The Australian Boom and Baffle Company

GPF 500 CONTAINMENT BOOM

Operations & Maintenance Manual

Table of Contents

GPF 500 boom Deployed to protect foreshore

GPF 500 Boom deployed to contain oil against shoreline to facilitate cleanup

Boom Description and Specifications

GPF 500 containment boom is a high end calm water general purpose fence type containment boom used for:

- Control and containment of marine oil spills
- Control of floating debris on inland waterways
- Management of floating noxious weeds

GPF 500 is constructed in a manner which optimises storage, transport and deployment with a minimum requirement for ancilliary equipment such as inflators, winders etc. integrated closed cell Polyethylene Foam buoyancy, webbing tension reinforcement and heavy coated base fabric enables the boom to continue effective operation even after sustaining considerable skirt damage.

Conforming Standards

GPF 500 containment boom either conform to or exceeds the following international standards relating to oil spill response booms:

- ASTM F 1523 Guideline line for the Selection of Booms According to Water Body Classification
- ASTM F 1093-91 Tensile strength Characteristics of Oil Spill Response Boom
- ASTM F 715-95 Membrane Strength
- ASTM F 962 End Connection of Oil Spill Response Booms

ASTM Standard		**Parameter**	**GPF500**
ASTM F 1523	**Height (mm)**	**150-600mm**	**500**
	Minimum skirt strength	**2.6kn N/50mm**	**3.5 N/50mm**
	Minimum skirt tear	**450N**	**1000 x 800 N**
ASTM F 1093	**Minimum tensile strength**	**6.8kN**	**68kN**
ASTM F 715	**Minimum skirt strength**	**2.6kn N/50mm**	**3.5 N/50mm**
	Minimum skirt tear	**450N**	**1000 x 800 N**
ASTM F 962		**Z Pattern hook**	**Yes**
	Up to 600mm height	**1 pin**	**2 provided**

GPF 500 Specifications

Dimensions	**Height**	**500mm**
	Freeboard	**150mm**
	Skirt depth	**350mm**
	Section Length	**20m**
Floatation	**TPFI PE 30 Closed cell Polyethylene foam 20mm sheet**	
Reinforcing	**2 of 38mm polyester webbing BL each 20kN**	
Vertical Stiffening	**13 x 4.6mm vinylester No 3 batten**	
Ballast	**6mm proof coil galvanised chain**	
Skirt Material	**Sioen B6000 PVC Membrane**	**900 gsm polyester reinforced**
Connector	**ASTM 962 pattern**	**10mm drop nose pin fitted with conical spring**
Rack hangers	**ABBCo poly slides 6mm**	
Weight per lineal metre	**2.3kg**	
Weight per 20m length	**46kg**	
Weight 5 lengths + rack	**300kg**	
Storage rack	**Contains**	**5 lengths (100m)**
	Dimensions	**2.4mmLx1.2mHx0.6mH**
	Stackable	**Yes**
	Workshop mobility	**Removable wheel sets**
	Rack weight	**70kg**

Repair Kit

<u>Repair Kit Contents</u>

Repair Adhesive	**HH-66 2 of 32oz cans**
Skirt Patch material	**3m^2 skirt fabric in square and strips**
Drop Nose pins	**20**
Rack hangers ABBCo poly slides 6mm	**20**
Silicon slide lubricant	**1 litre**
ASTM 962 Connector	**Cut and drilled to suit height of boom**

