

Rifle Trigger Commentary

Fred Bohl – 24 January 2006

CAUTION – DISCLAIMER

The suggestions and recommendations herein are the opinions of the author based upon his own experience and supported by the experience of others with and for whom he has done trigger work. However, the author claims no special knowledge or expertise and assumes no responsibility for the consequences of anyone using these suggestions or recommendations.

For the purposes of this commentary, only modern (post 1950) bolt action rifle trigger mechanisms were considered. The author's experience is almost entirely in target (from the bench) and Benchrest competitive shooting although many of the others that have shared their experiences have extensive successful hunting experience.

The author has no affiliation with any of the suppliers of the brands listed. Nor does the author receive any remuneration from the suppliers or dealers thereof for suggesting or recommending their products.

BACKGROUND

This commentary was prompted by many questions about proper trigger settings and complaints about the operation of the trigger mechanisms of factory rifles – particularly about most (but not all) recent US made commercial rifles.

The primary cause of the complaints is that the management of most of the U.S. firearms manufacturing firms let too many decisions be based on the ranting of anti-gun and non-shooting critics, lawyers and accountants rather than the desires of their shooter customers. This trend is reflected not only in the trend to deteriorating quality and movement of sales to foreign manufacturers, but also in the market share gains by manufactures that are managed by shooters and/or are listening to their shooter customers (for example: Savage Arms with their AccuTrigger™ as well as the upsurge in number and success of makers of replacement triggers).

TRIGGER FUNCTION

While all trained and experienced shooters understand that the basic function of the trigger is to release the cocked firing pin to initiate the firing sequence, most do not understand the mechanism well enough to appreciate how the function impacts their ability to accurately and precisely fire their rifle.

The trigger mechanism typical of most factory bolt action rifles has four basic working parts:

1. Trigger – operating lever (includes the spur that your finger engages)
2. Sear – holds the firing pin cocked (engages the operating lever)
3. Sear reset spring – returns the sear to set position after bolt release
4. Trigger spring – returns trigger to set position after spur release and provides most of the resistance (“pull force”)

In the cocked (pre-firing) position there is a small surface on the operating lever that engages a mating surface on the sear. This “sear engagement” combined with the parts alignment (mechanism geometry) and trigger spring hold the firing pin cocked.

The portion of the firing sequence of interest consists of the shooter squeezing the trigger with sufficient force to overcome the resistance of the trigger spring and sear engagement friction long enough (distance and time) for the trigger and sear to disengage so that the sear falls and the bolt releases.

For safety, the mechanism has to be designed so that with the “safety off” there is sufficient sear engagement area (distance) and force to insure that any force and movement (such as dropping the rifle) does not disengage the sear. For a given design this will establish that trigger mechanisms minimum safe sear engagement and trigger pull force for “safe handling with the safety off”.

The above notwithstanding, it must be noted that when the shooter has put the firearm in the status of “loaded, cocked and safety off” there is no trigger design that can prevent the shooter from pulling the trigger and firing the rifle when the barrel is pointed in an unsafe direction.

“In a bolt action rifle, when a live round is left in the chamber with the bolt closed, the action is “cocked” and the firing pin is pointed directly at a live primer! The firearm is configured to fire, in spite of any other outside influences like a mechanical safety. ...firearms can and DO discharge when safety levers are moved from “safe” to “fire”! This is common when triggers are adjusted with minimum sear engagement.

A safe firearm is achieved through safe handling techniques.”

Bob Brasfield of Rifle Basix, Inc.

TRIGGER FUNCTION IMPACT

Trigger mechanism basic quality impacts the shooters ability to accurately and precisely fire the rifle primarily by how consistently the function will repeat the same feel shot to shot. A new trigger may wear-in and get somewhat more repeatable but a poor quality trigger will need to be repaired or replaced (internal parts or complete assembly).

The trigger activation sequence impacts the shooters ability to accurately and precisely fire the rifle by creating effects on the shooter and a time period for the occurrence of these effects that might result in the rifle being moved away from the point of aim. These effects are reactions of the shooters muscles (tremor) to the feel of trigger squeeze that in turn tend to cause minute rifle movement. The three significant effects are:

1. PULL FORCE – most talked about and significant due to muscle reaction magnitude being proportional to the magnitude of the required force
2. CREEP – sear disengagement feel (distance, smoothness and time) which tends to cause variance in the other two and initiate muscle tremor
3. ENERGY – not discussed much but very significant in that the time to disengage the sear is directly proportional total required energy (force times distance) and the potential for muscle tremor being proportional to both energy and time

Obviously it is beneficial to minimize all three of the above effects. However, it is also possible to reduce the combination to a level were the shooter loses control. This can have negative consequences on both consistency and safety. The optimum setup (minimum pull force and creep) that will yield best accuracy and precision but keep the shooter in control varies primarily with the shooting conditions but also with the shooters experience and ability.

