M865 TID Improvement Study

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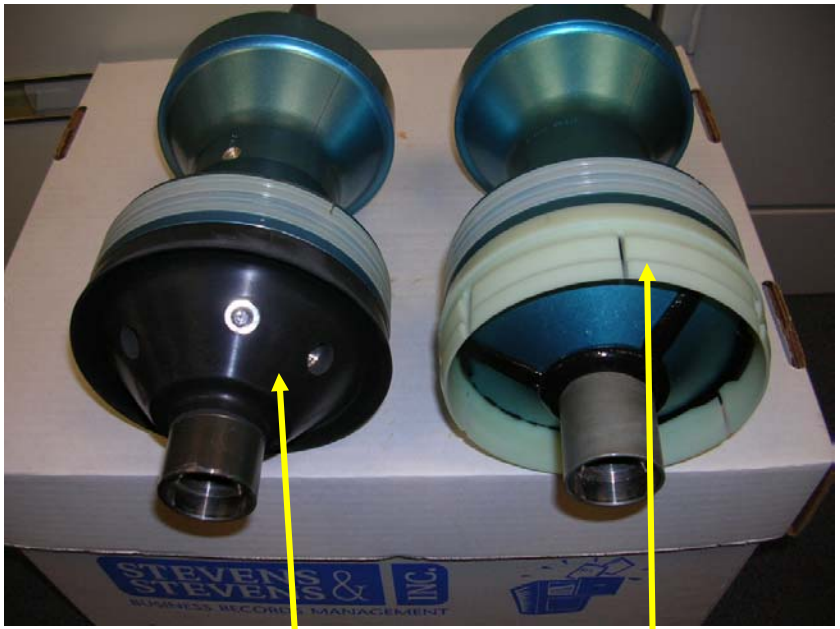
Introduction to the 120mm M865

- The M865 Kinetic Energy (KE) training round, in service with the United States Army's main battle tank fleet, provides a realistic training device displaying the accuracy and time-of-flight of the M829 series service rounds.

- The fin stabilizer provides a safety feature limiting the overall flight range to under 8 km.

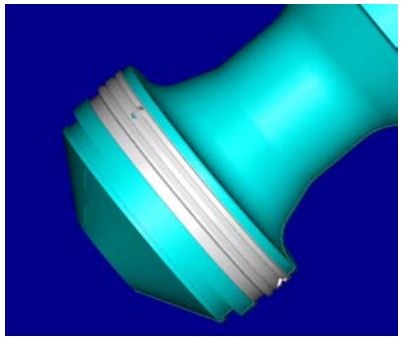
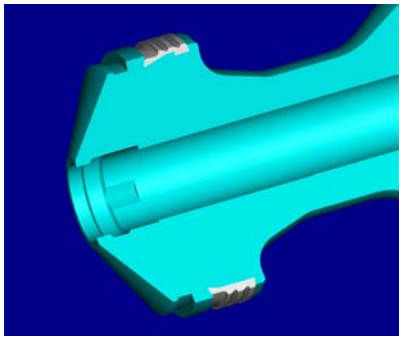
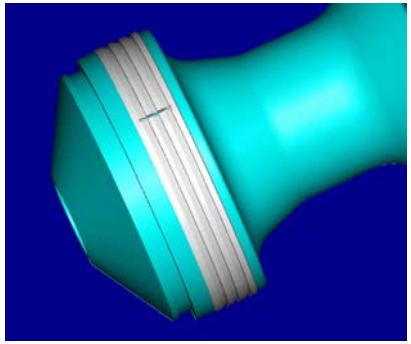
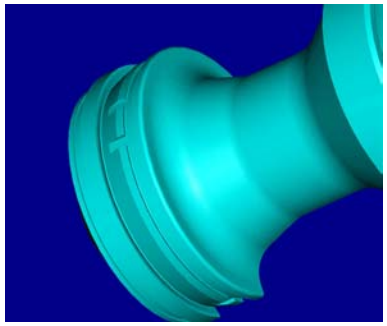
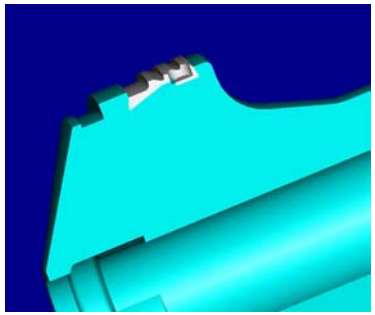
TID Background

- Target Impact Dispersion (TID) of the M865 at cold temperature (-32°C) has seen a consistent increase since the inception of the new design in FY99.
- This increase is largely due to the large number of fliers at cold temperature.
- The new design utilizes a plastic snap on insert cover which connects the projectile to the cartridge case adapter. The previous design utilized a rubber cuff which was bolted to the cartridge case adapter.

