Propellant Instability Leads to ECL Propellant Qualification for LW30 Ammunition

Teaming for Performance

US Army, Alliant Techsystems and
Rheinmetall Nitrochemie

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Outline

- **Definition of Current Weapon System**
- **Description and Discussion of the Failures in the Field**
  - Types of Failures
  - Root Cause Analysis from the IHIT (Inbore, Hangfire Investigation Team)
- **Hangfire Signature Linked to Propulsion Failures**
- **Search for Improved Propellant**
- **Head-to-Head Study of ECL (Extruded Composite Low Sensitivity) vs Ball Powder**
- **Transition of Swiss Production to the US**

Current Apache M230 30mm Weapon

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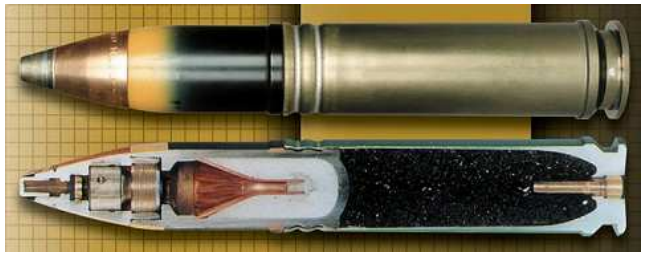
M230 Chain Gun

- Electric drive motor
- Single barrel, chain driven, automatic cannon
- 625 ± 25 shots per minute firing rate

LW-30 Ammunition Family

- 30 x 113 mm, linkless ammo
- M789 HEDP and M788 TP
- Propulsion system: PA520 primer + 3 BKNO3 FT pellets + WC 855 BALL POWDER®



Failures in Field Lead to New Propellant Qual

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Three main failure signatures identified by IHIT team:

Hangfire: Ballistic functioning of the cartridge occurs outside the dwell time of the weapon

- Damage: occurs at the operating group, and/or receiver
- 23 Incidents between Aug 97 – April 2007

Additional Failures in Field

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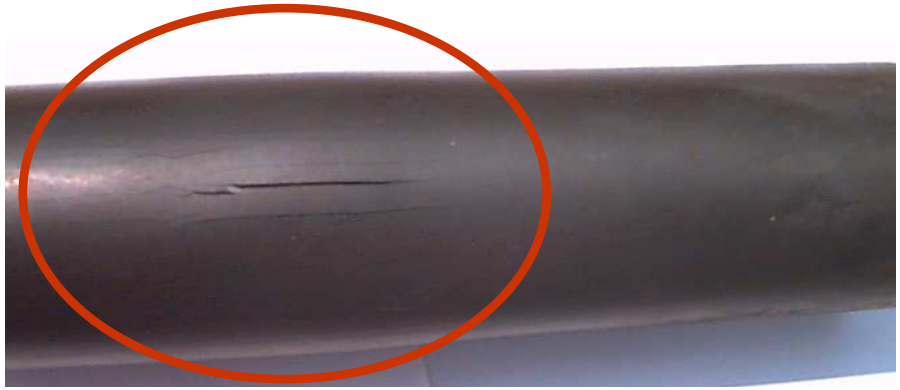
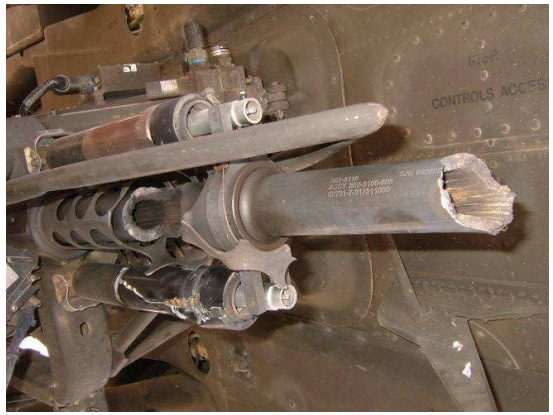
Inbore Detonation: Premature initiation of the HE in the barrel

- Damage: results in bulged barrel or severed barrel
- 21 Incidents between Aug 97 – April 2007



Bullet-on-Bullet: Bullet of previous round does not exit barrel before next round is fired. Signature attributed to puncture of case and loss of propellant.

