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March 20, 2002

Subject: M4 Carbine Flash Suppressor Test and Evaluation

Background: Many different flash suppressors have been used on the M16 Rifle and M4 Carbine. These flash suppressors are designed to reduce flash and dispersion. The goal of this testing was to compare the intensity of the flash and dispersion of the M4 Carbine when using various suppressors.

Testing: Testing was performed on January 14 and January 17, 2002 in the Armament Technology Facility at Picatinny Arsenal. The M16A1 Open Ended, M16A1, M16A2, XM-177, and Vortex flash suppressors were tested (see Figure 1).

Figure 1. Flash Suppressors Tested

An almost new M4 (s/n W000442) was used throughout the testing. It was rigidly mounted in a firing test fixture (see Figure 2). Standard M855 ball ammo from the same lot was used throughout testing.

Figure 2. M4 In Test Fixture

Single and three round bursts were fired from a cold barrel. The flash intensity was recorded in two different ways, using a Polaroid Camera and a Sony Digital Video Camera. During the recording process, the lights in the test range were turned off. The lens of the Polaroid camera was kept open for the duration of the burst. This gave an image that was the sum of the flash coming from the suppressor. In the first series of tests, the Polaroid and the Video camera were placed to the side of the weapon (see Figures 3, 4 and 5).

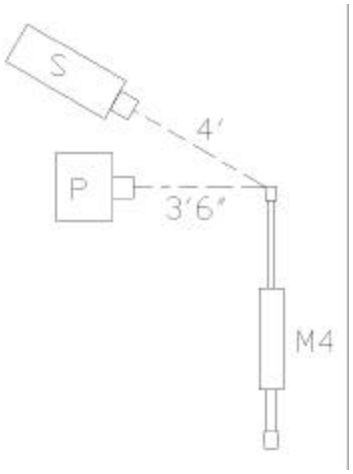

Figure 3. Polaroid and Video Camera Setup - Side View

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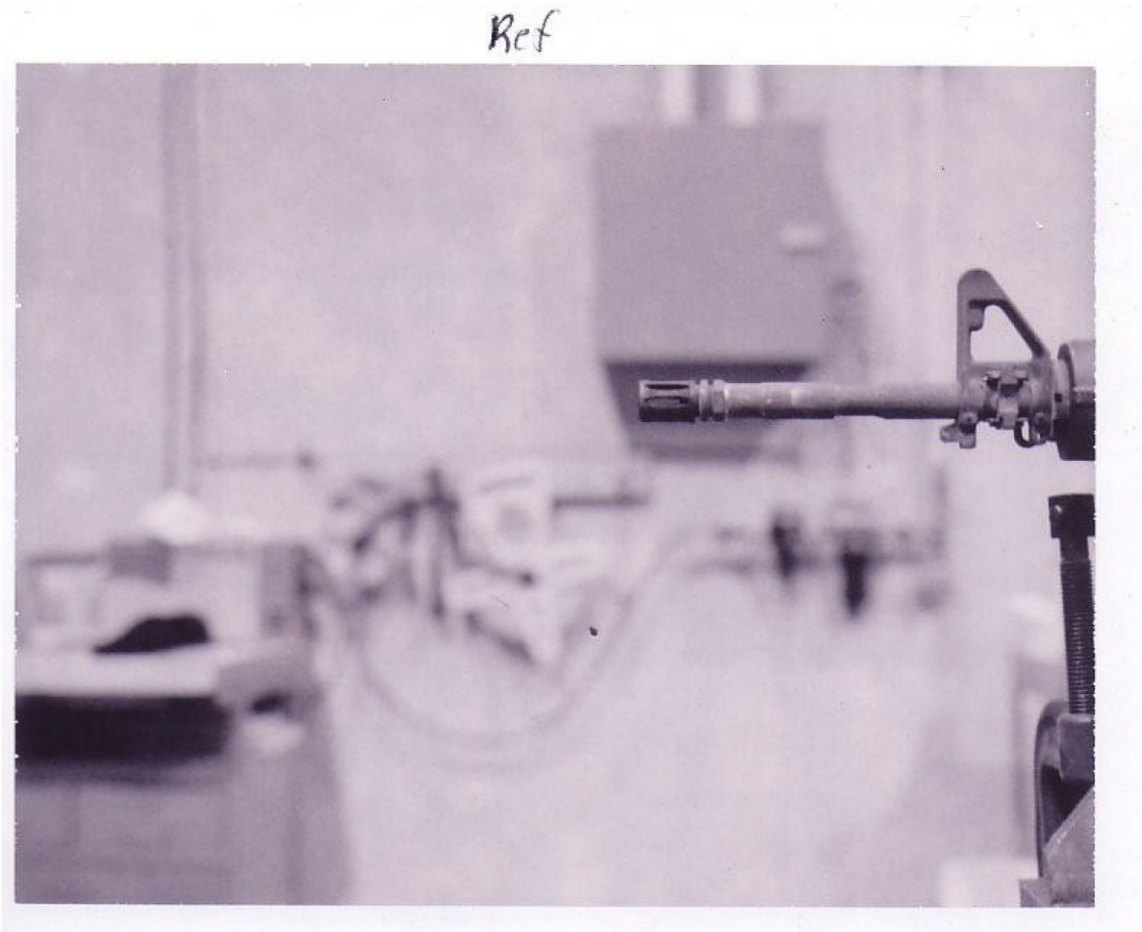