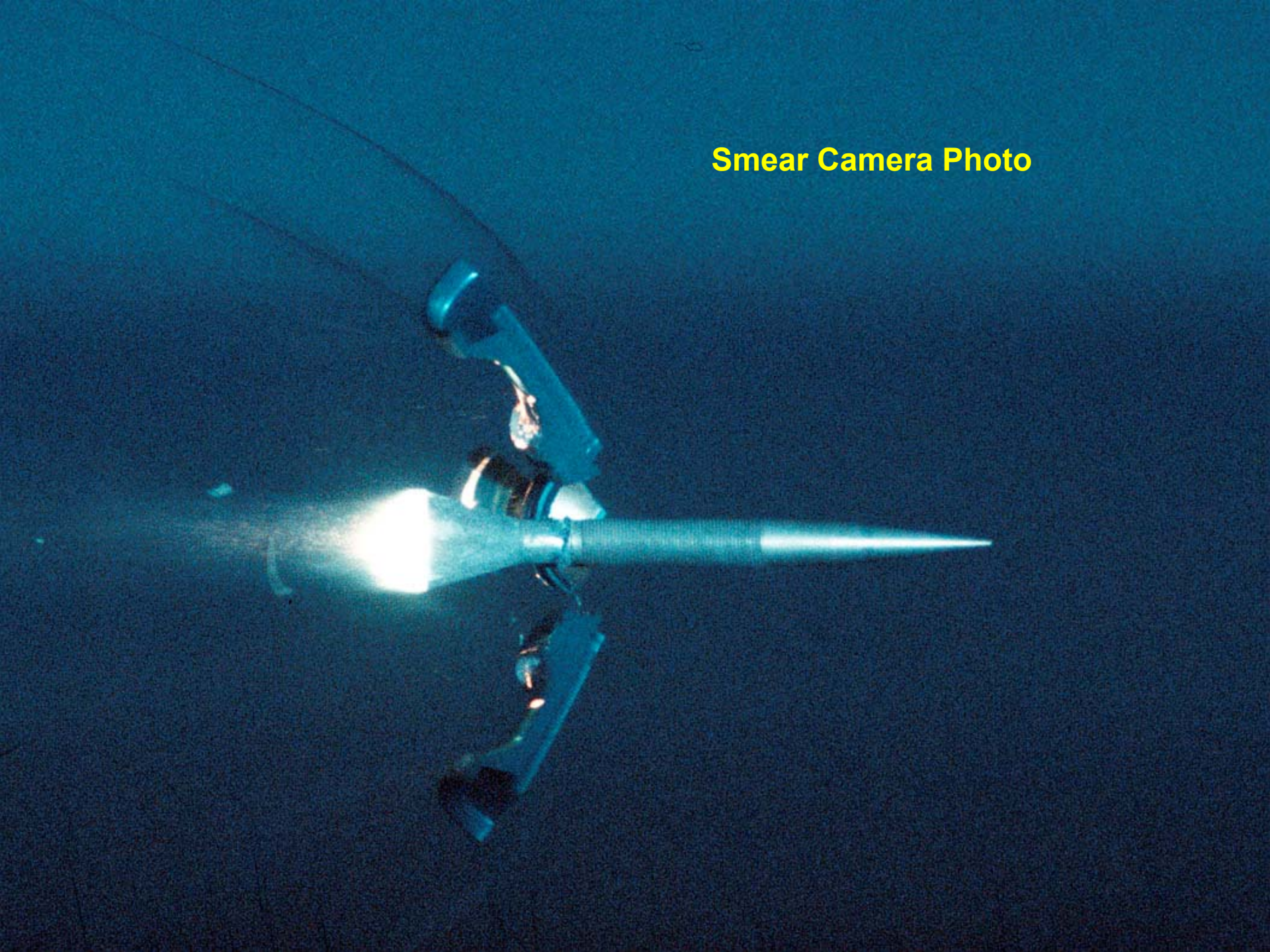


Project Objective

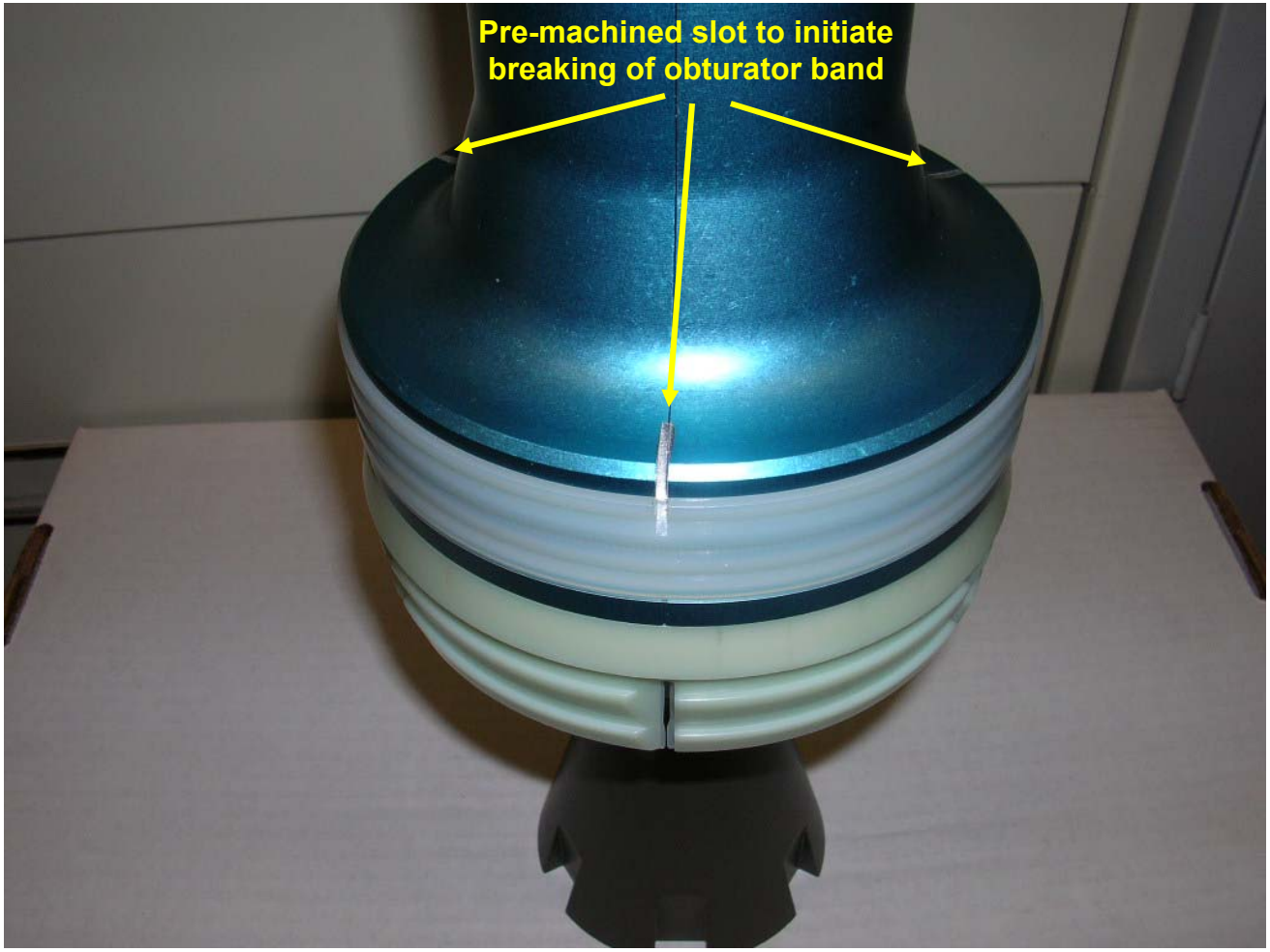
- To Improve the M865 KE Training Round's cold TID by reducing the number of "fliers" through redesigning the nylon obturator band and aluminum sabot.

