DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

0 3 JUN 1992

REPLY TO
ATTENTION OF:

CECW-ON

MEMORANDUM FOR ALL MAJOR SUBORDINATE COMMANDS

SUBJECT: Shoreline Management Floatation Requirements

1. Please refer to the multiple addressed memorandum of 24 June 1991 concerning the above subject which addresses a technical error in Condition 14 of Appendix C to Part 327.30, Shoreline Management Regulation.

2. We have amended the final rule in the Federal Register to correct this error. The effective date of this correction is 25 June 1992. This correction deletes the requirement pertaining to petroleum products and defines a standard protective coating, where one is necessary, as well as providing density and volume criteria. These changes are based on a study of floatation materials conducted by WES. Copies of the corrected Condition 14 and the Report on Floatation Device Study are enclosed.

3. These changes regarding floatation requirements effectively preclude the future use of expanded polystyrene unless it is encased in an approved protective coating as described in the revised Condition 14. Existing flotation, however, will be authorized in accordance with Condition 14.

4. Current, as well as future, lease conditions and requirements will determine types of floatation for lessees. New and renewed lease conditions and requirements should be based on the results of the WES study which provides useful information, especially when considering public safety, regarding various types of floatation and how their use affects the lake/waterway environment.

FOR THE DIRECTOR OF CIVIL WORKS:

JOHN P. ELMORE, P.E.
Chief, Operations, Construction
and Readiness Division
Directorate of Civil Works

CO-R

CECW-ON
SUBJECT: SHORELINE MANAGEMENT FLOATATION REQUIREMENTS

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Report on

FLOTATION DEVICE STUDY

by

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INVESTIGATION OF FLOTATION DEVICES

A survey was conducted to determine the status of flotation devices being used at Corps of Engineers projects. Questionnaires were sent to 21 Districts in seven Divisions. The Districts were asked to provide the questionnaire to a representative sample of their projects. The questionnaire included questions pertaining to the number of docks and materials being used for flotation for Corps, private and commercial docks, litter problems caused by deterioration of flotation, complaints registered regarding litter, damage caused by waterfowl or animals and any observed damage to waterfowl or aquatic life caused by ingestion of flotation materials. A synopsis of the survey results is found in the section entitled "Flotation Device Survey of Projects" on page 6.

A reconnaissance of Sidney Lanier was made to observe the various types of flotation in place and to see first hand the condition of the flotation materials that were in use at the lake. Numerous telephone calls were made to projects to gather further information about situations described in the returned questionnaires. Several manufacturers of flotation devices visited the U.S. Army Engineer Waterways Experiment Station (WES) to discuss their products and a number of other manufacturers made contact by phone and/or provided written information.

One of the manufacturers, Pal Products Inc., visited and provided samples of a polyethylene product, that up to now has not been considered for use as a flotation material. He asked that this new product be included in the tests and responded positively regarding testing it at a Corps lake. Facilities are currently not available for mass production of polyethylene for flotation devices and its availability is dependent upon the product receiving approval for use by the Corps of Engineers. Tests indicated that polyethylene had no reaction to petroleum products, resisted conpression, was less prone to breakage than extruded polystyrene, and did not "bead off" as was the case with expanded polystyrene. Test samples of this new material have been provided to three projects to evaluate the use of polyethylene as a flotation device in actual lake conditions. Results of these tests are not yet available.

Contact was made with Dr. Louis Sileo of the National Wildlife Health Research Center in Madison, Wisconsin, and others to determine whether there were any scientific data available regarding the ingestion of foam beads by waterfowl or fishes. Based on discussions with Dr. Sileo and other experts, it was determined such research has been performed only on marine life and sea birds. Two Corps projects indicated that they had observed fish or waterfowl ingesting the beads, but the literature does not support these reportings. Damage to wildlife, if any, resulting from foam beads that are sloughing off from expanded polystyrene flotation has not been substantiated.

The fact that more than 57 percent of the projects that have docks with expanded polystyrene report litter problems and more than 37 percent of these same projects have had complaints from the public about the litter being generated suggests that a serious problem exists. Grapevine Lake, in the Ft. Worth District, provided several color photos of the litter problem they are experiencing (encl). At Sidney Lanier, both beads and large chunks of expanded

polystyrene foam were observed washed up on shore. As there is no way to determine ownership of this litter, the clean-up becomes a Corps problem.

