(December, 1985)

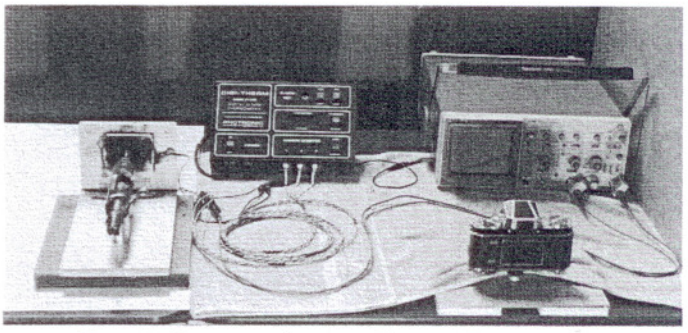
PRIMER TESTS

by
Steve Chernicky

Dear Dave,

I have been following your pursuit of the perfect accuracy cartridge with interest. I have suspected for some time that some variables in my shooting might be a result of (to some extent) variations in primers. Some of your recent articles in P.S. have touched on primer variations but have not provided any definitive answers.

Back in 1982-83 Al Angerman and Rick Hornbeck each had a good article on primer variations. Since I am interested in actual performance variations, I was particularly impressed with the primer flash photos in the March 83 issue of P.S. After recently reading of others using primers to shoot BB's over a chronograph to measure primer performance, I called Rick Hornbeck to see if any other methods may have been used in the past to evaluate primer performance. Rick said he has used primers in the past to shoot BB's but he felt that fouling after every shot provided more variation than the primer itself. Rick indicated that infrared heat measurement might be a good test parameter to look at. I mentioned that I was developing a pressure/impact test fixture for evaluating primer performance. After this and similar calls to others who have been shooting for some time, I began to find myself in the middle of a full scale primer test.



Test #1 Pressure/Impact Fixture Test Results

Well here it is a few months later and I am so sick of primers popping that I doubt that I will ever make any popcorn again.

Primer testing was divided into three major test areas:

1. Pressure/impact test fixture results.
2. Primer flash photography
3. Chronographed velocity and standard deviation in a 6 PPC.

Note: Heat measurement as suggested by Rick Hornbeck was not included due to cost limitations. In order that an infrared detector would not be destroyed after each firing the test fixture would require a lensed test system with remote infrared detection. This test system would need to be capable of detecting a ten microsecond event in the 2 to 12 micron infrared spectrum.

If any readers have the equipment to instrument this test I would be glad to supply any needed supporting information.

I do agree with Rick that good infrared data should give a valuable indication of just how well a primer is capable of igniting powder.

-ON TO THE TESTS-

The primers evaluated were all small rifle and consisted of different lots of the following:

1. Federal	200	
2. Federal	205	
3. Federal	205M	
4. Remington	7½	
5. Winchester	WSR	
6. Fiocchi	SR	
7. CCI	400	
8. CCI	450	
9. CCI	BR-4	
10.RWS	4033	196?
11.RWS	4033	1972
12.RWS	4033	1981

Note: No lots of RWS primers with date codes later than 1981 were available in the U.S.

The pressure/impact fixture test consists of a pressure transducer made from KYNAR piezo electric film sandwiched between two pieces of aluminum and sealed to protest it from hot flame and gases. The transducer was designed to be as free as possible from oscillation or harmonics within the frequency range of interest. It was then vibration isolated when mounted to the test fixture base to eliminate any vibration from the firing pin fall from being recorded. The test fixture utilized an action from

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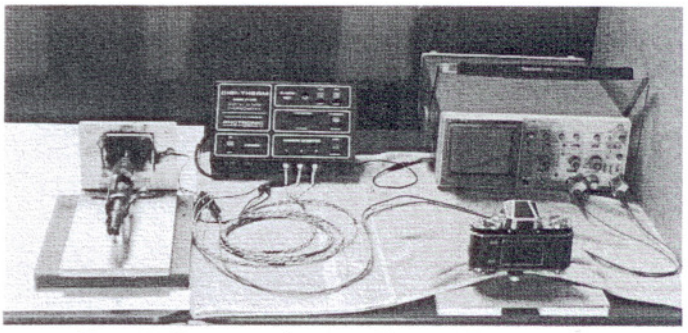

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an XP-100 in 221 REM. cal. The barrel was shortened to two inches bore length ahead of the neck. The output of the transducer was coupled directly to a Tektronix dual trace oscilliscope configured in an event triggered single sweep mode. Photos on a 35mm camera recorded each primer detonation.

