Small Arms Ammunition Primer Sensitivity

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Abstract

The aim of this project is to conduct an assessment of the hazards and risks involved in firing small arms ammunition primers and to develop a new firing procedure and test rig in order to conduct primer sensitivity testing. The results of the testing will be used to gain a better understanding of the 'no fire' and 'all fire' thresholds for 9 mm ammunition primers and compare how different primer initiation systems affect sensitivity.

The results indicate that Boxer priming systems appear to be more sensitive than Berdan priming systems, and statistically the kinetic energy required to initiate a Boxer primer is less compared to Berdan primers, albeit not by much. Primer age and storage conditions, however, were varied and must be taken into consideration.

Firing pin kinetic energy alone is not sufficient to assess a primer's sensitivity. Further work is recommended to establish how the energy delivered into a primer differs between a spring assisted firing pin and a projected firing pin and how this affects primer initiation. It is also recommended that research is conducted to look at how for a given amount of energy imparted into a primer, changes to the firing pin geometry and shape affect the probability of initiation.

Objectives

The objectives of this project are to:

- provide a review of previous/related primer research
- identify the hazards and risks
- mitigate the risks and produce a safe firing procedure
- develop a bespoke instrumentation rig
- conduct a test to compare the sensitivity of different primers
- evaluate the results using statistical analysis

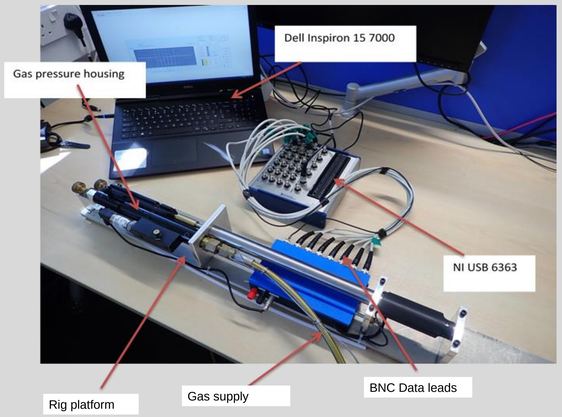
Project Deliverables

A capability to conduct further primer testing using a newly developed test rig and safe working procedure.

A better understanding of the firing thresholds for both 'no fire' and 'all fire' for 9 mm ammunition primers and how different primer initiation systems compare in terms of sensitivity.

Testing Requirements

1. The primed cartridge case needs to be fixed in a test rig.
2. A method is required to impart kinetic energy into the firing pin.
3. The firing pin must follow a path that enables it to impact with the primer.
4. An accurate means of recording the velocity of the firing pin at the point of impact.
5. The geometry of the firing pin needs to be selected.
6. Primers have to be prepared and made available prior to testing.

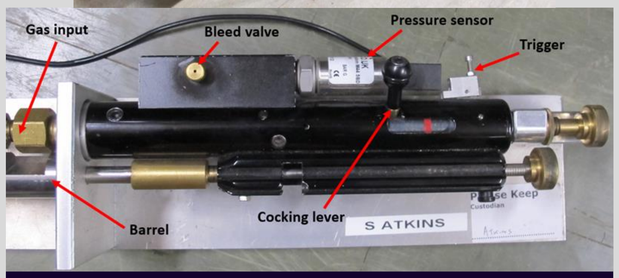


Primer sensitivity test rig in development

Rig Development

The rig utilised parts from an air rifle to enable compressed gas to be stored and released under control.
Components were machined to hold the cartridge cases and contain the effects of primer initiation.
Accurate means of measuring velocity – 6 x light sensors and National Instruments 6363 Data recorder.
Bespoke Labview software designed to estimate next velocity based on pressure in the gas chamber.

Eight batches of three hundred primed cartridge cases were prepared for this test (total of 2400 primed cases of varying age, condition and manufacturer)



Images of rig components

Operation

A primed cartridge case is placed into the machined cartridge case housing, which is then attached to the end of the barrel. The pin flight is positioned at the opposite end of the barrel and the desired volume of gas is allowed into the gas chamber. Activating the trigger releases the gas into the barrel. The pin flight is projected down the length of the barrel and prior to impacting the primed cartridge case, it passes six sensors which calculates the impact velocity. Depending on this velocity, it will either cause the primer to initiate, or not.