- Damage: severed barrel, muzzle completely destroyed
- 2 Incidents between Aug 97 – April 2007



Hangfire Signature Attributed to Propulsion System

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Two root causes identified by the IHIT team for a hangfire signature relating to the propulsion system:

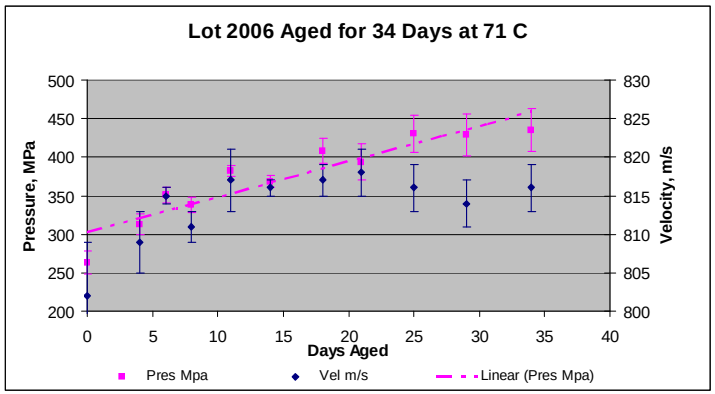
Ballistic instability of the propellant resulting in high pressures

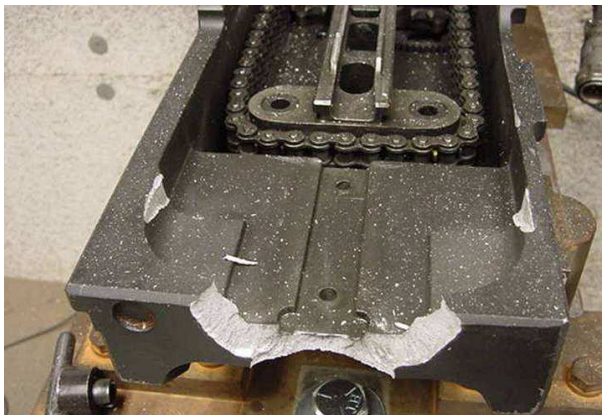
» Propellant no longer exhibits deterrent profile, expected migration of low MW deterrent

Ignition system damage resulting in high pressures or long action times

» Vibration during flight and upload/download result in broken flash tube assemblies

» Small particle size ball propellant able to enter flash tube assembly when lacquer seal fails





New Propellant Search Leads to ECL

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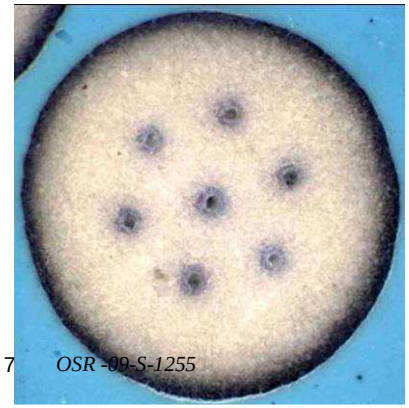
Improved Characteristic's of ECL®	Translates to…
High energy density formulations High thermal conversion Tuneable performance and force	Improved ballistic performance and efficiency Flat, tuneable ballistic profile across temperatures Improved dispersion, repeatability
No mobile plasticizers, non-nitrogylcerin	No migration of NG into cases Improved system compatability Improved safety during manufacture
Enhananced IM properties	Higher cook off temps - improved crew survival Less sensitive/no reaction to impact
Non-toxic, "green" formulation	Better for the environment Better for the user/manufacturer
Chemical stability Ballistic stability	Ammunition can be deployed to extreme climates with no degredation in performance Longer service life for ammunition



