NASA Range Safety Program
2006 Annual Report

DEVELOPMENT, IMPLEMENTATION, SUPPORT OF RANGE SAFETY POLICY
FLIGHT SAFETY SYSTEM CHALLENGES

Range Safety is often faced with many challenges when trying to ensure the protection of the public, the local workforce, and property. These challenges must be met with steadfast determination and urgency in order to ensure that public safety and mission success are preserved. One of the biggest challenges Range Safety dealt with in 2006 was the frequency interference issue between onboard flight termination system receivers used to independently terminate an errant vehicle and other radar systems used in a local area for various mission related and non-mission related support.

Frequency Dilemma

As noted above, one of the Range Safety's most important and ongoing issues involves flight termination system frequencies. For many years, 416.5 megahertz has been used as a flight termination system frequency for many years at the Eastern and Western ranges. However, because of overcrowding of that frequency in the 1990s, the National Telecommunications and Information Administration directed the Department of Defense to stop use of 416.5 megahertz for flight termination systems no later than the last day of calendar year 2006.

The National Telecommunications and Information Administration announced this change in August 2000. The reason for the change is that ultra high frequency wideband systems, such as flight termination systems, are required to operate in the 420-450 megahertz spectrum. 400-420 megahertz is reserved for narrow band systems. So the Eastern and Western ranges chose 421 megahertz as the center frequency to be used for flight termination systems on launch vehicles.

Interference at 421-450 Megahertz

During two recent launches at Vandenberg Air Force Base, it was discovered that the flight termination system receivers were undergoing interference problems. After research and several studies were performed, it was found that a high power radar system at Beale Air Force Base over 300 miles away was the cause of the interference. Beale Air Force Base maintains an upgraded early warning radar system called PAVE PAWS that operates in the same frequency of 400-450 megahertz. This upgraded early warning radar system is much more powerful than the command transmitter sites used for range operations.

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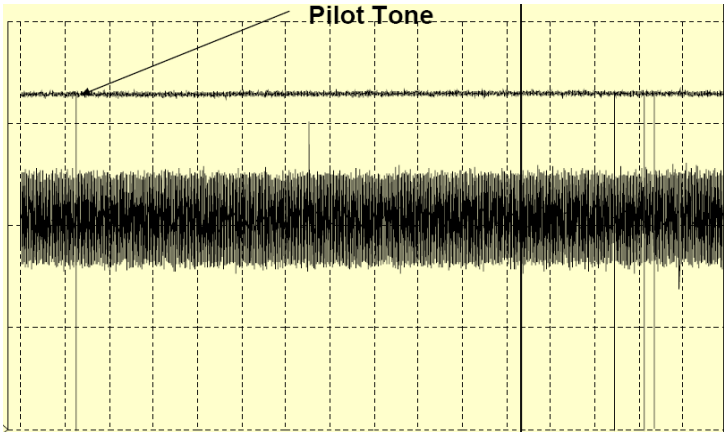
If the radar is operating at the same frequency as the command transmitter sites and command receiver decoders, the command receiver decoders could experience interference and be unable to process commands from the command transmitter site. At worst, this interference could prevent the termination of an erratic vehicle that could be endangering public safety.



The graph shows the interference between PAVE PAWS at Beale Air Force Base and a secure receiver that is used on various launch vehicles. The pilot tone is used to check the health and status of the receiver; a pilot tone dropout means that the receiver is not able to receive and/or process commands at that moment.

PAVE PAWS systems are also located at Clear Air Force Base in Alaska (see right) and Otis Air National Guard Base at Cape Cod, Massachusetts. The PAVE PAWS radars located at Clear and Cape Cod are early warning radars, not upgraded early warning radar like the Beale radar. Even though these early warning radars are not upgraded yet, it is possible that they could still pose interference issues with launches from the Eastern and Western ranges.

Beale Air Force Base has mitigated the interference before by "blanking out" certain segments of the operating frequencies, but this may not be a possibility much longer because these radars lose a great amount of their capability when mitigated. Although PAVE PAWS is the primary focus of this interference issue, other radars that can cause problems to range operations may be operating in this frequency band. Studies are being performed to identify the characteristics of various radar systems that could affect range operations.

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Options

Several options are currently being examined that would help correct the interference problems. Some of the possible solutions and their future implementation are described below.

