



TECHNICAL NOTE 100-6

SYNTACTIC FOAM BUOY DESIGN TIPS AND HINTS

The following list of tips and hints is intended to help you during the syntactic foam buoy design and procurement process. The list is by no means exhaustive, and many more items could be added, but it is hoped that reading over these tips before your next buoy project will aid in improving performance while reducing cost. Feel free to write us if you think of any additions or improvements. And remember Tip No. 25: We're looking forward to hearing from you.

- 1. MAXIMIZE LEAD TIME.**

Haste makes waste. Allowing as much time as possible to make your buoys will save money and improve quality. Involve your supplier early in the design process and provide plenty of time for hydrostatic testing and materials qualification.
- 2. KEEP IT SIMPLE.**

Buoys are inherently simple devices, and you should strive to keep it that way. Overly complicated engineering leads to difficulties in manufacturing, schedule delays, and increased costs. Often the cleverest designs are also the simplest.
- 3. FOLLOW STANDARD PRACTICE.**

Chances are that your buoyancy requirement is not unique. Consult with your supplier about how similar problems have been handled in the past. Study industry standard practice and try to conform to it as closely as possible.
- 4. AVOID TIGHT TOLERANCES.**

Buoys are not normally precision devices. Three-place dimensions should not be used if at all possible. Dimensional tolerances should start at ± 0.25 " and increase proportional to length. Tolerances on buoyancy (net upward lift) should be no less than ± 4.0 on individual buoys and $\pm 2.0\%$ on the total lot. If greater precision is required, provide for adjustable ballast.
- 5. STICK TO PROVEN MATERIALS.**

Nothing is more hazardous to cost and schedule control than conducting R&D during the production process. Design your buoy around materials with a solid track record. Insist on test data and other proof of performance before committing to a material selection.
- 6. ALWAYS BE CONSERVATIVE.**

A large safety factor is the best insurance policy. Make sure you know the actual crush strength of the buoy material; it must be sufficiently greater than the maximum operating pressure to ensure proper functioning throughout the life of the buoy.
- 7. MANAGE THE LOSS RATE.**

All syntactic foam buoys lose some of their buoyancy over time; the trick is to not lose too much. Require your supplier to furnish long-term test reports or other data that will enable you to predict buoyancy loss throughout the design life. In some cases, it may actually be cost-effective to design the buoy slightly over-size to compensate for future losses, rather than trying to hold the loss rate to an unrealistically low level.
- 8. ALLOW SUFFICIENT DISPLACEMENT.**

The most common mistake in buoyancy design is failing to provide sufficient volume or displacement. Don't paint yourself into a corner! Design conservatively for a little more density and a little greater volume than the nominal conditions require. Sometimes an extra 5% or 10% of volume can mean the difference between success and failure.
- 9. UNDERSTAND SYNTACTIC FOAM.**

The principles governing the performance of syntactic foam are few and simple, but they can make a big difference in the design of a deep sea buoy. All of the necessary technical information is readily available. Study the literature and apply the principles to your project for maximum cost-effectiveness.
- 10. SELECT APPROPRIATE MATERIALS.**

There are three basic types of syntactic foam: "solid" glass microsphere composites, "macrosphere" materials with fiberglass sphere up to 0.50" diameter, and "multisphere" foams with multiple sizes of fiberglass spheres up to 3.00" diameter. They are intended for deep, medium, and shallow-water service, respectively. Understand the strengths and weaknesses of each type, and use them correctly.
- 11. CONSIDER MACROSPHERE SIZE EFFECTS.**

The selection of appropriate macrosphere size is often influenced by factors other than depth alone. For example, small spheres will pack much better in a small buoy than will large spheres; large spheres are "softer" and display more buoyancy change with increasing pressure; and the energy released by an imploding sphere increases as the cube of its diameter, increasing the risk of damage. Again, study the literature so you can make an informed choice.
- 12. ALLOW FOR SPECIAL CONDITIONS.**

Environmental factors may affect buoy performance. Elevated water temperature may increase the rate of buoyancy loss.

Shock loading, handling impact, or extremely rapid submergence or surfacing may result in damage. Consult with your supplier to ensure that all conditions have been taken into account.

