Advanced Navigation for PADS

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Introduction:
The Portable Accessible Docking System (PADS) is a system designed to assist patients with spinal cord injury access watercraft for recreational rehabilitation (see Figure 1 and 2). The PADS is equipped with several amenities to help patients transfer to and from watercraft. The overall design of PADS prevents a traditional outboard or inboard marine motor from being utilized for propulsion. A novel propulsion system was designed to provide propulsion and precision control.

Problem:
Our objective was to design, test, and implement a controllable propulsion system for the 9.75-m [32 ft] portable dock (the PADS) for recreational rehabilitation.

Mounting Bracket
Requirements:
- Mount underneath PADS and house motor assembly
- Trim the motor up to 70˚ for trailering and beaching
- Weatherproof
Specifications:
- CMC Marine linear actuator rated for 16.7 kN [3750 lbs]
- Limit switches used for bracket positioning
- Aluminum and Stainless Steel construction
- The actuator can move the motor 72˚ in less than 20 seconds
- Limit switches stop rotation of bracket at 0˚ and 72˚ from vertical

Breakaway System
Requirements:
- Motor should be able to break away if impacted to prevent damage to the system
Specifications:
- Bracket remains rigid until there is a 2.22 kN [500 lb] load applied at the distal end of the motor housing

Steering, Shaft and Pulley
Requirements:
- Steering motor must hold 12 N-m torque (Figure 6)
- Rotate shaft 180˚ without interference
- Drive motor positioned below pontoon depth
- Emergency manual steering handle
Specifications:
- Submersible

Drive Motor
Requirements:
- Electric powered motor
- Pontoons do not interfere with motor wake (Figure 7)
- Operates on a 48V 90Ah battery system
Specifications:
- Forward at min of 5 mph with a 10 mph headwind
- Maneuver and trailer with a 10 mph wind
- Resist a 10 mph side wind

Controls
Requirements:
- Joystick
- Tetra Universal Controller (TUC) (enables tetraplegic and quadriplegics to operate the controls using their breath, a muscle movement, or a head movement)
Specifications:
- Operates in two degrees of freedom
- Navigates with minimal or no hand movements
- Intuitive controls (Figure 9)

Key Results (Conclusion)
We created a simulation model to select a drive motor and built a breakaway system that would protect the motor from impact. We also designed a steering motor system and user interface to provide control for patients operating the PADS using a joystick or the TUC.

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Figure 1: PADS beached at East Canyon Reservoir
Figure 2: PADS floating at East Canyon Reservoir
Figure 3: CAD model of bracket and breakaway system design.
Figure 4: Schematic of shear pin design.
Figure 5: Removable manual steering handle
Figure 6: Flow simulation for max torque on motor
T = 10.5 N*m [7.74 lbf*ft]
Figure 7: Perpendicular flow simulation on pontoons to find drag force of .62 kN [140 lb]
Figure 8: Parallel flow simulation on pontoons to find drag force of .89 kN [200 lb] at 6 mph
Figure 9: Joystick control panel