The best accuracy and precision occur when the shooter knows when the gun will fire. This is obtained by using a good adjustable trigger with setup optimized for the shooting conditions and many rounds of practice by the shooter to adapt to the setup.

There are two primary trigger functional adjustments:

1. Sear Engagement (“creep”) – difficult to achieve a balance between best “feel” and “safe handling with the safety off” which is why manufactures usually warn against the user attempting this adjustment
2. Pull Force (“weight”) – factory triggers often set the minimum possible too high for the accuracy and precision needed for many shooting conditions

Some designs may also include one or both of these adjustments:

1. Pre Travel – trigger spur movement before sear disengagement starts
2. Over Travel – trigger spur movement after sear disengages

[These allow “fine tuning” of the feel to suite the individual shooters preference]

TRIGGER SETUP RANGES

Note that the data sets included in the following while calculated for most values are verified by and based on actual measured values for representative firearms.

Bad Examples

The range below is the area that draws complaints and samples that fall in this range (and there actually were new popular factory rifles that did) require serious repair or replacement before break-in or sight-in.

Trigger Actuation Energy (inch-ounce)				
Trigger Pull Force		Sear Engagement (inches)		
Pounds	Ounces	0.06	0.05	0.04
8.0	128	7.68	6.40	5.12
7.5	120	7.20	6.00	4.80
7.0	112	6.72	5.60	4.48
6.5	104	6.24	5.20	4.16
6.0	96	5.76	4.80	3.84
5.5	88	5.28	4.40	3.52
5.0	80	4.80	4.00	3.20

Field Hunting

The range below can be used in field hunting (offhand or opportunity positions). A 4 to 5 pound pull force with 0.04 to 0.05 inch sear engagement is suitable for hunting with a gloved trigger finger. Otherwise prefer 3 to 4 pound pull force with 0.03 to 0.04 inch sear engagement.

Trigger Actuation Energy (inch-ounce)				
Trigger Pull Force		Sear Engagement (inches)		
Pounds	Ounces	0.05	0.04	0.03
5	80	4.00	3.20	2.40
4.5	72	3.60	2.88	2.16
4.0	64	3.20	2.56	1.92
3.5	56	2.80	2.24	1.68
3.0	48	2.40	1.92	1.44

Even in this range it is very difficult to achieve sufficient precision even off a rest and bag from the bench to be able to precisely set sights ("sight-in").

Informal Target or Hunting from Rest

This is the range in which accuracy and precision become expected results with practice (not occasional good luck). In this range it is also best to shoot from a rest or bipod and rear bag. Also, more focus and attention to safety is required of the shooter. Only the better factory, specialty (like Savage Arms AccuTrigger™) and replacement triggers are likely to perform in this range and provide “safe handling with the safety off”.

Trigger Actuation Energy (inch-ounce)				
Trigger Pull Force		Sear Engagement (inches)		
Pounds	Ounces	0.04	0.03	0.02
3.0	48	1.92	1.44	0.96
2.5	40	1.60	1.20	0.80
2.0	32	1.28	0.96	0.64
1.5	24	0.96	0.72	0.48
1.0	16	0.64	0.48	0.32

Serious Target and Benchrest

We are now entering the realm of custom built rifles and purpose built triggers used by dedicated shooters that believe in frequent extensive practice. The trigger mechanisms are usually much different in design with different geometry and often multiple links. Below 8 ounce pull force and 0.008 sear engagements these rifles will not even have safety mechanisms as they would not be effective.

Trigger Actuation Energy (inch-ounce)					
Trigger Pull Force		Sear Engagement (inches)			
Pounds	Ounces	0.010	0.008	0.006	0.004
1.00	16	0.160	0.128	0.096	0.064
0.88	14	0.140	0.112	0.084	0.056
0.75	12	0.120	0.096	0.072	0.048
0.63	10	0.100	0.080	0.060	0.040
0.50	8	0.080	0.064	0.048	0.032
0.38	6	0.060	0.048	0.036	0.024
0.25	4	0.040	0.032	0.024	0.016
0.19	3	0.030	0.024	0.018	0.012
0.13	2	0.020	0.016	0.012	0.008
0.09	1.5	0.015	0.012	0.009	0.006

Note that at and below 3 ounce pull force many shooters no longer touch then squeeze the trigger but sort of slap it with the finger tip to fire do to difficulty of controlling lower finger contact pressure.

One Rifle Two Pull Forces?