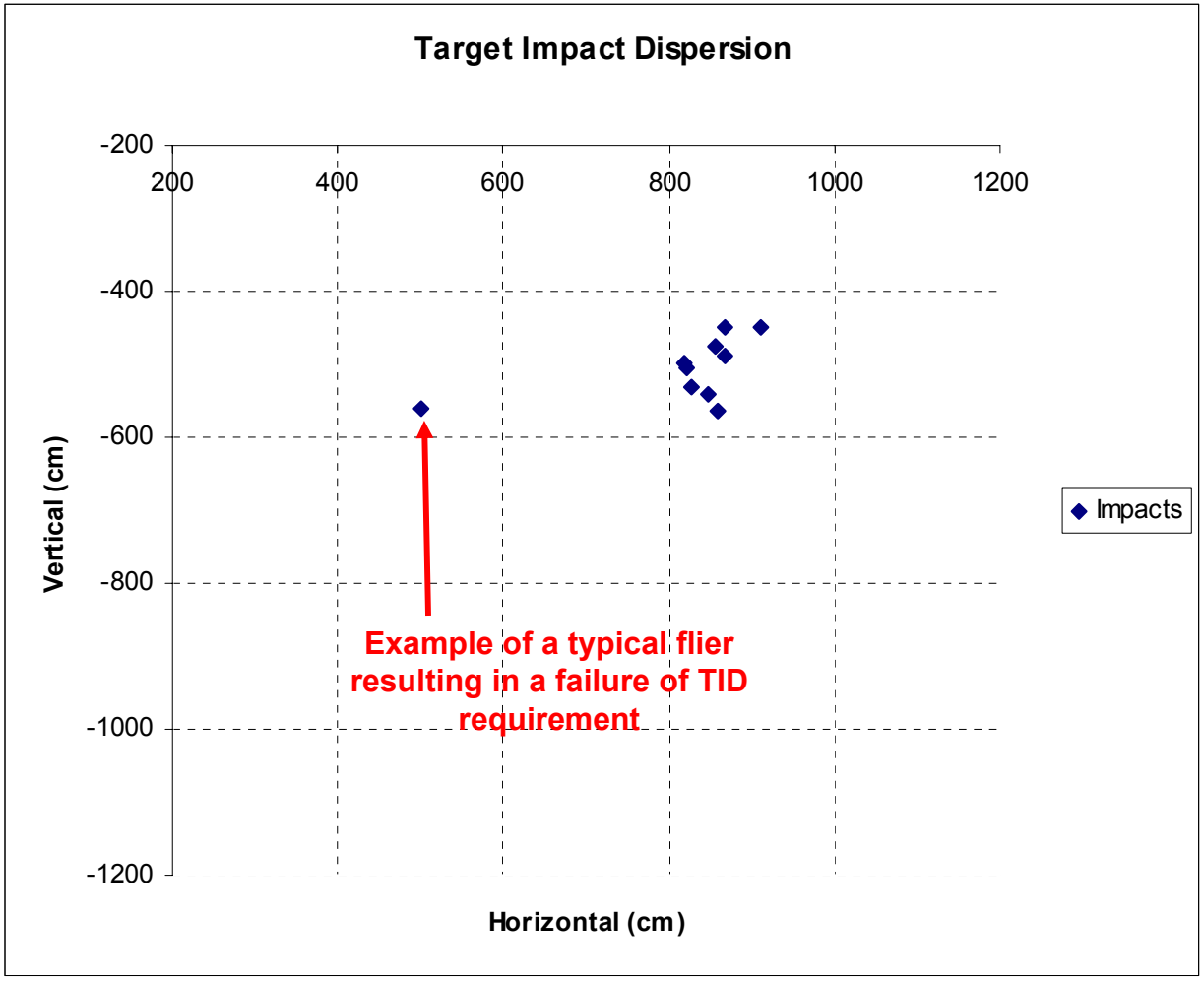
High Speed Flight Follower


Smear Camera Photo

Current M865 Projectile Design



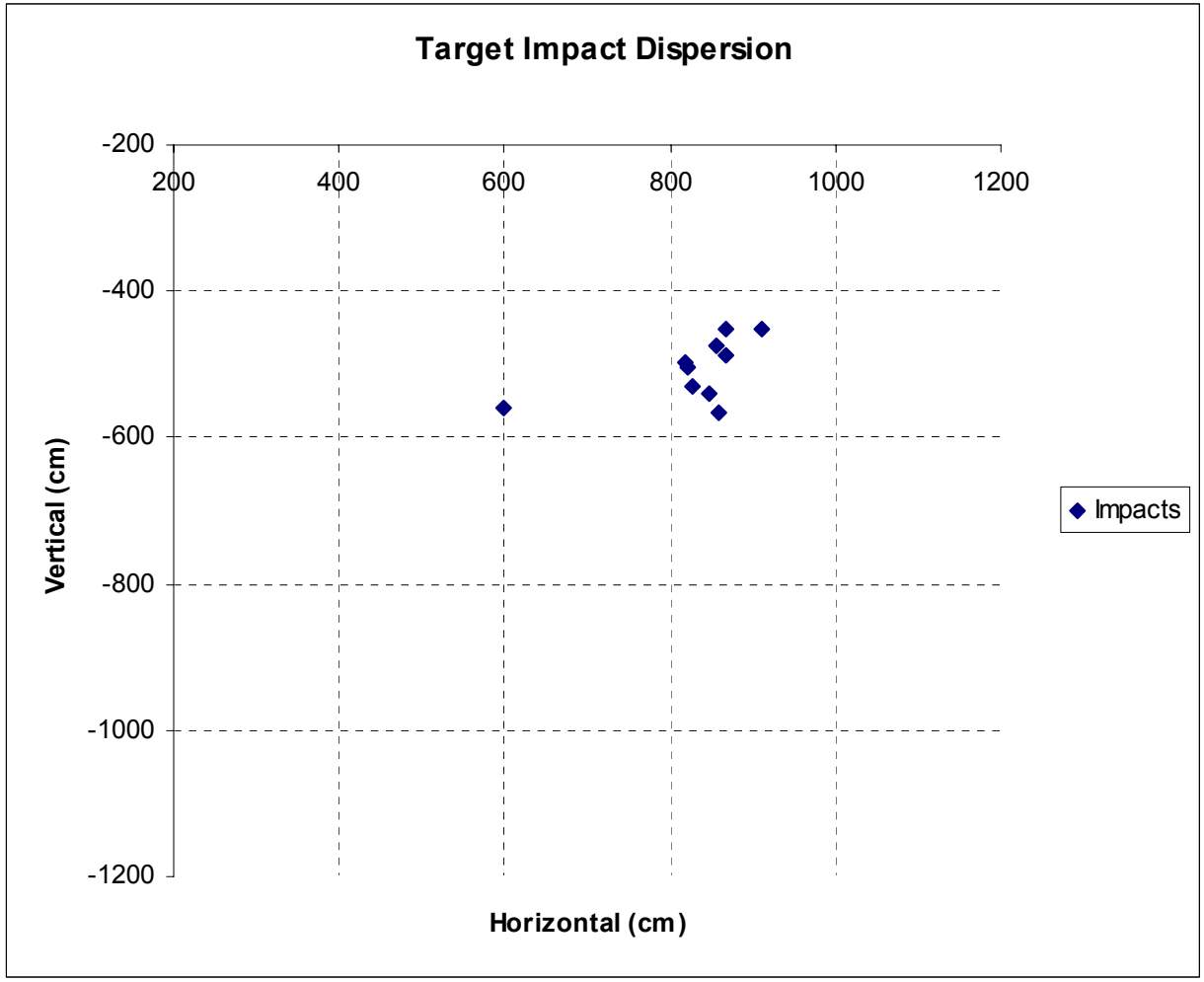
Impact Result at -32°C



TID (mils)		
	X	Y
First 5	**0.61**	**0.12**
Second 5	**0.12**	**0.13**
Pooled	**0.44**	**0.13**

The M865 Performance Specification requires a TID of .30 x .30 or lower to accept a cartridge lot.

