

## FLIR Technical Series

Application Note for Research & Science

# Effects of Heat on Firearm Barrels

Matthew Iannone

Naval Surface Warfare Center – Philadelphia, PA

### Abstract

The purpose of this study is to examine the advantage of using a thermal imaging system to capture the effects of heat on gun barrels. During firing action, gun barrels quickly heat and cool. The thermal imaging camera will provide such data as the temperatures reached and the distribution of heat along the barrel. Defects can also be found in the construction of the barrel. For example, a change in density of the metal will appear because that part of the barrel will absorb and distribute heat at a different rate. This data can be used to determine the quality of a barrel's construction and the advantages/disadvantages of the different types of metal used. In addition to the basic construction and material of a barrel, the advantages/disadvantages of different barrel designs can also be seen.

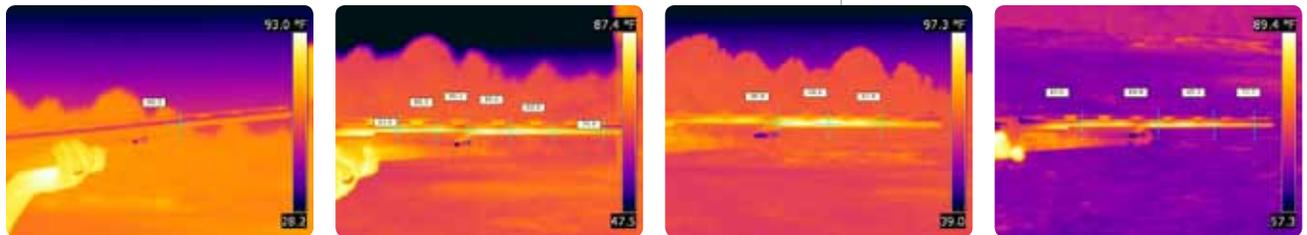
### Introduction

The focus of this study will be specifically on shotgun barrels. Shotgun barrels are exposed to shells that can contain different levels of power along with various sizes of shot. For example, a 3 1/2" magnum shell firing No. 4 shot will generate a larger amount of heat than a 2 3/4" shell firing bird shot (No. 8 shot).

The study will show the effects of heat on a barrels constructed in the early 1900's and modern barrels, the effects of heat on barrels designed with vented ribs and barrels with a traditional design, and the effects of heat created from different types of ammunition. It will also be shown how the thermal imaging camera can be used to see the shot patterns created by various types of shotgun chokes.

### Different Types of Shot

Different sizes and types of shells produce different amounts of heat. Figure 1 compares various shot sizes and shell sizes. Shotgun shot is categorized by number. The largest shot is designated as No. 0 or No. 1 shot, or more commonly, buckshot. The common smaller shot sizes would be No. 7 1/2 or 9, also called birdshot. The title "magnum shot" is given to longer shells that use more gun powder than standard size shells. This gives the round more power and velocity.



a) At ambient temperature.

b) After two rounds of No. 8 Shot (bird shot).

c) After two rounds of No. 4 magnum shot.

d) After two rounds of No. 6 shot.

Figure 1. Thermal images of gun barrels

### Spray Patterns Created By Different Chokes

Shotguns use a design feature called a “choke” to manipulate the pattern created by the spray of the shot. The chokes inserted into the end of the barrel are approximately 2-3 inches long. Each choke is designed with a different taper which forces the shot pattern to leave the barrel with a specific trajectory.

For example, a full choke is the maximum taper angle used in shotguns and creates a tighter pattern. The tighter pattern will be less accurate at shorter distances, but as the pattern moves farther away, it will spread wider. This effect makes the shot more accurate at greater distances. This choke is more common in bigger game or duck hunting scenarios.

On the other end of the spectrum is the skeet choke. The skeet choke has very minimal taper angle. It projects a wider pattern and makes the shot more accurate at shorter distances. This choke is typically used for close range sporting clay shooting and small game hunting.

There are many other types in between these defined chokes. The following images show how infrared technology can be used to see the spray pattern on a flat target. The thermal imager allows the user to differentiate between recently created shot holes and old holes on the target. The only other way to do this is to use many different targets that are only fired upon once. The infrared camera eliminates the need for multiple targets.

