A review of the performance of bilge socks proposed for use in Buzzards Bay recreational boats in response to a request for proposals issued by the Buzzards Bay Action Committee and the Town of Dartmouth

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Introduction

Most boats have compartments inside their hull that serve to capture rain and seawater entering the hull of the boat. These compartments also capture fuel and engine oil that may leak within the boat. Boats with fuel compartments, inboard engines, and drive shafts are far more likely to leak oil into these compartments. Maintenance of inboard engines can also result in spills into the bilge. Many bilges can drain automatically when a boat is in motion, but almost all boats have pumps to evacuate the bilge compartment to prevent boats from swamping. These pumps often turn on automatically when water levels rise too high in the boat. The pumping of bilge water laden with fuel and oil is an important source of oil to the marine environment and is often the cause of the oily sheen seen in some harbors or near some marinas.

In the fall of 1999, the Buzzards Bay Action Committee (BBAC) received a grant from the Massachusetts Coastal Zone Management office, through its Coastal Pollution Remediation Program, to provide free bilge oil absorption devices to recreational boaters in Buzzards Bay. These devices are generally referred to as "bilge socks", "bilge pads", or "bilge pillows" depending on their shape. The purpose of this initiative was to raise the awareness of the boating community as to the significance of oil and fuel inputs from boat bilge compartment discharges. Additionally, this initiative was meant to encourage boaters to use oil-absorbing bilge socks to capture this oil and fuel before it is discharged to the marine environment. The grant also provided funds for towns to pay for the establishment of collection sites for the bilge socks, and to pay for their disposal. The Town of Dartmouth, on behalf of the Buzzards Bay municipalities, administered the BBAC grant.

Most boats are expected to require one or two bilge socks during each boating season to capture oil and fuel leaking into their bilge compartments. While each boater would get their first bilge sock free through this program, the expectation is that when boaters see the value of the bilge sock, they will continue to purchase and use them on their own. Although it is believed that bilge socks are not widely used by Buzzards Bay boaters, their typical retail cost of $7 to $12 is not viewed as an impediment if their utility and value is recognized and understood. Another benefit of this program is that Buzzards Bay municipalities and private marinas will continue to provide disposal services for bilge socks.

At the request of the Buzzards Bay Action Committee, the Buzzards Bay Project provided technical assistance in the development of the request for proposals and the testing of the bilge socks. A foremost goal of the BBAC was to implement an easy, clean, and cost effective process for recovering bilge oil. Because of concerns about maintaining recycling equipment, OSHA requirements on operating recycling equipment, and permitting and liability issues that would be involved with keep used oil drums on docks, the use of reusable bilge socks was rejected. Instead, single use socks that could be incinerated at conventional waste disposal facilities was the preferred type of product.

Besides desiring single use disposable socks, the BBAC had interest in a "no-mess" product that physically or chemically bound the oil so that when the sock was removed and transported by the boater, or when dozens of the socks were deposited in storage drum, oil would not seep from the

devices. This was viewed as a very important consideration because the municipalities did not want any potential for oil spills should a storage drum be tipped. Also, it was felt that boaters would be more likely to use a product that did not drip oil on their boat or person.

Response to Request for Bids
Eleven companies submitted bids, but 3 of the companies did not submit products. Based on the literature on the products provided, these products all appeared to be made of polyethylene adsorptive fibers. Of the remaining eight companies, several offered more than one product so that altogether 21 products were submitted. One of the products (a pad) was rejected outright because it did not conform to bid specifications, so that altogether 20 products were tested.

Of the twenty products tested, nine socks consisted of polypropylene fibers, two socks tested (actually one product in two sizes) contained a hydrocarbon absorbing foam, one product contained cellulose, four contained a plasticizing polymer, two had a plasticizing polymer-cellulose blend, and two socks (one product in two sizes) contained emulsifiers with purported bacterial treatment.

Evaluation Criteria
To meet the performance goals identified by the BBAC, the Buzzards Bay Project proposed the following design and performance criteria:

1) The absorbent device must be able to pass through a 3 1/2" inch diameter hole with a 12-inch clearance below the hole. This was meant to simulate small bilge compartments on some boats.

2) The device must have a rope with loop to enable its attachment and removal from within bilges, and to prevent the device from blocking bilge pumps.