ECL® Propellant Superior Stability Response

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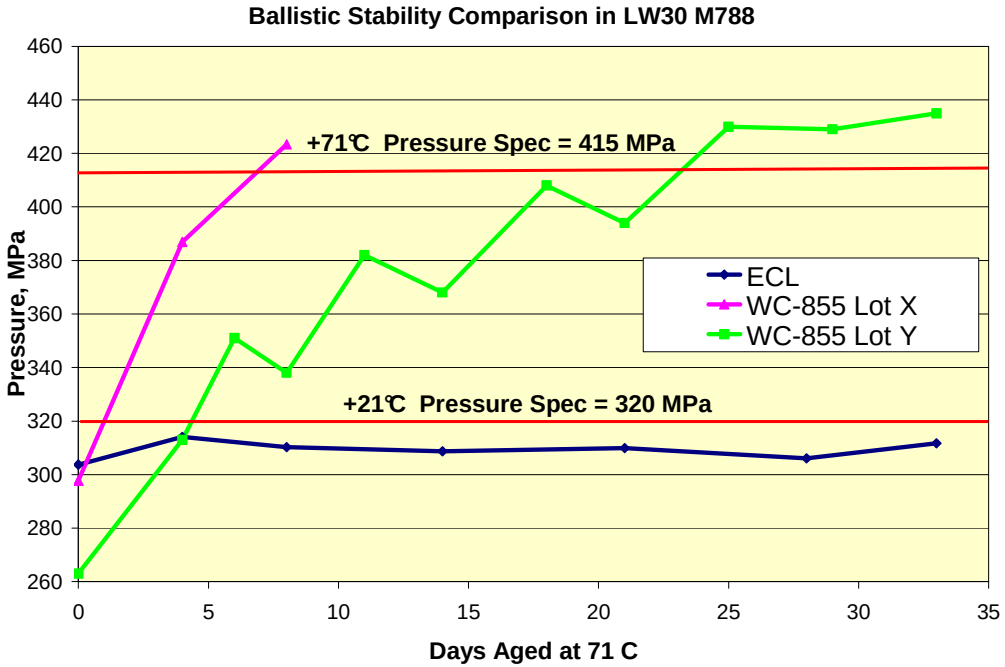

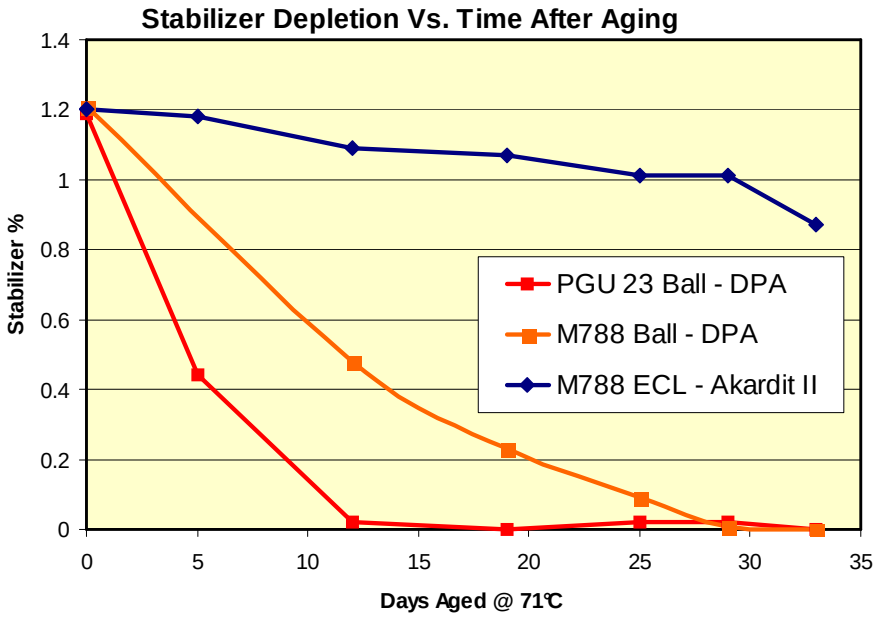

- **Large variation in ballistic stability response for WC-855 after hot temp storage**
- **Propellant lot 'X' reaches upper spec limit for pressure after 7 days at 71℃**

- **Ball propellant analyzed 0% stabilizer after 18 days at 71℃**
- **ECL propellant analyzed 1.1% stabilizer after 18 days at 71℃**

Ball Powder = Performance and Safety Concerns

No change in ballistic performance of ECL after 33 days at 71℃!