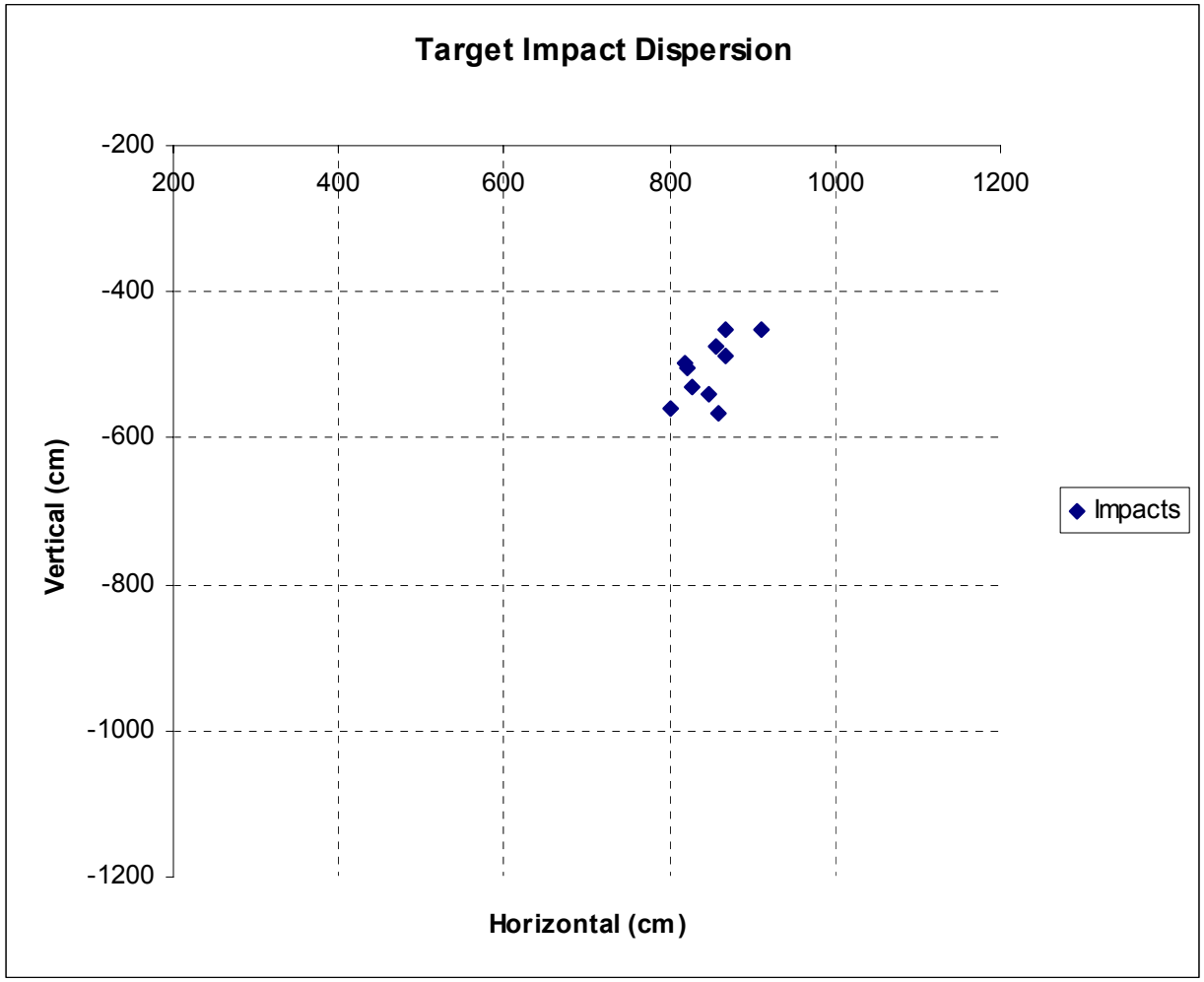
Improved Impact Result at -32 °C



TID (mils)		
	X	Y
First 5	0.43	0.12
Second 5	0.12	0.13
Pooled	0.32	0.13

The M865 Performance Specification requires a TID of .30 x .30 or lower to accept a cartridge lot.

Desired Impact Result at -32 °C



TID (mils)		
	X	Y
First 5	**0.10**	**0.12**
Second 5	**0.12**	**0.13**
Pooled	**0.11**	**0.13**

The M865 Performance Specification requires a TID of .30 x .30 or lower to accept a cartridge lot.

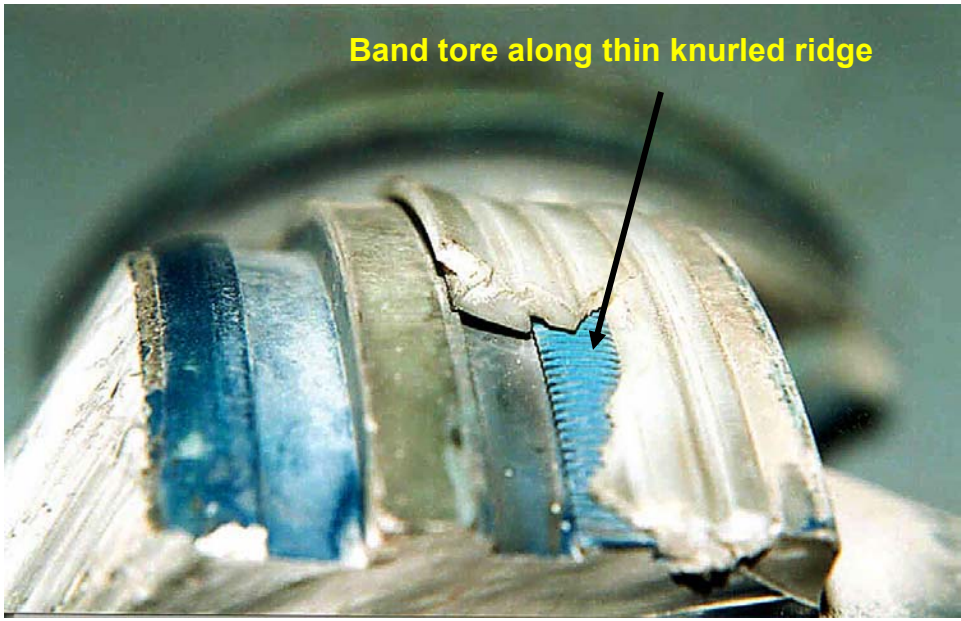
M865 Sabot Recovery History

- General Dynamics – OTS Red Lion Operations has been evaluating recovered sabot segments for the past 10 years.
- After the design change in 1999, the focus was primarily on the function of the nylon obturator band.
- Three major phenomena where discovered which raised concern that an asymmetrical discard of the sabot could be contributing to the sometimes, erratic flight of the M865 Projectile at cold temperatures.
    1. Circumferential tearing of obturator band
    2. Gas intrusion beneath aft end of obturator band
    3. In-bore obturator band rotation