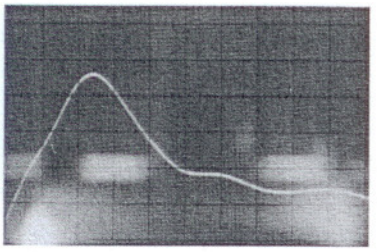
The transducer not only measures the pressure wave from the burning gases of the primer but also the impact of any burning particle mass on it thus giving a very accurate measure of primer uniformity.

Temperature was monitored during the tests to insure that test data was not affected since the piezo film is somewhat sensitive to temperature. Monitoring indicated that the heat sinking of the test fixture was sufficient to prevent temperature from affecting the test data.

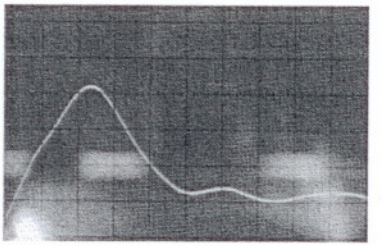
Each primer lot was tested using the same 221 case. The primer pocket was cleaned after each shot. A series of 20 shots were fired from each primer lot. Test shots were fired from a control lot of prime before and after the tests to verify there w no drift in test fixture performance.

Typical test photographs of the different primer types follows:

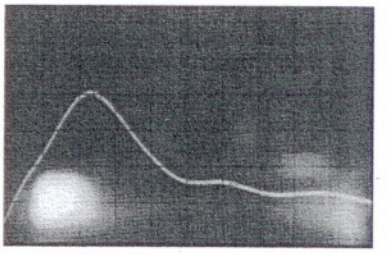
Note: Oscilliscope was set at 10 volts per division vertical and 5 microseconds per division horizontal.



