Low-volume, medium-expansion foam nozzle
...from your workshop

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Introduction
Class A wildland foam is a very useful tool for both fire suppression and prescribed fire operations. A particularly useful version is medium expansion foam. It can be used in direct attack, blanketing fuels in mop-up, protecting selected resources and anchoring and building wetlines for backfiring, burnout and prescribed fire operations.

Commercially available medium expansion, aspirating nozzles are expensive. Typically, prices range from $300 to $500 per unit. Additionally, these nozzles are all designed to work with flow rates in excess of 50 GPM.

The U.S. Fish and Wildlife Services (FWS) actively manages over 91 million acres of wildlife habitat as the national Wildlife Refuge System. Prescribed fire is a primary tool. Most refuges are equipped with small slip-on packages varying in capacity from 75 to 200 gallons. The small water tank capacities of most FWS engines combined with limited funding suggested that an alternative to current nozzles be developed. Most other resource agencies, including the Bureau of Land Management (BLM), also experience this problem. All are looking to minimize costs of equipment, yet still accomplish the tasks of the job.

The BLM program at the Boise Interagency Fire Center includes a Foam Technology Development group. As part of the many foam workshops this group presents, one demonstration shows the basics behind generating aspirating medium-expansion foam. The demonstration is done with a 4-

(See FROM YOUR SHOP..., p. 2)
inch stove pipe with screening taped over the end and a KK variable pattern type nozzle found in NFES caches. The results are crude, but low- to medium-expansion foam is generated.

A medium expansion nozzle was built using simple materials, available at local hardware and plumbing suppliers, and through the NFES caches. The design of the nozzle then could be used by any agency wishing to produce a low-cost efficient nozzle.

By using the 1-inch KK variable-pattern type nozzle, the resulting foam nozzle has the flexibility to produce both low-expansion foam (discharge distance 30 ft.) and medium-expansion foam (discharge distance 15 feet). Another benefit is it also allows the nozzle to deliver foam solution at either the 10 gpm or 24 gpm flow rate. One can see these flow ranges are well below the 50 gpm flows most commercially-produced nozzles operate at.

Note: For higher flows and more expansion, a 12- to 14-inch length of 8-inch diameter PVC pipe can be used along with a 1-1/2” KK variable-pattern type nozzle (NFES 1082; GSA 4210-01-167-1123). This nozzle allows the operator to deliver foam solution at either the 40 gpm or 60 gpm flow rate.

Most aspects of assembly are not critical. However, for best foam production and discharge distance, the nozzle must be centered within the opening of the PVC pipe. This is critical because if the nozzle is not completely centered and balanced, foam production is dramatically decreased.

To determine the three places to mount the brackets, place a piece of string around the PVC pipe’s circumference. Mark the spot where the string meets itself and cut off the excess string. Next, divide and cut the string into three equal parts. One piece of string will be the “measuring tool.” Place the measuring tool in an arc on the PVC pipe edge, and mark the beginning and ending point. At the ending point, place the measuring tool in another arc and mark. (See Figure 1).

To mount stock brackets: Wrap string around circumference of PVC pipe. Cut away excess string. Cut string into 3 equal pieces. Use one piece of string to measure 1/3. Mark pipe at each end of the string until there are 3 marks on the pipe. Drill holes through PVC pipe where marked.

At these three points, measure down 1/2", and drill a 1/4" hole. These will become the anchor points for the brackets. This will also become the rear end of the medium nozzle. Now mount the strap handle parallel with the pipe length on the outside and halfway down the PVC pipe. The exact location does not matter.

Using the 1/2” flat stock material, build the brackets to hold the KK nozzle to the PVC pipe. Cut the flat stock material into three straps 5-1/4 inches long. On each strap, drill one 1/4” hole, with the edge a half-inch from the end of the stock (the center of the hole will be 5/8ths of an inch). The measurements to bend the straps into brackets will be taken from these drilled hole ends. All three brackets will be bent in the same way.

