

FLIGHT TESTS FOR AEGIS BALLISTIC MISSILE DEFENSE

** The matrix below is a summary of the major flight tests in the Navy's Aegis Ballistic Missile Defense system. The U.S. Aegis BMD system has made twelve intercepts out of fourteen attempts. The most recent flight test intercept by a U.S. ship occurred on Nov.6, 2007 and was a success; the most recent (and only) flight test intercept by a Japanese ship occurred on Dec. 17, 2007, and was a success. However, the primary cause of an earlier U.S. flight test failure - the new guidance control system, the Solid Divert and Attitude Control System (SDACS) – still is not being used in its most advanced mode, which may affect its maneuverability against more demanding targets.**

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Flight Test Number	Date	Intercept?	Notes
Control Test Vehicle-1A (CTV-1A)	Sept. 24, 1999	n/a	This test was the first launch of the SM-3 missile, which showed a successful second and third stage separation and flight endurance – once it launched (it actually was supposed to be launched on Sept. 23, but did not fire due to a computer error; the test had to be repeated the following day).
FTR-1 (the first risk reduction flight and the second flight overall in the Aegis LEAP intercept (ALI) test series)	July 14, 2000	n/a	The third stage of the SM-3 failed to separate. An errant interrupt signal was transmitted to the missile that caused it to fail immediately after launch. The software, which had been used in an earlier test without problems, had to be re-coded.
Flight Test Round-1A; a repeat of FTR-1 (third flight test of nine scheduled)	Jan. 25, 2001	n/a	This test was conducted to evaluate the SM-3's airframe stability and control through a nominal kinetic warhead separation. The test launch achieved third-stage separation, third-stage motor burn, and attitude control through nominal KW separation.
Flight Mission (FM)-2	Jan. 25, 2002	Yes	This fly-by test was not intended to be an intercept: its objective was to evaluate the SM-3's fourth-stage kinetic warhead guidance, navigation and control. The SM-3 was launched by the USS Erie Aegis cruiser against an Aries target missile, which has been reported as having been five times longer and a third wider than any medium-range ballistic missile that the SMD is being designed to shoot down.

			It was the first fully operational SM-3 with a live solid divert and attitude control system to steer the kinetic warhead into the target.
FM-3	June 13, 2002	Yes	In this designated intercept test, an SM-3 launched from the USS Erie Aegis cruiser successfully intercepted an Aries ballistic missile target. This was the fifth of nine planned developmental tests. FM-3 only intended to show that a Navy interceptor can hit a ballistic missile target; FM-3 did not attempt to demonstrate lethality. To be "killed", certain types of enemy missiles must be hit at the right spot for a hit to also be a kill. This will be attempted on FM-4.
FM-4	Nov. 21, 2002	Yes	FM-4 marked the first time a Navy theater test target was intercepted during its ascent phase. An SM-3 missile was launched from the Aegis cruiser USS Lake Erie to counter an Orbital Sciences Test Target Vehicle that was launched from the Pacific Missile Range Facility in Kauai, Hawaii. The SM-3 missile had an altitude of 93 miles at the time of impact; because of this, its flight time was shorter by about a minute and a half. FM-4 demonstrated the SM-3's ability to switch its aimpoint while in flight to increase its accuracy, according to Raytheon program officials. FM-4 was the first of six planned flight tests to develop an emergency sea-based short- and medium-range ballistic missile defense capability.
FM-5	June 18, 2003	No	FM-5 was supposed to demonstrate the Block 2004 system's solid divert and attitude control system (SDACS) and its ability to achieve a lethal aim point shift in an ascent phase scenario; it failed at both. The attitude control system had been reengineered, so this was its first flight test. Another new addition for the testing program was a package on the Aries target missile that MDA officials hoped would allow for a more thorough post-test assessment of the attempted interception. In FM-5, an Aries target missile was launched from the Pacific Missile Range Facility in Kauai, Hawaii; two minutes later, an SM-3 interceptor was launched from the USS Lake Erie Aegis cruiser. The mock warhead was deployed and the