Discussions with representatives of manufacturers indicate that the major suppliers of flotation devices agree with the Corps' attempt to remove exposed expanded polystyrene as an approved product. The representatives are also concerned with the quality of the encapsulation being administered by some of their competitors. They gave reports of some individuals selling the idea to customers that by allowing them to "paint" an epoxy or other material onto expanded polystyrene, the new guidelines would be met. However, coverings not administered under controlled conditions tend not to bond to the polystyrene and have a very short lifespan. After a period of time this "painted" material would slough off into the water, leaving the same conditions as before, but with potential pollutents being added to the lake. Some manufacturers expressed that if restrictions may become sufficiently severe for encapsulation, it would increase the cost of production for those manufacturing inferior products.

Mr. Frederic G. Hunt, a Professional Engineer, has done considerable work in developing a simple test to determine the water absorption characteristics of foam for floating docks. The test can be easily administered at a jobsite or a plant. The greatest difficulty in conducting the test is the preparation of sample which needs to be precisely 5.0 inches x 5.0 inches x 4.32 inches. These dimensions produce a 1/16 cu ft sample, which allows easy calculations on a cubic foot basis. Correspondence with Mr. Hunt indicates he has done some initial work also on the coatings used for encapsulation. He states "Although some coatings are offered in thicknesses of 3 to 10 mils, I don't feel at all confortable unless I have a minimum thickness of 1/8 inch (0.125 inch)." Mr. Hunt also stresses that minimum thickness is more important than average thickness.

Although tests to determine the "ideal" thickness for encapsulation would be useful, the difficulty in determining the necessary thickness for each different coating would be enormous, and with new coating products becoming available, it would be an never ending process. Therefore it is recommended that the manufacturer be required to warrant his product for a specified time, and thus put the responsibility on the manufacturer to produce a product that is acceptable for use in encapsulating foam for docks.

Costs associated with flotation devices are difficult to ascertain. Sales representatives are reluctant to provide definitive costs unless an order for the quantity required and the shipping location is given. Obviously, large orders are given a quantity discount. Shipping costs are based primarily on bulk and not the weight, and on small orders shipping costs can exceed the cost of the product itself. Therefore, it is very difficult to arrive at cost comparisons between the various manufacturers. To complicate the matter further, there are no industry guidelines or regulations to govern the dimensions of the flotation billets. In general, standard sizes for expanded polystyrene are: width (in inches), 12 to 48; length (in inches), 48 to 192; and thickness (in inches), 3/8 to 24. These standards sizes evolved because most materials being used for flotation were developed as insulating materials. Therefore, either trimming of the material is required before incapsulation, or the resulting billets are of a nonstandard size. Also, many of the physical requirements that manufacturers cite are from the American Society for Testing and Materials (ASTM)

which are used for testing insulation. For instance, water absorption may be based on a misting process rather than immersing the product in water for a stated period of time, which is more appropriate for testing the water obsorption properties of flotation materials.

FLOTATION MATERIALS

For the purpose of this report flotation materials will be limited to man-made materials. Three materials currently in use have experienced varying degrees of success. The three materials are polyurethane, extruded polystyrene, and expanded polystyrene.

POLYURETHANE is a foam produced by mixing two separate liquid chemicals together. Polyurethane requires encasement or coating to prevent erosive deterioration. Polyurethane has a great propensisty for developing voids during manufacturing, unless the material is properly formulated and expanded with the use of precise equipment and closely controlled temperatures. Polyurethane foam, when exposed to freezing and thawing conditions and moisture, will become saturated with water and lose its value as a floatation material. Only a few floating dock manufacturers currently use polyurethane foam for flotation.

EXTRUDED POLYSTYRENE is currently manufactured by only one company, Dow Chemical, and uses the tradename of Styrofoam. It is blue in color (also a trademark) and has a low water absorbency rate. Styrofoam is usually used without protective encapsulation. Because it is manufactured by only one company, the density of Styrofoam is typically maintained at 1.8 lb/cu ft. Styrofoam is subject to attack by some solvents including concentrated quantities of gasolene and oil (Dow Chemical Co). In the recent survey of Corps projects, only eleven reports of damage to Styrofoam by gnawing animals or waterfowl were reported. Styrofoam is available in three standard sizes: 7′ x 20" x 8′, 10" x 20" x 8′, and 10" x 2′ x 8′.

