

# On Time...On Target

*Land, Sea, Air, and Space*

## ATK Company Overview

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## Experience with Propellant Well Stimulation

Steve Moore

February 2014

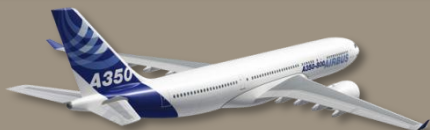


- **Introduction and Responsibilities**
- **Overview of ATK**
- **ATK's Propellant-Based Well Stimulation Technology**
- **Overview of the Stimulation Tool**
- **Case Histories**
- **Summary**

*ATK is an aerospace, defense and commercial products company with almost \$5B in annual sales*

## Aerospace Group

President: Blake Larson



- Propulsion for space exploration, commercial launch vehicles, strategic and missile defense
- Composite structures for military and commercial aircraft
- Satellite components and subsystems
- Military flares and decoys
- Space engineering services

## Defense Group

President: Mike Kahn



- Strike weapons
- Medium-caliber gun systems
- Precision-guided munitions
- Missile warning
- Small / medium / large-caliber ammo
- Tactical propulsion & controls
- Advanced fuzing & warheads
- Defense facility management
- Weaponized special mission aircraft

## Sporting Group

President: Jay Tibbets

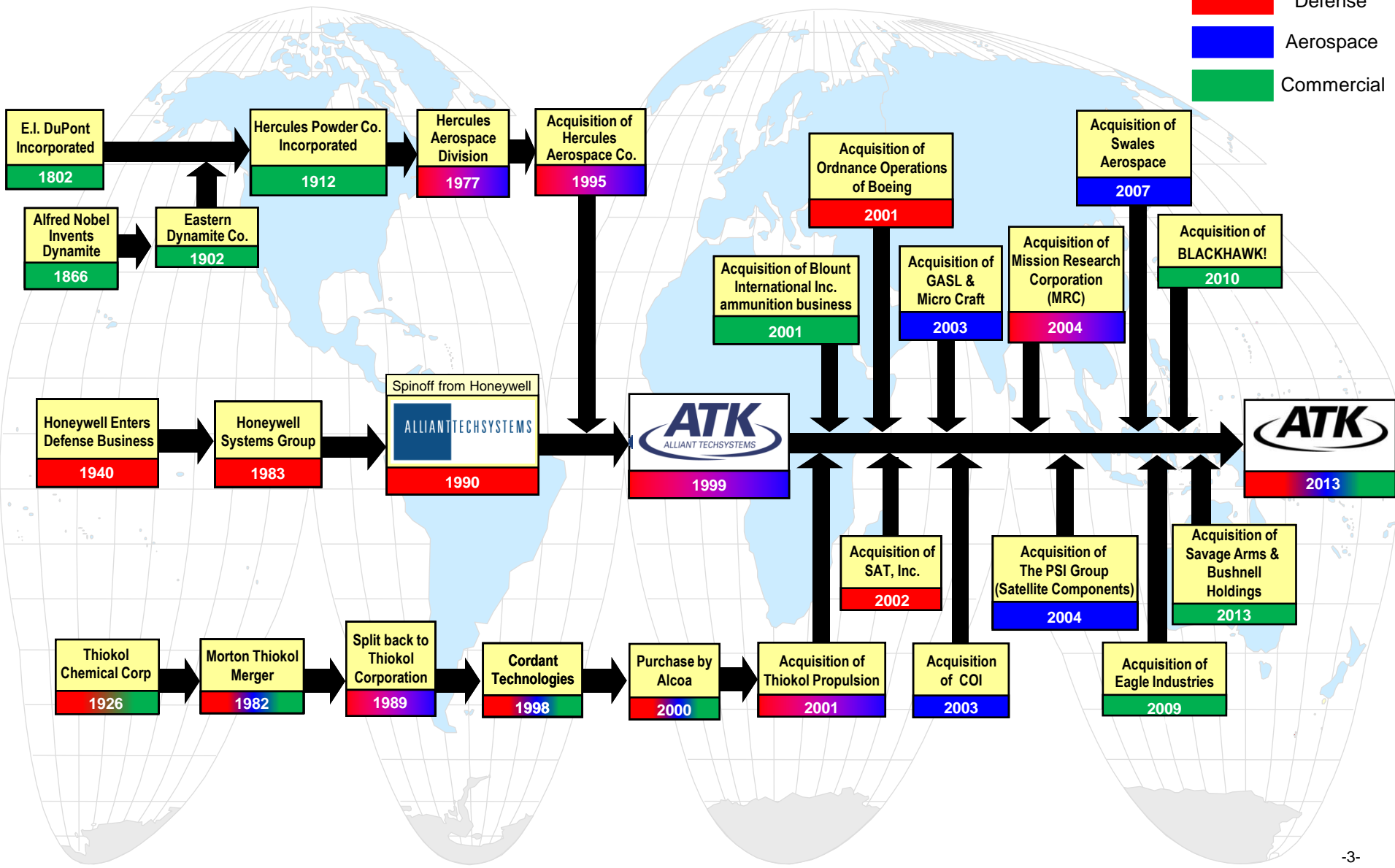


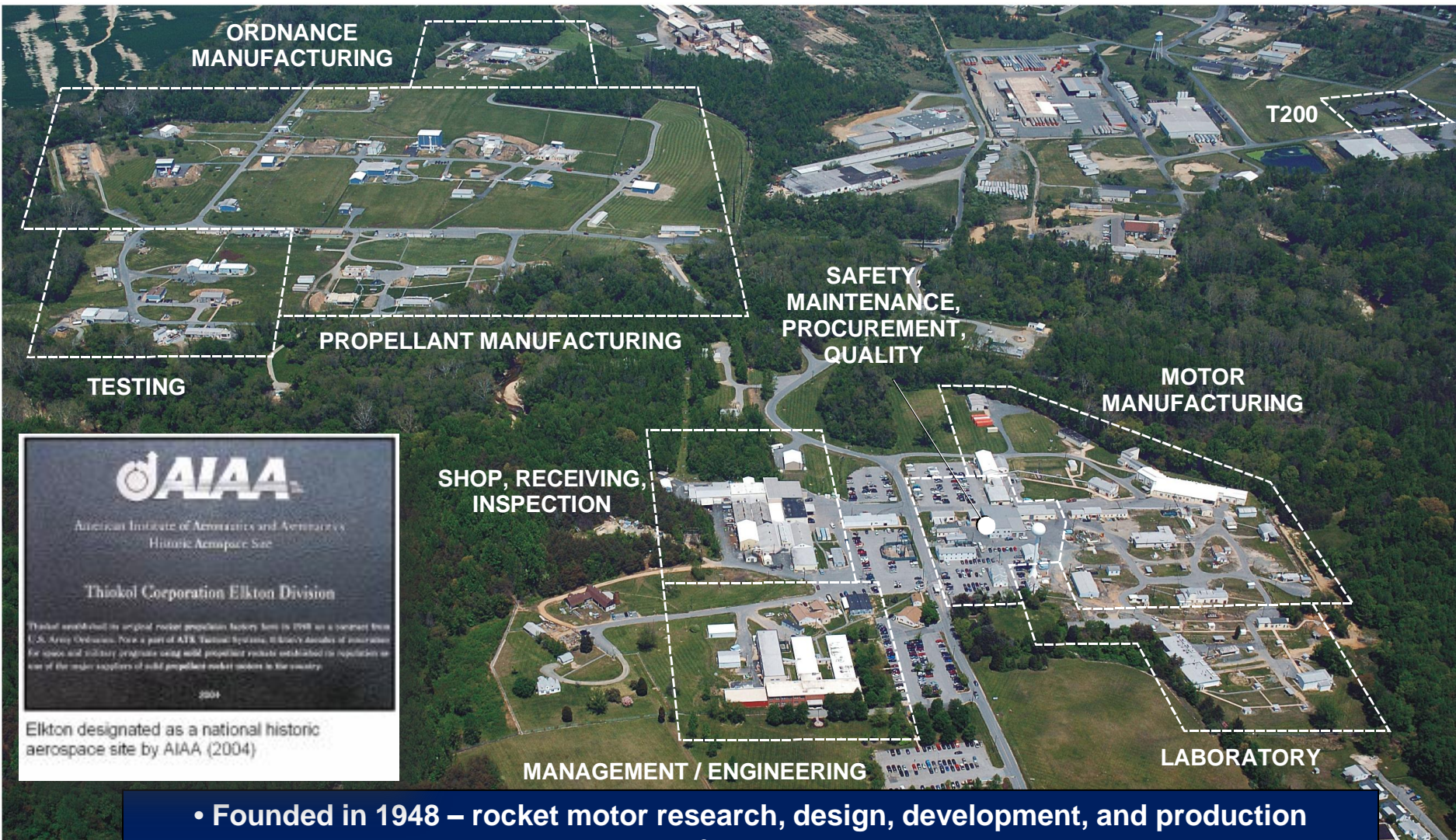
- Sporting and hunting ammunition
- Law enforcement and security forces ammunition
- Gun powder for ammo and re-loaders
- Shooting sport accessories
- Tactical systems and accessories for:
  - Military customers
  - Law enforcement and security markets

