

# STANDARD MISSILE: THE COMMON DENOMINATOR

STANDARD Missile has evolved from the wing-controlled beam rider of 30 years ago into the free world's most advanced operational homing missile. Its design is based upon the proven airframe of its TERRIER and TARTAR surface-to-air missile predecessors. STANDARD Missile has followed the concepts of modular design and commonality throughout its history.

## INTRODUCTION

STANDARD Missile is a surface-to-air ship-launched missile for defense against attacking aircraft and antiship missiles (Fig. 1). It is presently deployed, in its various configurations, on over 70 frigates, destroyers, and cruisers of the U.S. Navy. More than 80 new ships, planned and being built, and including the new AEGIS ships, will also use STANDARD Missile. STANDARD Missile is currently operational in 28 ships of eight allied navies; this foreign force is planned to increase to 35 ships by the mid-1980's.

STANDARD Missile is a supersonic, solid-rocket-propelled, tail-controlled missile with all-electric guidance and control equipment. It is modular, permitting maximum commonality among its various configurations. There are extended- and medium-range versions and an inertial midcourse guidance feature that distinguishes the STANDARD Missile-2 from the STANDARD Missile-1. Common guidance receivers, warheads, autopilots, and control sections are found in all versions.

The ability to successfully evolve a missile design to double and redouble its performance through the years and adapt it to a variety of tactical applications is based upon several basic design principles and disciplines. The compact tail control aerodynamic configuration not only provides high performance but can readily accommodate a widely varying flight regime and changes in component sizes and weights. Adherence to the discipline of sectionalized design, with interchangeable components having a high degree of commonality among the several versions of the missiles, provides great flexibility at minimum cost. Finally, strict conformance to the standard physical dimensions of diameter and maximum length is a basic principle.

In reality, STANDARD Missile is a family of missiles rather than a single configuration. The "family history" of this missile is a success story that forms the theme of this article.

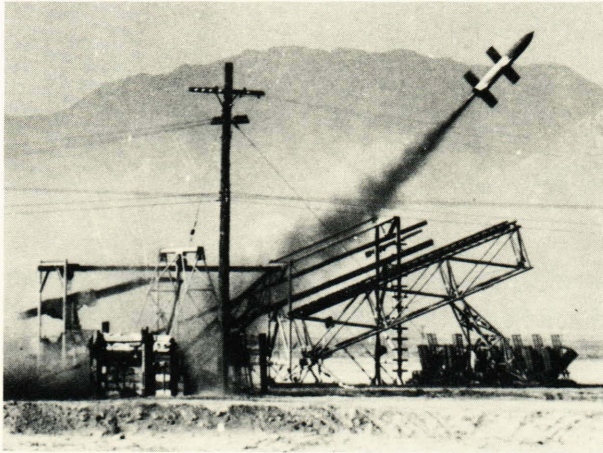


**Figure 1** — STANDARD Missile-2 launch from USS MAHAN. A STANDARD Missile firing, whether from a land test site or a ship, is an impressive and unforgettable experience. If it were not for the rocket smoke trail, the eye could not follow the path of the missile as it flies under precision control to a target many miles away. The complex, interactive systems required for a STANDARD Missile firing rival the most sophisticated mechanisms developed by man.