Three Racks GPF 500 each containing 100m of containment boom

Five racks one high for transport total boom length 500m

Using the GPF 500

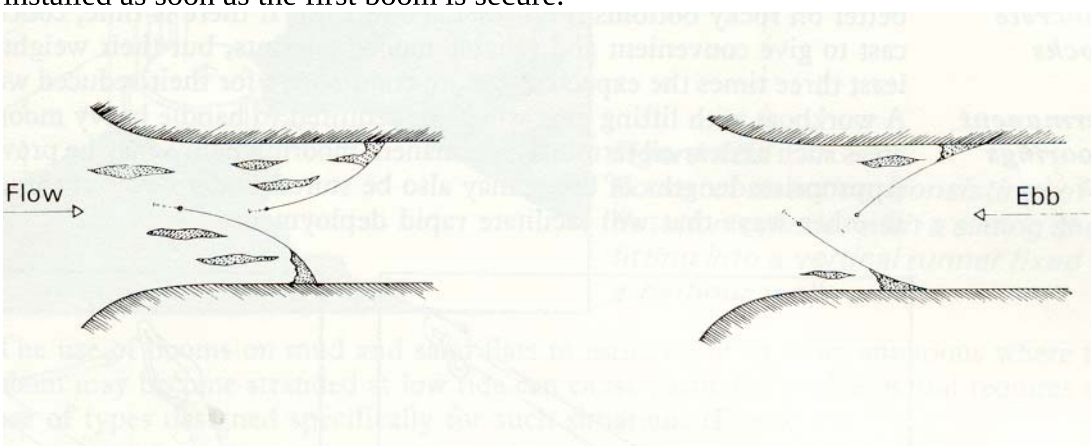
Deploying the Oil Boom

A plan should be made up in advance for securing the boom at your boom deployment site. You may be using buoys and anchors, bulk head risers or a combination of both. The shore termination may require a channel to be dug with an excavator or back-hoe.
If the boom is part of a permanent installation, there will be facilities available, such as a bulkhead riser and preplaced buoys and anchors, to which it may be attached. If you have a bulkhead riser, attach the free end of it first. Otherwise when a load builds up on the boom, you may not be able to connect it. You have a long length of boom, do not attempt to pull all of it against the current. Anchor points are provided on many booms, which provide convenient intermediate towing points. You may have to pull only 30m of boom against a current instead of the whole length.

If you predetermine that your shore termination requires an excavation, you should have a shovel with you, or already have had a backhoe dispatched to the recovery site. If the boom has to be anchored against a current from the shoreline, proceed to the shoreline spot where the boom will terminate. Secure the end of the boom that is being towed at the shoreline and then proceed downstream to pick up the other end. If you proceed upstream again, very closely to the boom and along the shoreline, the boat will have very little difficulty. However, if you attempt to swing wide out into the current, you may never reach your upstream mooring spot. When the boom end that you are towing is further upstream than you had planned on mooring it, you can swing out into the current and proceed to the spot where you will drop your upstream anchor.

If current direction changes, buoys and anchors should be used on both sides of the boom.All spill booms should be monitored for change in wind and tide. Many spills have escaped because no one slacked off on a tight line as the tide went out. Every boom that is actually performing a function should have a man assigned to it whose responsibility is to adjust the position periodically, and either stop or notify you of any leaks. The same situation applies to a boom that is part of a permanent installation around vessels when they are transferring cargo.

Quick changes in wind direction are common so a second boom to enclose the spill should be installed as soon as the first boom is secure.



When booming a narrow channel angle booms to divert to shore for recovery

NOTE
Always use a bridle when towing an oil boom. Simply attaching the boom to one cleat or the other will make steering the boat very difficult.

Deploying an oil boom looks easy. Wind and current begin exerting a force on the oil boom as soon as it is in the water. The success or failure of the operation often depends entirely upon the boat operator and his ability to judge the movements of the boom.

GPF 500 configured in hanging racks to facilitate transport and deployment

When the boat crew arrives at the boom storage location, they should attach the tow line onto a bridle or towing bit. Do not attempt to hold the rope. Pull the first few sections of boom straight out before increasing speed. If a current is running, head the boat up into the current so that the boom comes straight out from the storage area. The exact angle that you head into the current can only be determined by practice at your location.

Do not attempt to go too fast when launching the boom. You could subject the boom or anyone foolish enough to stand near it on the shoreline.

When making turns, the boat should slow down until at least the first 6 metres of the boom is in line with the boat. This procedure will prevent the boom from rolling and twisting on turns. Once the turn is completed, the boat can speed up again.

Sweeping

Because sweeping is extremely inefficient, it is not recommended for general practice. However, there are times when sweeping is the only technique which will work.