3) The device must have a 1.5-quart hydrocarbon capacity.

4) The device does not drip or release oil under moderate pressure.

The manufacture also had to confirm that the product was of a material that would be accepted at conventional waste disposal incineration facilities in Massachusetts.

Materials and Methods
The Town of Dartmouth and Buzzards Bay Action Committee performed tests with technical support and guidance from the Buzzards Bay Project. Len Gonsalves, Executive Director of the

BBAC procured all materials used in the tests, and conducted and oversaw the tests in the presence of several additional municipal officials including fire chiefs and harbormasters.

A bilge compartment port size-test device was constructed as shown in the plans in Figure 2. The purpose of this device was to ensure that the product could be retrieved from boat bilge compartments with 3.5" openings after becoming saturated with hydrocarbons.

Socks being placed in bins.

To evaluate hydrocarbon uptake capacity, one and a half quarts of hydrocarbons composed of 3 cups of engine oil (10W30) and 3 cups of diesel fuel were added to 10-gallon bins containing 7 gallons of fresh water. The bsorbent device was added to the bin and left for 3 days with 1 minute of stirring each day. The bins were kept in an unheated garage. Ambient temperatures in the garage during the test period were approximately 40-50 degrees F. The test site was kept locked and secure.

The device was retrieved after three days and any remaining oil was observed. After the three-day period, the device was evaluated if it passed the three performance tests (absorb 1.5 quarts, pass through the hole, drip test). To evaluate whether the devices released oil under moderate pressure, the absorbent device grasped firmly with two hands and was attempted to be twisted 180 degrees by hand. The individual performing this "twist and squeeze test" applied firm but not too exertive effort, so that even if the device became rigid and could not be twisted 180 degrees as attempted, it would receive about the same pressure as the other devices.

Results

Table 1 summarizes the results of all tests. Five products overtly failed the 1.5-quart hydrocarbon absorption test. Three of these conspicuous failures appeared to be the result of the fact that the products appeared undersized to adsorb the 1.5-quart oil-fuel mix volume. The two emulsifier socks failed to absorbed oil to any appreciable degree as claimed. The manufacture of these products claim that the emulsifiers in the sock break down the oil into smaller droplets, and this oil is then broken down by bacteria in the sock so there is no waste oil to dispose of. The results of this test did not support these claims. Because of these overt failures, these products were not tested further.

Most of the remaining socks appeared successful in removing the 1.5-quart fuel-oil mixture. There actually was some variability in oil uptake final performance in the form of some droplets at the surface, but these proved very difficult to quantify or characterize. The volume of this very small amount of residual oil could have also been influenced by the amount of mixing time and exposure to the sock. Because the remaining 15 socks did not overtly fail the 1.5-quart test, and could be judged to have taken up 95% of the oil, it was determined they passed the hydrocarbon absorption test.

Of the 15 absorbent devices that passed the hydrocarbon uptake test, only one did not pass the hole test. This device, a 4-inch foam cube (5.6" diagonal) could not pass through the 3.5 inch hole. This device also failed the squeeze test.

Of the 14 absorbent devices passing the hydrocarbon absorption and hole tests, 11 failed the twist and squeeze test. In particular, any bilge sock filled exclusively with adsorptive materials like polyethylene or cellulose easily failed the squeeze test. In fact, many of these products dripped a milky water-oil immersion when lifted from the test bins or when placed in trays. The two devices that were composed of polymer-cellulose mix did well in oil uptake, however, they still released oil in the twist and squeeze test. Only three devices passed the twist and squeeze test, and these were the only ones composed exclusively of plasticizing polymer compounds that physically or chemically bound the oil.

Conclusion and Discussion

Only three devices passed all tests and criteria outlined in the Request for Bids. These bilge socks were the only ones composed exclusively of plasticizing polymer compounds. These

passing socks were Bilge Sock G from Dawg Inc., Bilge Sock H, from Dawg Inc., and "Enviro-bond" bilge sock from Lakefront Enterprises. Based on bid price, the Town of Dartmouth and BBAC selected the Enviro-bond sock from Lakefront enterprises.