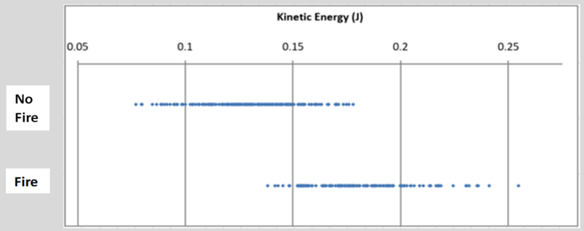
Results & Discussion

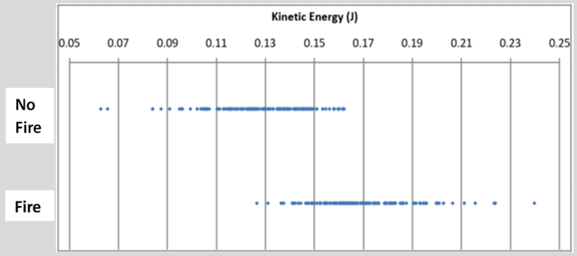
The Fire/No Fire data for all types of primer shows a range of kinetic energy where the Fire and No Fire results overlap. If a pin flight impacts the primer within this range, the result is not certain. The average range of overlap across the four batches of Berdan primers was 0.44 J compared to 0.38 J for the Boxer primers. However, this test did not provide sufficient data to determine which primer type had more variance.

The results appear to show that the method of primer initiation does affect primer sensitivity, with the lowest recorded kinetic energy successfully initiating a Berdan primer being 0.137 J, compared to that of 0.119 J for a Boxer primer. This in itself is not enough to determine which is more/less sensitive, but statistically the testing results indicate that the kinetic energy required to initiate a primer is less for Boxer primers than it is for Berdan primers. This is a much more accurate way to determine the difference in primer sensitivity as statistical analysis helps to identify outliers in the data and provide smaller margins of error.

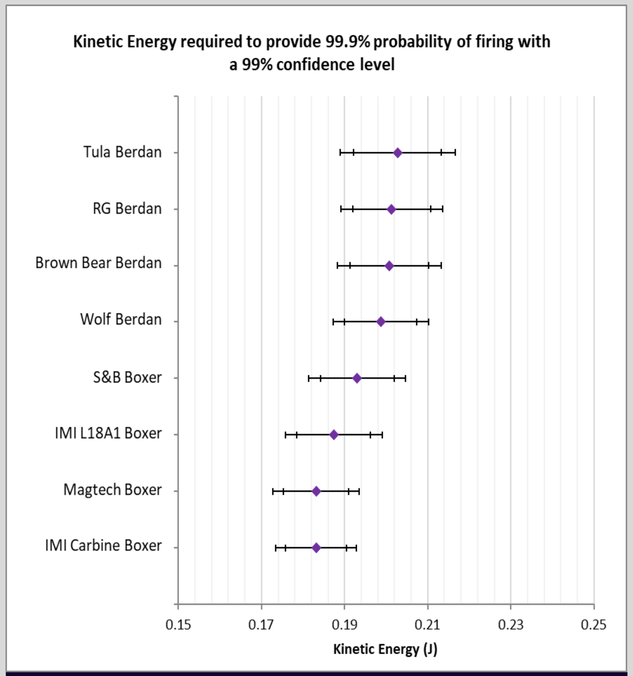
The primers tested in this project were from a variety of manufacturers, of different ages and stored in unknown conditions. It is not known how these factors might affect the primer's sensitivity and must be taken into consideration.

The 'all fire' primer sensitivity results are lower than the researched weapon firing pin energies, which is expected. Minor differences in how Glock firing mechanisms and the rig's projected pins impart the energy means the results cannot be directly compared.





Graphs showing Fire/No Fire results for Tula Berdan primer (top) and IMI Boxer primer (bottom)



Kinetic energy required for 99.9% probability of 'Fire'

Conclusion

This project successfully identified the hazards involved in firing small arms primers, and suggested appropriate controls and mitigation to bring the risk to ALARP. A safe and efficient procedure was developed which allowed for a large sample of primers to be tested.

The test rig managed to achieve the six essential testing requirements and is a useful tool when directly comparing the sensitivity of different batches of primers, but it is not representative of a particular weapon.

The project has delivered in terms of gaining a better understanding of the sensitivity of primers used within 9 x 19 mm ammunition and comparing the sensitivity of the different primers under test. Berdan primers appear less sensitive than Boxer primers and require more energy to function, albeit not by much. However, certain variables such as; primer age and storage conditions, were not the same for all primers and must be taken into consideration.

Firing pin kinetic energy alone is not sufficient to assess a primer's sensitivity and further work is recommended.

Recommendations

Further work is recommended to conduct testing to:

- observe how the kinetic energy of a projected firing pin compares to the energy imparted into the primer by a spring assisted firing pin.
- compare the sensitivity of new vs aged primers, with all other factors remaining constant.
- determine how changes to the firing pin geometry and shape affects the probability of initiation.