

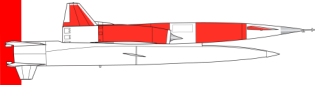
# Navaho Missile Program: Part 2

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Paths to the Present

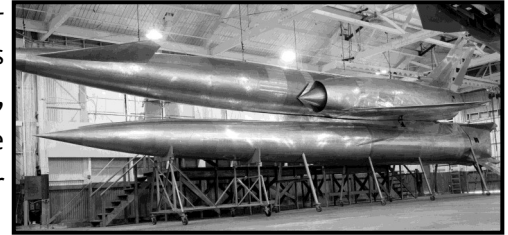
# FLASHBACK



## XSM-64 and XSM-64A



As Phase 1 testing of the X-10 Program came to an end, the flight test portion for Phase 2 began to ramp up at the Air Force Missile Test Center, Cape Canaveral, Florida. From the beginning, North American Aviation (NAA) designed the vertically launched *Navaho II*- XSM-64 as a rocket-boosted, ramjet-powered, two-third scale, intermediate range cruise missile testbed for the operational XSM-64A intercontinental missile. For XSM-64 testing, NAA engineers needed to launch the missile to a speed exceeding Mach 3 by the use of a liquid-fueled rocket booster powered by two Rocketdyne XLR71-NA-1 engines capable of achiev-



*Prior to constructing the first XSM-64, North American constructed a full-scale metal mock-up to verify overall design.*



*North American Aviation assembled all of the XSM-64 Navaho missiles and boosters at their facility in Downey, California.*

ing 249,000 pounds thrust. At speed and altitude the missile separated from its booster and the two Wright Aeronautical XRJ47-W-5 ramjets powering the XSM-64 took over and the missile performed its intended mission. NAA designed the XSM-64A operational missile system to be powered by even more powerful XRJ47-W-9 ramjets and propelled to speed by a rocket booster powered with a cluster of three XLR83-NA-1 engines.

Pushing the limits of technology with this radically futuristic design put the entire *Navaho* program years behind schedule and vastly over budget. The original test program called for nine controlled flights of *Navaho* before attempting a mission profile flight of 1,500 miles ending with a dive-in to target. In February 1956, the Department of Defense (DOD) designated the *Navaho* program as a top priority and under Project 'Broomstick', required NAA to attempt the full mission scenario from the outset, with four missions to be flown between October 1956 and May 1957. The Air Force accepted the high-risk project and North American worked tirelessly to overcome all difficulties as they arose.

However, problems with the XN-6 auto navigation system, rocket booster and a host of other issues, pushed the first launch out for months. One problem of significance was a shortage of titanium alloy, specifically a weldable titanium alloy expected for use throughout the missile and booster to keep weight to a minimum.



*Many of the Navaho missiles launched from the Air Force Missile Test Center were painted in bright color schemes to facilitate in long-range tracking.*

The problem became such an issue that NAA had to use stainless steel in place of titanium in many places on the test missiles and early production XSM-64A's which significantly reduced their range.

The Navaho N-6 auto-navigator, an all-inertial guidance system, consisted of two NAA-designed NAVAN gyroscopes, accelerometers and a new transistorized digital computer, called NATAN. NAA began aircraft testing the XN-6 unit in early 1955 aboard a Convair T-29 trainer and by October, the first XN-6 unit completed a total



The first XSM-64 launched, sits in its hangar at the East Coast launch facility undergoing final assembly and testing. Clearly seen are the Rocketdyne XLR71 engines on the booster.

**GUIDANCE HAS BEEN FIELD DEMONSTRATED**

|                                    |   |
|------------------------------------|---|
| <p>STELLAR-SUPERVISED INERTIAL</p> | DEVELOPMENT AGENCY<br><b>NORTH AMERICAN AVIATION</b>  |
|                                    | SYSTEM WEIGHT 1200 LB<br>SYSTEM VOLUME 50 CU. FT.<br>ESTIMATED CEP APPROX. 3000 FT.           |
| <p>REVERSING GYRO ALL INERTIAL</p> | SYSTEM WEIGHT 700 LB<br>SYSTEM VOLUME 20 CU. FT.<br>ESTIMATED CEP APPROX. 3000 FT. (AT 3 HRS) |

**TEST SCHEDULE**

|                       |          |              |                       |       |                  |
|-----------------------|----------|--------------|-----------------------|-------|------------------|
| YAN                   | AIRPLANE | EXPERIMENTAL | STELLAR-INERTIAL      | XN-6A | STELLAR-INERTIAL |
| 1950                  | 1951     | 1952         | 1953                  | 1954  | 1955             |
| AIRPLANE AND MISSILES |          |              | AIRPLANE AND MISSILES |       |                  |
| XN-6A                 |          |              | XN-6A                 |       |                  |
| ALL INERTIAL          |          |              | ALL INERTIAL          |       |                  |

of sixty-four T-29 flights with nominal results. By the end of that year, NAA deemed the XN-6 units ready for testing in the X-10 vehicles, however, NAA performed a second series of tests with the second XN-6 unit aboard a C-131 for additional reassurance. With this complete, the new guidance system began testing in the X-10's located at the Cape, eventually providing