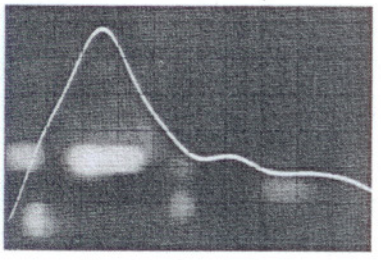
Federal 200



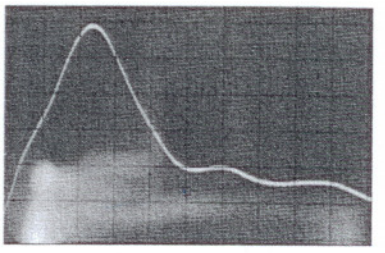
Federal 205



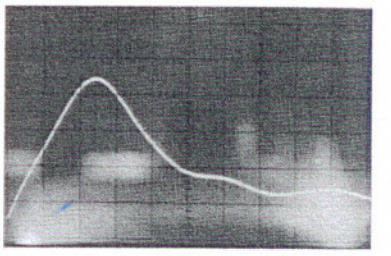
Federal 205M



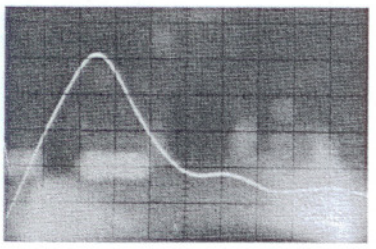
Remington 7 1/2



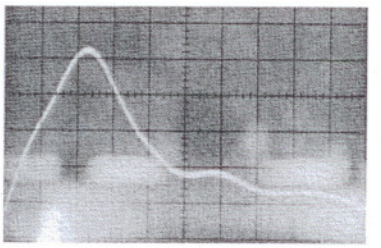
Winchester WSR



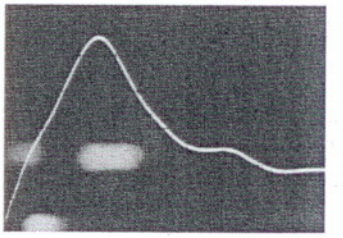
Fiocchi SR



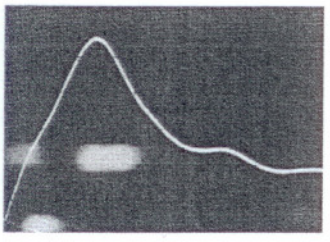
CCI 400



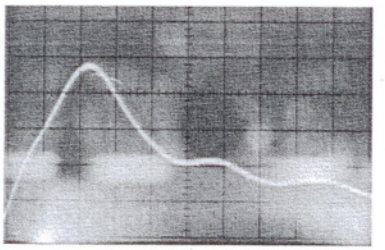
CCI 450



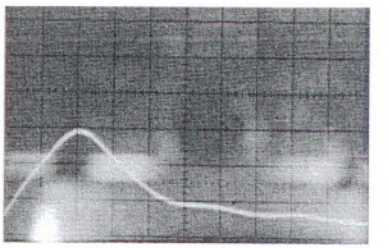
CCI BR-4



RWS 196?



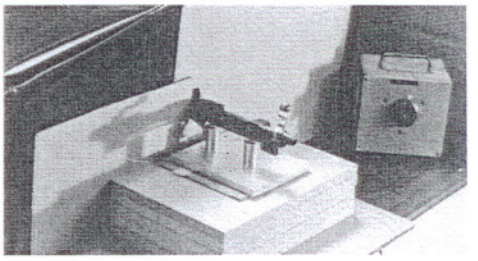
RWS 1972



RWS 1981

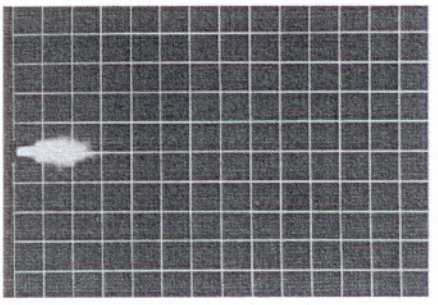
Pressure/Impact Fxture Test Summary

Primer Type	Rise Time to Peak		Peak Amplitude	
	% Variation	mic-sec	% Variation	volts
Federal 200	15.6%	12.2	20.4%	44.5
Federal 205	15.4%	11.8	24.4%	39.6
Federal 205M	8.3%	11.7	13.6%	41.8
Remington 7½	7.3%	12.5	15.3%	55.9
Winchester WSR	16.6%	11.7	46.8%	52.9
Fiocchi SR	7.7%	12.1	17.2%	42.7
CCI 400	7.8%	12.3	27.1%	53.0
CCI 450	16.8%	11.3	30.2%	48.2
CCI BR-4	7.6%	12.7	9.4%	50.7
RWS 196?	7.9%	12.3	33.9%	49.2
RWS 1972	8.3%	11.2	17.4%	50.4
RWS 1981	16.0%	11.0	79.6%	33.6

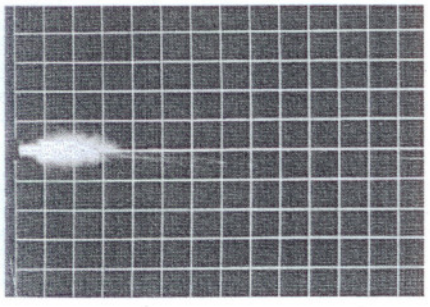


TEST #2 Primer Flash Photography

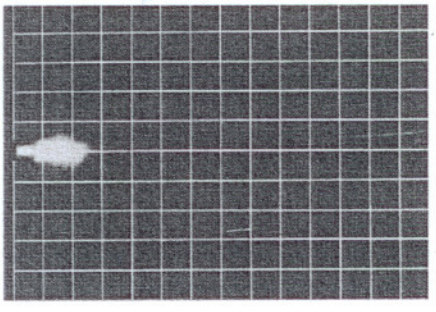
The primer flash photos were taken using a refinement of the method described by Al Angerman in the March 83 issue of *Precision Shooting*. The photos were taken in front of a one inch grid pattern fabricated on a piece of 1/8 inch thick translucent Plexiglas. The grid was illuminated from the rear using a single 25 watt lamp. All photos were taken at night using a one second exposure on ASA 400 B&W film. The primers were fired from an XP-100 action in 221 REM cal. The barrel was shortened to a bore length of two inches in front of the neck. The photos were taken with the end of the barrel at the edge of the grid pattern and about one inch in front of and parallel to it.



