



Tactical Grenade-Extended Range (TGER) A Precision Small Unit Tactical Weapon

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Operational Need

- Small tactical units need a precise, rapid response, extended range weapon for employment at the discretion of the on-site commander
 - Troops deployed in urban environments
 - Fire Team, Squad, Platoon, Company
- Small hand launched, extended range weapon provides a solution
- Potential applications
 - Counter sniper weapon
 - Targets beyond effective small arms range
 - Targets obscured by walls, buildings, or ditches
 - Key positions / targets posing an immediate threat
 - Machine guns, personnel, cars, trucks, tactical vehicles, crew served weapons
 - Destruction of IED weapon
- This requirement is now showing up with SOCOM as LMAMS (Lethal Miniature Aerial Munition System)

Tactical Grenade Extended Range

- Hand Launched, extended range weapon
 - 3 pound fly away weight
 - 1 pound warhead
 - Inflatable wing
 - 24 inch wingspan
 - 2 inch diameter fuselage, 12 inch long
 - Vertical stabilizer 3 inch
 - Dual 40 mm grenade warhead
 - Electronic Safe and Arm Fuze
- Containerized for transport
 - 4 inch diameter by 15 inch long sealed canister
 - 4 pound shipping weight

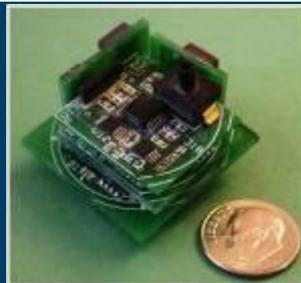


TGER Vehicle

Currently Developed TGER Components



Inflatable Wing



Tiny Guidance Engine



Ground Control



Data Link



TGER Weapon



Motor



GPS



Warhead

Company Information

MBDA Incorporated,
Westlake Division

- Westlake Village, California
 - US Arm of MBDA in Europe
- Expertise in guided weapon technology
 - Precision air to ground weapons
 - Weapon control data links
 - Laser guided rockets
 - Small Diameter Bomb wing kit



Company Information

Continental Controls and Design

- Huntington Beach, California
 - Active since 1997
 - CCD is a small business

Locust ISR Vehicle



- Expertise in Guidance, Navigation and Control technology
- CCD's mission
 - Design and support innovative, rapid response solutions by employing miniature instruments and UAV autopilot

Company Information

DSE, Inc

- Tampa, Florida
 - Production facility in Gaffney, South Carolina
- Primary Expertise
 - Currently one of two existing prime contractors to U.S. Army for 40mm ammunition
- Major Products
 - 40mm to 155mm munitions
 - 40mm High Velocity Rounds
 - 40mm Low Velocity Rounds



M430 40mm Grenade Round

Company Information

ILC Dover

- Location
 - Fredricka, Delaware
- Primary Expertise
 - Inflatable design and advanced materials development
 - Over 30 years experience in design and manufacture of inflatable UAV wings
 - Provides space suits for space shuttle crews



ILC Inflatable UAV Wing

TGER Development

Background

- TGER History
 - Derivative of Locust ISR vehicle
 - Locust program started in December 2004 by CCD
 - 18 systems delivered to the Army
 - Currently being operationally evaluated at Ft Huachuca
 - Airframe has flown > 750 flights
 - Locust avionics suite integrated into TGER vehicle
 - Camera, GPS, data link, autopilot, flight instruments, ground station
 - Capable of geo-locating points within the video field of view