After 33 days, ECL analyzed with 83% primary stabilizer

LW30 Vibration Testing

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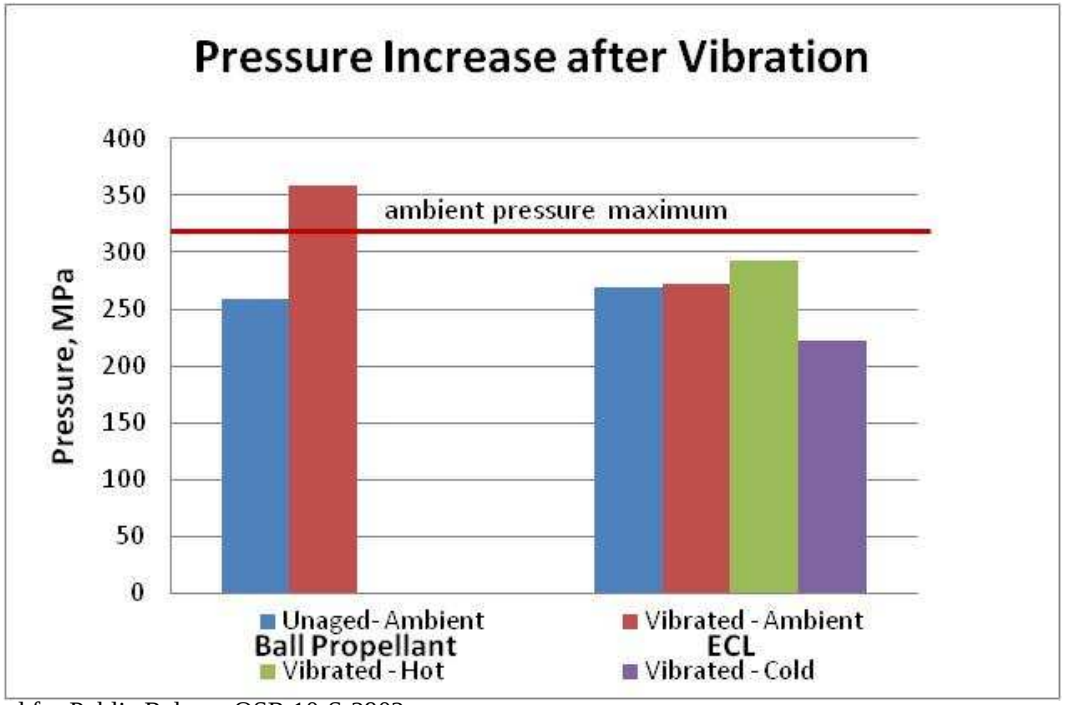
- **Extreme pressures (> 500 MPa) measured with ammunition that suffered from ignition failure coupled with propellant**
- **To demonstrate superiority of ECL, M592 ammo container loaded with 20 rounds (ball propellant) and 90 ECL rounds were subjected to vibration testing**
- **Vibration testing consisted of 500+ hours of vibration across 3 axes coupled with over 350 hours of temperature cycling (-40 to +65℃)**

- **ECL rounds tested at ambient, hot +71℃ and cold -54℃**
- **Ball propellant rounds only tested at ambient due to high pressure ~ Pressure increase of approximately 40%**



LW30 Ballistic Advantages

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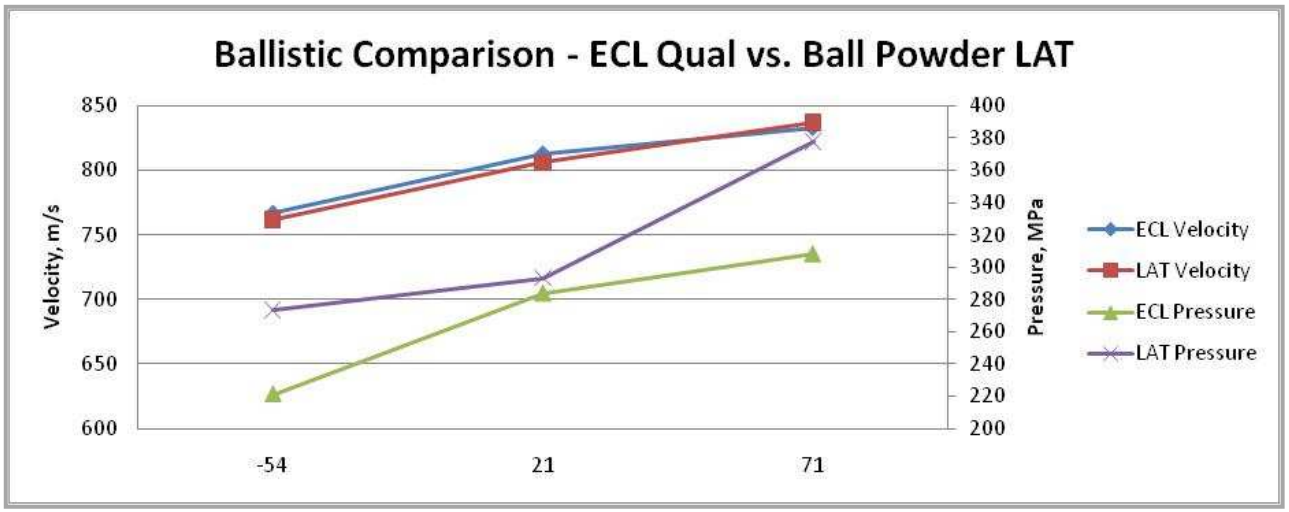
ECL® Exceeds Ballistic Performance of Ball Powder WC 855:

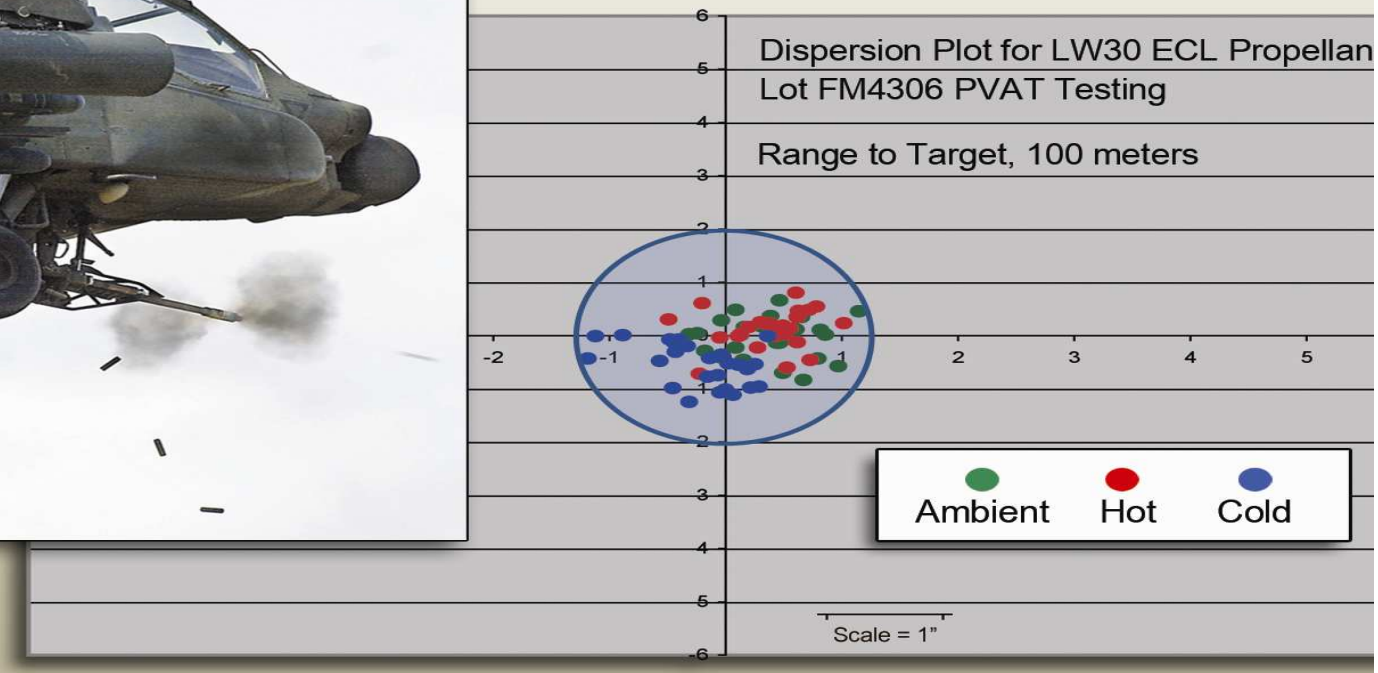
- ✓ Lower Charge Weight ~ -5%
- ✓ Higher Velocity ~ +15 m/s
- ✓ Reduced Pressure ~ -20% at hot

Extra Efficiency of ECL Translates to:

- ✓ Extended Range
- ✓ Increased Lethality
- ✓ Cost Savings
- ✓ Ballistic Margin



Innovation ... Delivered.



ECL is currently undergoing qualification testing for 30mm Apache ammunition.

RHEINMETALL NITROCHEMIE

Photo courtesy of the U.S. Army

Extruded Composite Low-sensitivity (ECL) gun propellant allows 30mm Apache ammunition to provide low dispersion at cold, ambient and hot operating temperatures. ATK.