# ATK's History of Diversification



- Defense
- Aerospace
- Commercial





American Institute of Aeronautics and Astronautics  
Historic Aerospace Site

Thiokol Corporation Elkton Division

Thiokol established its original rocket propellant factory here in 1948 as a contract from U.S. Army Ordnance. Now a part of ATK Tactical Systems, Thiokol's decades of innovation for space and military programs using solid propellant rockets established its reputation as one of the major suppliers of solid propellant rocket motors in the country.

2004

Elkton designated as a national historic aerospace site by AIAA (2004)

- Founded in 1948 – rocket motor research, design, development, and production
- 550 acres, 150 buildings, and 380,000 ft<sup>2</sup> of enclosed floor space – wholly owned facility
- ISO 9001:2000 certified and AS9100 Rev C certified

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## Experience with Propellant Well Stimulation

John Arrell

February 2014



# Current Hydraulic Fracturing Process



**Water usage nominally 3 to 5 million gallons per well**



## **ATK's propellant-based procedure requires:**

- No change in current well drilling, casing, and perforation
- No specialized or modified tools
- Minimal equipment
- Short set-up and operations time



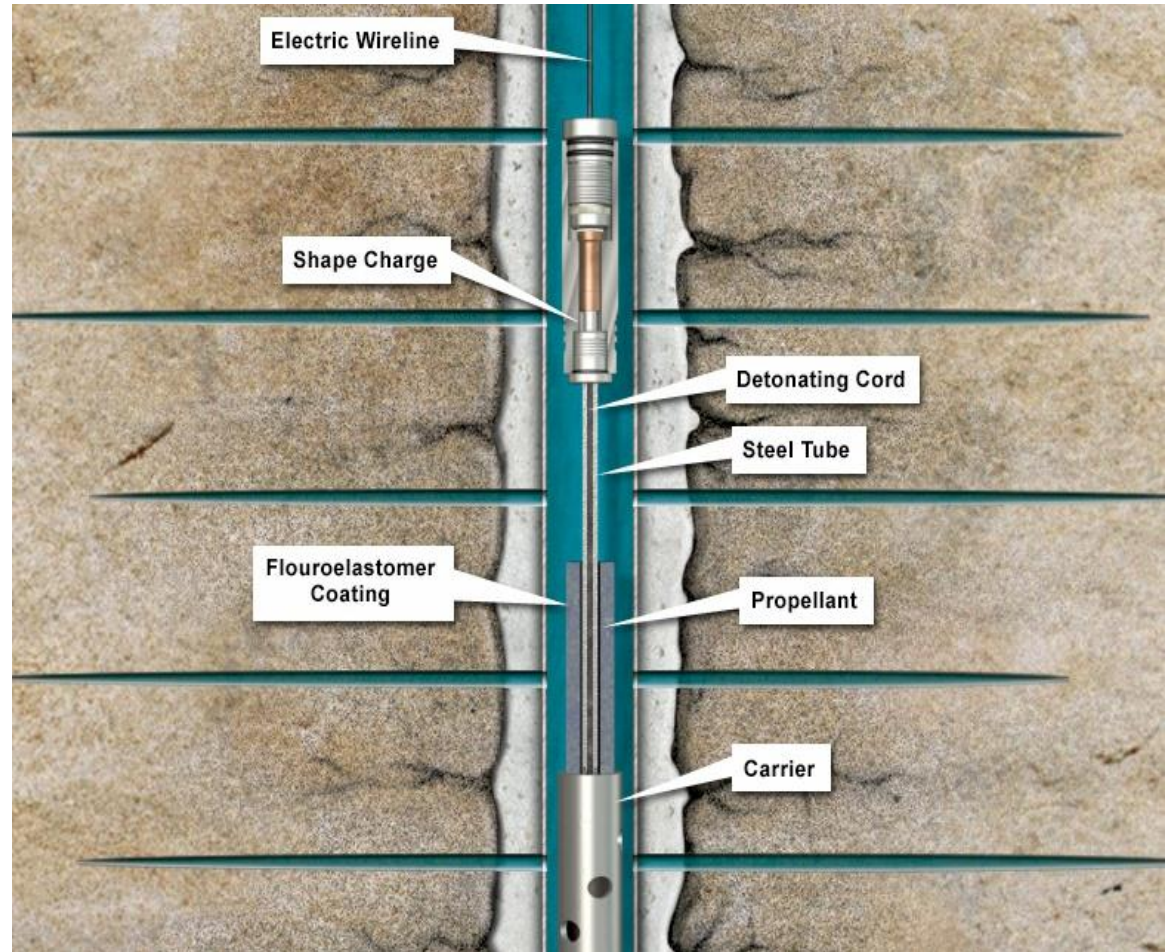
ATK, partnered with PPS, has developed a **propellant-based** alternative/augmentation to the current hydraulic fracturing process

- Solid propellant is ignited generating specified volume of gas creating pressure that fractures the rock
- Propellant type, amount, and burning rate can be adjusted depending on geological conditions
  - Propellants can be designed to operate in the pressure and rise rate regime between single-blast explosives and HF
  - Extension of fractures can be controlled
    - Distance from wellbore: 10 to 100 feet
    - Directional: 360 deg to 45 deg
- Propellant solution is adaptive and can be readily modified, fabricated, and demonstrated with new formulations based on fracturing requirements
- Applicable for use in oil, gas, and geothermal wells
  - Re-stimulation of existing wells
  - In concert with hydro-fracking (e.g., reduce breakdown pressures)
  - Substitution for hydro-fracking operations

# Solid Propellant Stimulation Tool Description



- Environmentally sealed ignition designed tool with premachined fracturing segments that ideally provide equal flame spreading and, therefore, completely burn the propellant grain
- Configuration design is critical to the success of the tool
- Assembled at well site to assure maximum tool benefit and ease of transportation
- Results can be measured in the same day
- Successfully demonstrated in many applications and down-hole conditions