			<p>guidance system was activated, but an interception did not occur and both missiles fell into the Pacific ocean. The malfunction may have resulted from a crack in the diverter ball that regulates gas flow in the SDACS. The SDACS has three solid propellant sections. The first pulse (the sustain pulse) may have overheated the warhead enough so that one of the other pulses (pulse one and two) cracked the diverter ball. Because of this problem, the first five SM-3 interceptors deployed by Oct. 1, 2004, will have their SDACS pulse one and pulse two disabled.</p>
FM-6	Dec. 11, 2003	Yes	<p>FM-6 was designed to demonstrate the Block 2004 system's solid divert and attitude control system (SDACS) and its ability to achieve a lethal aim point shift in an ascent phase scenario. While an interception did occur, the SDACS was tested in a different mode than the one in which it will be deployed. This flight test has been portrayed by the Missile Defense Agency as part of the SM-3's "more complex, stressing, and operationally realistic ballistic missile engagement scenarios." However, FM-6 was a modified, less difficult version of FM-5, which was held in June 2003 and a failure. FM-5's problem has been traced to the SDACS that was used for the first time in that test. Specifically, the SDACS was being used in pulse mode, which probably created the cracked piece which resulted in the malfunction that caused the intercept failure. FM-6 used the new SDACS but in a sustain mode, with no additional pulses being used (which is not how it is designed to work out in the field). FM-6 saw a Standard Missile (SM)-3 interceptor (off of the Lake Erie near Kauai) intercept an Aries target at the speed of 3.7 kilometers per second and at an altitude of 137 kilometers.</p>
Flight Test Maritime 04-1 (formerly FM-7)	Feb. 24, 2005	Yes	<p>During Flight Test Mission (FTM) 04-1, a target was launched from the Pacific Missile Test Range in Kauai, followed one minute later by a Standard Missile (SM)-3 Block 1 interceptor from the <i>USS Erie</i>, an Aegis cruiser which was situated about 100 miles from Kauai. Two minutes after that, an intercept was</p>

			<p>reported. The interceptor again used only the sustain pulse mode of its guidance control system, the SDACS. FTM 04-1 was the first for the initial operational variant of the Aegis BMD system and used a “no-notice” launch for the target missile. During this scenario, the Aegis crews are put on alert, like they would be during a time of heightened hostilities, but they do not know exactly when the test target will be launched. FTM 04-1 had been originally scheduled to be tested in summer 2004; likewise, it did not include a target with a separating warhead, as first planned by program officials.</p>
FTM-04-2 (formerly FM-8)	Nov. 17, 2005	Yes	<p>A medium-range target missile with a separating warhead was launched from the Pacific Missile Range Facility. The target had a range of 620 to 1,860 miles. It was intercepted by an SM-3 at an altitude over 100 miles. This was the first time a separating target was used. According to the DOT&E report, “Recent ground tests of the SM-3 third-stage rocket motor surfaced problems with thrust performance for certain fly-out scenarios. Also during ground tests of the redesigned kinetic warhead maneuvering system, the highest pulsed thrust mode failed to consistently perform to specification. This maneuvering system was redesigned in FY05 an attempt to address past problems with thrust response. These thrust anomalies could lead to additional design changes.”</p>
FTM-04-3 (formerly FM-9)	4QFY06	N/A	<p>FTM-04-3 was cancelled, as a missile defense official claimed that “After FTM 04-2, we learned enough that FTM 04-3 objectives had essentially been met.” Instead, MDA will focus on future flight tests.</p>
Joint Control Test Vehicle (JCTV)-1	March 8, 2006	N/A	<p>This was the first test of a Japanese-designed nosecone for the U.S.-designed SM-3 interceptor, and comes after nearly six years of cooperative effort by the two countries. This new nosecone opens up so that the SM-3 missile doesn’t have to maneuver around when it is ready to launch its kinetic kill vehicle. JCTV-1 used a simulated target.</p>
FTM-10 (FTM-06-1/	June 22, 2006	Yes	<p>In this test, a medium-range target with a</p>