TGER System Characteristics

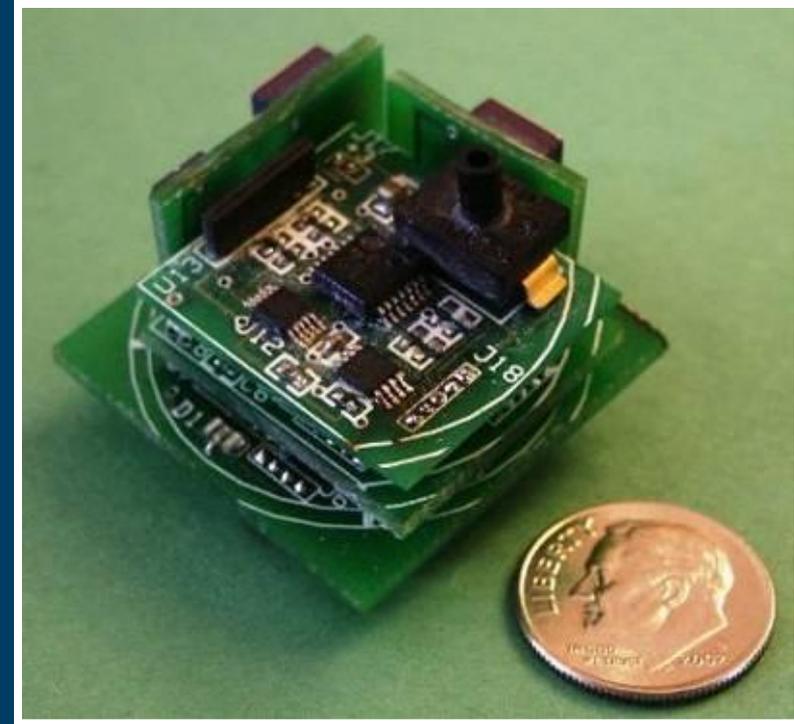
- Autonomous flight
 - Autopilot and inertial instruments fly the vehicle
 - Joystick operation supported but not desired for tactical use
- Flight Performance
 - Electric motor propulsion
 - Speed: 50 mph cruise, 30 mph loiter, 80 mph dive
 - Altitude 20,000 feet MSL capable
 - Typical flyout altitude 400 feet AGL
 - 12 -15 minute flight time
 - 2 mile operational range
- GPS waypoint programmable
 - Enables attack of targets behind buildings and walls
- Two way digital data link
- On-board terminal guidance
 - Man in the loop aim point selection
 - Attacks fixed and moving targets

TGER Concept of Operation

- Pre-Launch
 - Target located by troops on the ground or overhead assets
 - Launch weapon from concealment / defilade
 - Launch at best heading for launch condition
- Post Launch
 - Weapon automatically follows waypoints to the target area
 - Video image down linked to operator
- End game capability
 - Loiter while look over target area
 - Allows attack of targets that are obscured or moved after launch
 - Mission abort
- Terminal guidance
 - Operator selects target aim point on control station touch screen
 - Terminal guidance engages and guides weapon to the target
 - Wave off and target reacquire

Enabling Technologies - TGE

- Tiny Guidance Engine (TGE) provides
 - 3 Axis IMU
 - MEMS rate gyros and accelerometers
 - Magnetometer and pressure sensor
 - GPS Navigation interface
 - Full GPS / INS estimation filter
 - 13 grams, 1 cubic inch
- TGE designed and produced by CCD
- TGE tested for environments
 - Operates from -30°C to $+50^{\circ}\text{C}$
 - Survives Mil Std 810 Minimum Integrity Vibration for fixed wing aircraft and helicopters
 - 1 hour each axis



Tiny Guidance Engine
(without GPS)

Enabling Technologies - Ground Control Station

- Locust ground control station fully developed and operational
- Hosted on standard laptop
 - Compatible with existing ground stations like Rover
- Ground control station provides
 - Point and click functionality
 - Compatible with DTED and Falcon View map data
 - Waypoints and target location uploaded to weapon
 - Real time video display for target selection
 - Vehicle status
 - Remaining flight time
 - Arming status



TGER Ground Station Display

Enabling Technologies – Data Link

- CCD currently completing a Phase II SBIR for upgrading the Locust from analog to digital data link
 - Locust data link is a direct application for use in TGER
- Digital data link
 - Two way data link uses 802.11g communications format (2.4 GHz)
 - Video and status down, operator commands up
 - 1 watt power amplifier in vehicle and ground station
 - Operational range of 2 miles
- Data link antenna
 - Vehicle: 2 inch monopole
 - Ground Station: 6 inch monopole
- CCD proprietary software minimizes contention with other 802.11 users
 - Allows data link use in urban areas