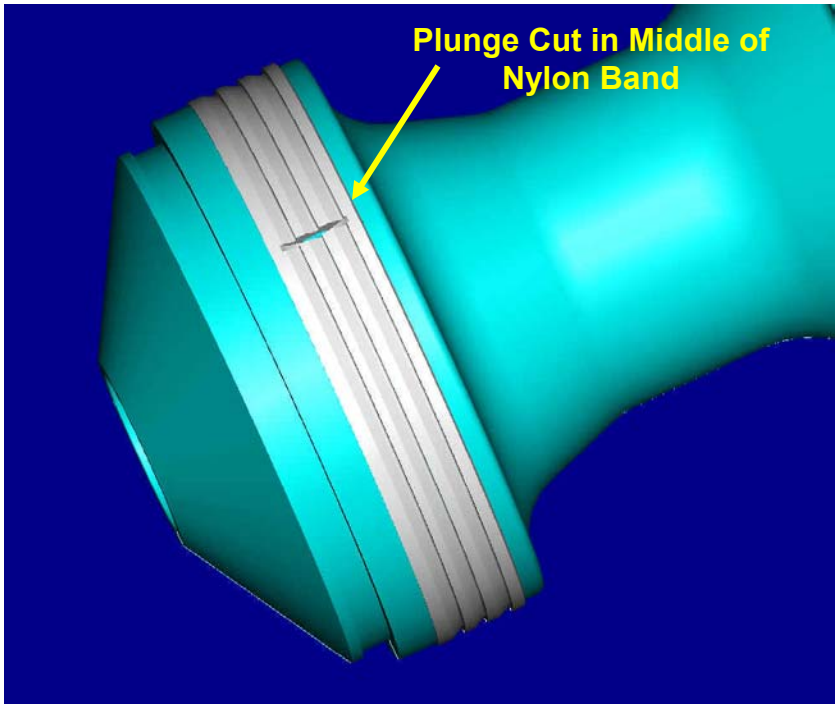
Circumferential Tearing

- Sabot recovery analysis revealed evidence that the nylon obturator band did not always break along the pre machined slot.

- In many instances, the fracture reaches the area of thinner nylon over the knurled area between the dovetails and the fracture will on occasion, especially at cold temperatures, propagate circumferentially rather than directly aft.

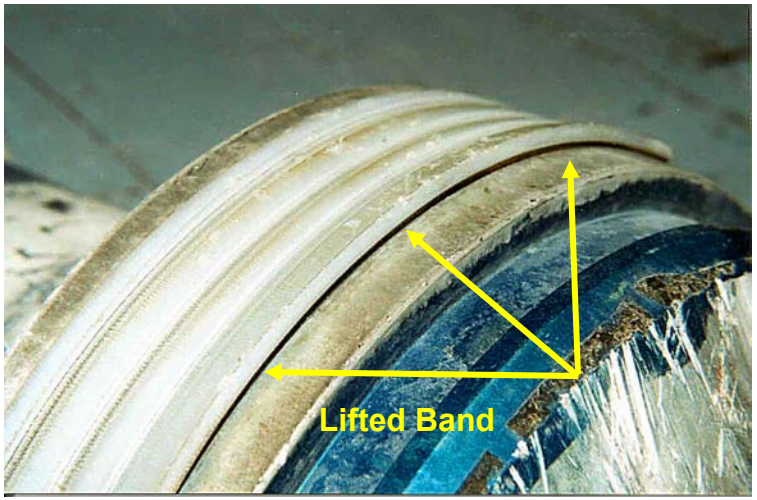


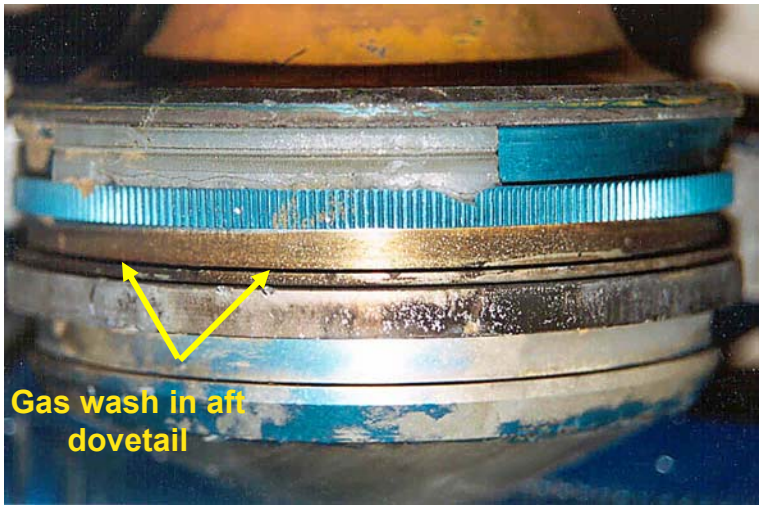
Design Feature One – Plunge Cut



- The plunge cut is designed to prevent circumferential tearing of the obturator band.
- The plunge cut is located directly in the center of the band so that each shoulder, forward and aft, of the cut have an identical thickness. This will promote an even, symmetrical break.