In presenting the findings of this study, the Buzzards Bay Project is not endorsing or recommending against any of the products tested. Furthermore, the results of these tests should not be considered as invalidating the utility of any products tested in this study, or other comparable devices on the market. The test results in this report were developed to address some very specific needs identified by Buzzards Bay municipalities. For example, many of the oil adsorptive materials and bilge socks composed of polyethylene or other materials can be wrung out and recycled. Thus, these products, which tend to be cheaper than socks containing polymers, can be recycled and reused, and are cheaper for the consumer. If adequate recycling facilities are available, and if properly handled and bagged by the consumer, these products can have utility in many situations.

The only class of products evaluated in this study that have been found by others to be of questionable efficacy in protecting the environment are those products that contain emulsifiers. Although some of these products are composed of natural plant-derived soap-like products, and are themselves biodegradable and non-toxic, their ability to emulsifier oil into small droplets may make the oil more harmful to marine life. In fact, the US Coast Guard and the US EPA expressly prohibit the use of soap products, like dishwashing liquid, to disperse oil spills. Although some of these bilge products contain bacteria that purportedly digest the oil, there has been no independent substantiation of the decomposition of oil in the hours, days or weeks that oil may remain in a bilge compartment before it is pumped overboard. Some government agencies and environmental organizations have questioned the utility of emulsifying products in bilges. For example the Coast Guard and Fisheries and Oceans Department of Canada goes so far as to state "Bilge cleaners, even the biodegradable ones, merely emulsify or break down the oil into tiny, less visible droplets. This process spreads the fluids over a greater volume of water and severely inhibits all forms of marine life from mammals, to fish, to plants, to algae" (http://www.pacific.ccg-gcc.gc.ca/Epages/offboat/pae/bilges.htm).

Table 1. Bilge sock test summary of products submitted in response to the BBAC-Town of Dartmouth request for bid. Only products #7G, #7H, and #5 passed all tests and criteria in the Request for Bids. (NT= Not Tested)							
				initial	**3 day**		
PRODUCT #	**Company-Product**	**Product Type**	**OIL BIN**	**absorption**	**6 cup abs.**	**hole test**	**wring test**
# 1-long	(withheld)	"biological removal", probably emulsifier	1	Low	Fail	Pass	NT
# 1-short	(withheld)	"biological removal", probably emulsifier	2	Low	Fail	Pass	NT
# 7-D-A	(withheld)	polymer-cellulose blend, recommended by App.	3	High	Pass	Pass	Fail
# 7-D-B	(withheld)	polypropylene in polypropylene sock	4	High	Pass	Pass	Fail
# 7-D-C	(withheld)	Cellulose in polypropylene sock	5	High	Pass	Pass	Fail
# 7-D-D	(withheld)	polypropylene in polypropylene sock	6	High	Pass	Pass	Fail
# 7-D-E	(withheld)	polypropylene in polypropylene sock	7	Medium	Pass	Pass	Fail
# 7-D-F	(withheld)	polymer-cellulose Blend	8	Medium	Pass	Pass	Fail
# 7-D-G (pass)	(withheld)	Polymer absorbent	9	Medium	Pass	Pass	Pass
# 7-D-H (pass)	(withheld)	Polymer absorbent	10	Medium	Pass	Pass	Pass
# 5 (pass-selected)	Lakefront Enterprises	envirobond 403 polymer in sock	11	High	Pass	Pass	Pass
# 3	(withheld)	not specified, polymer?	12	High	Pass	Pass	Fail
# 6	(withheld)	polypropylene fibers in sock	13	Low	Fail	Pass	NT
# 9	(withheld)	polypropylene? Sock	18	Low	Fail	Pass	NT
# 8B	(withheld)	Proprietary foam	19	Low	Pass	Fail	Pass
# 8A	(withheld)	Proprietary foam	17	Low	Fail	Fail	NT
# 2	(withheld)	polypropylene fibers in sock	20	Medium	Pass	Pass	Fail
# 4-No product submitted	(withheld)	polypropylene fibers in sock	NA				
# 10-No product submitted	(withheld)	meltblown polypropylene in nylon sock	NA				
# 11-No product submitted	(withheld)	meltblown polypropylene	NA				
# 9B -square pad rejected	(withheld)-pad	square pad equivalent to sock in # 9	rejected				