TGER Data Link Card

Enabling Technologies – Camera

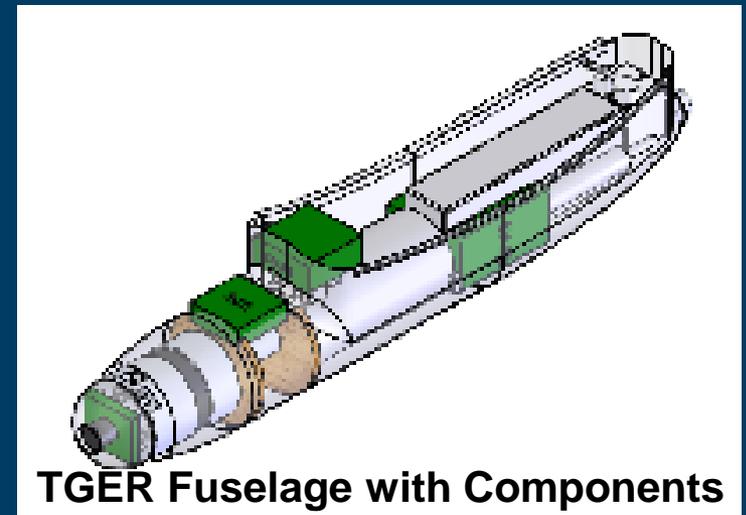
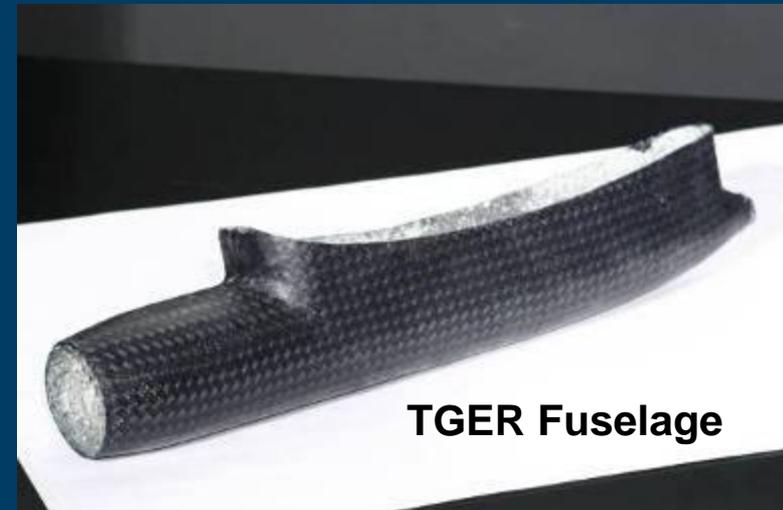
- TGER development uses digital CMOS visible light camera
 - 5 mega pixel resolution
 - Low cost, commercially available
 - Can be upgraded for new technology
- TGER can operate with IR camera for night operation
 - IR useful for detection of obscured human targets
 - Higher cost than visible light camera
- Locust has flown with the DRS E3500S IR camera
 - 3 ounce weight
 - 8-12 μm waveband



DRS E3500S IR Camera

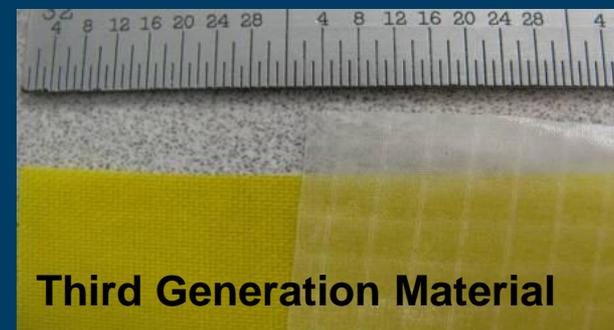
Enabling Technologies - Fuselage

- Second generation TGER fuselage has been designed and fabricated
 - Lightweight, one piece, carbon fiber fuselage
 - Wing bonds directly to fuselage
 - Open top for installation of avionics
- Flight tests
 - Verification flight tests of the TGER vehicle with new wing, motor, and fuselage conducted in mid 2009



Enabling Technologies - Inflatable Wing

- High lift wing provides
 - Variable flight speed
 - High speed ingress to target area
 - Slow loiter for aimpoint selection
 - Dash speed for terminal attack
 - Large payload capacity
 - Carry batteries and warhead
- Fabricated from coated, commercially available sail cloth material
 - Light weight
 - Folds easily for canister storage
 - Translucent material for stealthy operation
- Life vest type CO₂ inflation system
 - Over pressure relief valve for operation at different altitudes



Enabling Technologies - Inflatable Wing

- TGER launch video with first generation inflatable wing



Click
Video to
Play

Terminal Guidance Mode

- TGER avionics and flight algorithms support GPS only terminal attack

GPS
Only
Attack
Video



Click
Video
to Play

Terminal Guidance Mode

- TGER uses Man-in-the-Loop Corrected Impact Point GPS Terminal Guidance (referred to as Nudge Guidance)
 - Vehicle uses GPS coordinates of selected target to initiate terminal attack
 - Projected impact point displayed on the ground station video screen
 - System errors cause impact point to drift off the target
 - Operator touches desired impact point on the video screen
 - New input corrects errors in the target coordinates
 - Successive inputs allow the system to auto correct errors and to track moving targets
- Integration and flight tests of Nudge Guidance are currently being conducted
 - Nudge Guidance is working
 - Conducting further tests to accommodate user requirements and feedback