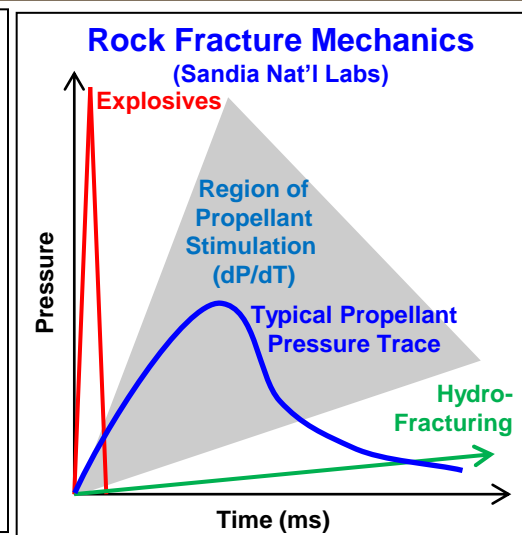
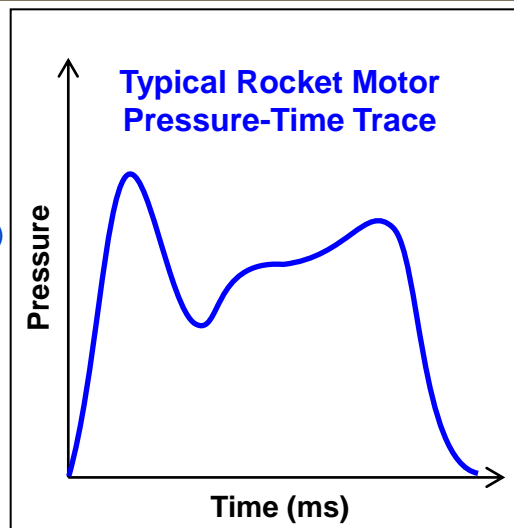


# Benefits of Energetics Fracturing Process



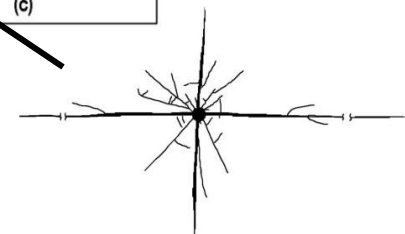
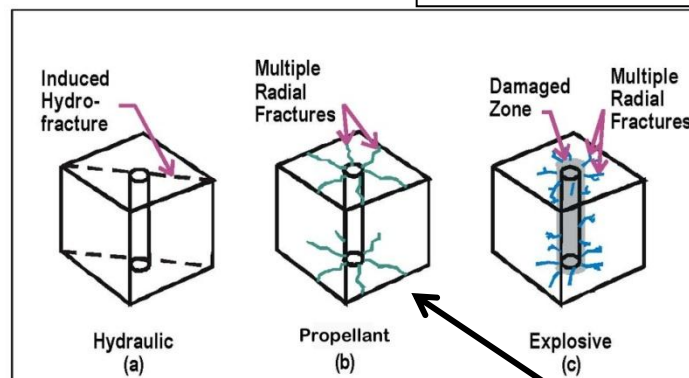
## PRIMARY BENEFITS

- Release of the gas disbursement
  - Explosives 1,000,000 psi in 1 microsecond
  - Hydraulic 5,000 psi in 1 hour
  - Propellants 20,000 psi in 10-1000 milliseconds (Tailored)
- Reduces or eliminates the amount of water required
- Drastically reduces or eliminates the disposal of used fracturing water
- Much lower cost
  - 50% cost reduction versus current procedure
  - Minimal on-site equipment
  - Shorter service time needed to get well on line



## ADDITIONAL BENEFITS

- Eliminates the need for chemicals to alter the success of the fracturing technique
- Creates multiple fractures with controls instantly around boreholes to eliminate aquifer contamination
- Increases injection and withdraw rates in gas storage wells
  - Removes "skin" and cleans the wellbore damage the perforating process creates, which reduces breakdown pressure in some formations
  - Improves effectiveness of acidizing by using propellant before acidizing
  - Stimulates selected zones without the need to set packers
  - Minimal formation damage from incompatible fluids and minimal vertical growth out of the pay zo