EXPANDED POLYSTYRENE (EPS) is the most widely used material, currently being used both in an exposed state and encapsulated. EPS absorbs water, is subject to erosion by "beading off," and will disintegrate when exposed to gasoline. The density of EPS varies widely. Although many of the manufacturers claim to maintain an average density of 0.9 lb/cu ft, samples may range from 0.7 lb to over 1.5 lb/cu ft. The quality of EPS is determined by a number of factors, such as, its density, the number and size of voids it contains, the process used to expand the beads, whether the beads were oiled, and whether only virgin material was used or regrind was added. EPS is subject to waterlogging by absorbing water into the voids between the beads and also by the absorption of water by the beads themselves. The amount of water absorbed depends on the quality of the sample, the length of time it is exposed to water, and the depth of water contacting the EPS. It is noted that because of the relative ease in becoming a manufacturer of EPS, the competition is quite fierce and, therefore, some manufacturers tend to "cut corners" to maintain a competitive edge. This, plus the lack of experience of some manufacturers reduces the quality of some of the EPS being used for flotation devices. Over 89 percent of the Corps projects listing EPS being used as flotation material reported damage to the flotation by gnawing animals and/or waterfowl.

ENCAPSULATED EPS is rapidly becoming the flotation device of choice. The reason for this is that encapsulation eliminates many of the undesireable characteristics of EPS while maintaining most of its bouyancy. Well designed encapsulation of EPS provides a suitable flotation device which will outlast

exposed EPS by 3 to 4 times. The weaknesses of encapsulation is that should the covering be punctured, waterlogging may become more severe than exposed EPS. There are any number of methods and materials being used to encapsulate EPS for flotation. There is no one "best" product, as considerations must include cost, ease of installation, design of the dock, method of anchoring, resistance to ultraviolet rays, effect of ice, resiliency of product to impacts, etc. The thickness of the material used for encapsulation is probable of less importance than the characteristics of the material itself. Generally speaking rigid encapsulation requires a greater thickness than does a nonrigid material. Also minimum thickness for a given covering is more important than the average thickness. Some manufacturers recommend attaching their products by placing threaded rods through the billet and anchoring to the dock. Unless extreme caution is practiced in sealing around the inserted rod, an avenue has been provided for water to enter, resulting in waterlogging.

Another method used in manufacturing encapsulated flotation is placing polystyrene beads in a premolded container and expanding the beads in place. Difficulty in achieving uniform expansion has been experienced using this method. Should there be a failure to achieve complete and even expansion of the beads, there will be voids, and should the container become punctured or cracked waterlogging will occur and buoyancy will be reduced. Based on the recent survey of Corps projects, encapsulated EPS is not prone to damage by gnawing animals or waterfowl.

POLYETHYLENE, a member of the olefin series of chemicals, has potential as a flotation material. Polyethylene was originally developed in Germany as a packing material to replace polystyrene, as it has greater resistance to compression. It was developed for use as packing for electonic equipment. Although manufactured by the expansion of beads, its characteristics differ greatly from EPS. The material is much less prone to "beading off" and has a texture unlike EPS. Tests of polyethylene gave little indication that gasoline, diesel fuel, oil, or muriatic acid had any effect on it. Polyethylene has a low water absorbancy rate and has a propensity to return to its original shape after being compressed. Although laboratory tests appear promising for the use of polyethylene and sample billets have been supplied to three Corps projects, the length of time for exposure to lake use has not been long enough to determine its acceptability as a flotation material under field conditions. It is believed (though not substantiataed) that the texture of polyethylene is such that gnawing animals and waterfowl will not be prone to damage it as they do EPS. The texture is somewhat gummy compared to the brittleness of EPS.

FLOTATION DEVICE SURVEY OF PROJECTS

Questionnaires were sent to 21 Districts in seven Divisions with requests to distribute copies to their projects. It was not required that each project respond, but it was stressed that a representative sample was necessary.

Of the 21 Districts surveyed, 19 responded with a total of 139 projects completing the questionnaire. One District, with only one project reporting, was deleted as it reported it had no dock facilities.

Of the 138 projects with docks, 85 (61%) stated they had one or more docks using unprotected expanded polystyrene (EPS) as the flotation device. Forty nine (57.6%) of the 85 projects stated they experienced litter from the deterioration of the EPS in the form of beads and/or chunks of broken flotation blocks. Public complaints were received from 37.6% of the 85 projects about the EPS litter.

Questions pertaining to the composition of the flotation devices used for the docks at the 138 projects and the number of each produced the following information:

Flotation Device	Corps Docks	Private Docks	Commercial Docks
Expanded polystyrene (EPS)	182	15,974	3739
Styrofoam* (extruded polystyrene)	118	2,595	404
Encapsulated EPS	306	10,045	8267
Other	33	52	4

*Styrofoam and Blue are registered trademarks for Dow's extruded polystyrene.