Gas Intrusion Beneath Nylon Band

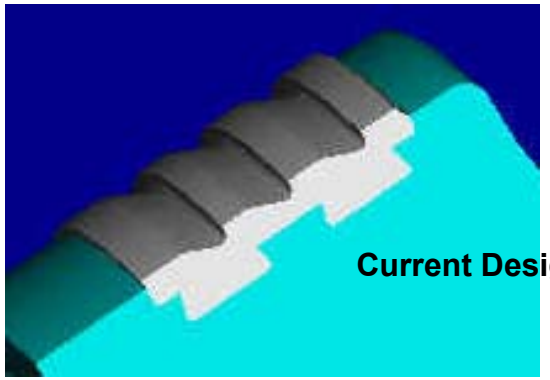


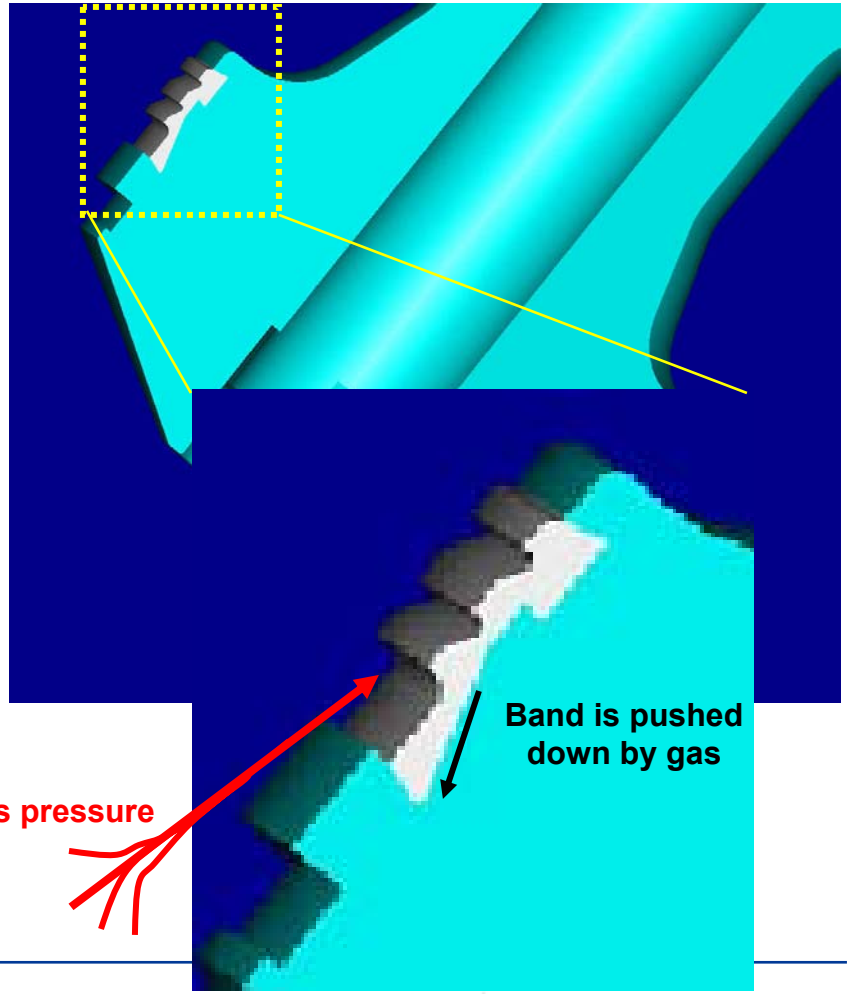


- It was noticed during the sabot recovery evaluation that there was evidence of gas intruding under the aft dovetail of the nylon band.
- The evidence of this lifting was shared with the technical community and the modified dovetail design was created and became known as the ARL design.

Design Feature Two – ARL Groove

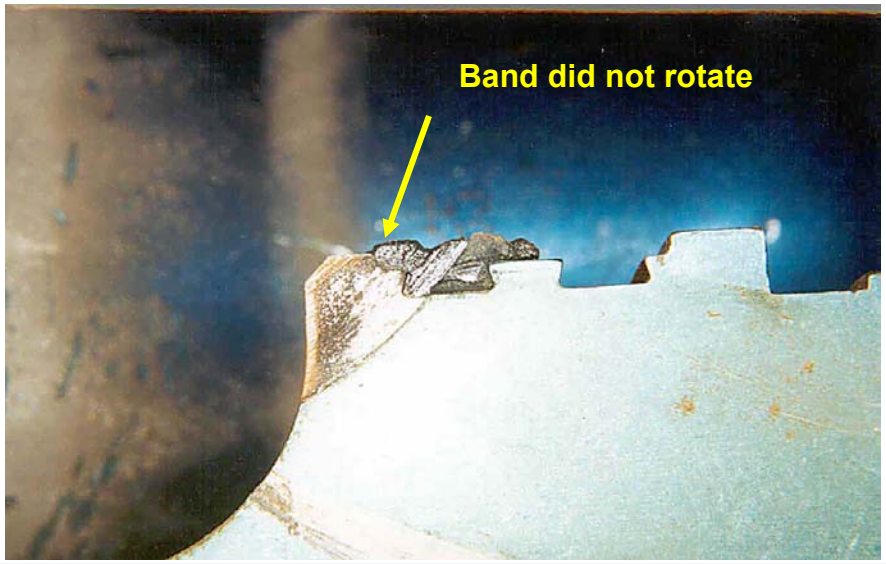
- Designed to prevent gas intrusion underneath the obturator band causing the band to lift prior to exiting the gun tube.
- In theory the gas should force the obturator band into the extended dovetail.