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Ultimate LW30 : New Propellant + New Ignition

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Action time critical to the LW30 M230 gun system

- Rate of fire is 625 rounds per minute

Propellant	Description	AT, ms
Reference	Std Ignition	2.70
LW30 ECL FM4285	Std Ignition	2.49
LW30 ECL FM4285	Standard primer, no flash tube	3.74
WC 855 L574	Standard primer, no flash tube	75.25
LW30 ECL FM4285	MIC primer, with flash tube	3.26
WC 855 L574	MIC primer, with flash tube	3.43
LW30 ECL FM4285	MIC primer, no flash tube	4.03
WC 855 L574	MIC primer, no flash tube	85.61

Conducted work share investigation with PM MAS to investigate alternate primer mix effects

- MIC primers are aluminum based primers
- Potential next generation lead-free “green” primer

Alternate ignition testing illustrates superior ignitability of ECL propellant

Additional Investigations with ECL

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Super 40

20mm

120mm Mortar ER

EAPS

EXTENDED AREA PROTECTION & SURVIVABILITY

XM-350

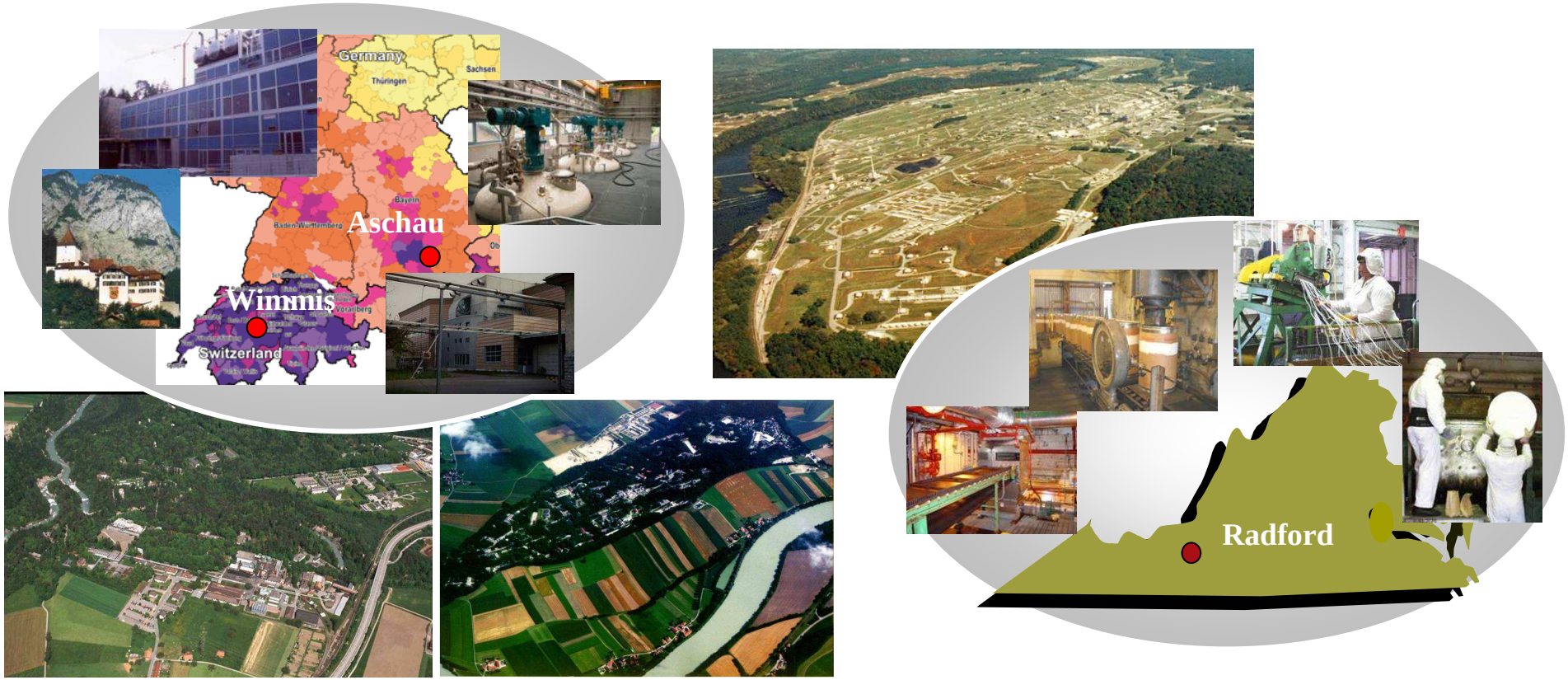
Phalanx

Bringing Advanced Propellants to the US DOD Market

A premier aerospace and defense company

Combining Nitrochemie's Advanced Technology with ATK's High Volume Manufacturing to Provide our DOD Customers with Key Requirements

Combining Nitrochemie's modern world class propellant production capabilities with the US Army's largest propellant production facility



Thanks and Questions?

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Thanks for your attention!

Questions???

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