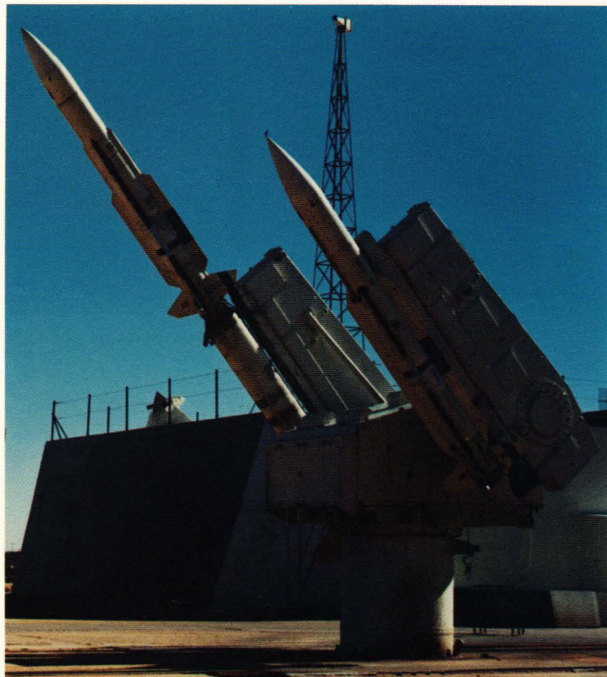
## HISTORY OF THE STANDARD MISSILE

In 1949, a supersonic test vehicle using a solid fuel rocket was used to test and evaluate the guidance and control system for the TALOS Guided Missile (Fig. 2). A version of that test vehicle performed so well that it was developed into the operational TERRIER Missile.





**Figure 2** — Early subsonic test vehicle used in the development of TALOS guidance and control systems. This solid fuel rocket, developed in 1949, is shown being launched at Inyokern, Calif.



**Figure 3** — TERRIER and TARTAR Missiles on launcher at White Sands Missile Range. The extended-range TERRIER Missile has a separate booster.

The first significant improvement to the TERRIER Missile was the change in the control system from wing control to tail control. This was prompted by the need for better maneuverability to counter evasive maneuvers on the part of the attacker. The second major improvement was the change from a beamrider guidance system to semiactive homing. The third major change, concurrent with the second, was the development of an integral dual-thrust rocket motor (a single rocket that provides a high thrust for boost followed by a much lower thrust for the sustain phase). This version became the TARTAR Missile (Fig. 3).

In the early 1960's, the technological advances of solid-state electronics had matured sufficiently to justify the redesign of both the TERRIER and the TARTAR Missiles to improve their reliability and manufacture. The TERRIER Missile became STANDARD Missile, Extended Range [SM-1(ER)] and the TARTAR Missile became STANDARD Missile, Medium Range [SM-1(MR)]. With the use of modular construction, performance improvements by block changes (a collection of related design changes introduced during production) were possible and have led to a progressive family of STANDARD Missiles. SM-1(ER) is a two-stage configuration having a single thrust booster that separates from the missile a few seconds after launch. The rocket sustainer then ignites and provides thrust until burnout. The missile coasts for the remainder of flight. SM-1(MR) employs a dual-thrust, solid rocket developed earlier for the TARTAR Missile. This type of rocket permits both the boost and sustain phases to be implemented in a single rocket.

In the 1960's, the air threats to Naval forces began undergoing a transition from aircraft to antiship missiles. Such missile attacks may be coordinated with the use of various countermeasures and special tactics, making anti-air defense more complex and stressful. At this point, the Advanced Surface Missile System Study Group, involving the Navy, industry, and APL, concluded that the nature of the projected threat dictated the need for a new weapon system combining high performance, quick reaction time, an inherent countermeasures capability, and high reliability. In 1969, the contract was awarded for the AEGIS Weapon System, which would utilize improved versions of STANDARD Missile.

As initially conceived, the ASMS (AEGIS) was to include a new missile with improved performance, including midcourse command and semiactive terminal guidance. During the deliberations of Technical Planning Group II, it was perceived that, with certain modifications, STANDARD Missile might be upgraded to provide the new capability, and the study report so indicated. In late 1969, just prior to award of the contract, the new missile was deleted from the budget and a modified version of STANDARD Missile was substituted. This version incorporated a new inertial guidance system and missile/radar data link and was designated STANDARD Missile 2, Medium Range [SM-2(MR)].

These modifications substantially improve the performance of the missile in range, altitude and terminal homing accuracy and also provide a capability for simultaneous control of multiple missiles in flight.

In the early 1970's, subsequent to award of the AEGIS contract, the Navy, with APL as technical lead, sponsored a new study group to determine how these new capabilities might be used to enhance the performance of the TERRIER/TARTAR combat systems. This group soon evolved a concept incorporating those advantages that could be used with both sys-



tems. The TARTAR concept used the medium-range missile designed for AEGIS, with minimal changes. The TERRIER system, incorporating the previously developed booster, was officially designated STANDARD Missile 2, Extended Range [SM-2(ER)].