Once oil has been collected in the boom, a slow turn is made to shoreward to tow the oil into a still water location. The boom can then be secured in this location to allow recovery of the oil. The two boats can then proceed out into the river to continue operations.

Sweeping operations should only be attempted with optimum radio communications and highly skilled boat handlers. Careful pre-planning and drilling is essential!

If you do have extremely serious conditions and no other recovery technique is available, it then becomes feasible to use a sweeping technique as described.

The boats must maintain a shallow arch in the boom to prevent an apex from forming, otherwise the oil will be lost.

Recovery, Cleaning and Repairing Oil Booms

Recovery

After the cleanup is officially terminated it is necessary to remove the oil boom, clean it, and return it to its storage area or redeploy it. This is very important since its condition may make it unusable until it is cleaned and/or repaired.

Cleaning

When cleanup has begun make sure that the oily residue does not run back into a navigable waterway and create another pollution incident. Use a properly constructed washdown bay or establish a suitable area, line it with plastic sheeting, and begin cleaning booms. Three trays, each slightly larger than a section or group of sections of boom, should be available for the soaking steps. The first tray should contain kerosene or diesel, which will cut any heavy oil accumulations on the outside of the boom. A long bristled, stiff scrub brush can be used to help loosen the sludge. (If the boom has been deployed to contain light oil or debris this first step may not be required)

The second tray should contain a mixture of water and a quick break detergent proven to be effective. This strong detergent solution will wash away any primary cleaner and accumulations of grime on the outside of the boom. Again a little elbow grease and a stiff brush will help to loosen any material that may remain. Do not use wire brushes.

The third tray utilises clean water or ideally a pressure washer, which uses clean water under high pressure. Any remaining detergent is rinsed away leaving a clean boom. Do not use steam or hot water. The boom should be allowed to dry before inspection and restowing.

Note: Prior to restowing boom in transport and deployment racks lubricate rails with silicon lubricant provided in repair kit.

Inspect the boom very carefully. Loose or missing parts should be replaced. Sections destroyed beyond repair should be removed and the boom spliced in the manner recommended by the manufacturer. When replacing the boom in storage, do it carefully, as you will want to launch it just as you did the first time without snagging or sustaining damage. If you are replacing it in storage directly from the water, a small boat should be made available to help keep it away from any snags.

Repair

All booms should be inspected and repaired immediately after cleaning. Apply patches in accordance with directions on HH-66 vinyl cement tin taking care to round corners of patches with scissors to limit peeling.

Forces Acting on Booms

Generally, there are three forces which are imposed on an oil boom while it is being used. These forces are current loading, wind loading, and loads imposed while towing.

Current Loading

Current is the strongest of the forces affecting boom loading. To estimate the force F_c(kg) exerted on a boom with a subsurface area As (m^2) by a current with velocity Vc (knots) the following formula can be used:

$F_c = 26 \times A_x \times V_c2$

Thus, the force acting on a 100m length of boom with an 0.6m skirt placed at right angles to an 0.5 knot water flow would be:

$F_c = 26 \times (0.6 \times 100) \times (0.5)^2 = 390$ kg (force)

Wind Loading

Wind loading has a secondary effect except in the absence of current where it will have the primary effect. A strong gusting wind working against a slow to medium current will force a boom to move back and forth alternately with the effects of the opposing forces. When wind and current are moving together, the total load on a boom can be calculated by adding the two together. When they are opposed to each other, however, the effects are not merely subtracted because wind doesn't blow at a constant force. Formula 2 is used for calculating wind loading.

Formula 2

The force (Fw) exerted by wind (Vw) directly on the freeboard (Af) of the boom can also be considerable. A similar formula can be used to estimate windage:

$$Fw = 26 \times Af \; \frac{(Vw)^2}{(40)}$$

For example, the force on a 100m length of boom with an 0.5 freeboard in a 15 knot wind would be:

$$Fw = 26\,(0.5 \times 100)^2 \times \frac{(15)^2}{(40)} = 183 \text{ kg force}$$

Effects of Waves

Waves greatly affect the overall efficiency of booms. Choppy waves are very difficult to deal with because the boom must be very flexible.