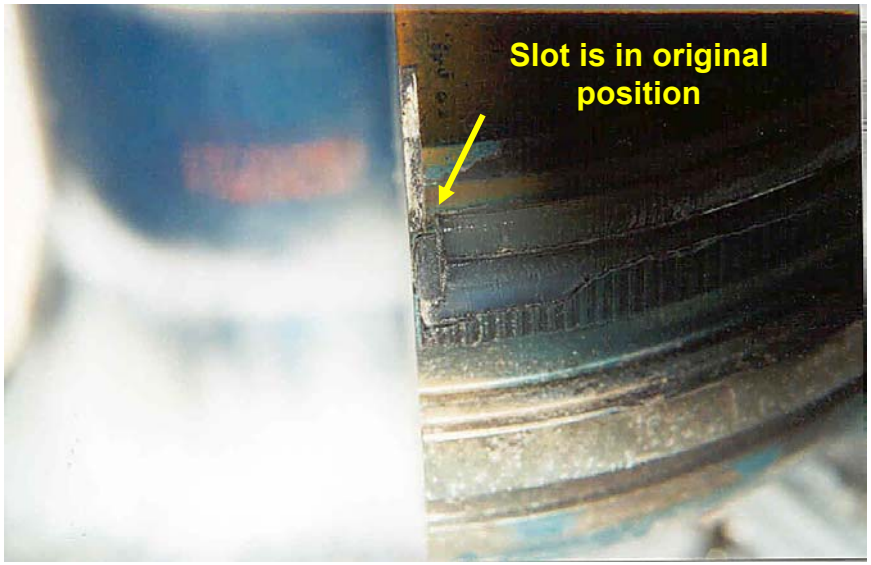




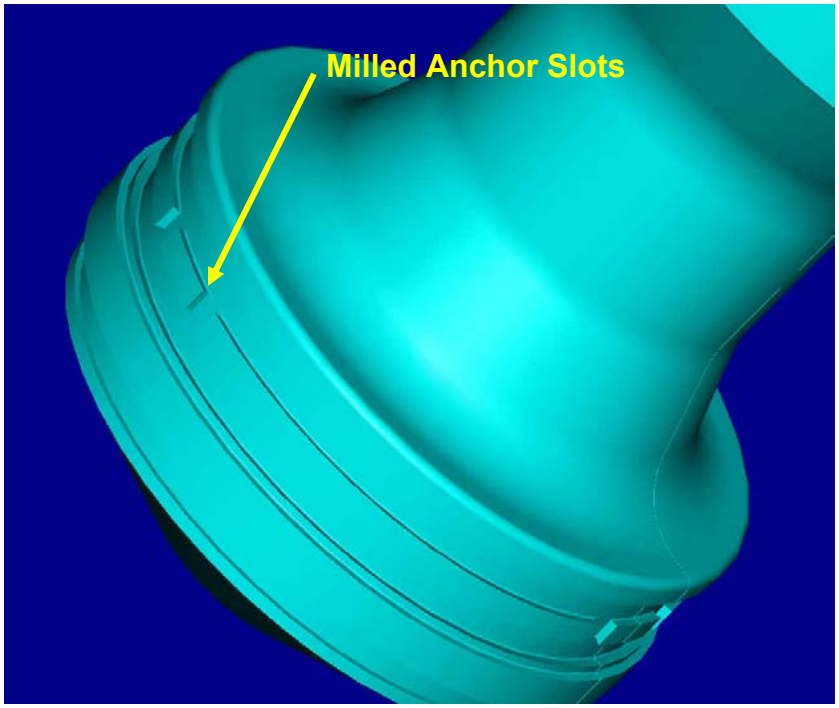
Band Rotation

- It was noticed that on some recovered sabots there was evidence of in-bore band rotation.
- Some recovered sabot segments showed evidence of the slot being intact and shifted circumferentially up to ten or twenty degrees.
- This rotation would not stop the discarding of the sabot, but it would certainly create a different discarding process than what is normally seen.





Design Feature Three – Anchor Slots



- Anchor slots are designed to prevent the obturator band from rotating while in bore.
- Rotation of the band in-bore causes the band to break in a location other than the precut slots resulting in a negative affect on final TID results.

Design Combinations

- 5 test groups were developed from the three design features

	ARL Groove	Plunge Cut	Anchor Slots	Ballistic Test Qty.
Design 1 (T_1)		X		30
Design 2 (T_2)	X	X*		30
Design 3 (T_3)			X	30
Design 4 (T_4)		X	X	30
Design 5 (T_5)	X		X	30
Control Rounds				60

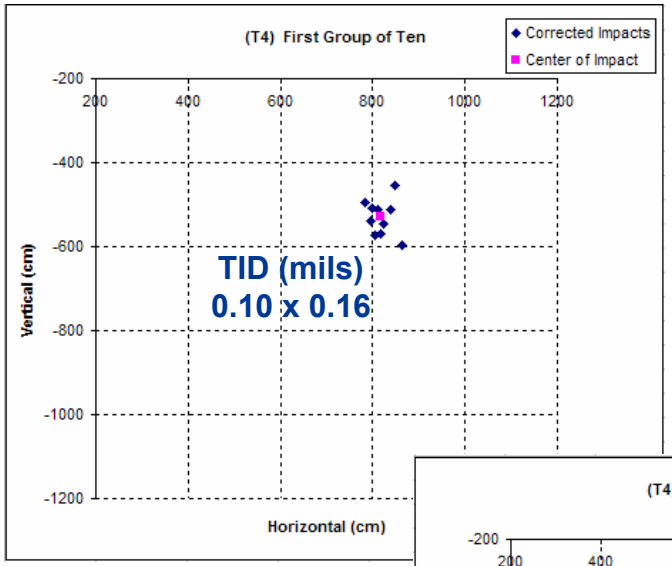
*** Plunge cut had to be modified from a slot to a drill cut due to modified obturator band**

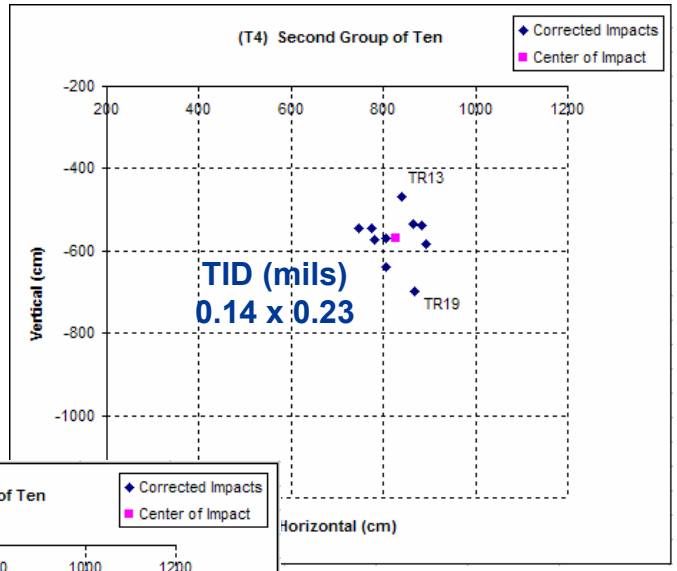
Summary of Results

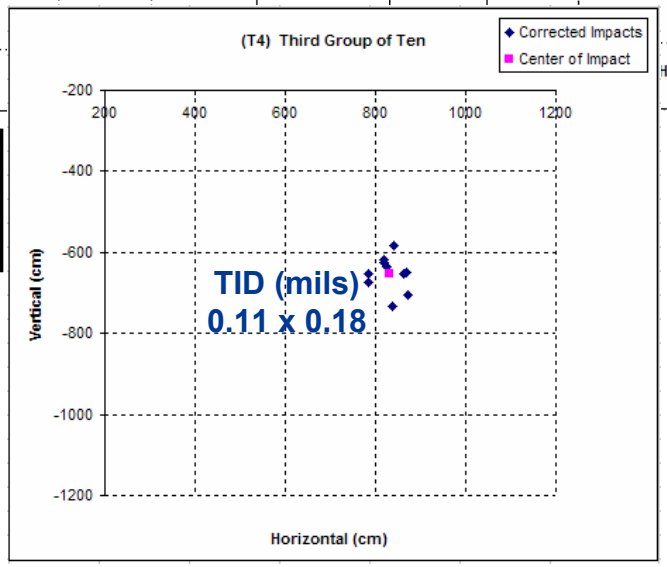
	No of Rounds Fired	Fliers[1]	Percent Fliers	Improvement over Control Rounds	Total Average TID
Design 1	30	7	23.3%	8.3%	.20 x .27
Design 2	30	6	20%	11.6%	.25 x .25
Design 3	30	6	20%	11.6%	.27 x .26
Design 4	**30**	**2**	**6.6%**	**25%**	**.12 x .19**
Design 5	30	4	13.3%	18.3%	.21 x .23
Controls	60	19	31.6%	-	.26 x .26

[1]Any single round which resulted in an impact greater than 100 cm from the center of impact was considered a flier during test evaluation.