Measure two inches along the strap. This is the location of the first 90-degree bend. Now measure another 1-3/4 inches. This is the next point to make a 90-degree bend. The two bends made to the finished bracket will look somewhat like a “Z” (with 90-degree corners). The ending run, or “tang,” which is about 1-1/2 inches long, is where the KK nozzle will be attached. It should be the (see ASSEMBLY, p. 5)

Mount stock brackets with nuts, bolts and washers as shown. Insert nozzle within brackets. Nozzle should be centered. Attach handle.
Place the KK nozzle between the tangs with the KK nozzle tip pointing towards the front of the medium nozzle. Place the small hose clamp over the tangs and nozzle, then screw tight. This action will compress the tangs against the KK nozzle and secure it in a centered position. Make sure the tangs do not interfere with the twist open/close action of the nozzle. (See Figure 3)

Next comes the nylon window screening, used to fracture the foam solution stream that is flowing through the PVC pipe. Building the two fracturing screens is simple. Take the 20" screen, and fold two opposite corners together to form a triangle. Sew up (with an ordinary sewing machine) one side of the triangle-shaped screen, forming a conical screen. (Figure 4).

Place the 10" screen over the non-drilled end of the PVC pipe, and then the conical-shaped screen over the 10" screen. The 10" screen should be flat across the end of the pipe. The conical screen should be pulled down tightly over the pipe opening and the conical-shaped screen should form a cone (big to small) from the front end of the PVC pipe. Cut off excess screening around the hose clamp. (Figure 5).

The inexpensive, low volume, medium-expansion nozzle is now complete. The materials used to build this nozzle cost roughly $35.

Adjusting the nozzle

A brief explanation of how the KK variable-pattern nozzle works is needed to understand how to produce low- as well as medium-expansion foam. Both the 1-inch and the 1-1/2 inch nozzle have a two-setting gpm flow range. At 100 p.s.i., the 1" nozzle has a 10 and a 24 gpm range. The 1-1/2" has a 20 and a 40 gpm range at 100 p.s.i.

These nozzles are also capable of producing variable-flow patterns, from straight stream to a fog pattern in both ranges. By using the flow pattern and the different gpm settings, we can create low-expansion foam as well as medium-expansion foams.
Now you've made your own low-volume, medium-expansion foam nozzle, here are

...Test results

The resulting nozzles were tested to measure their flow rates and foam-expansion ratios. By using an automatic regulated proportioner, we were able to monitor and set both flow rates and concentrate mix ratios. The concentrate mix ratio was set at five-tenths (0.5) per cent and remained constant during all flow volumes. Expansion ratios were determined by collecting the foam generated from a timed volume of solution flow at a set nozzle pressure of 70 psi, and then measuring the volume of foam.

The two nozzles were compared to the Angus MEX225 medium-expansion nozzle, the closest performing commercially available nozzle. The results are by no means to be considered scientific. They are rough field evaluations, but they do give a feel for the nozzle's performance.

(See Chart this page)

### Nozzle Discharge and Expansion Rates

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Flow Rate (gpm)</th>
<th>Discharge Distance (feet)</th>
<th>Expansion Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus MEX225</td>
<td>55</td>
<td>13</td>
<td>70/1</td>
</tr>
<tr>
<td>6&quot; med., SS low</td>
<td>7</td>
<td>12</td>
<td>25/1</td>
</tr>
<tr>
<td>6&quot; med., FG low</td>
<td>11</td>
<td>5</td>
<td>50/1</td>
</tr>
<tr>
<td>6&quot; med., SS high</td>
<td>25</td>
<td>25</td>
<td>70/1</td>
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<tr>
<td>6&quot; med., FG high</td>
<td>26</td>
<td>12</td>
<td>80/1</td>
</tr>
<tr>
<td>8&quot; med., SS low</td>
<td>20</td>
<td>10</td>
<td>80/1</td>
</tr>
<tr>
<td>8&quot; med., FG low</td>
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<td>8&quot; med., FG high</td>
<td>40</td>
<td>21</td>
<td>80/1</td>
</tr>
<tr>
<td>8&quot; med., FG high</td>
<td>42</td>
<td>7</td>
<td>80/1</td>
</tr>
</tbody>
</table>

SS = Straight Steam    FG = Fog Pattern
Low = Low flow end of variable pattern nozzle
High = High flow end of variable pattern nozzle

(1) "Expansion Ratio" compares the Gallons of Foam produced to each Gallon of Water. "Medium-expansion" foam falls in the range of 20/1 to 80/1. There is no one "best" or "preferred" ratio, since the various tasks — direct attack, mop-up, wetlines, etc. — have their own requirements.

### Conclusion

By following these instructions you should be able to make an inexpensive, low-volume, medium-expansion foam nozzle. By doing some experimentation, i.e., adding or subtracting screens, regulating pressures, changing flow patterns, you could get different expansion ratios and varying discharge distances to meet different objectives.