FM-10)			separating warhead was intercepted by an SM-3 Block 1A missile at an altitude of roughly 100 miles. It was launched from the <i>USS Shiloh</i> , instead of the usual <i>USS Lake Erie</i> . FTM-10 is notable as the first time another country's ship – Japan's Aegis destroyer <i>Kirishima</i> – participated in such an exercise. According to the FY 06 budget justification documents, it was to attempt the intercept of multiple targets using SM-3 Block I and IA missiles in separate engagements; this did not happen.
FTM-11 (FTM-06-2/FTM-11)	Dec. 7, 2006	No	The test failed abruptly when <i>USS Lake Erie</i> 's incorrectly-set fire control prevented the interceptors from launching. The test was based from the Pacific Missile Range Facility in Hawaii, and was scheduled to have an SM-3 Block 1A interceptor hit a low exoatmospheric ballistic missile target and an SM-2 Block III-A interceptor hit a surrogate aircraft target (a BQM-74 aerial target). The <i>USS Hopper</i> and the Royal Netherlands Navy's <i>TROMP</i> tracked the targets, both of which dropped into the Pacific Ocean without incident.
FTM-11 Event 4	April 26, 2007	Yes and yes	This was a repeat of the failed FTM-11 test. During the test, the <i>USS Lake Erie</i> launched an SM-3 Block 1A against a short-range unitary, low exoatmospheric ballistic missile target, and an SM-2 Block IIIA against a "target with characteristics similar to a hostile high performance aircraft" (a BQM-74 aerial target). The ballistic missile target was launched from PMRF facility, while the air-breathing target was launched from a Navy aircraft. The SM-3 Block 1A target was destroyed at an altitude of approximately 100 miles. According to the MDA, "The test also demonstrated the effectiveness of engineering, manufacturing, and mission assurance changes in the solid divert and attitude control system (SDACS);" however, it is not clear whether the system was used in multipulse mode, which had caused a flight test failure the last time it was used in June 2003.
FTM-11a	4QFY07	TBD	This test will attempt to demonstrate an operationally realistic engagement. "Minimal" data will be provided to the AEGIS cruiser prior

			to the test. It is unclear whether or not an intercept is a primary goal of the test. Details appear in the Test and Targets section of the FY 08 budget but not in the Aegis BMD section.
FTM-12 (FTM-06-3/FM-12)	June 22, 2007	Yes	During this test, a medium range ballistic missile target with a separating warhead was launched from the Pacific Missile Test Facility in Hawaii. A SM-3 Block IA interceptor was then launched from the USS Decatur, a Navy destroyer, and it directly intercepted the target missile 250 miles northwest of Hawaii and at an altitude of over 100 miles. This was the first time a destroyer was used for a test intercept attempt. Also participating in this test was a Terminal High Altitude Area Defense (THAAD) radar, the USS Port Royal (CG-73), an Aegis cruiser, and the Mendez Nunez (F-104), a Spanish frigate. According to Rear Adm. Brad Hicks, Aegis Ballistic Missile Defense program director, "It was a no-notice launch in an operationally realistic environment." How the program officials defined the latter part is unclear.
FTM-13 (FTM-06-4/FM-13)	Nov. 6, 2007	Yes and yes	Two SM-3 interceptors were launched from the USS Lake Erie off the coast of Kauai, Hawaii, while the two short-range ballistic missile targets were launched from a missile range on Kauai. Both targets were intercepted near-simultaneously. This was the first time a dual intercept had been attempted. According to the Director of Operational Test & Evaluation, that while even though a kill vehicle has been flown with a fully capable divert system, "flight tests to date have not yet exercised the full range of the divert system pulse modes," which were the downfall of FM-5 in June 2003.
JFTM-1	Dec. 17, 2007	Yes	This was the first time a non-U.S. ship fitted out with the Aegis BMD system was able to intercept a ballistic missile target. Japan's JS Kongo Aegis destroyer launched an SM-3 that had a special 21-inch Japanese-designed nosecone (which the U.S. SM-3s do not have) against a medium-range ballistic missile target launched from the Pacific Missile Test Facility in Hawaii. The Kongo is the first Japanese ship to have this version of the Aegis BMD; Japan

