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**UCS Backgrounder**

# Missile Defense Test FTG-05

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The Missile Defense Agency (MDA) has scheduled an intercept test for the Ground-Based Midcourse missile defense system for tomorrow, Friday, December 5, between noon and 4 pm California time (3 pm to 7 pm EST). If it is delayed, the window continues through December 8. The test is labeled FTG-05.

In this test, MDA will launch a target missile from Kodiak Island, Alaska, and an interceptor from Vandenberg Air Force Base in California. The range of the target missile will be significantly shorter than an intercontinental range missile, and therefore the target speed will be significantly slower than it would be in an intercept attempt against a warhead from a long-range missile.

While little is known publicly about MDA's target in this test, it appears that the mock warhead will be accompanied by countermeasures, such as decoys. If so, this will be first test since test IFT-10 in December 2002 to use decoys.

Successful or not, this test will not prove that the missile defense system can counter real-world decoys. It appears that the defense system will attempt to rely on the kill vehicle's sensor to distinguish the mock warhead from the decoys. This method of "discrimination," however, requires the defense system to know what the various objects look like in advance, which would not be the case in an actual attack. Moreover, anyone launching an attack could easily change the various objects' appearance prior to the attack to fool the defense.

In other words, the discrimination capability MDA plans to test tomorrow would not be useful in an actual attack, since it can be easily countered by an attacker.

MDA stated that it cancelled the previous planned test, FTG-04, in June 2008, because of a long-standing problem with the telemetry unit in the interceptor. But the reason may have had more to do with schedule pressures. The telemetry problem has been recurring since 2001 and it is not clear that MDA has been able to solve it for tomorrow's test.[2]

## The Target Set for FTG-05

MDA will launch the target from Kodiak Island, Alaska. The path of the target can be inferred from the location of the third-stage hazard zone released by the Coast Guard (see red region in Figure 1).[3] This is the region where the third stage of the booster launching the target is expected to splash down. Since the target will have essentially the same speed as the third stage of the booster, it is expected to splash down in the same region if it is not intercepted.

The range from the launch site to the center of the hazard zone is roughly 3,200 km (2,000 miles), which is significantly shorter than the range of an intercontinental missile. For example, the range from North Korea to the U.S. West Coast is 8,000 to 9,000 km (5,000 to 5,600 miles), and from Iran to the U.S. East Coast is 10,000 to 11,000 km (6,200 to 6,800 miles). This means that the speed of the target on a 9,000-km-range trajectory (6.8 km/s) would be more than 40 percent greater than the speed of the target in this test (approximately 4.8 km/s). This is presumably what MDA means when it refers to this as a "medium/high closing velocity" target.[4]

MDA's description of the next scheduled test, FTG-06, says that it would use a "medium velocity" object, which suggests that the target missile may be even shorter range.[5]

