

## AEGIS: ADVANCED SURFACE MISSILE SYSTEM

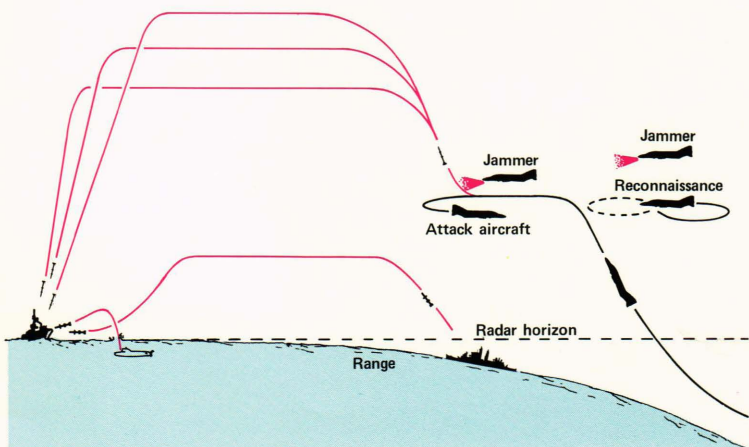
The development of the Advanced Surface Missile System, which evolved into AEGIS, was initiated in the mid 1960's. It was the result of a Chief of Naval Operations directive in 1963 to begin concept formulation of a new fully integrated missile weapon system. Subsequent to formulation of concepts by seven teams of industrial contractors, an ASMS Assessment Group headed by Rear Admiral F. S. Withington (Ret.), was convened to evaluate concepts and identify a baseline system. APL was heavily represented in the ASMS Assessment Group and was instrumental in the resultant early development work process, performing analyses and experiments attendant on the reduction of perceived technological risk prior to entering engineering development. Concepts proven feasible are embodied in the AEGIS Combat System entering U.S. Navy service in 1983.

The AEGIS Mk 7 Weapon System evolved from the work initiated in 1957 by APL as part of the Advanced Weapon System (AWS) Program. It was apparent to the Navy even then that the TERRIER, TARTAR, and TALOS (3T) Systems (just becoming operational) had performance limitations, particularly in the context of the growth and diversity of air attacks foreseeable in the next several decades (Fig. 1).

As part of the AWS Program, APL established the basic concepts and techniques for a fully integrated missile weapon system based on the use of a phased-array radar. In 1959, APL and Westinghouse began development of the TYPHON Weapon System. TYPHON was unique in that it used a phased-array radar with virtually simultaneous search, track, and fire control capabilities; comprehensive signal processing; track-via-missile guidance; advanced missiles; a new launching system; and digital computer control. Although TYPHON's design achieved its expected performance, it could not be produced with the technology available at that time. After early

engineering testing in USS NORTON SOUND (Fig. 2), the program was cancelled in 1962.

In 1963, a formal expression of requirement was made by the Chief of Naval Operations for an "Advanced Surface Missile System (ASMS)." Subsequently, a group within the Surface Missile Systems Project Office in the Bureau of Weapons began concept formulation of a new, fully integrated missile weapon system. During the program definition phase, seven leading industrial teams developed families of candidate systems. With these system concepts as input data, the Navy created an ASMS Assessment Group under the leadership of Rear Admiral Frederic S. Withington, who was recalled from retirement. The group included senior officers from the operating forces of the Navy, the Office of the Chief of Naval Operations, the Bureau of Ships, and the Bureau of Weapons. It also included civilian engineers and scientists from the Navy and the Army and their counterparts from Bell Telephone Laboratories and APL. In a somewhat unusual departure



**Figure 1** — Threat challenges to the AEGIS ship. The threat is characterized by high- and low-altitude, high-speed anti-ship missiles — some with quite small radar cross-sectional areas — supported by intense electronic countermeasures.





**Figure 2** — TYPHON installation in USS NORTON SOUND about 1962. The TYPHON Program was discontinued in 1962, but the lessons learned from development of that system aided in the formulation of the Advanced Surface Missile System concept.

from tradition, the Assessment Group also included representatives from the seven industrial teams and some of their major subcontractors.