Figure 4. Reference Picture from Polaroid Camera - Side View Barrel

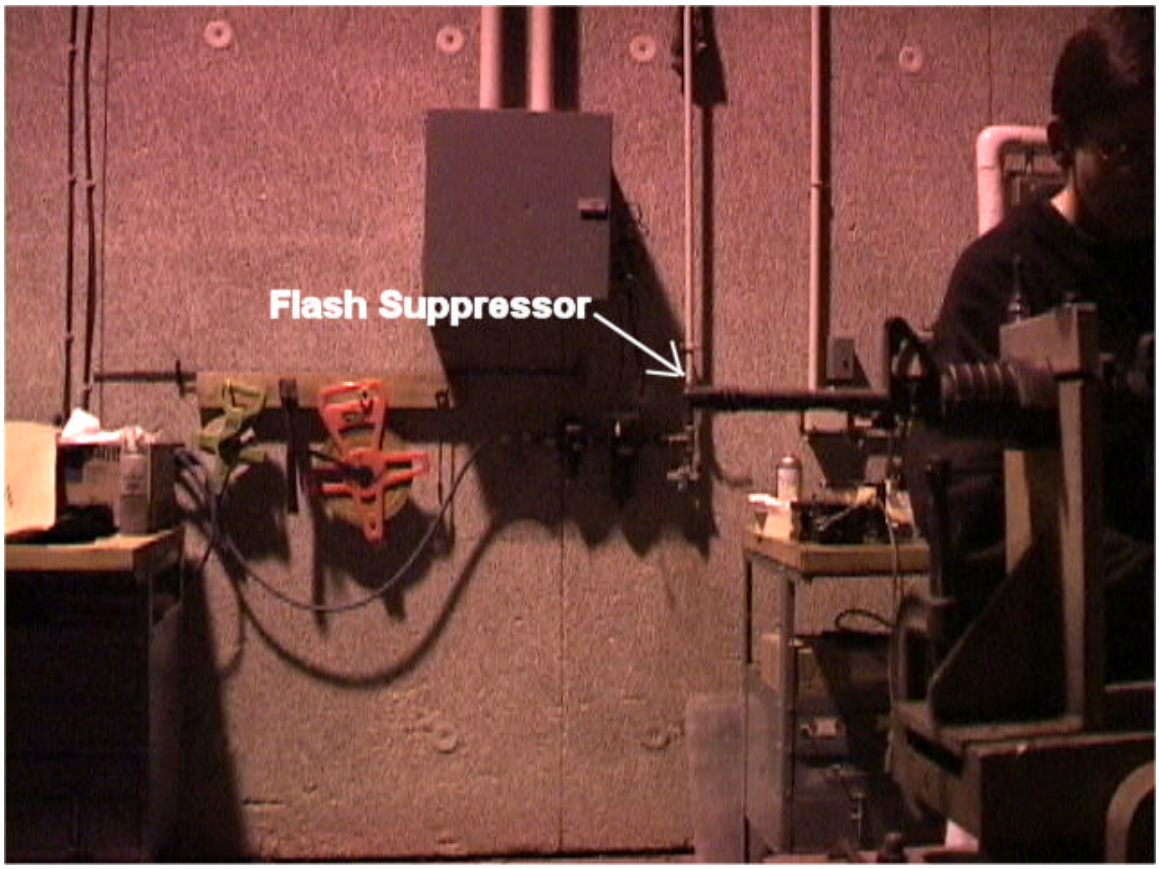

Figure 5. Reference Frame Grab from Video Camera - Side View Barrel

The Polaroid and Video camera were placed in front of the weapon in the second series of tests. The cameras were offset 1 foot from the centerline of the barrel. The Polaroid camera and the Sony Video camera were 26° and 17° off center respectively (see Figures 6, 7 and 8).

Figure 6. Polaroid and Video Camera Setup - Front View

Figure 7. Reference Picture from Polaroid Camera - Front View

Figure 8. Reference Picture from Video Camera - Front View

In both orientations, three series of three round bursts were fired then one single shot was fired. Large paper targets were set up 50m down range. After each burst, the impact area was marked to indicate which flash suppressor was being used so dispersion could be calculated.

Test Results: The Polaroid and the video camera showed noticeable differences between the intensity of the flash from the different suppressors. Due to difficulty in determining optimum shutter speed of the video camera, not all of the video data was useful. One Polaroid picture from the 3-round bursts for each suppressor from the side and front views is shown below (see Figures 9 and 10). These pictures were representative of the average flash of a 3-round burst for each suppressor. The single round photos showed similar images with less intensity in the picture so they have not been included.

Note: The M16A1 Suppressor was not tested.