NAA technicians put in long hours over several months in preparation for the first Navaho launch out of the Cape. Technical difficulties delayed the launch until March of 1957.

satisfactory results. NAA installed the follow-on units, the N-6A, in the XSM-64's for testing. While the Air Force wanted the greatest accuracy, known as Circular Error of Probability (CEP), the requirements were eventually 'relaxed' to a 12,000 ft CEP after 5,000 miles of flight. A later version, the N-6B, a much-improved version over the N-6A destined for use in the operational XSM-64A Navaho III, never saw use in the program with the cancellation of Navaho. However, NAA offered the guidance platform for use in future vehicles.

In late September 1956, Air Research and Development Command (ARDC) modified the flight test program once again. It's leadership recommended that NAA complete one successful mis-

sile-booster combination flight before attempting the first 'Broomstick' flight. The first XSM-64 finally left the launch pad on November 6, 1956, but the flight lasted only twenty-six seconds. It was determined that a pitch rate gyro had been installed backwards and the vehicle broke up at 10,000 feet. The second launch attempt would not occur until March 22, 1957, this time a faulty jettison system caused a loss of thrust in the booster. The missile separated at Mach 1.3 at 28,000 feet, well below the speed needed for ramjet ignition, but the ground-based safety pilot took control and glided the XSM-64 over the Atlantic, testing the landing gear system before impacting the ocean.



The first XSM-64 Navaho launch experienced severe pitch oscillations early in its flight before it broke up after reaching an altitude of only 10,000 ft



Many of the early Navaho launches from the East Coast launch facility ended in failure.

The third flight attempt, on April 25, 1957, lasted only a few seconds before the booster engines cut out, allowing the vehicle to fall back to the launch pad causing extensive damage and even more delays. Flight four on June 26th, saw the loss of an engine on the booster with the vehicle reaching only 12,000 feet before separating and gliding in for another ocean impact. Within a month of that failure, the Pentagon cancelled the *Navaho* program on July 10, 1957, with no money allocated for *Navaho* in the next years budget. Nevertheless, the Air Force sent a message two days later allowing the flight testing of five more vehicles to provide data in the areas of high temperature conditions, cruise data above Mach 2.75, inertial guidance system and ramjet propulsion. Under the 'Fly Five' program, the Air Force authorized five additional XSM-64 launches to the schedule at a cost of less than \$5 million with one launch every seven weeks beginning on August 1st.

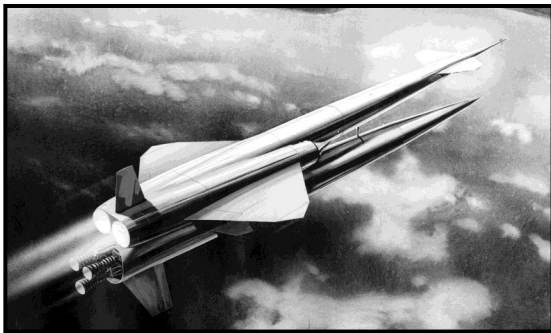
The first of the 'Fly Five' missions took place on August 12th with the boost, separation, ramjet ignition and initial cruise phase being successful for the first time. Their success short lived, as the auto-navigator sent a



Aerial view of the Navaho launch area at the Air Force Missile Test Center, Cape Canaveral, Florida.

right turn command five minutes into the cruise flight causing the left engine to quit, followed a minute later by the right engine. Still, the vehicle achieved a speed of Mach 3.08 and cruised between 70,000 and 80,000 feet with flight duration of nine minutes and twenty-six seconds covering a distance of 238 nautical miles. The next flight, on September 18th, had a similar flight profile, but as in the past, the auto-navigator commanded another right turn sixteen minutes into the flight leading to engine shutdown.

The third flight of 'Fly Five' and the seventh of the XSM-64 *Navaho* program came on November 13th, but a volt-



NAA artist concept of the XSM-64A operational Navaho missile system. The XSM-64A was larger and faster than its predecessor, the XSM-64.

age regulator failed seventy-five seconds into the flight and the Range Safety Officer commanded its destruction. The following flight on January 10, 1958 proceeded well as the vehicle cruised near Mach 3 at 64,000 feet for approximately 850 miles at which point the auto-navigator initiated a programmed turnaround for a flight back to the Cape. The autopilot made the turn too wide and ground control took over. In the ensuing sharp

turn, the right engine flamed out and the aircraft crashed into the ocean. It had flown for forty-two minutes and twenty-four seconds covering 1,075 nautical miles. The final flight in this phase occurred on February 25<sup>th</sup>. Like the previous four, this mission ended in failure when the booster cut out fifteen

STRATEGIC COVERAGE BY B-64 MISSILES







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