Chapter 6: Buoyancy, Stability, and Ballast

Stories From Real Life: Ben Franklin

Chapter Outline

1. Introduction
2. Why Things Float or Sink
   2.1. Buoyant Force
   2.2. Archimedes’ Principle
   2.3. Positive, Negative, and Neutral Buoyancy
3. Designing for Optimal Buoyancy
   3.1. The Weight Statement Table
   3.2. Adjusting Vehicle Buoyancy
4. Why Things in Water Tip or Flip
   4.1. Preliminary Concepts
   4.2. How CG and CB Determine Vehicle Orientation
5. Trimming a Vehicle’s Orientation
   5.1. Pitch and Roll
   5.2. Trimming Pitch and Roll
6. Stability
   6.1. Vehicle Stability Under Water
   6.2. Stability on the Surface
   6.3. Shifting Weights and Loss of Stability
7. Ballast Systems
   7.1. Air Under Pressure
   7.2. Static Ballast Systems
   7.3. Active Ballast Systems
8. Practical Tips for Ballasting and Trimming a Small Underwater Vehicle
9. Chapter Summary

Chapter Learning Outcomes

- Explain why things in water sink, float, or tip over and how ballast systems can be used to control these processes.
- Describe the difference between positive, negative, and neutral buoyancy and explain why the designers of most underwater vehicles strive for near-neutral buoyancy.
- Know why and how to use a simple weight statement table to design a vehicle with the desired degree of buoyancy.
- Describe how some active ballast systems function and explain why most ROVs and AUVs rely on the simpler static ballast approach.