13. CONSIDER SIZE AND SHAPE FACTORS.

Small, narrow, or complex shapes have greater area-to-volume ratios and higher buoyancy loss rates than do large, simple shapes. The sphere is the ideal shape for a minimum area-to-volume ratio. Taking these factors into consideration will help in optimizing your buoy design.

14. PROVIDE FOR EXPANSION AND CONTRACTION.

Buoys of one-piece construction have few problems with expansion or contraction caused by thermal or pressure effects, but buoys built up from dissimilar materials, or with metal frames, may experience damaging stresses from dimensional change. Proper design and compliant joints can overcome these problems.

15. PLAN LARGE BUOYS DIFFERENTLY.

If your buoy is so large that it must be cast in many segments, additional thought should be given to the problems of expansion and contraction. The syntactic foam segments must be joined with a compliant adhesive or a fastening system that permits relative movement between the segments themselves and/or the metal framework.

16. EVALUATE METAL VS. COMPOSITES.

The new trend in buoy design is to reduce or eliminate metal frames and hardpoints and replace them with fiberglass or other composite parts, or to use the syntactic foam itself as a structural component. This can result in a buoy that is smaller and lighter than traditional construction, while minimizing corrosion problems and the difficulties cited in Tips 14 and 15.

17. MINIMIZE HARDWARE.

Fancy metal brackets and threaded inserts may look good on the drawing board, but they can be expensive. Avoid fastening systems that require precision molding and exact alignment. A simple strap and turnbuckle usually works well, and saves money.

18. DESIGN FOR ECONOMY.

A few large buoys are usually less expensive than many small buoys, so design your system to have as few components as possible. Pattern, mold, and other tooling costs have a major impact on buoy economics. Careful design and planning, buying in quantity, and consultation with your supplier will help to keep tooling costs under control.

19. BUY IN QUANTITY.

Economies of scale really work. Combine orders, team with another buyer, use timed releases or any strategy that maximizes order quantity and avoids the expensive habit of buying one or two little buoys at a time.

20. SELECT THE RIGHT FINISH.

Function is more important than appearance. An integrally-molded fiberglass skin with a good coat of marine paint may be all you need. Resilient elastomeric coverings improve impact resistance slightly, but can add a lot to costs. Avoid fancy marking schemes and automotive-quality paint jobs: the fish don't care what your buoy looks like.

21. PROVIDE FOR CONTINGENCIES.

Never assume that you know everything you need to know; it's always the unexpected that bites you in the backside. Provide extra displacement, design for slightly heavier foam, make the frame a little stronger, and so on. You'll sleep better, if nothing else.

22. INSIST ON QUALITY CONTROL.

Evidence of satisfactory hydrostatic performance, keyed to your specific requirements, is essential to any buoy procurement. Pre-qualification of candidate syntactic materials, followed by a systematic program of conformance testing, will guarantee your satisfaction now and in the future.

23. AVOID OVER-SPECIFICATION.

Setting too many requirements can be as bad as setting too few. Avoid "specification gridlock" by identifying only those few parameters truly critical to your project. Allow your supplier some latitude to arrive at the most cost-effective solution.

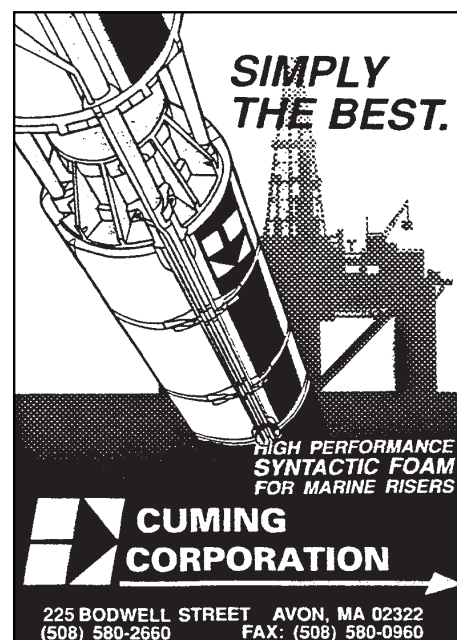
24. DON'T DESIGN THE BUOY YOURSELF.

Having studied all of the above topics, you may still not be an expert buoy designer. That's okay, you don't have to be. Leave the detailed design of the buoy to your supplier: after all, it's his job.

25. 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, 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



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