An assumption should be made that no boom or skimmer will ever be 100% effective. Its effectiveness will vary according to a multitude of conditions such as:

1. wave length to height ratio

2. temperatures - water and ambient.

3. wind direction, particularly when the wind is not in the exact same direction as the waves.

Towing Loads

Wind and current loads are encountered when a boom is at anchor. Towing loads are experienced when a boom is dragged through the water from place to place. Towing loads are a function of the size and material characteristics of the boom being towed. Booms exposing wide frontal areas with rough surface areas will offer more drag than booms offering a narrow profile and smooth streamlined surfaces. Towing loads are determined empirically since every boom has its own drag characteristics. The total towing load in pounds per linear foot is required when selecting a boat and the horsepower of the engine required.

Oil Movement on Water

Movement of oil on water, due to the water interface, is theoretically independent of current direction, however, current will affect direction with winds of less than 7 knots. When dealing with winds of 7 knots or greater, wind will become a primary driving force controlling the rate of spread. Waves can also have an effect on the drift rate, however, the exact rate will be determined by the ambient temperature and the type and quality of oil spilled.

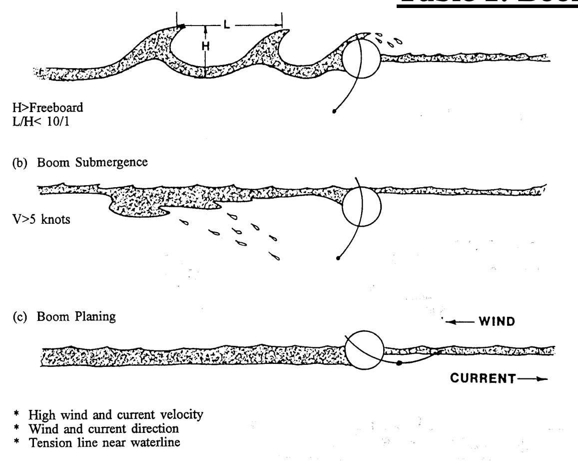
Oil on Rivers and Streams

We have just indicated that oil on the surface of the water will move with the wind. In moving streams this remains true. However, as the current velocities increase, the influence of the current becomes greater and greater.

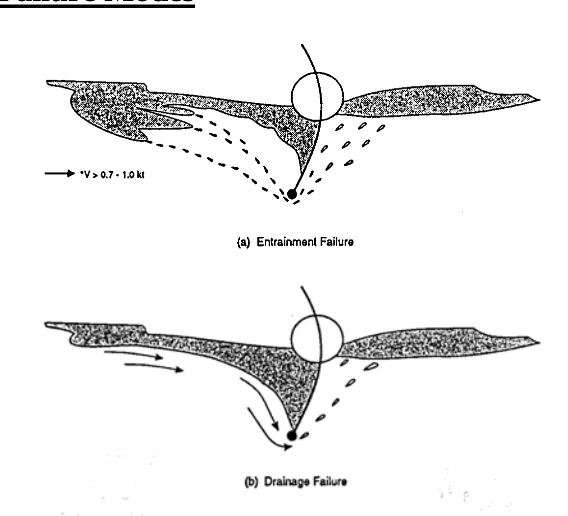
The velocity of the water in a stream is not equal at all points across the stream. Higher velocities are generally encountered in the deeper parts of the stream and the outside of curves in the stream. Changes in velocity will have a substantial affect on movement of oil on a stream.

Almost every stream with fast moving currents has numerous back eddies or relatively still water sections. These occur primarily where there are indentations in the bank. If booms are deployed in such a way as to guide the oil into these areas, control and removal is made much easier. Where there are no such locations available, it is recommended that a backhoe or similar piece of machinery be used to make an indentation.