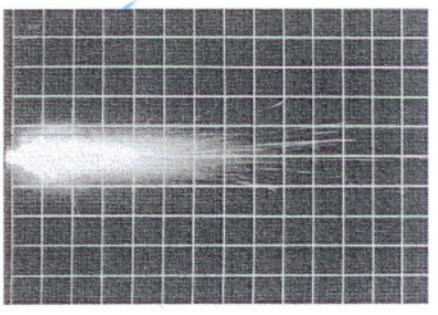
Federal 205M



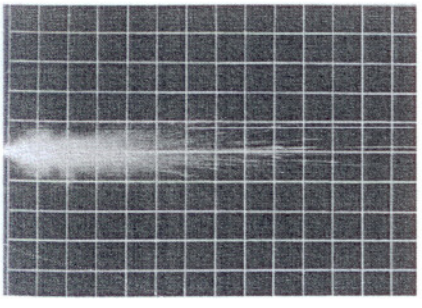
Federal 200



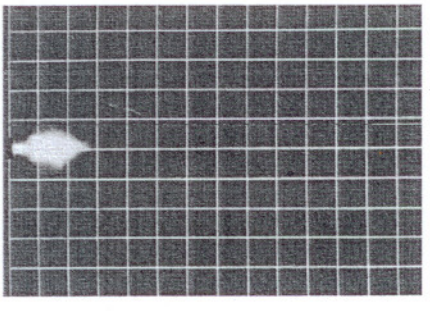
Federal 205



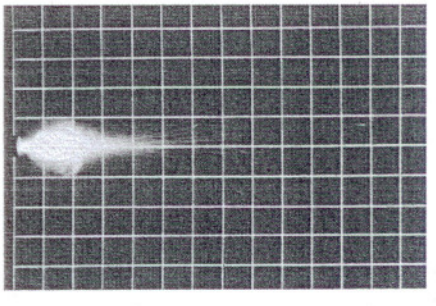
Remington 7 1/2



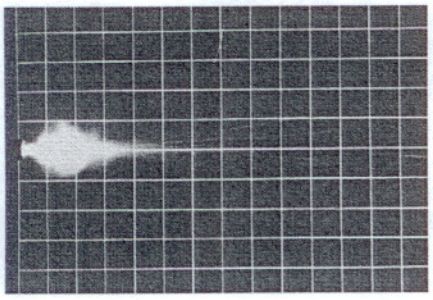
Winchester WSR



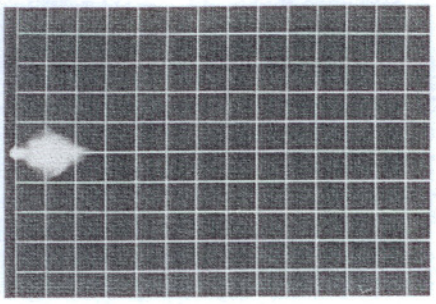
Fiocchi SR



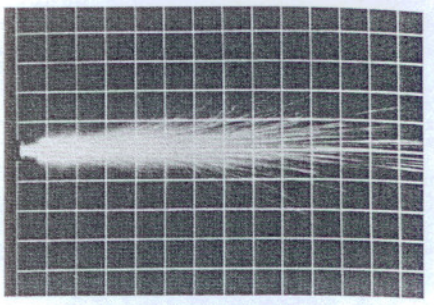
CCI 400



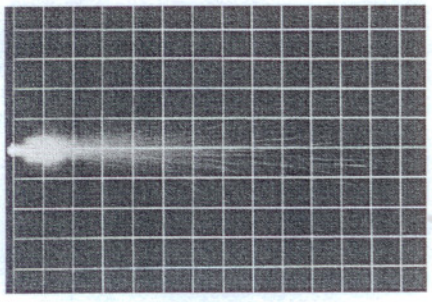
CCI 450



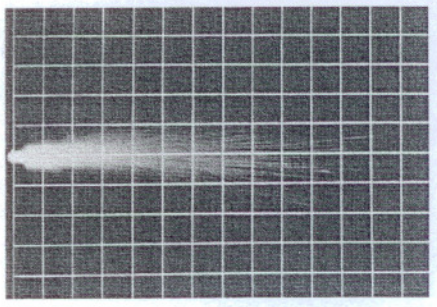
CCI BR-4



RWS 196?