Figure 2 shows shot patterns on a 4' x 8' board lying lengthwise. The shooter was approximately 25 yards from the board.

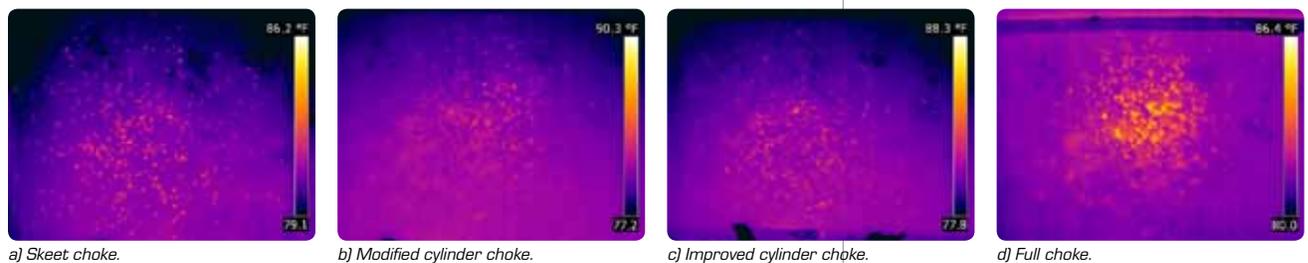


Figure 2. Thermal images of patterns with different chokes

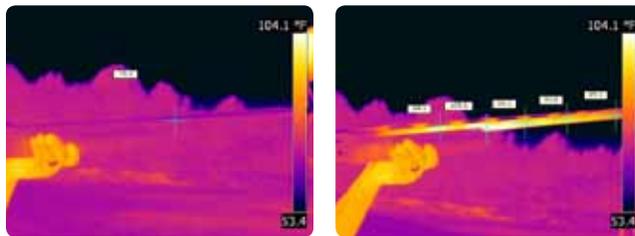
Examining Figure 2, it can be seen how the pattern changes with use of different chokes. The skeet choke presents a very wide pattern and the full choke shows the shot grouping to be much closer together. The modified and improved cylinder chokes have almost similar patterns, but subtle differences can be seen in these images.

### Browning Silver – 12 Gauge

The barrel of this firearm has a vented rib design. The design has two purposes. One purpose is to provide a long flat level to use as a sight when pointing the shotgun. The other purpose is to dissipate heat in a manner that allows the barrel to cool more quickly and prevents excessive heat from disrupting the shooter's vision. On a smooth, traditional barrel, an excessive amount of heat can create a blurred effect across the top. This would make accurate shooting more difficult.

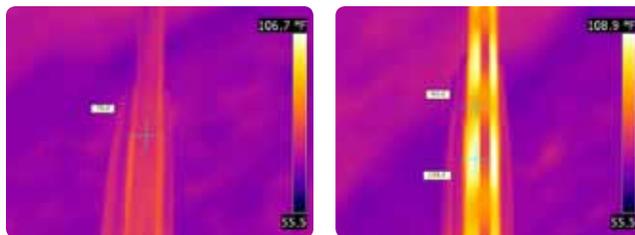


Browning Silver – 12 Gauge



a) At ambient temperature. b) After three rounds of bird shot.

Figure 3. BROWNING SILVER – 12 GAUGE



a) Top view of the barrel at ambient temperature. b) Top view after three rounds of bird shot

Figure 4. Thermal images showing effects of vented rib design

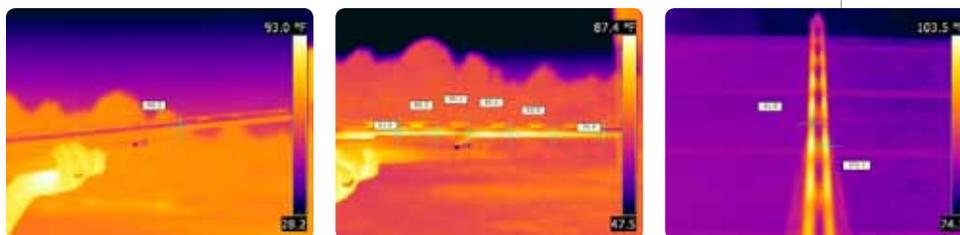
The image above shows the heat effects on the barrel after three consecutive rounds are fired. The mid part of the barrel reaches the highest temperatures. The highest temperature reaches about 105.5-106°F. Figures 3 and 4 demonstrate how the metal is affected by the vented rib design.