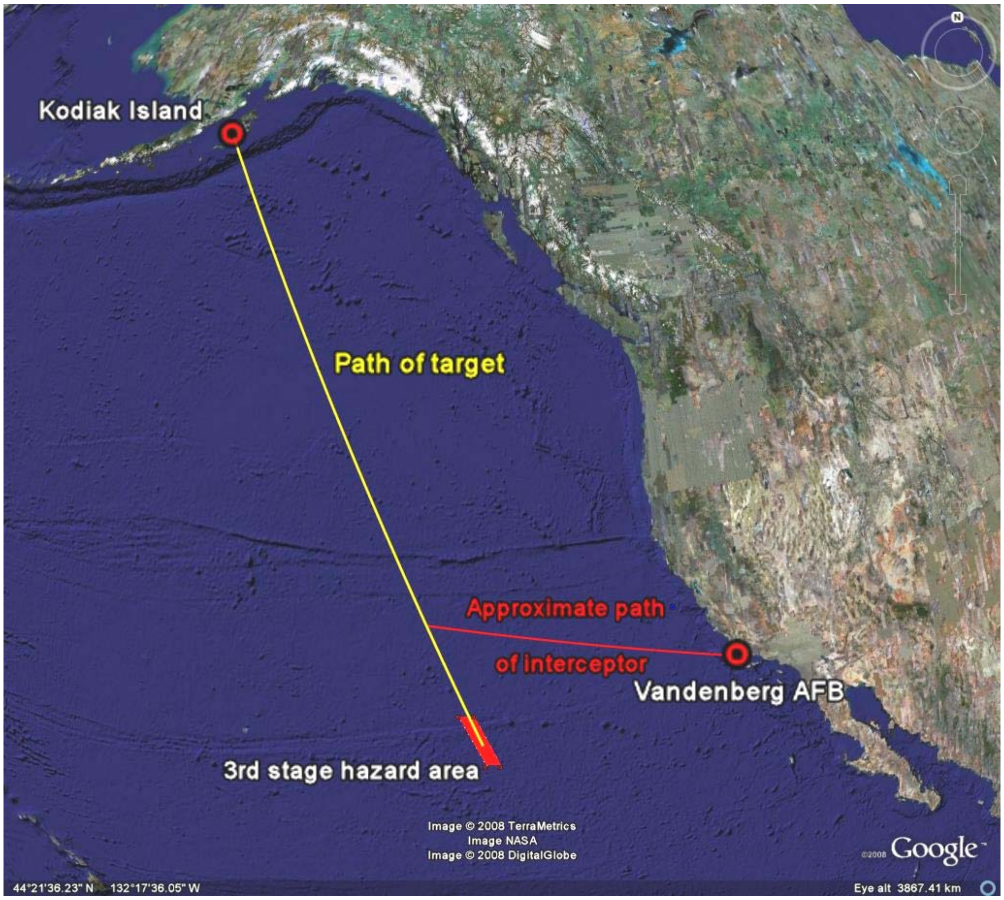


**Figure 1.** The projected path of the target is shown in yellow, based on the announced location of the 3rd stage hazard area of the target booster. The interceptor will be launched from Vandenberg Air Force Base, and must engage the target before it drops below an altitude of about 150 km (95 miles). In past tests, the intercepts have reportedly occurred around 230 km (140 km) altitude.

MDA has not released any information publicly about the target set that it will use in this test. However, budget descriptions suggest that MDA planned some form of decoys or other countermeasures for the canceled test FTG-04 and for FTG-05. The descriptions of both tests state they would include "a more complex target scene" than previous tests.[6]

While no details are available, if the target set is similar to that planned for FTG-04, it appears that the target set is designed so that "discrimination," *i.e.*, distinguishing the warhead from decoys, is to be done only by the infrared (IR) sensor on the interceptor's kill vehicle. This inference comes from the fact that the Sea-Based X-band radar (SBX) was undergoing repairs and was not expected to take part in FTG-04, and there are no other radars in the system with the capability and location to help with discrimination during midcourse phase.

If the plan is to discriminate using only IR sensors on the kill vehicle, then this would be similar to what MDA did in several of its early intercept tests, when it added balloon decoys to the target set.[7]

In this test, discrimination would only be based on observing the brightness and fluctuation in brightness of the various objects that MDA is launching from Alaska. These observed values would then be compared to a set of expected values for each object that were given to the kill vehicle before launch. Such discrimination can be done if the signatures of the warhead and decoys are sufficiently different from each other, and if the kill vehicle knows *a priori* what signature each object will have so that it can identify which object is the warhead.

It is important to note that in the earlier tests the decoys were not made to look like the mock warhead, but instead had significantly different brightnesses. The same is expected to be true in this case.

While this "discrimination" may be an interesting technical exercise, it is not a discrimination capability that can be expected to be useful in an actual attack, since it can be easily countered by an attacker. As a result, the defense system would not be able to identify the warhead to fire a kill vehicle at it.

In particular, the IR signatures of the warhead and decoys are not likely to be known by the defense in advance in a real-world attack. This is especially problematic for the defense system since IR signatures of launched objects can be easily modified by the attacker to confuse the defense, so there is no *a priori* way to know what they would be. Modifying these signatures requires much simpler technology than is required to build a missile and decoys in the first place, and any attacker would have strong motivations to do so. An attacker could add dozens of light-weight decoys to each missile, and the defense system would not be able to shoot at all the objects it sees. (For more information on countering this method of discrimination, see the appendix below.)