Very popular in Europe and with some shooters here are “Set” triggers. These provide a super-light trigger when “set” and hunting trigger when “unset” as an all-in-one mechanism. Two versions are seen:

1. Double Set – has two trigger spurs one (typically the rear spur) to “set” the main spur (typically the front spur); most common in Europe and usually built in to allow the added trigger guard and mechanism space
2. Single Set – has a single spur which can be pressed forward to quickly “set” or convert the “unset” hunting pull force into a super-light pull force; more common in the U.S. and can replace some (limited) factory triggers

In the hands of an experienced shooter (practiced with both pull forces), trigger pull can be matched to shooting conditions:

- Sight-in – “set” from a rest or bipod and rear bag on bench
- Target – “set” from a rest or bipod and rear bag on bench
- Match Position – “set” from a secure hold on secure range
- Hunting – “set” from a secure hold particularly long shots
- Tough Hunting – “unset” insecure hold or quick shots

There is a too-good-to-be-true aspect to these triggers. Excluding the ridiculously expensive, the single set versions that can replace some factory triggers have some issues that limit their popularity and general use.

1. There is a significant difference in not only pull force but also in “feel” between the “set” and “unset” operation and a small but noticeable change in position of the spur. This often requires a great deal of practice for the shooter to become proficient and comfortable with both.
2. Since the “set” pull force is super-light, when “set” with the “safety-off”, there is a more likely chance of unintended discharge so the shooter must bear a greater burden of concentration on safe handling.
3. Because these are so rare and different than conventional triggers, the owner must never allow a firearm so equipped to get into the hands of another shooter without warning and instruction in use and handling.

REPLACEMENT TRIGGER SUGGESTIONS

If you decide that you need or just want to replace a poor performing factory trigger, there are several firms that make assemblies and/or upgrade parts including Jard, Jewell, Rifle Basix, Sharp Shooter Supply, Shilen and Timney. Depending on your rifle brand the task may be “near-drop-in” to “needs-a-good-gunsmith”. However, if accuracy and precision are your goal, nothing beats replacing a bad trigger for results and it should even precede getting a high end custom barrel.

THE BEST

If you have a Winchester Model 70, Remington 700, 40XB, XP100 or one of the many custom rifles/actions that are built to use a Remington compatible trigger assembly, then the best is a Jewell trigger. The Jewell is a complete functioning trigger assembly; three pull force range springs provided (heavier ones are available); among the easiest to install and adjust; all hardened stainless steel; operates best unlubricated; and can be cleaned in the rifle (flush from the top suggested). Performance data follows:

Trigger Actuation Energy (inch-ounce)						Jewell Trigger		
Trigger Pull Force		Sear Engagement (inches)				HVR Model	Spring Ranges	
Pounds	Ounces	0.010	0.008	0.006	0.004	BR Model "C" Spring Only		
3.00	48	0.480	0.384	0.288	0.192	"A"		
2.50	40	0.400	0.320	0.240	0.160	"A"		
2.00	32	0.320	0.256	0.192	0.128	"A"		
1.50	24	0.240	0.192	0.144	0.096	"A"		
1.00	16	0.160	0.128	0.096	0.064	"A"	"B"	
0.88	14	0.140	0.112	0.084	0.056	"A"	"B"	
0.75	12	0.120	0.096	0.072	0.048	"A"	"B"	
0.63	10	0.100	0.080	0.060	0.040	"A"	"B"	
0.50	8	0.080	0.064	0.048	0.032	"A"	"B"	
0.38	6	0.060	0.048	0.036	0.024		"B"	
0.25	4	0.040	0.032	0.024	0.016		"B"	
0.19	3	0.030	0.024	0.018	0.012		"B"	"C"
0.13	2	0.020	0.016	0.012	0.008		"B"	"C"
0.09	1.5	0.015	0.012	0.009	0.006			"C"

The Jewell trigger uses a unique over center toggle link design so that almost no trigger pull spring force is required to hold the sear engaged. The trigger pull spring just resists pulling the trigger so changing the spring or adjusting the pull force has no other effect on trigger operation. Therefore, there is almost no minimum pull force required to keep the sear engaged. That allows pull force to be set to very low for "safe handling with the safety off". As a practical matter the minimum is the finger contact pressure at which involuntary movement (such as pulse or muscle tremor) could disengage the sear. Therefore, 1.5 ounce is the minimum recommended trigger pull force for "safe handling with the safety off".

Note that at and below 3 ounce pull force many shooters no longer touch then squeeze the trigger but sort of slap it with the finger tip to fire do to difficulty of controlling lower finger contact pressure.

We do not recommended use of the Jewell BR trigger or HVR trigger with "C" spring except in "rail guns" or "unlimited" Benchrest rifles fired from a front rest and rear bag on a securely anchored bench.