Design 4 Resultant Impacts



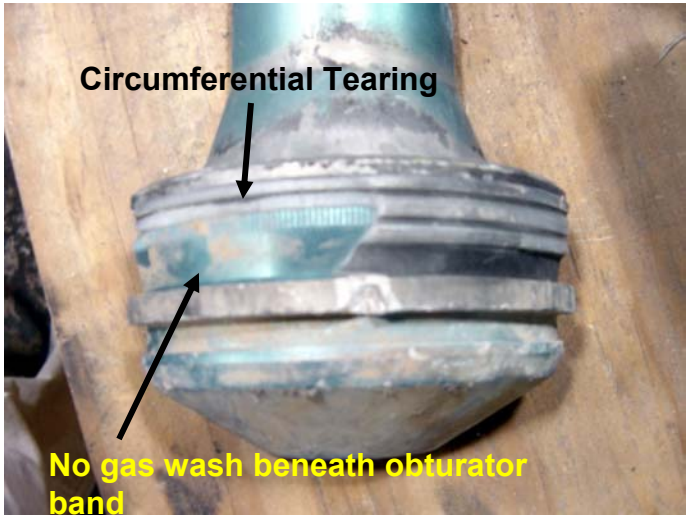




3 out of 40 test since the design change have had a TID result below a 0.20 x 0.20.

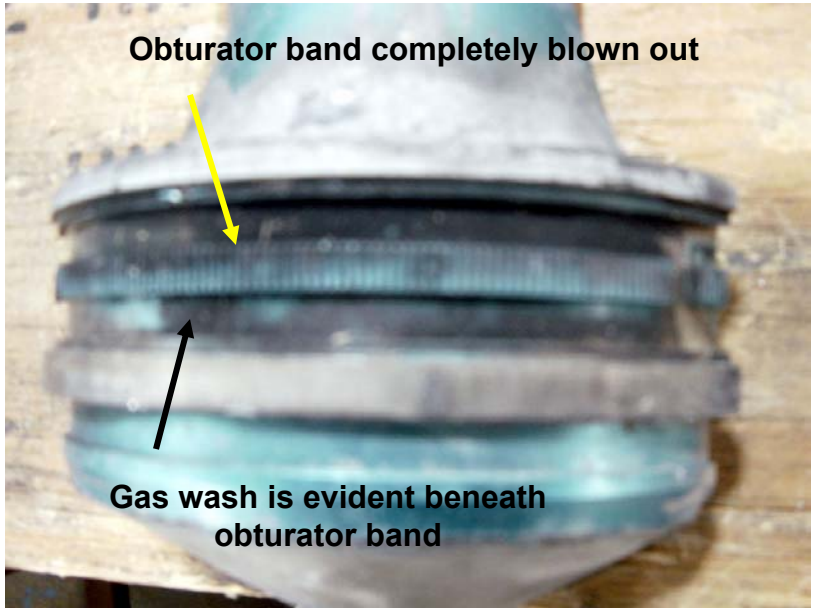
Recovered Sabots – General results

1. ARL Groove
   - Gas did not intrude underneath nylon obturator band.
   - There were many recovered sabots that exhibited circumferential tearing.
   - In most instances large portions of the obturator band remained in tact.



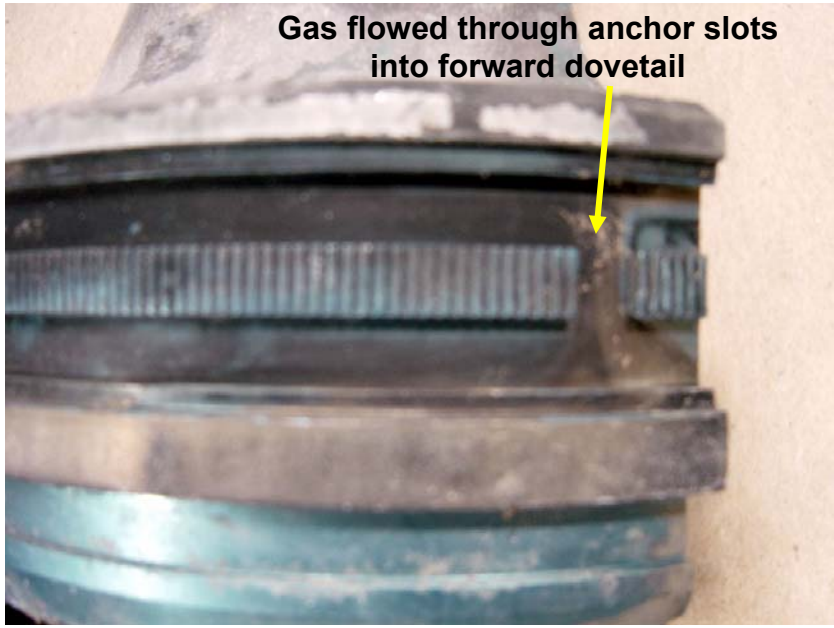
Recovered Sabots – General results

2. Plunge Cut
   - The nylon obturator bands showed very little signs of circumferential tearing.
   - 90% of the bands were completely blown out of the sabot segments. This is typical to what is seen during +52°C and +21 °C.
   - Gas was able to intrude under the obturator bands.



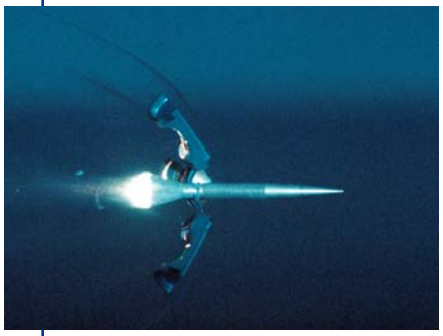
Recovered Sabots – General results

3. Anchor Slots
   - Gas wash intruded into forward and aft dovetail on 95% of the sabot segments. Gas wash flowed through the anchor slots.
   - There was no evidence of band rotation.
   - Designs with this feature on average exhibited an increase in muzzle velocity of 20 m/s.



Conclusions and Path Forward

Design 4 (Plunge cut and Anchor slots) performed significantly better than the current M865 design.



- Significant improvement in TID
- 25% lower rate of fliers than current design
- Increased muzzle velocity by an average of 20 m/s
- Recovered sabot segments exhibited characteristics similar to what is seen after +52°C and +21 °C tests.

Verification testing of Design 4 to take place in June 2005 at YPG.

- GD-OTS and ATK to participate in verification test
- 180 test rounds with 60 control rounds.

Questions