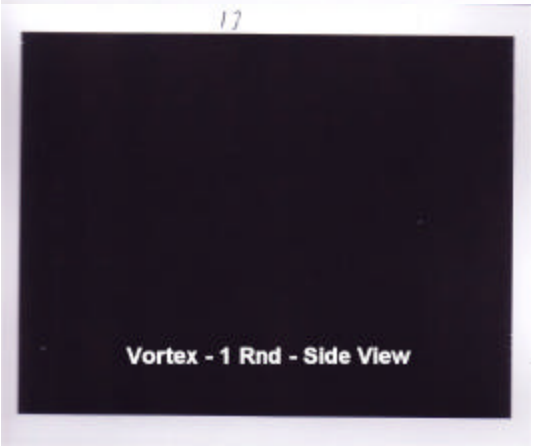

Figure 9 - Polaroid Pictures of 3-Round Burst - Side Views

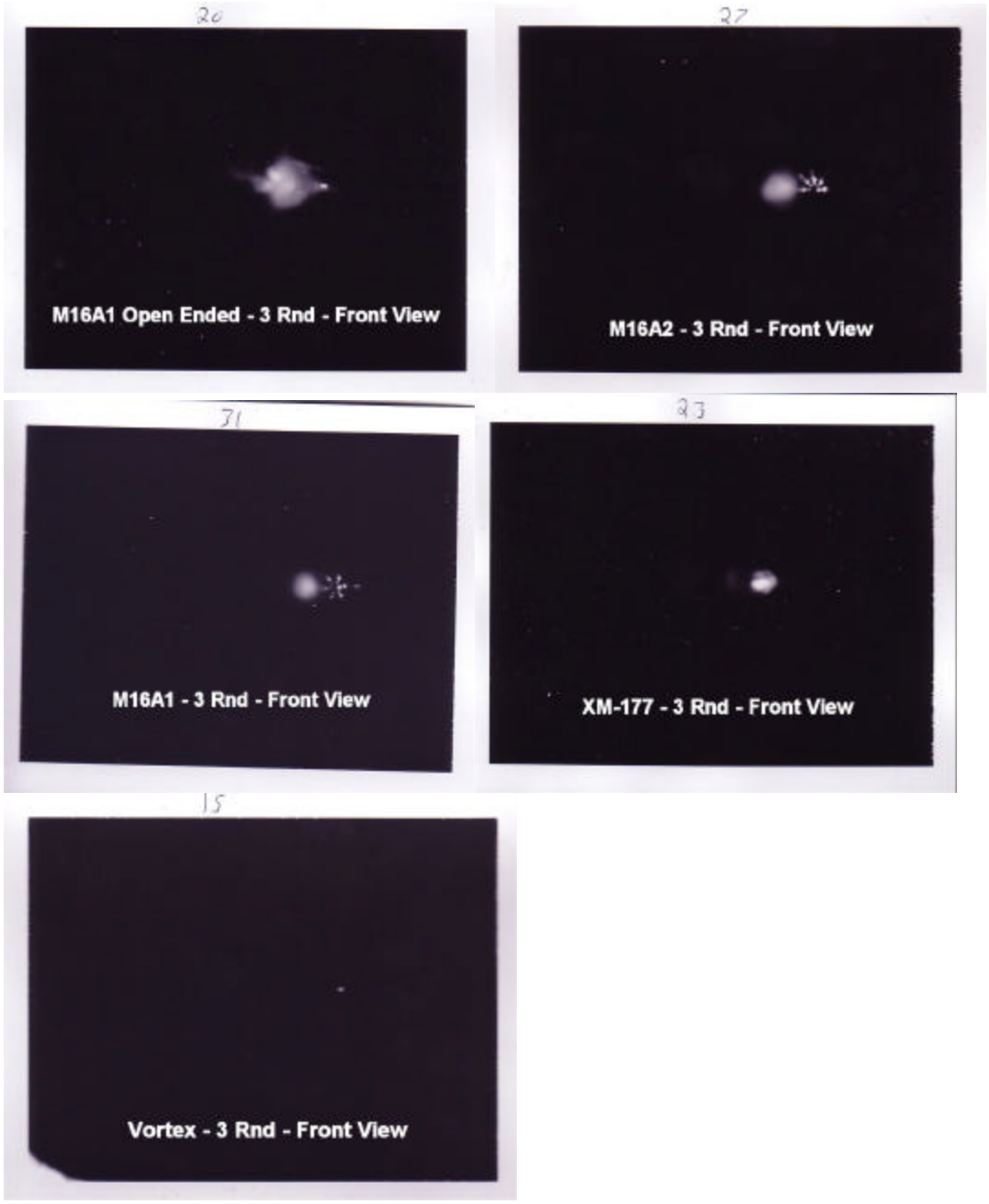

Figure 10. Polaroid Pictures of 3-Round Burst - Front Views

Although the video camera did not always provide conclusive results, there were some frames that were quite clear (see Figure 11).