			plans on putting this in three more ships by 2010, and will hold three flight tests.
JFTM-2	1QFY09	TBD	This test will demonstrate the lethal intercept of an exo-atmospheric “Group ‘B’ MRBM target.” The interceptor will be launched from a Japanese destroyer.
FTM-14 (FTM-08-1/FM-14)	3QFY08	TBD	According to the MDA FY 09 budget justification documents, this test is to be a “Launch on Tactical Digital Information Link [TADIL] (LOT) engagement of group F Intermediate Range Ballistic Missile target.” It also will include “Flight testing of the BMD 3.6.1 (Near term SBT [sea-based terminal defense]) computer program with a Navy-developed SM-2 Block IV fuze-modified missile against a Foreign Military Acquisition (FMA) target.”
FTM-15 (FTM-08-2/FM-15), Block 2008	2QFY09	TBD	This test will be a “zero-pulse” mission, which is a specific setting of the interceptor’s third-stage rocket designed to increase the missile’s capability against short range threats. (This is different from the Solid Divert and Attitude Control System which was the cause of a flight test failure in 2003.) An interceptor with a zero-pulse mission has yet to be successfully flight tested since being added as part of the new Block 2006 suite of capabilities. This test will include a “Launch on TADIL [Tactical Digital Information Link] (Aegis to Aegis) flight test against a Group F target,” the latter of which is an SRBM.
FTM-16 (FTM-08-3/FM-16)	4QFY10 (moved back from 3QFY09)	TBD	This test will be the “1st flight test of SM-3 Block IB missile against a group B Medium range Ballistic Missile target.”
FTM-17 (FTM-08-4/FM-17?)	3QFY11 (moved back from 3QFY10)	TBD	This test will be a “BMD 4.0.1 engagement with SM-3 Block IB against a group c target.” Previous budget documents had indicated that it would be a simultaneous intercept attempt of one “Group B” and one “Group C” MRBM target in a “multi-warfare environment.”
FTM-18	3QFY12 (moved back from 3QFY11)	TBD	This test will be a “BMD 4.0.1 engagement against a group C target with an SM-3 Block IB missile.” Previous budget documents had indicated that the test would involve both a “developmental” intercept of an IRBM target

			and an “operational” test of a MRBM target, again in a “multi-warfare environment.”
FTM-19	3QFY 13 (moved back from 3QFY12)	N/A	This test will be a “BMD 5.0 engagement against a group C target with an SM-3 Block IB missile.” Previous budget documents had indicated that this was scheduled to test the SM-3 Block IIA interceptor and will involve a simulated target only.
FTM-20	2QFY13???	TBD	This test does not show up in the FY 09 budget documents. But according to the FY 08 budget documents, it was intended to use the Block IIA interceptor against a “Group C” MRBM target.
FTM 10-1	1QFY10	TBD	The FTM-10 test series is a residual from the FY 06 budget justification documents, but they do not show up in more recent budget justification documents. It is unclear if they have been pushed back farther, eliminated, or renamed.
FTM 10-2	3QFY10	TBD	
FTM 10-3	1QFY11	TBD	
FTM 10-4	3QFY11	TBD	

SOURCES:

CTV-1A: *Director, Operational Test and Evaluation FY 2005 Annual Report*, December 2000 report; “Navy conducts first flight of SM-3 for NTW program,” *Aerospace Daily*, Sept. 28, 1999

FTR-1: *DOT&E FY 00 report*; “NTW flight test fails,” *Defense Daily*, July 18, 2000

FTR-1A: “Standard Missile-3 flight test provides data for NTW,” *Defense Daily*, Jan. 29, 2001