## Sensors in Test FTG-05

Descriptions of the upcoming test state that the sensors that will be involved in FTG-05 are:

- DSP early warning satellites: These infrared satellites are located in geosynchronous orbit and detect the missile plume early in flight to give warning of the launch and some trajectory information.

- The AN/TPY-2 radar: MDA has temporarily placed this small, transportable X-band radar in Alaska to observe the launch (see below).

- The AN/SPY-1 radar: This S-band radar is deployed on Aegis cruisers, which will be watching the test. This radar may provide cueing information to allow the SBX radar to locate and track the target, but does not have the resolution needed for discrimination.

- The Upgraded Early Warning Radar (UEWR) at Beale, California: This radar should be able to detect and track the radar at long range, but because of its frequency it does not have the resolution to help with discrimination.

- The Sea-Based X-band radar (SBX): This radar is said to be the primary radar that will control the interceptor's engagement with the target during this test.[8] It is much larger and more powerful than the TPY-2 and SPY-1 radars.

## The AN/TPY-2 Radar

The AN/TPY-2 radar, a transportable X-band radar, was developed for the THAAD system, and was formerly called the forward-based X-band transportable [FBX-T] radar. It was moved to Juneau, Alaska, for the FTG-04 test earlier this year, but is being used in FTG-05 since the earlier test was canceled. It is intended to detect and track a ballistic missile early in flight. This information can be used to estimate the trajectory of the missile.

MDA has deployed a radar of this kind in Japan as part of its missile defense system there, and has discussed deploying one as part of the proposed European missile defense system, where it would be intended to cue the European midcourse radar (EMR) proposed for the Czech Republic.

The radar is reportedly located approximately 29 kilometers northwest of Juneau, Alaska, at the site of a former rock quarry on a bluff overlooking Favorite Channel.[9] After the test, MDA will disassemble the radar and ship it to either Japan or Europe.[10]

## Appendix: Countermeasures to the Kill Vehicle's IR Sensor

The temperature and infrared signature of a warhead or decoy can be easily manipulated by an attacker, particularly if the attack takes place so that these objects are illuminated by the sun. For example, by simply changing the surface coating of an object (e.g., by painting its surface), its infrared signal can be changed[11] by more than a factor of 10. An attacker could make the temperature of the objects in the package of decoys and warheads different from each other or make them nearly identical. In either case, a kill vehicle would be unable to determine which object was the warhead.

If an attacker did not take measures to "spin stabilize" the warhead, it would tumble as it traveled through space. A defense system's infrared sensor would see a fluctuating signal as it viewed different parts of the tumbling warhead. However, an attacker also could make a balloon decoy show a time-varying infrared signal by painting stripes or markings on its surface so that the defense system's infrared sensor would detect different signals as the decoy rotates.

Moreover, an attacker could enclose the warhead in a balloon so that its signature is modified as well. This ploy is known as "anti-simulation," meaning that instead of trying to make a decoy look like the warhead, the attacker makes the warhead look like one of the many decoys.

Aside from an object's brightness and fluctuation, the defense system's kill vehicle can extract little information about the size or shape of an object before it must decide which object to intercept, so this kind of information is not useful in IR discrimination.[12]

The infrared sensor on a kill vehicle uses a telescope to focus radiation from an object onto an array of small detectors, called pixels. When the kill vehicle's infrared sensor first detects an object, the radiation from that object will fall on a single pixel, and it will appear as a tiny dot of light with no distinct features.[13] A warhead-sized object of roughly 2 meters (6 feet) in size would occupy more than 1 pixel only at a distance of 30 km (19 miles), which would be roughly 3 seconds prior to intercept (see Figure 2).

Even then, each warhead would occupy at most 1 or 2 pixels. In order to get any information on the shape of warhead-sized objects, a resolution that is a fraction of the object's dimensions is needed. For example, if the required resolution is a quarter of the warhead size, or 0.5 meters (20 inches), then this would not be achieved until the warhead is within about 7 km (4 miles) of the target. At this point there would be 0.5 to 1 second left to intercept the target. Moreover, at this point the kill vehicle's field of view is only about 120 meters (400 feet) across. If the potential targets are more widely separated, then the kill vehicle would not be able to determine anything about the shape of all the objects because there would not be time to maneuver to view each object individually. In this case, the kill vehicle would have to decide which object to attempt to intercept without knowing anything about all their shapes, or even their relative shapes.