Terminal Guidance Mode

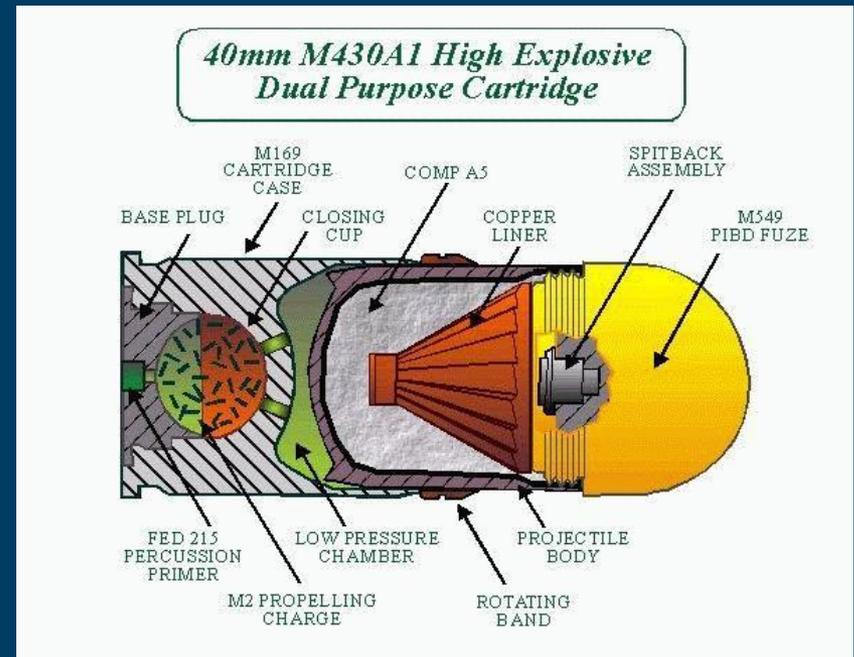
- Features of Nudge Guidance
 - Takes advantage of the high quality human tracking ability
 - Avoids loss of track associated with auto trackers when operating in
 - High clutter regions
 - Urban environments
 - Enables terminal attack on targets that an auto tracker can not lock on to
 - Targets under foliage
 - Individual person in a moving group
 - Selected point on a large featureless region
 - Remains operational in a GPS denied environment
 - TGER vehicle capable of inertially guided flight using INS and magnetometer without GPS
 - TGER can fly heading hold to the target area

Warhead

- Warhead concept based on existing M430 40mm grenade round
 - High Explosive – Dual Purpose impact rounds
 - Designed to penetrate 2” of steel armor
 - Inflict personnel casualties, 5 meter effective radius
 - DSE’s M430 production rate for first quarter 09 > 650,000