In 1975, projections showed that the threat would become increasingly severe in terms of speed, maneuverability, and countermeasures. A study performed by APL concluded that once again the threat could be countered through evolutionary improvements to STANDARD Missile in propulsion, signal processing, and warhead technology.

The Surface Warfare Directorate of the Office of the Chief of Naval Operations chartered a study group in 1980 to assess current and projected threats and make recommendations for further upgrades in surface-to-air missile capability.

## THE APL ROLE

In January 1945, the Laboratory was directed by the Navy Bureau of Ordnance in the following manner:

“A comprehensive research and development program shall be undertaken, embracing all technical activities necessary to the development of one or more types of rocket-launched, jet-propelled, guided, and anti-aircraft missiles. . . . This program shall include pertinent basic research, investigations, and experiments, and the design, fabrication and testing of such missiles, their component parts, and supplementary equipment. . . .”

During the years following this initial assignment, APL has supported the Navy in anti-aircraft missile development in keeping with these general guidelines established in the 1940's.

APL has made vital contributions to the development of U.S. Navy anti-air warfare missiles since the mid-1940's. These contributions include threat assessments, performance requirements definitions, concept definitions and engineering, design monitoring, and performance tests and evaluations.

APL's participation in the development of STANDARD Missile has been as Technical Direction Agent and Technical Support Agent. In these assignments, APL has conducted assessments of design, development, and improvement programs. The Laboratory has coordinated and conducted test activities during the initial design stages, through production, and when in use by the Fleet.

## THE COMMON DENOMINATOR

The operational use of any guided missile requires direct support from a combat system whether it be launched from land, sea, or air. In the surface Navy, many missile system design requirements are unique, not only because of the sea environment, but, more

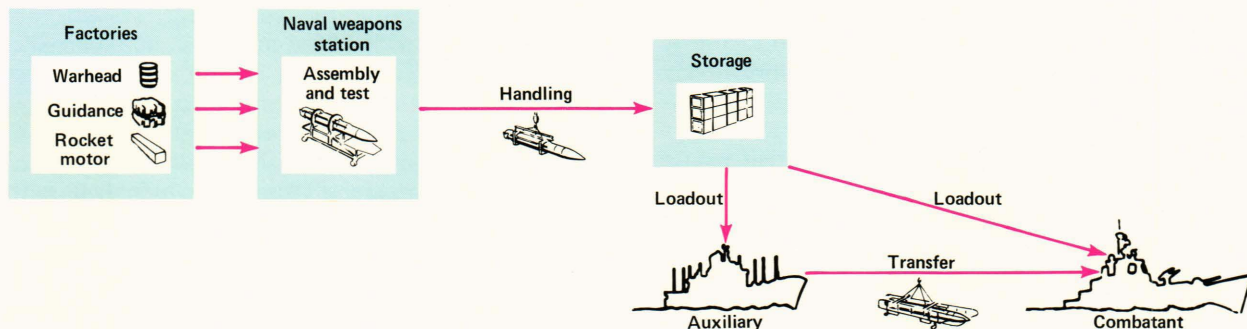
significantly, because the supporting systems are combatant ships with varied missions and tactical requirements. This means that missile weapon system designs are under severe constraints in terms of physical size, weight, and shipboard location. Additionally, the missile system must be totally consolidated within the ship command structure, which deals with all weapons aboard the ship. Because of this close weapon-to-ship integration requirement, it is technically and economically practical to upgrade the missile system's performance provided forethought in planning and special design concepts are incorporated.

Development of STANDARD Missile has followed these concepts throughout its history. There have been incremental missile upgrades based on long-term requirements, in which improvements are made by building solidly on existing resources and knowledge. Each module is designed with a tolerance to change so that missile upgrades have a minimum impact on other ship elements and support activities. In a word, STANDARD Missile is based on commonality: commonality of critical components within the missile from one generation to the next; commonality among versions fired from TERRIER, TARTAR, and AEGIS ships; commonality of interfaces with supporting launchers and radars; and commonality in engineering expertise, technical data base, and logistic support.

