CUMING CORPORATION

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TECHNICAL NOTE 100-4

Specifying, Purchasing and Testing Syntactic Foam

INTRODUCTION

In earlier Technical Notes of this series, we discussed the selection of syntactic foam buoyancy materials and the prediction of their performance over time. Now we will apply some of these principles to the acquisition process, aiming to purchase products which get the job done safely at least overall cost.

THE MISSION STATEMENT

In Technical Note 100-3, the mission statement was cited as an important first step in buoy design. The mission statement should also be part of any bid request, purchase order, or specification, since it answers many basic questions about expected performance: How deep is the buoy going? How long will it be there? How much change in buoyancy is acceptable during that time? What are the consequences of failure? This information will help your supplier design the most efficient and cost effective buoy for the job.

BASIC BUOY DESIGN PARAMETERS

A buoy can be said to be fully defined by four parameters:

- Volume (A function of size and shape).
- Density (Determined by operating depth).
- Buoyancy (As required for the payload).
- Weight (Often a constraint).

Rigidly defining all four parameters will create a “specification gridlock” that deprives the supplier of any latitude in meeting the requirements. It is much better to define the limits of two parameters (say, minimum buoyancy and maximum size) that are most important to the mission, and leave the other variables to the discretion of the supplier.

QUALITY ASSURANCE LEVEL AND HYDROSTATIC TESTING

If a buoy is intended to support valuable equipment or to protect human life, it makes sense to require more stringent quality assurance measures for it than for buoys in less demanding applications. On the other hand, rigorous testing and inspection are expensive, and should be used with discretion. Selecting the appropriate QA level requires careful analysis of the following variables:

- Safety Factor: How close to its crush pressure will the buoy be operating? Critical payloads should be protected by greater safety factors, and the crush strength of the syntactic foam confirmed by destructive testing.
- Time at Depth: Long-term or highly cyclical service is more demanding than short-term/low-cycle service, and will require proof of performance through long-term or cyclical hydrostatic testing.
- Degree of Precision: Holding buoyancy, size, or weight within close tolerances may be difficult, requiring increased inspection to confirm. The following are typical buoyancy tolerances on routine production runs:

  Buoyancy tolerance, per individual buoy. . . . . +/- 4.0%

  Buoyancy tolerance, total lot of buoys . . . . +/- 2.0%

TOTAL HYDROSTATIC TESTING REQUIREMENTS

Type of Application	Destructive Crush Test	100% Test at Service Depth	Long-Term Testing	Cyclical Testing	Sampling Hydro Test 10%-20%	Little or no Hydro Testing
Man-rated	■	■	■			
Critical Payload	■		■		■	
Long-Term Service			■			
Large No. of Cycles				■		
General Purpose					■	
Light-Duty						■

TYPES OF TESTING I: QUALIFICATION VS. CONFORMANCE

Hydrostatic test programs can be conveniently divided into two types:

- **Qualification Testing** is a one-time series of tests designed to prove the suitability of a supplier’s materials and processes. Qualification testing frequently includes crush tests, long-term tests, or cyclic tests that are too expensive or time-consuming to perform repeatedly during production. Qualification testing should be designed to provide performance “benchmarks” which can be used to judge the adequacy of behavior during conformance testing.
- **Conformance Testing** is the repetitive series of tests performed throughout production to ensure that the supplier’s process continues to make products of the same high quality as were accepted during qualification testing. Typical conformance testing consists of short-term hydrostatic tests (24 hours, for example) at maximum rated pressure, performed on 10% to 20% of the buoys being produced. Failure of any buoy in conformance testing may be cause for increased frequency of testing or other remedial measures.