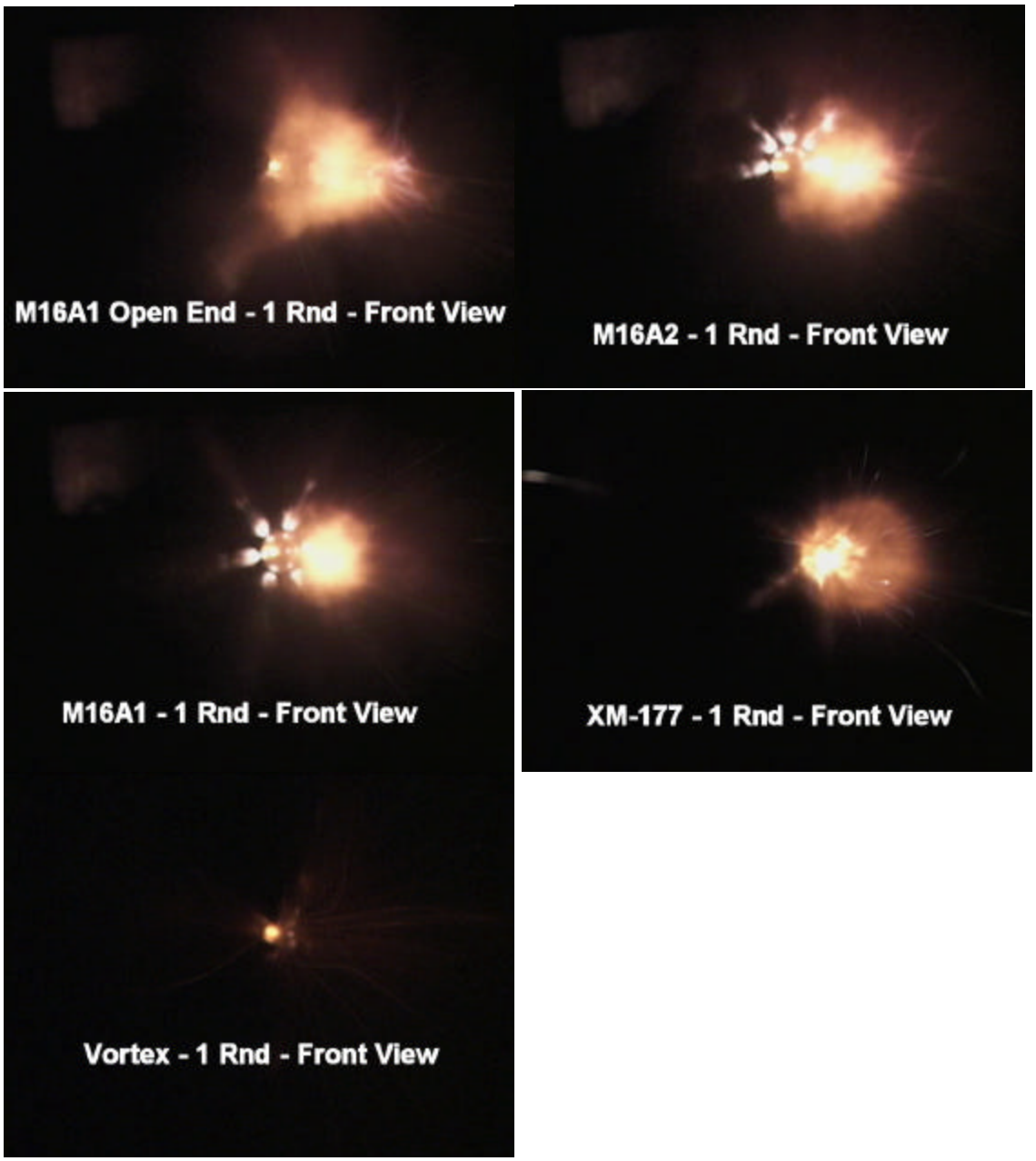

Figure 11 - Digital Video Camera Frame Grab of 1-Round Shot - Front Views

The dispersion data collected during this test is provided below:

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	Average Radius of Burst (in)	Average Standard Deviation (in)
M16A1 Open Ended	1.83	0.78
M16A1	2.07	0.71
M16A2	2.1	0.73
XM-177	2.99	1.6
Vortex	1.62	0.85
Average	1.77	0.78

Conclusions: The open-ended flash suppressors (with the exception of the M16A1 open ended) substantially reduce the flash emitted from the M4 carbine during single shot and burst. The evidence of this is clear from the Polaroid pictures and digital video. The order from best to worst regarding flash appears to be:

1. Vortex
2. XM-177
3. M16A2
4. M16A1
5. M16A1 Open Ended

The M16A2, M16A1, and M16A1 Open Ended had very similar flash intensities. At times the flash from the suppressors seemed to be larger than or smaller than usual. There are many possible reasons for this, so it is not possible to say for sure that one suppressor will always be better than another. However, during this testing the Vortex suppressor had the smallest flash on average.

It can be seen from the dispersion data that Vortex also had the smallest average shot grouping of 1.62" at 50 meters. The M16A1 and M16A2 were very close in regards to dispersion. The order from best to worst was:

1. Vortex
2. M16A1 Open Ended
3. M16A1
4. M16A2
5. XM-177

Future Testing and Evaluation: In future testing, the video camera aperture speed should be set to a speed of 30 (the aperture will be open for 1/30 of a second per frame). This will give a picture that may not be as sharp, but it will contain the entire flash emanating from the weapon. During the testing, the aperture speed was set to 60 (the aperture will be open for 1/60 of a second per frame). The frame rate of the video camera is 30 frames per second, so the aperture was actually only open half of the time.

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Additional dispersion testing should be conducted with a minimum 10-rounds fired in semi-auto mode to confirm the results of the dispersion test.

Compatibility with the M9 bayonet and Blank Firing Attachment should be evaluated.

Flash suppression at various temperatures should be evaluated.

Other promising commercial flash suppressors should be evaluated.

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