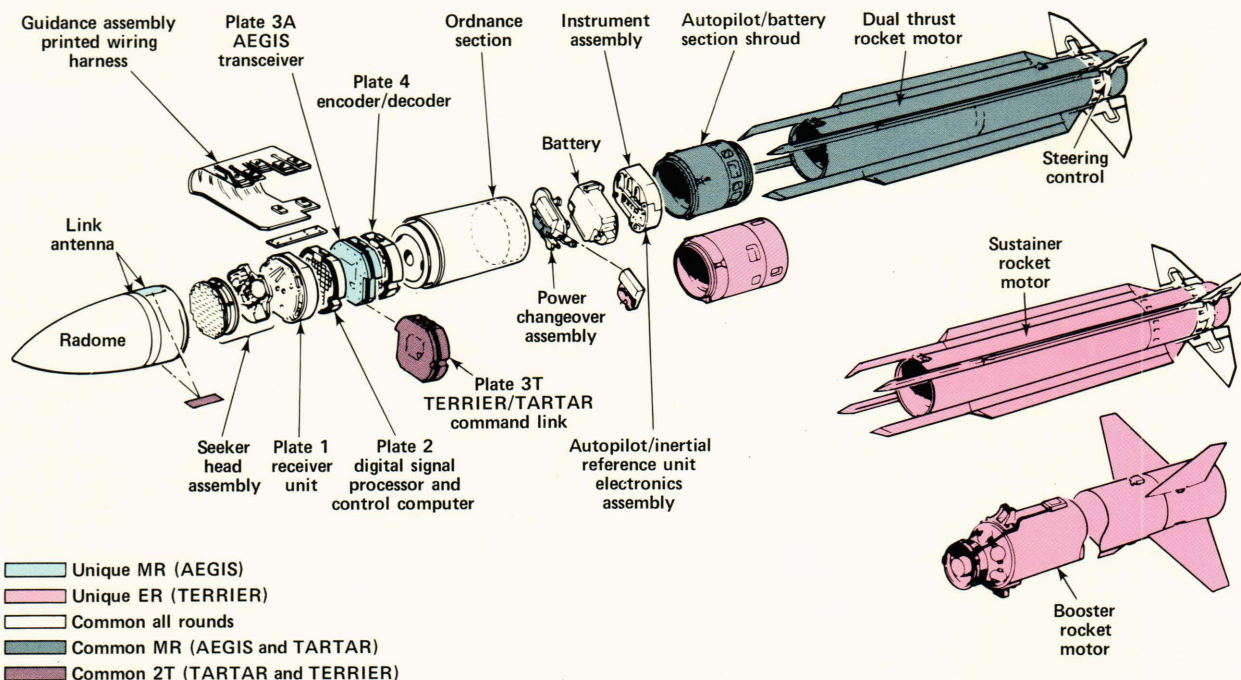
Because STANDARD Missile subsystems (radome, guidance electronics, warhead, autopilot, etc.) are common to versions for TERRIER, TARTAR, and AEGIS ships, there is essentially only one production line. In some instances, major components are identical; in others, only subcomponents differ. Because of this commonality, production acceptance testing is simplified. The handling and transporting equipment within factories, and the shipping and transporting containers as well, can also be common in order to simplify the whole logistics chain from the production line to a shipboard supply of combat ready missiles (Fig. 4). Two design features of STANDARD Missile predominate in permitting an efficient logistics chain: a diameter of 13.5 inches, which has remained constant for over 30 years, and a uniform approach to sectionalization whereby major pieces of the missile are physically separable into major subsections that are functionally unique (Fig. 5).

A missile's capabilities must keep pace with the threat. Often this mandate requires significant modification at the component level, e.g., guidance electronic upgrades demanded by the changing electronic countermeasures environment. To minimize the development time and cost of production change, STANDARD Missile is typically upgraded by a block change program. In this process, specific design changes are made only for those subsections affected by the operational need. Unaffected performance specifications, production drawings, and subcontract elements can therefore be retained. Economic savings are therefore obtained at all levels of development.