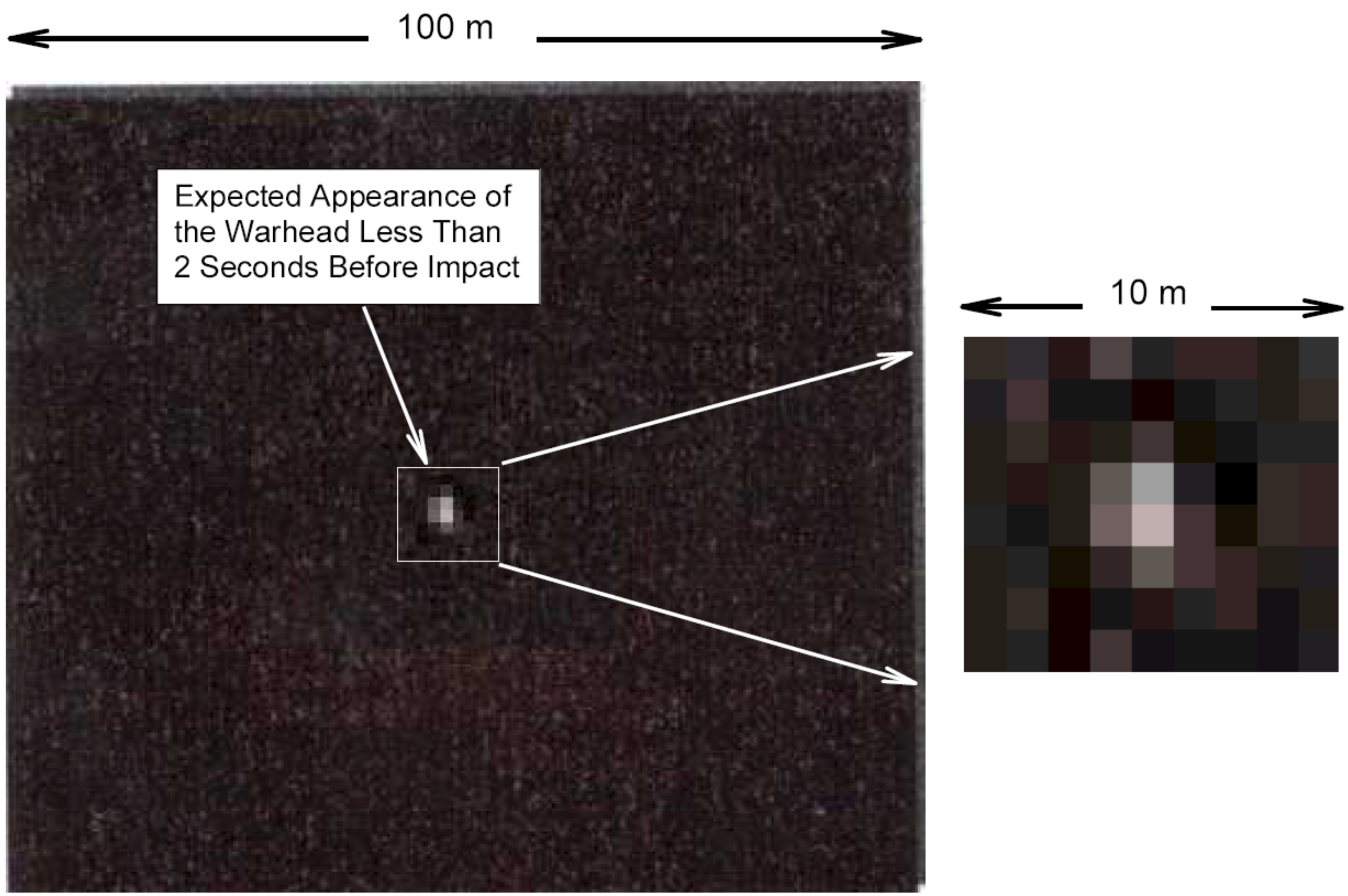


**Figure 2. How Objects Appear to the Kill Vehicle**
It shows a portion of the field of view of the kill vehicle's infrared sensor when the kill vehicle is about 16 km from an object of roughly 2 m size, comparable to a warhead or decoy. Impact would occur in about a second and a half. The small light and dark squares represent the individual pixels of the infrared detector array. Even at this short range, the object only covers a small number of pixels, which appear lighter than the others (a blow-up of the center of the image is shown on the right). This illustrates that the kill vehicle will not be able to get information about the shape of objects in the threat cloud until it is too late to use for discrimination. (The kill vehicle's sensor uses a 256 x 256 element array.) (Source of figure: Theodore Postol, MIT.)