RWS 1972



RWS 1981

TEST #3 Chronographed Velocity & Standard Deviation in a 6PPC

The velocity tests were conducted using the same rifle and same batch of cases for all tests. A powder charge of 26.0 grains of T-322 was used with Berger 68 gr bullets. All powder charges were consistent to within 0.1 grain. Chronographing was done on an Oehler model 33 with type III skyscreens. All primer pockets were cleaned after each shot and necks were also cleaned to insure uniform bullet seating and tension.

Tests were run in batches of 12 shots. The first 2 shots were considered foulers and are not included in the statistics. The last 10 shots of each batch were used for statistics. Several batches were fired of each primer lot with the exception of the RWS 196? primers of which only one 12 shot batch was fired due to the small quantity available for test.

PRIMER TEST SUMMARY

This test was conducted as a comparison between currently available primer types. Several lots of each type were evaluated to come up with an average performance of each type tested. The exception to this was the RWS primers which were divided by date codes because of difference in performance. Whether this difference was characteristic or due to aging is not known. The three dated lots tested are the only date codes currently known to exist in the U.S.

Probably the first question to be asked after all this testing is: Are some primer lots betterthan other lots of a given type? The answer is yes - BUT -. The "BUT" refers to how the primers were packaged. Obviously if several thousand primers are made from one sheet of primer compound (a "LOT") and separately

Primer type	LO	HI	Spread	Average	Stan. Dev.
Federal 200	3120	3169	49	3152	16
Federal 205	3108	3172	64	3141	16
Federal 205M	3086	3134	48	3109	14
Remington 7½	3098	3164	66	3133	15
Winchester WSR	3086	3144	58	3112	18
Fiocchi SR	3108	3154	46	3125	14
CCI 400	3105	3187	82	3136	22
CCI 450	3112	3179	67	3153	19
CCI BR-4	3108	3149	41	3126	13
RWS 196?	3105	3149	44	3128	14
RWS 1972	3088	3159	71	3134	17
RWS 1981	3095	3219	115	3121	34

packaged then one has a chance of getting a large quantity of uniform primers. But, if the sheet had some dead spots (areas of poor uniformity) these may not get uniformly mixed with the others thus a single spot check may indicate a good or a bad lot when the overall case might be exactly opposite. The end result is you might get several hundred primers with good uniformity and some other 100 boxes with poor uniformity. The only way to safeguard against this occurrence is to test 10 primers from each box of 100. Testing can be accomplished by chronographing under controlled conditions and using standard deviation figures as a measure of uniformity. There still is the other variables of a loaded round to consider when making decisions based on rather small statistical samples. The Pressure/Impact test fixture described in this test effectively eliminates these variables by measuring only the output of the primer itself. This gives a very accurate and repeatable indication of primer uniformity.

For the primer types and lots evaluated in this test the best primer types in order of uniformity were:

1. CCI BR-4
2. Federal 205M
3. Fiocchi SR
4. Remington 7½

It is extremely interesting to note that in the primer flash photographs the top three performers have a small soft flame.

An important aspect not covered in these tests is the resultant accuracy impact of primer variation. One can pick a slow rise time primer with good uniformity but that primer may or may not give good accuracy. Two other important factors come into play to make the right primer choice.

1.Intensity of the primer detonation.

Since a powder charge will burn faster the higher the pressure, one has to realize that high intensity primers will start the powder burning at a much faster or higher rate (pressure rise time). This may improve or degrade accuracy depending on the chosen load.

2.Bullet Jump

If the bullet is not held with enough tension by the neck for the particular primer being used the bullet will jump toward the lands from the primer detonation then momentarily slow until the burning powder pushes the bullet out of the barrel. This momentary lull in acceleration causes a very high frequency vibration to propagate through the rifle. If the shooter does not have good uniformity in bullet seating depth then this vibration becomes non-uniform shot to shot affecting accuracy. It is my opinion that firm bullet seating tension improves accuracy by minimizing the initial jump thus providing more uniform bullet acceleration and less vibration of the rifle at a critical time.

Dave, I hope this test report helps shed some light on the primer variation question everyone has been talking about.

Unfortunately it appears that there are no "Super Uniform" primers currently available just a few "good" primers and a lot of "not so good" primers.

Good Shooting,
Steve Chernicky