**Bottom line: Demonstrated performance, lower cost**

## Features

- Propellant is highly energetic and long burning for an extended propellant treatment
- Unique initiation process and patented coating process ensures predictability
- Variable surface area ignition increases or decreases the release of gas as needed
- Wireline, tubing (TCP) and coiled tubing conveyed

## Specifications

- Maximum temperature: 450° F 1 hour
- Hydrostatic pressure up to 14,500 psi
- Standard propellant cartridges come in four sizes
  - **Multiple diameters (1.2 to 3.6 inches in diameter)**
  - **Propellant is cast in sticks up to 27 inches long**
- We can manufacture custom sizes based upon your application

## **Beyond time and production advantages, ATK's propellant-based stimulation technology has the following attributes:**

- Eases competing community demands for (often scarce) water resources
- Reduces traffic congestion/usage and the need for associated road repairs
- Smaller operating footprint is more acceptable to environmentally conscious communities
- ATK's record of handling, transporting, and operating safety provides additional assurance to hosting communities
- Reduction/elimination of chemicals viewed more favorably by communities with concerns regarding impact to their land
- Reduced infrastructure required in remote or foreign locations

- **ATK has conducted demonstrations on more than 600 wells using solid propellant technology with various data from ~60 demonstrations**
- **Demonstrations performed in 11 states, off-shore, and internationally in multiple oil, gas, & geothermal wells demonstrated positive results**
  - **225% increase in production propellant versus hydraulic stimulated wells**
  - **100% increase in old, re-stimulated well production**
  - **30% to 50% reduction in pressure required to breakdown wells**
  - **200% increase in volume with 75% decrease in the pressure for disposal wells**
  - **Created opportunity for production in a well that was dormant for 30 years**
  - **Demonstrated utility for repair operations (e.g., stuck components, damaged wells)**
  - **Demonstrations proved successful in test wells in Alabama, Alaska, Arkansas, California, Colorado, Louisiana, Kentucky, Mississippi, Oklahoma, Texas, Utah, North Sea, Gulf of Mexico, Nicaragua, Iceland, and Ukraine**
- **Data is vital to long-term improvement of the energetic stimulation technology**
  - **Each well provides an opportunity to collect important data to identify key parameters to improve performance**

- **ATK has submitted a DoE proposal to gather hi-fidelity data from a well stimulation scenario**
  - **Subject well is a horizontal gas well in Louisiana**
  - **Instrumentation includes the advanced 3-dimensional micro-seismic capability available in the US**
  - **Instrumentation also includes remote pressure transducer for precision measurement of the pressure vs. time curve**
- **Data from this test, other US and international wells will support a data based statistical solution to optimize the propellant technology**
  - **The more data gathered will benefit other wells with other customers by improving the efficiency and effectiveness of the propellant stimulation**
- **Additionally, ATK is partnering to build an analytical model to support stimulation optimization**



- **Subject well in Western Ukraine was abandoned for more than 10 years**
  - Vertical well depth was >10,000 feet
  - No infrastructure available
  - Demonstration of concept
  - Long-term production data unavailable
- **Partnered with local company and received a purchase order for stimulation of 100 wells in Ukraine**
  - >3000 existing wells available
  - In negotiation with one independent
  - Other Ukrainian independents lining up
- **Formation Type: Paleaogen shale**
- **Stimulated 3 Intervals**
  - 2083-2086m
  - 2380-2386m
  - 2394-2397m
- **Video was shot during retrieval of tool after second zone was stimulated**



- ATK is actively pursuing the following worldwide:
  - **Additional test wells to validate and quantify initial positive results**
  - **Additional contract opportunities to improve production or supplement/replace hydraulic fracking**
  - **Collaborative teaming with industry leaders to develop additional propellant treatments that are customized to optimize specific geological plays**
  - **Extension of geological penetration beyond current reach using energetics and modeling & simulation technology.**