**Figure 4** — STANDARD Missile logistics chain. The common characteristics of STANDARD Missile versions allow an efficient logistic chain from factory to ship.



**Figure 5** — STANDARD Missile's modular construction permits maximum commonality between missile configurations and allows improvements to be made efficiently.

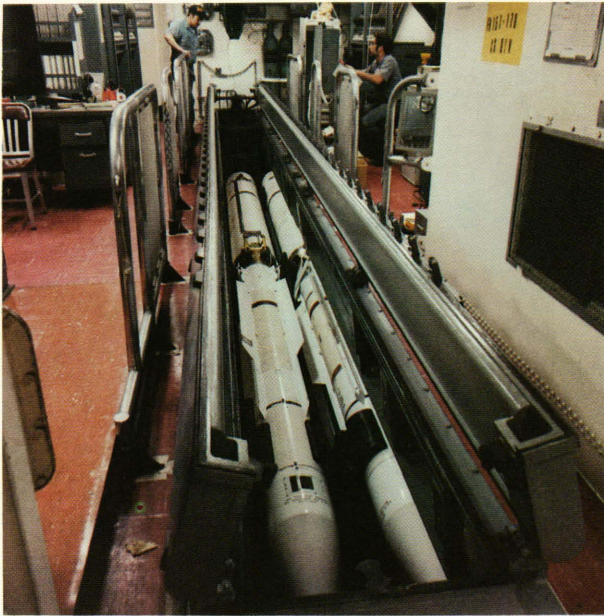
Today, all STANDARD Missiles are fired from rail launchers that move in azimuth and elevation to provide the desired launch direction (Fig. 6). Because of the demanding mechanical operation of these launchers, missile designers must observe a number of constraints such as launch attachment devices. Additionally, a number of launcher-to-missile connectors are required to prepare the missile properly for launch and conduct the actual firing. With launchers within a major ship class having common loading, holding, and firing mechanisms, the corresponding connecting points on the missile can be standardized. Because this logistics principle is observed in STANDARD Missile and its corresponding ship weapon systems, it is possible, for example, to fire SM-1(MR) from a variety of ship classes. Obvious benefits are reduced ship installation costs as well as increased flexibility in resupplying ammunition.

The team associated with Naval anti-air missile development for over 30 years includes a large industrial base headed by General Dynamics/Pomona, the prime contractor; Navy laboratories and support agencies; and APL. In spite of the normal attrition and migration of technical and management personnel from the program, there has remained a surprisingly large cadre of technical experts within these organizations. These people represent a very strong base of corporate knowledge and are, indeed, a real part of the common denominator.

## LOOKING AHEAD

As hostile forces utilize new technology to improve their ability to attack our surface Navy, we must continue to upgrade our weapon systems to keep pace. As a particular threat vehicle appears with increased