<u>Table 1: Boom Failure Modes</u>



Wind, waves and current limit the effectiveness of booms. These forces should be considered prior to boom deployment



Entrainment and drainage failure can occur as a result of excessive accumulation of oil or debris behind a boom

Effect of Current on Oil Contained by Booms

When an oil spill barrier is placed in the water, it acts like a dam. In a moving body of water, the surface water being held back by the dam will accelerate in an attempt to keep up with the water flowing under the boom (dam). The velocity of the surface water flowing past the bottom edge of the skirt is a function of the skirt depth. As the skirt depth increases, so will the distance that the restricted water has to travel to catch up to the main stream. As the velocity of the water travelling under the skirt increases, material at the surface is drawn under the boom. The speed at which material is drawn under the skirt is referred to as critical velocity. This suction effect accounts for most of the loss of oil from the up current side of the boom.

Critical velocity varies with skirt depth, viscosity, film thickness, and specific gravity of the oils spilled. Escapements of oil in this manner usually occur when a boom is moored or towed in the catenary configuration (sweeping movements etc).

Table 2 indicated maximum allowable skirt depth vs. maximum water velocity. For example, when water is moving at 41m/min. a boom having a skirt depth of 150mm or greater will not effectively contain oil if the boom is placed perpendicular to the current. However, this situation can be alleviated or even overcome by placing the boom on an angle to the current as discussed in subsequent paragraphs. Angling the boom to the current in such a manner not only helps to prevent oil loss from the boom, but it is a method that can and is frequently used to direct the spilled material to an area that will facilitate effective recovery. This is one of those times if adequate thought is used, that you can set up, in a manner that will let nature help, not hinder you.

Critical velocities for various depths of skirt				
SKIRT DEPTH	150mm	300mm	450mm	600mm
Critical Velocity for heavy oil	41m/min	33.5m/min	24.5/min	16m/min

For this reason it is strongly recommended that dual booming be used in any current in excess of 0.9 knots (27.8 m/min), regardless of the boom utilised.

It should be noted in using this technique the second boom should be down stream approximately 1.2m to 1.8m of the first boom. It is also recommended that the upstream boom be terminated at least 3.0m away from the shore.

In any case where booms are used in excess of 0.9 knots (27.8m/min) it is absolutely essential that oil removal start immediately.

Escape of oil at the face of the Boom

Refer Table 1 page 10 Entrainment and Drainage Failure: You will note the maximum depth of oil does not occur directly at the face of the boom but at a distance of 1.22m to 1.83m in front of the boom. When the critical velocity has been reached, oil will first start to escape from the head wave. There is a considerable droplet breakaway. Shortly thereafter (with an increase in velocity of only 1.52 to 3.05 m/m small sheets of oil will commence to escape.

Using oil Booms in Currents

We have discussed that containment of oil in velocities in excess of .9 knots 27.43 m/min appears impossible. Fortunately, this is not the case and by proper deployment and utilisation of booms this phenomena of oil escapement can be controlled.

There are two basic items one should do in high current situations. The first is to angle a boom (refer Table 3). By angling a boom one reduces the actual velocity to an apparent velocity against the face of the boom. While this will not stop escape of oil entirely but it will reduce it and allow you to handle the oil by utilising a two stage booming system.

Negative pressure is created on the backside of a boom. What this means is that the oil will come to the surface directly behind the boom and tend to follow an angled boom downstream. By double booming this oil can readily be carried to a collection point at the shoreline.

At the shoreline there is normally low current, if any. If a high current does exist at this point, it is recommended that a section of the boom be removed to allow for an adequate collection point for oil removal. It is essential that oil be removed rapidly under the above conditions, or the oil will escape through entrainment and drainage.

Table 3: Angles to reduce apparent velocity of current

True Water Velocity Knots	True Water Velocity Metres/min.	Angle
1.01	31.18	30^o
1.06	32.72	35^o
1.11	34.26	40^o
1.18	36.42	45^o
1.27	39.2	50^o
1.39	42.9	55^o
1.53	47.23	60^o
1.72	53.09	65^o
1.98	61.12	70^o
Above the relative velocity of .9 knots, (27.78m per min.) double booming is recommended		