**Endnotes**

[1] David Wright is co-director and a senior scientist in the Global Security Program at the Union of Concerned Scientists.
[2] Victoria Samson, **"**Canceling FTG-04: Another Missile Defense Test Disappears," 16 June 2008, http://www.cdi.org/program/issue/document.cfm?DocumentID=4318&IssueID=78&StartRow=1&ListRows=10&appendURL=&Orderby=DateLastUpdated&ProgramID=6&issueID=78
[3] "Rocket launch expected from Narrow Cape late next week," *Kodiak Daily Mirror*, November 28, 2008, http://www.kodiakdailymirror.com/?pid=19&id=7035
[4] Missile Defense Agency R-2 RDT&E Budget Item Justification, BMD Midcourse Defense Segment (0603882C), February 2008, p. 165, http://www.defenselink.mil/comptroller/defbudget/fy2009/budget_justification/pdfs/03_RDT_and_E/Vol_2_MDA/04_PE-0603882C-Midcourse%20Defense.pdf
[5] Missile Defense Agency R-2 RDT&E Budget Item Justification, BMD Midcourse Defense Segment (0603882C), February 2008, p. 165, http://www.defenselink.mil/comptroller/defbudget/fy2009/budget_justification/pdfs/03_RDT_and_E/Vol_2_MDA/04_PE-0603882C-Midcourse%20Defense.pdf
[6] Missile Defense Agency R-2 RDT&E Budget Item Justification, BMD Test and Targets (0603888C), February 2008, p. 464, http://www.defenselink.mil/comptroller/defbudget/fy2009/budget_justification/pdfs/03_RDT_and_E/Vol_2_MDA/08_PE-0603888C-Test%20and%20Targets.pdf
[7] See L. Gronlund, D. Wright, S. Young, "An Assessment of the Intercept Test Program of the Ground-Based Midcourse Missile Defense System," November 30, 2001, http://www.ucsusa.org/assets/documents/nwgs/ift7.pdf; D. Wright and L. Gronlund, "Decoys and Discrimination in IFT-8", 14 March 2002, http://www.ucsusa.org/assets/documents/nwgs/acfxoq64k.pdf; D. Wright, "The Target Set for Missile Defense Test IFT-9," October 11, 2002, http://www.ucsusa.org/assets/documents/nwgs/ift9.pdf .
[8] Raytheon press release, "Raytheon Radars Play Key Role in Missile Defense Test," July 21, 2008, http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=104&STORY=/www/story/07-21-2008/0004852272&EDATE=
[9] Missile Defense Agency, Record of Environmental Consideration, 24 May 2007, http://www.mda.mil/mdalink/pdf/recantpy2.pdf
[10] P. Forgey, "Juneau's role in '08 missile test small," Juneau Empire.com, 22 August 2007, http://www.juneauempire.com/stories/082207/loc_20070822009.shtml
[11] A. Sessler et al., *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System*, April 2000, p. 122, table A1, http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf
[12] See L. Gronlund, D. Wright, G. Lewis, P. Coyle, *Technical Realities: An Analysis of the 2004 Missile Defense System*, May 2004, http://www.ucsusa.org/assets/documents/nwgs/technicalrealities_fullreport.pdf
[13] If the kill vehicle's aperture is 20 cm, then with a LWIR wavelength of 10 microns the diffraction-limited angular resolution would be roughly 0.00001/0.2 = 0.05 milliradians. The kill vehicle uses a 256 x 256 array and has just under a 1 degree field of view, so each pixel corresponds to an angle of 0.0175/256 = 0.07 milliradians, or slightly greater than the diffraction limit. Using this value, we see that at a range of 500 km, each pixel corresponds to an azimuthal width of 35 m.

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