanisms must be regularly tested.

11. References

11.1 https://diving-rov-specialists.com/index_htm_files/rov_43-%20dnv-part-5-chapt-7-rov.pdf