TYPES OF TESTING II: WEIGHT GAIN VS. INSTRUMENTED

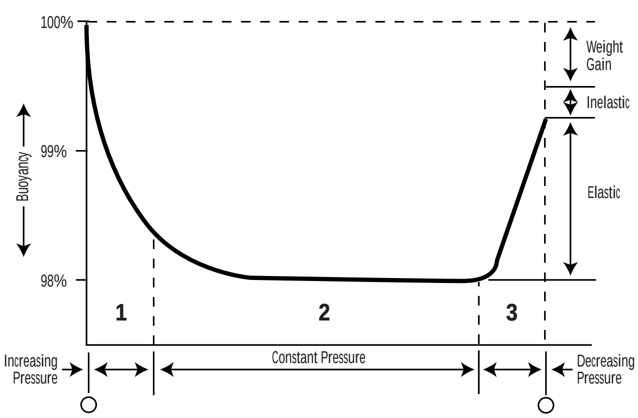
It stands to reason that hydrostatically testing full-size buoys is superior to testing small coupons or samples. Less well understood is the distinction between weight gain measurements and instrumented testing.

- The weight gain method is based on the assumption that any buoyancy lost due to water absorption will be reflected as an increase in weight. The buoy is weighed before hydrostatic testing, then weighed again immediately after testing, and any increase expressed as a percentage of the initial weight. This method has the advantage of being relatively quick and inexpensive, but it does not yield as much data as instrumented testing. Typical acceptance thresholds range between 1.0% and 3.0% weight gain after 24 hours at pressure.

$$W = 100[(W2-Wl)/Wl]$$

- The instrumented method measures actual change in buoyancy during pressurization by suspending the buoy in the pressure vessel from an electronic load cell. The result is a plot that yields valuable information about bulk modulus, water absorption rate, and inelastic losses. A typical curve is illustrated below. Because instrumented testing is the only way to fully characterize the performance of syntactic foam, it is the preferred test method, particularly for critical applications.

TYPICAL INSTRUMENTED PRESSURE TEST CURVE



In zone 1, increasing pressure, buoyancy declines as a result of both compression and absorption. In zone 2, constant pressure, little if any additional compression occurs and the small amount of loss is due to gradual infiltration of water. In zone 3, pressure is reduced to atmospheric and most buoyancy is recovered. When weight gain is subtracted, the small amount of loss remaining can be attributed to inelastic compression. It should be noted that weight gain and inelastic compression constitute the permanent, nonrecoverable portion of buoyancy lost under pressure, whereas elastic compression is temporary and recoverable.

SPECIAL FEATURES

If you require any special features, such as brackets, inserts, or fasteners, identify them clearly. The straps or attachment system should be designed for maximum convenience in assembly. Any preference for exterior coating, paint, and markings should be indicated. Very large or complex buoys may require special handling or assembly techniques. See Technical Note 100-6 for helpful hints and tips on syntactic foam buoy design.

THE DANGERS OF OVER-SPECIFYING

It is often tempting, especially for first-time buyers of syntactic foam, to state their requirements in excessive detail, to pile on too many specifications, and to demand extensive testing. Remember that every word in your specification costs you money. Maximum cost effectiveness is realized when specifications are honed to the bare essentials, testing is keyed to the nature of the application, and the supplier has latitude to use state-of-the-art innovations to reduce size, weight, and cost. Avoid the “specification gridlock” mentioned in Basic Buoy Design Parameters on page 1. Involve your supplier as early as possible in the design process (see next paragraph), and consult the other Technical Notes in this series.

CONSULT THE EXPERTS

Cuming corporation makes more buoys than anybody else, and our engineers are the most experienced in the world. Bring your design problems to us for free consultation and prompt quotation on all kinds of deep sea buoys and floats. Call, fax, or write for other Technical Notes in this series on syntactic foam:

- 100-1 Acoustic Properties
- 100-2 Predicting Long-Term Performance
- 100-3 Materials Selection And Depth Rating
- 100-4 Specification And Testing
- 100-5 Thermal Properties
- 100-6 Design Hints and Tips
- 100-7 Estimating Module Diameters
- 100-8 Fairings for Marine Riser
- 100-9 Maintenance and Repair
- 100-10 Stacking and Racking

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