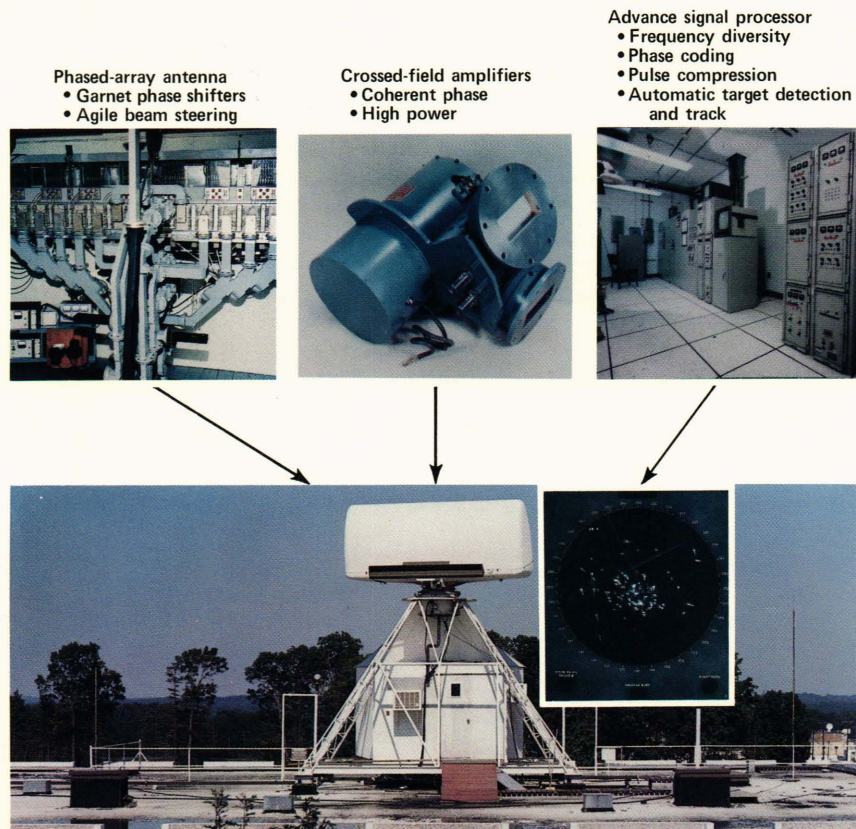
This group of Naval officers and engineers synthesized a basic system from the techniques and concepts provided by the contractors. The architecture of the system being installed in TICONDEROGA in 1981 is substantially the same as that established by the ASMS Assessment Group in 1965. In addition to providing a system concept review (its principal product) and selecting the baseline system, the ASMS Assessment Group prepared a variety of formal documents, including a preliminary Technical Develop-

ment Plan and a recommended Specific Operating Requirement.

Although the findings of the Assessment Group were published and accepted by the Navy in 1965, development was deferred. The Mobile Field Army Air Defense System (later called SAM-D and now called PATRIOT) was then in a competitive program definition phase. Development of the Navy's system was delayed to investigate the possibility of combining Army and Navy development efforts to achieve commonality. After an extensive joint examination by the Army and Navy, it was concluded that complete commonality was not practical. By 1967, ASMS implementation was authorized by the Department of Defense. Three industrial teams were selected for competitive contract definition during 1968. Contract definition concluded in 1969 with the selection of RCA as the prime contractor.

During 1965 to 1969, APL conducted experiments and analyses to minimize technological risks and to validate design concepts for the system and for elements of the system. The major work performed was the development of the Advanced Multi-Function Array Radar (AMFAR), the immediate predecessor of Radar System AN/SPY-1A and its derivatives (Fig. 3).

Significant questions were raised about the soundness of the technical approach to ASMS design and about some of its components, e.g., the crossed-field amplifier used as the basic component of the transmitter, and the garnet phase shifters used as the fun-



**Figure 3** — Components of the APL AMFAR system.

damental element of the electronically steered antenna array. The AMFAR Program was structured to examine these components and to investigate new concepts in radar system pulse-by-pulse transmit/receive control by a digital computer. Both the crossed-field amplifiers and garnet phase shifters were successfully developed by subcontractors working for APL and later adapted by the AEGIS contractor for use in the SPY-1A radar system, which is now installed in TI-CONDEROGA and embodies the concepts first conceived and demonstrated effectively in AMFAR .

In 1969, the Development Concept Paper (DCP-16), approved by Secretary of Defense David Packard, established key parameters to be measured during AEGIS system development. Threshold values were established for each parameter. Failure to achieve a threshold value was cause for review and possible termination of development. Some of the measurement parameters were based upon the shortcomings

of the 3T's and became the basic design parameters or cornerstones of the newly named AEGIS:

- *Fast reaction time* — to cope with fast, low-altitude threats
- *High firepower* — to survive a saturation attack
- *Electronic countermeasures and clutter resistance* — to perform in severe natural and man-made environments
- *High availability* — to be ready immediately when needed
- *Area coverage* — to provide an effective area defense for the task force

The performance characterized by these cornerstones has been demonstrated by Engineering Development Model performance in USS NORTON SOUND and at the Navy Combat System Engineering Development Site at Moorestown, N. J.