

# NASA Range Safety Program 2006 Annual Report

## EMERGING TECHNOLOGY ENHANCED FLIGHT TERMINATION SYSTEM PROGRAM

The objective of the enhanced flight termination system program is to develop the next generation flight termination system for the Department of Defense and NASA ranges. The program addresses robust command links for flight termination, including message formats, modulation methods, and encryption.

### Previous Status

The Range Safety Group of the Range Commanders Council initiated a study task and ultimately selected continuous phase frequency shift keying as the modulation scheme, a 64-bit triple data encryption standard for security, and the layout of the 64-bit message for the new system. The Air Force Flight Test Center then let a contract to build prototype enhanced flight termination receiver decoders and an encoder for the ground transmitter. The receiver decoder and encoder units successfully demonstrated that the enhanced flight termination system would function in flight and in an operational setting.

The Central Test and Evaluation Investment Program is funding the development of the flight termination receiver decoders, encoders, monitors, and encryption units for different range applications, such as uninhabited aerial vehicles, space launch vehicles, and missiles. In August 2004, two contracts to develop the enhanced flight termination receiver decoder engineering development units were awarded to L-3 Cincinnati Electronics and Herley Industries. In August 2005, a contract to develop the ground systems (enhanced flight termination system encoder, monitor, and encryption unit) was awarded to L-3 Cincinnati Electronics.

### Current Accomplishments

Milestones accomplished this year are described below.

- In September and November 2005 and February 2006, system, preliminary, and critical design reviews on the development of the ground systems were held with L-3 Cincinnati Electronics.
- In February 2006, L-3 Cincinnati Electronics successfully held a test readiness review to initiate the qualification and acceptance testing of the flight termination receiver decoder. Qualification testing is expected to be completed in November 2006.
- In early August 2006, three of the units successfully passed acceptance testing at L-3 Cincinnati Electronics.
- In late August 2006, the ground systems (encoder, monitor, encryption unit) were successfully tested at L-3 Cincinnati Electronics and delivered to the Air Force Flight Test Center.

### Future Plans

The enhanced flight termination system program plans to test the operational hardware on an advanced mid-range air-to-air missile at Eglin Air Force Base, Florida in early

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## **EMERGING TECHNOLOGY ENHANCED FLIGHT TERMINATION SYSTEM PROGRAM**

2007 using a qualified flight termination receiver and the ground equipment currently under development. This will be the first of several flight tests in 2007 involving the new enhanced flight termination system components.

The final phase of the program provides the mechanism to field ground systems for production and deployment on all Department of Defense and NASA ranges. This part of the program is expected to begin in the 2007 timeframe.

### **Enhanced Flight Termination System Architecture**

The enhanced flight termination system architecture consists of the vehicle and ground systems shown in the diagram below. The enhanced flight termination system was designed so that upon the completion and qualification of all units for both airborne and ground systems, implementation with existing architecture would minimally impact the ranges.

On the airborne side, the enhanced flight termination system uses existing components and systems, where the only new addition would be the new enhanced flight termination system command receiver/decoder. Legacy antennas, couplers, logic units, safety devices, and ordnance will be used along with the new command receiver/decoders and ground equipment.

The ground systems architecture will change somewhat, but the impacts will not be severe. Ranges will have to purchase the new enhanced flight termination system ground equipment (encoders, monitors, and triple data encryption units) and each range can develop the unencrypted 64-bit enhanced flight termination system command frame (command controller) based on its own culture. The ground system will also implement existing technology and equipment including Range Safety Officer command panels, modulators/excitors, high power amplifiers, and command transmitters.

### **Enhanced Flight Termination System Equipment**

Four of the major components of the enhanced flight termination system—enhanced flight termination receiver, triple data encryption unit, encoder, and monitor—are described below.

#### **Enhanced Flight Termination Receiver**

The receiver takes the encrypted messages sent from the command transmitter system (modulator, exciter, power amplifier) and decrypts them into useable commands.

#### **Triple Data Encryption Unit**

The triple data encryption unit is embedded within the encoders and encrypts the

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messages using the Triple Data Encryption Standard. A triple data encryption unit is embedded within each monitor for decryption of the enhanced flight termination system message for analysis.

### **Encoder**

The encoder takes the encrypted message from the triple data encryption unit and adds a certain amount of frame synchronization and parity bits for forward error correction before sending the final message to the Legacy excitors.

### **Monitor**

The monitor is used as an analysis tool for Range Safety by providing an independent verification process for the transmitted enhanced flight termination system signal. The command transmitter system sends the final, encrypted enhanced flight termination system message to the receiver and to the monitor.

After 2006, the enhanced flight termination system program is one step closer to bringing a new, qualified, improved system to ranges and range users. As this program nears completion of qualification testing on all components involved, Range Safety has set its sights toward the operational and flight testing that will take place throughout 2007.

Multiple milestones have to be met as the program continues to get closer to bringing a new system currently under development into operational status. Range Safety will continue to work with the enhanced flight termination system program and support the mission of providing a new advanced method of flight termination that will be low cost and low impact to ranges and range users, while providing a reliable system that will help ensure public safety during launch operations.