Option 1. One option is to continue the use of 416.5 megahertz as the main flight termination system frequency. 416.5 megahertz has been used for many years and very few problems exist at this frequency. Ranges are currently designed to handle this frequency, so no new hardware or upgrades would be necessary to support 416.5 megahertz.

However, the National Telecommunications and Information Administration has instructed that 416.5 megahertz should not be used as a flight termination system frequency. To use this frequency for flight termination system operations, ranges must submit an “Exception to Policy” to the National Telecommunications and Information Administration and receive approval.

Option 2. Another option is to use 421/425 megahertz as the flight termination system frequency. To use this frequency, some sort of mitigation effort must be made to the PAVE PAWS radars to ensure that all commands can get through without interference. However, as stated earlier, PAVE PAWS loses a great amount of its capability when mitigated, so Beale Air Force Base may not always continue to mitigate the radar.

If the radar cannot be mitigated to negate the interference, one way to improve the probability of getting commands through is to use secure receivers. Secure receivers are still susceptible to PAVE PAWS, but are more robust than standard tone receivers. Standard tone receivers are highly susceptible to the interference from PAVE PAWS and would have significant trouble processing commands if interfered with by PAVE PAWS.

Option 3. The next option is to move to an entirely new frequency band. The Range Commander’s Council Frequency Management Group, Air Force Space Command, and some Range Users are leading studies to look at a new frequency band, specifically in the 370-380 megahertz range. If approved for flight termination system use by the National Telecommunications and Information Administration, dedicated frequencies would be authorized within this range for use only by flight termination system users.

Migrating to a new band in the 370-380 megahertz region with flight termination system operations as the primary user reduces the probability of interference. The high power radar systems such as PAVE PAWS do not operate in this region. For this option to be realized, several criteria must be considered. First, the Eastern and Western ranges would have to upgrade their ground equipment to support the migration to a new band. The current ground equipment is capable of tuning down to 416.5 megahertz but would not be able to accommodate the new lower frequency of 370-380 megahertz.

Additionally, the airborne side of the equation would also have to be upgraded. The new frequency band of 370-380 megahertz will cause the development of a new receiving

system. Antennas, couplers, and receivers would have to be replaced to accommodate the move. This option will take time and money to test and procure new equipment, but the end product would be a newly designed system that would operate in a frequency band where the flight termination system is the primary user, resolving the interference issues seen today.

Option 4. Another option that would alleviate the interference issues is a future system that is currently under development, the autonomous flight safety system. The autonomous flight safety system is immune to the previously discussed interference issues because it operates using the Tracking and Data Relay Satellite System, Ku-Band, and S-Band. The vehicle would use an onboard autonomous system that detects when and if the vehicle violates pre-established flight safety rules.

If the vehicle violates the pre-determined accepted flight rules, the autonomous system responds and initiates the ordnance train. This system is not expected to be available for use on expendable launch vehicles or similar vehicles until late 2008 or 2009. In theory, the autonomous flight safety system could act alone and be the only method of initiating a destruct command, eliminating the need of a flight termination system frequency for termination. Although the autonomous flight safety system could theoretically be the sole means of initiating a destruct, right now the system is viewed mainly as a potential downrange application to be used in conjunction with an up-range (human-in-the-loop) command destruct system.

Current Status

Both the Eastern Range and Western ranges are working hard to come up with an answer to this issue. In 2006, each range submitted an “Exception to Policy” to remain at 416.5 megahertz. The Western Range has received approval to stay at 416.5 megahertz for all launch vehicles until the end of calendar year 2008. After this date, the Western Range must move to the appropriate frequency band whether it is 420-450 megahertz or a new band such as 370-380 megahertz or submit a new “Exception To Policy.” The Eastern Range has submitted an “Exception To Policy” to stay at 416.5 megahertz until the end of calendar year 2010; this “Exception To Policy” has not been approved as of this writing.

The Shuttle program has received waiver approval to continue the use of 416.5 megahertz until the end of program; however the National Telecommunications and Information Administration stipulated that all follow-on programs had to comply with its mandate to move to 420-450 megahertz. NASA Range Safety is working closely with the Department of Defense, Air Force Space Command, and industry to ensure that a viable and robust solution is chosen that will not only alleviate the problems seen with frequency interference, but also improve the overall confidence and reliability of flight termination systems.