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TECHNICAL NOTE 100-5
A DISCUSSION OF AREA-TO VOLUME RATIO

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Because of its light weight and high strength, syntactic foam is often used as a deepsea buoyancy material. In service, all syntactic foams experience some loss of buoyancy under hydrostatic pressure. Loss in buoyancy is attributable to two phenomena: (1) elastic compression and (2) water absorption. Compressive loss is usually small, seldom amounting to more than 1.0% of total buoyancy. The effect of water absorption, on the other hand, tends to be somewhat larger, especially over long periods of time.

Water absorption occurs as hydrostatic pressure forces water into the surface of the syntactic foam, entering tiny porosities and breaking exposed glass microspheres. Properly rated syntactic foam will show a logarithmically diminishing rate of weight gain over time as it becomes progressively more difficult for water to penetrate farther into the tightly bonded syntactic structure. The water absorption rate thus stabilizes into a slow, predictable, and manageable loss over the service life of the buoy.

Weight gain due to water absorption is typically expressed as a percent of the initial weight. Because water absorption is a surface phenomenon, proper interpretation of weight gain test data requires knowledge of the sample size and area-to-volume (A/V) ratio. Large buoys have a smaller A/V ratio than small samples, and therefore exhibit a lower percentage of water absorption under identical conditions. Conversely, prediction of water absorption based on small samples tends to overstate the amount of buoyancy loss to be expected from full-size buoys.

For example, consider data based on a small sample 6.00 inch diameter x 6.00 inches long. The total surface area of the sample is 169.65 square inches, and its volume is 169.65 cubic inches, yielding an A/V ratio of 1.0 inch.* Next, consider a large buoy divided into two blocks, each 41.0" x 67.0" x 118.0". Each block has a surface area of 30,982 square inches and a volume of 324,146 cubic inches, for an A/V ratio of 0.10 inch. The ratio between the two A/V ratios is (1.00/0.10) = 10. In other words, the small sample can be expected to absorb water at about ten times (10x) the rate absorbed by the large block.

This logic can be used to justify dividing large objects into sections for hydrostatic testing. For example, say the same block described above must be cast in two halves so that the parts will fit into a pressure vessel. Each half will have dimensions 33.5" x 41" x 118". This equates to an A/V ratio of 0.125 inch. Comparing this to the A/V ratio calculated above for the full block leads to the following ratio between A/V ratios: (0.125/0.10) = 1.25. Therefore, testing half-blocks will be conservative in the sense that weight gain measurements will tend to overstate the amount of water absorption of full-size blocks by about 25%.

* Note that A/V ratios are not dimensionless, so that the values will change depending on the units (inches, feet, or mm) used; however, <u>ratios</u> between A/V ratios <u>are</u> dimensionless, and therefore are <u>not</u> affected by choice of units.