### Benelli Nova – 20 Gauge

This barrel also has a vented rib design. It is a 20 gauge shotgun, which means the barrel diameter is smaller than a 12 gauge. Since the diameter of the barrel is smaller, so is the diameter of the shells. Smaller shells use comparably less gun powder due to the smaller size of the rounds and smaller capacity. Figure 5 shows thermal images of this firearm immediately after use.



Benelli Nova – 20 Gauge



a) At ambient temperature. b) After three rounds of bird shot. c) Top view after three rounds of bird shot.

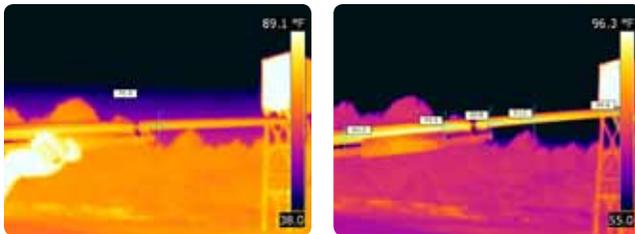
Figure 5. BENELLI NOVA - 20 GAUGE

### Winchester Model 1897 – 12 Gauge

This shotgun was manufactured in 1914. It is a pump action shotgun with a traditionally designed barrel (the outside surface of the barrel is smooth and does not have any added features). The maximum temperature reached after firing two rounds was 93°F. It should be noted that in Figure 6, it appears higher temperatures exist on a portion of the barrel. However, that heat is created by the hand of the firearm handler and thus is not significant in this case.



Winchester Model 1897 – 12 Gauge



a) At ambient temperature. b) After three rounds of bird shot.

Figure 6. WINCHESTER MODEL 1897 – 12 GAUGE

### Summary

The use of the thermal imaging camera has provided some interesting results. The camera allows the user to see the effects of the vented rib design. There is a significant difference in the way the heat moves through the structure of the barrel. The design allows the gun to cool more quickly and prevents excessive heat from disrupting the line of sight over the top of the barrel during rapid fire action.

The use of the camera to see the difference in spray patterns can be a useful tool. Different chokes are used for different applications whether it is for hunting or sporting clays. This technology can be used to determine which choke is best for someone's specific application and to give that person an actual idea of the size of the pattern they are firing.

### Acknowledgements

The author would like to acknowledge the assistance of Russell Philipp who supplied two of the firearms used in this study and for also performing much of the firing of these firearms while these images were being taken. Special thanks also go to the Atglen Sportsmen's Club of Atglen, PA where this study was accomplished.

### About the Author

Matthew works as a Mechanical Engineer at the Naval Surface Warfare Center in Philadelphia, PA. He is a graduate of the Massachusetts Maritime Academy where he received his Bachelor's of Science Degree in Marine Engineering. He is a Level I Thermographer and has been working with infrared imaging technology for two years.

#### BOSTON

FLIR Systems, Inc.  
25 Esquire Road  
North Billerica, MA 01862  
USA  
PH: +1 866.477.3687  
PH: +1 978.901.8000

#### PORTLAND

Corporate Headquarters  
FLIR Systems, Inc.  
27700 SW Parkway Ave.  
Wilsonville, OR 97070  
USA  
PH: +1 866.477.3687

#### CANADA

FLIR Systems, Ltd.  
920 Sheldon Ct.  
Burlington, ON L7L 5L6  
Canada  
PH: +1 800.613.0507

#### MEXICO/LATIN AMERICA

FLIR Systems Brasil  
Av. Antonio Bardella  
320 - B. Boa Vista- Cep:  
18085-852 - Sorocaba – SP - Brazil  
PH: +55 15 3238 8070