Courtesy General Dynamics/Pomona

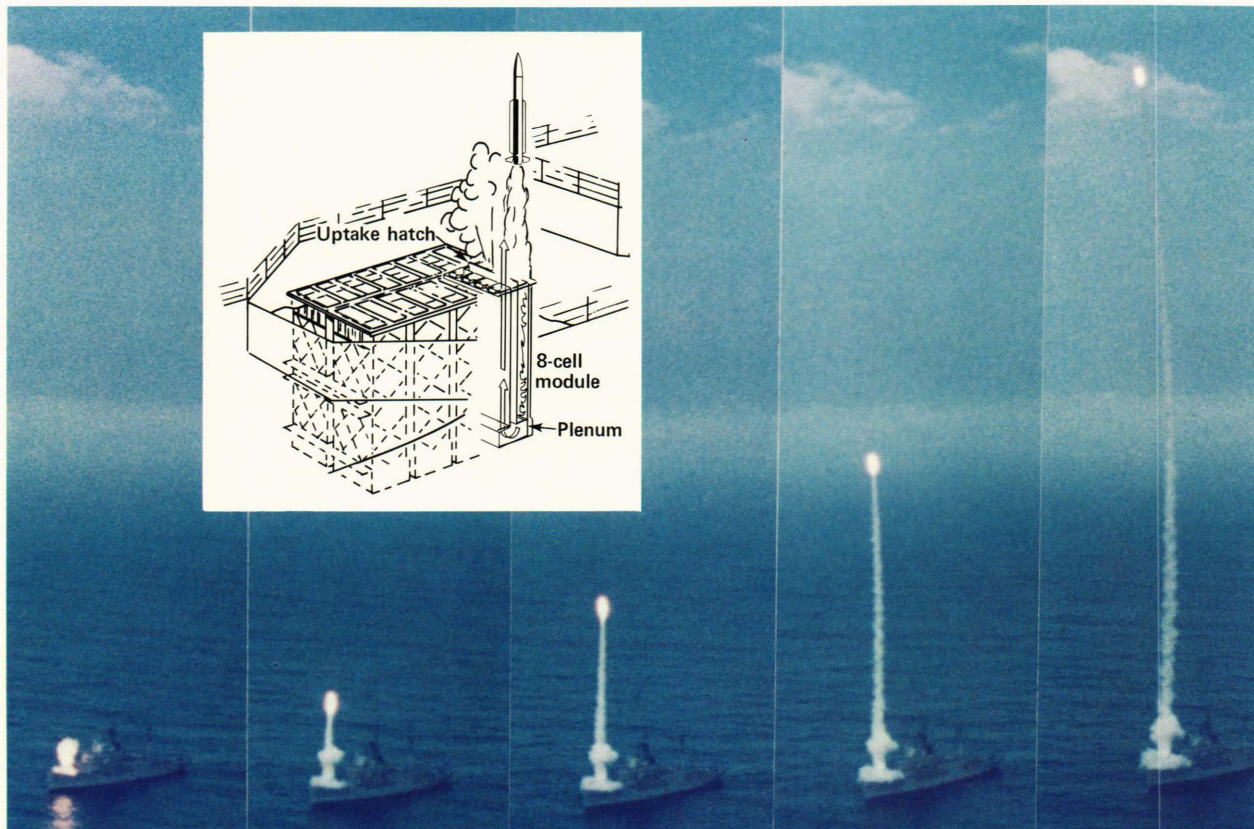
**Figure 6** — STANDARD Missile is fired from dual rail launchers. The Mk 10 launcher fires the extended-range version from TERRIER ships while the Mk 26 launcher fires the medium-range version from TARTAR and AEGIS ships. Missiles are loaded horizontally onto the Mk 10 launcher and vertically onto the Mk 26 launcher.

speed and operating altitude, for example, a countering increase in missile rocket impulse is generally required. Fortunately for the missile designer, a new vertical launcher is currently being developed that will permit major increases in rocket impulse. The Vertical Launching System is planned for installation in new ship construction. Unlike current launching systems, the Vertical Launching System is fixed and will be installed below decks. Storing and firing of missiles will be in a vertical position (Fig. 7). Because of this arrangement, the overall length and diameter

of STANDARD Missile can be increased if necessary. The aerodynamic shape and the size of the dorsals and steering tails also can be modified. This new flexibility in design will provide a new dimension in the growth potential for surface-to-air missiles for decades to come.

For immediate application, the next major upgrade in STANDARD Missile will make use of the additional length in the Vertical Launching System to provide a substantial increase in total rocket impulse. This upgrade will be only one of many improvements





**Figure 7** — STANDARD Missile test firing from the Vertical Launching System in USS NORTON SOUND. The flush deck vertical launch concept will eliminate the above-deck rail launcher and permit modifications in missile length and diameter.

planned for meeting the challenges of the next decade. Other improvements will include an enhanced guidance and control capability.

## SUMMARY

STANDARD Missile has evolved from the wing-controlled beamrider of 30 years ago to the free world's most advanced operational tail-controlled

homing missile. Its design is based upon the proven airframe of its TERRIER and TARTAR surface-to-air-missile predecessors. Today's STANDARD Missile uses solid-state devices throughout, reducing warm-up time and eliminating the need for shipboard checkout. Continued advancements in performance, introduced in a series of evolutionary block changes, will keep the STANDARD Missile family ready to meet threats to the United States Fleet.