FM-2: “Intercept starts long road to sea-based missile defense,” *Aviation Week & Space Technology*, Feb. 4, 2002

FM-3: “Navy reports success in missile defense test,” *New York Times*, June 14, 2002;

“Navy missile defense hit opens door for variety of test scenarios from sea,” *Defense Daily*, June 17, 2002

FM-4: “Standard Missile-3 demonstrates aimpoint shift maneuver in latest SMD flight test,” *Defense Daily*, Dec. 4, 2002

FM-5: MDA RDT&E, Defense-Wide Budget Documentation, FY 2004 Budget Request;

“Defense Watch,” *Defense Daily*, May 27, 2003; “MDA, Navy Prepare For Next SMD

Flight Test,” *Defense Daily*, April 21, 2003; “Test of missile system misses target,”

Associated Press Online, June 19, 2003; “Aegis ballistic missile defense flight test

conducted,” Missile Defense Agency News Release, June 18, 2003; “Failed Missile-

Defense Test Probed,” *Washington Times*, June 20, 2003; “Probe of Aegis BMD Test

Failure Looking at Role of Heat,” *Aerospace Daily*, Aug. 25, 2003

FM-6: “Aegis Missile Test Successful,” *Department of Defense press release*, Dec. 11,

2003; “MDA Reports Hit In Yesterday's Missile Defense Test,” *Defense Daily*, Dec. 12,

2003; “Aegis BMD system intercepts target missile over Pacific,” *Aerospace Daily*, Dec. 12, 2003

FTM 04-1: “Navy ‘successfully’ intercepts short-range missile during test,” *Inside Missile Defense*, March 2, 2005; “In latest test, Aegis BMD intercepts missile target,” *Aerospace Daily & Defense Report*, Feb. 28, 2005; *MDA RDT&E, Defense-Wide Budget Documentation, FY 2004 Budget Request*, February 2004

FM-17: *MDA RDT&E, Defense-Wide Budget Documentation, FY 2004 Budget Request*, February 2004

FTM-04-2: “Navy successfully hits separating target in missile defense test,” *Inside Missile Defense*, Nov. 23, 2005; *Director, Operational Test and Evaluation FY 2005 Annual Report*, December 2005

FTM-04-3 (formerly FM-9): “MDA Mulls Skipping Next Aegis BMD Test,” *Defense Daily*, Dec. 19, 2005

JCTV-1: “United States, Japan conduct successful missile defense test,” *Inside the Navy*, March 13, 2006

FTM-10: “Missile defense test yields successful ‘hit to kill’ intercept,” Navy press release, June 23, 2006

FTM-11: “Sea-based intercept test,” MDA Press Release, Dec. 7, 2006

FTM-11 Event 4: “Successful sea-based missile defense “hit to kill” intercept,” MDA Press Release, April 26, 2007; *FY 2008, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2007; *FY 2009, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2008

FTM-11a: *FY 2008, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2007.

FTM-12: “Navy scores hit on missile 100 miles up,” *Honolulu Advertiser*, June 23, 2007; “Aegis Missile Defense System Scores In New Test,” *Defense Daily*, June 26, 2007; *FY 2009, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2008

FTM-13: “Aegis successfully shoots down dual missiles for first time,” *Inside Missile Defense*, Nov. 21, 2007; *Director, Operational Test and Evaluation FY 2007 Annual Report*, January 2008; *FY 2009, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2008

JFTM-1: “Japan Test Fires Its First Raytheon-Built Standard Missile-3,” *Space Daily*, Dec. 20, 2007; “Successful Japanese Aegis test marks new BMD era, advocates say,” *Aerospace Daily & Defense Report*, Dec. 19, 2007

JFTM-2: *FY 2008, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2007

FTM-14 - FTM-19: *FY 2009, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2008; *FY 2008, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2007

FTM 20: *FY 2008, Missile Defense Agency (MDA) Exhibit R-2A RDT&E Project Justification*, February 2007

FTM 10-1- FTM 10-4: *MDA FY 2006/2007 Budget Estimates*, February 2005