Responses to questions pertaining to damage to wildlife caused by the ingestion of beads or particles of EPS indicated that there is little observation of this occurring. Only two projects reported that wildlife were impacted, but there was no scientific support for these reports. This does not imply that some adverse impacts are not occurring, just that there are no scientific data to support such a charge.

Answers to questions regarding whether damage to EPS flotation by wildlife was evident disclosed a totally different picture. Seventy-six (89.4%) of the 85 projects reporting the use of EPS for flotation indicated that there was damage to the flotation by wildlife. Damage caused by beavers leads the list with 48 projects, followed by 33 projects with waterfowl-caused damage, 26 projects with muskrat-caused damage, 3 with mink-caused damage, 3 reporting damage from nutria, and 1 project with damage being caused by river otter.

Damage to flotation other than EPS was reported by 14 projects. In eleven instances the damage was to Styrofoam, seven by beavers, two by muskrats and two by waterfowl. Three projects reported damage to encapsulated flotation by beavers and muskrats, but did not indicate the type of damage.

COMPARISON CHART

	EXPANDED POLYSTYRENE	EXTRUDED POLYSTYRENE	ENCAPSULATED Expanded Polystyrene	POLY-ETHYLENE
Subject to waterlogging	High	Low	NA	Low
Susceptible to damage from petroleum products	High	Med	Not	Not
Susceptible to damage from wildlife	High	Low	Not	Unknown
Inflammable*	Yes	Yes	Yes	Yes
Approximate cost**	X	2-2.5X	4-6X	3-4X
Density (lb/cu ft)	.07-1.2	1.8	varies	>1

* The American Society for Testing and Materials (ASTM) Designation:C578-83, specification 7.2, Fire Requirements, states: "RCPS (rigid cellular polystyrene) thermal insulation is an organic material and is therefore combustible. It should not be exposed to flames or other ignition sources." As all of the materials listed above are organic, they are all combustible. The degree of fire risk for each material, however, is not equal. Kindling temperatures vary, depending on the molecular structure and chemical makeup. The greatest danger of combustion of these materials is in storage, and manufacturers caution purchasers of the dangers involved. Flame retardants are added to some expanded polystyrene formulas to reduce the risk of combustion. With the use of flame retardants combustion is not sustained without a continued ignition source. Flame retardants are not currently added to extruded polystyrene or polyethylene. Heat sources, when sufficient, melt or ignite most materials used in incapsulation.

** Cost depends on the price of petroleum, market area, quantity purchased, and the quality of product. The cost comparisons listed are general. However, these comparisons do not include shipping charges, which can add substantially to the total cost, depending on the location of the manufacturer.

CONCLUSIONS

Decisions regarding which flotation material or device to use are dependent on a number of factors. The design of the dock itself, as well as the flotation used, will determine the length of time the dock is expected to last. Generally, the longer the expected life of a dock, the higher the cost.

Materials that are subject to dissolution upon contact with petroleum products should not be used for flotation for refueling docks. None of the flotation devices tested should be exposed to high temperatures as they are subject to combustion and/or melting. The flash point and melting point varies with the individulal material, but generally, non-encapsulated materials tend to be subject to combustion at lower flash points. Damage to encapsulation materials may occur if exposed to welding or other similar high temperatures.

The use of encapsulated flotation from a reputable manufacturer, together with a dock designed for the size of the flotation blocks will provide a dock that is serviceable as long as 30 years or more. Encapsulated flotation that is punctured is subject to waterlogging if expanded polystyrene is used as the filler flotation material. The density and quality of the expanded polystyrene used, as well as the covering material and method of application, determines its suitability as a flotation device. Encapsulated flotation does not lend itself to modification at the site and may require ordering custom sizes.

Materials not requiring encapsulation, such as extruded polystyrene and polyethylene, are less costly and can be altered at the site for custom fitting to the dock. Alterations should be made using a hot wire. If not subjected to harsh physical abuse or petroleum products, extruded polystryrene can provide many years of service as flotation for docks. Polyethylene is not subject to damage by petroleum products, but its longevity in water has not been tested. It is expected to be as long lasting as extruded polystyrene. Neither polyethylene or extruded polystyrene are subject to waterlogging by being punctured and will serve well as flotation devices for both private and commercial docks.

The longevity of any flotation material is dependent upon the design of the dock, the care and maintenance provided and the environment in to which it is placed. These considerations, in addition to the strenghts and weaknesses of each individual material, will determine the lifespan of the flotation device.