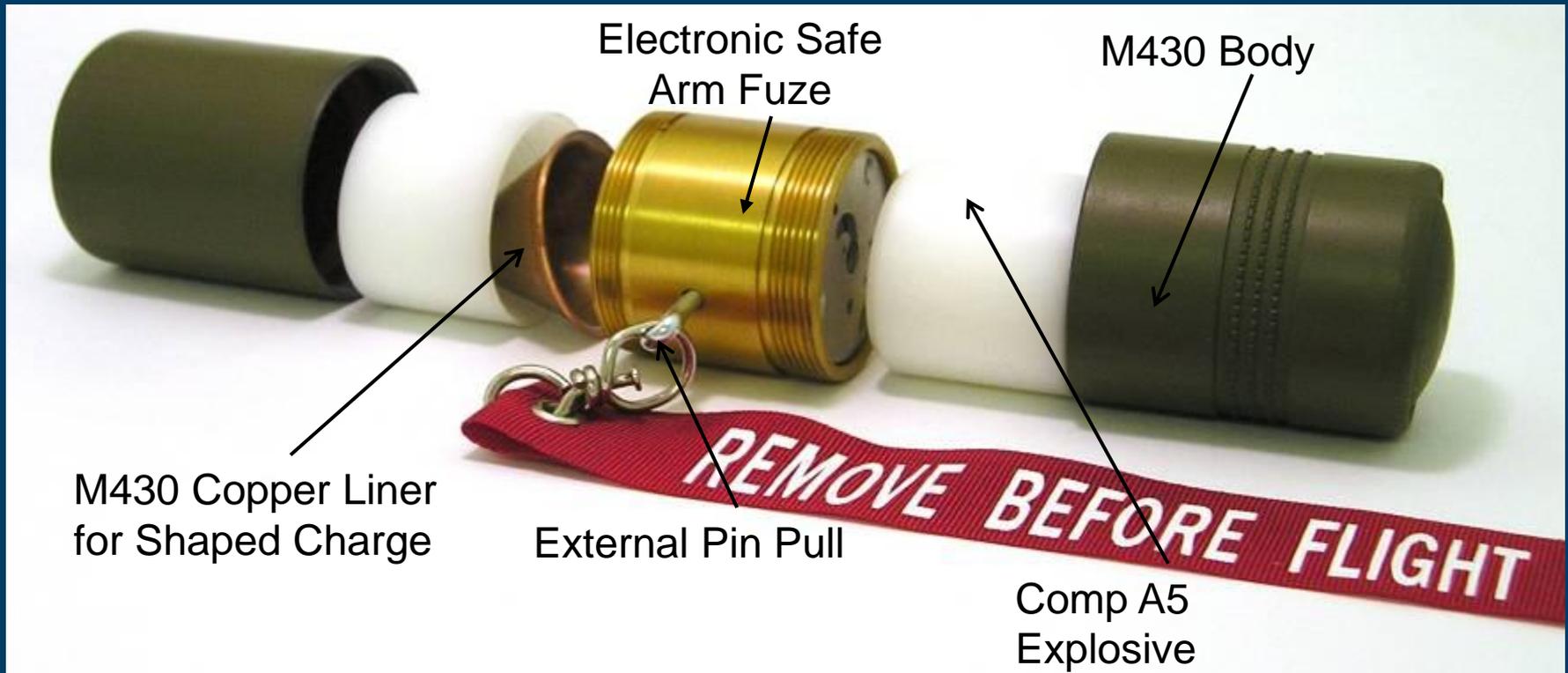


M430A1 – 40mm HEDP



Warhead

- Shaped Charge/Frag Configuration



Warhead

- Design and test of a lethal payload is ongoing
 - Dual purpose anti-personnel, light armor penetrating
- Single, double, and triple configurations of M430 bodies
 - Armor Penetrating
 - Fragmentation
- Seven 40 mm configurations tested at DSE's facility in Gaffney, SC
- Arena tests at Redstone Arsenal to determine effectiveness
 - Conducted September 2009
 - Four configurations
 - 2 Fragmentation/Shaped Charge
 - 1 Fragmentation/Fragmentation
 - 1 Fragmentation/Fragmentation/Fragmentation
- Test data currently being analyzed by Redstone
 - Test report expected before the end of the year

DSE Warhead Test Set Up at Gaffney, SC



Click
Video
to Play

Warhead

- Warhead arena test setup at Redstone Arsenal



Warhead

- Side view of warhead placement inside arena



Warhead

- Top view of warhead placement inside the arena



Warhead

- Witness panels after warhead detonation



Warhead

- Witness panels after warhead detonation



Safe and Arm Fuze

- Since TGER is a hand deployed weapon special safety concerns are applicable
- The desire is to use an ESAF (Electronic Safe and Arm Fuze) for TGER
- Two options available for ESAF
 - Picatinny Arsenal has a TRL 4 ESAF designed for lethal UAVs
 - TRL 9 ESAF is available from a commercial company
- Multiple arming environments will be utilized to fully arm the warhead
 - Relying on the Army to drive the final ESAF operation
 - Manual, external pin pull
 - Safety environments available
 - Distance from launch site
 - Altitude above ground
 - Velocity
 - Final arming step will be operator selection of target on the video screen

Proposed TGER Development Program

Quick Reaction Program

- Development is focused on a Quick Reaction Program
 - MBDA – System integrator
 - CCD – Avionics and guidance
 - DSE – Warhead
 - ILC Dover – Inflatable wings
- Program can deliver 40 Quick Reaction weapons within 6 months
 - Weapons will be end to end flight worthy
 - Ground station
 - Warhead
 - Safe and Arm Fuze
 - Nudge Guidance

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