

# Air and Missile Defense Radar (AMDR) / AN/SPY-6



In March 2024, DOT&E published a classified operational assessment (OA) report on the Air and Missile Defense Radar (AMDR), designated AN/SPY-6(V)1. The OA, conducted in FY23 by the Navy's Operational Test and Evaluation Force (OPTEVFOR), provided an early evaluation of the radar's performance and enables modifications that could optimize performance for IOT&E. In addition, the Missile Defense Agency (MDA), in collaboration with OPTEVFOR, conducted the Flight Test Aegis Weapon System-32 (FTM-32) event in FY24 as an integrated test to demonstrate the capability to detect, track, engage, and intercept a medium-range ballistic missile target. Guided-missile destroyer USS *Jack H. Lucas* (DDG 125) participated in the flight test as part of IOT&E for AMDR / AN/SPY-6(V)1, DDG 51 Flight III, and Aegis Weapon System (AWS) Baseline 10.

## SYSTEM DESCRIPTION

AN/SPY-6 is the Navy's next-generation, S-Band, family of radars. AN/SPY-6 uses a radar modular assembly (RMA) as a building block for the radar's antenna. Each individual RMA is a self-contained radar antenna built from a set of active transmit/receive (T/R) digital modules that are electronically scanned. Each RMA block can integrate with other RMA blocks to create antenna assemblies of various size and capability. The large number of T/R modules provides a high degree of fault tolerance through antenna redundancy and graceful degradation.

AMDR has two major components:

- An S-band radar to provide search, track, cueing, missile discrimination, S-band missile communications, surveillance capability for ship self-defense and area air defense, and S-band kill assessment support functions.
- A Radar Suite Controller to provide radar resource management and coordination and an open interface with the ship's combat system.

The AMDR fielded on DDG 51 Flight III *Arleigh Burke*-class guided-missile destroyers is designated AN/SPY-6(V)1. AN/SPY-6(V)1 uses four fixed-antenna assemblies (faces) with each antenna having 37 RMAs. This provides a 360-degree field-of-view about the ship. AN/SPY-6(V)1 integrates with AWS to provide DDG 51 Flight III

ships with enhanced surveillance, tracking, and ballistic missile defense (BMD) discrimination. AN/SPY-6(V)1 is designed to operate in high clutter, littoral regions near land, and electromagnetic congested, contested, and complex environments.

The AN/SPY-6 family of radars has other variants such as:

- AN/SPY-6(V)2 is comprised of nine RMAs for the single-face rotating antenna intended for the next flights of the *San Antonio*-class and *America*-class amphibious ships and as a back-fit to the *Nimitz*-class aircraft carriers.
- AN/SPY-6(V)3 is comprised of three fixed-antenna faces with nine RMAs on each antenna face, intended for the *Gerald R. Ford*-class aircraft carrier and the *Constellation*-class frigates.
- AN/SPY-6(V)4 is a planned back-fit modernization to the DDG 51 Flight IIA ships that will use 4 fixed-antenna faces, with each antenna face having 24 RMAs.

## MISSION

Navy commanders will use AMDR to detect, track, and support engagements against cruise and ballistic missiles, aircraft, and unmanned aerial vehicles in support of air warfare (AW) missions, BMD, or concurrent AW and BMD known as integrated air and missile defense (IAMD). Commanders additionally use AMDR for contact localization and situational awareness in

surface warfare missions. AN/SPY-6(V)4 is expected to support similar missions as AN/SPY-6(V)1. AN/SPY-6(V)2 and AN/SPY-6(V)3 will also support similar missions, except for BMD and IAMD, and additionally support air traffic control.

## PROGRAM

AN/SPY-6 is an Acquisition Category IC program. The Navy intends to align IOT&E of the different variants of AN/SPY-6 with IOT&E or FOT&E of the ship platforms they are intended for, resulting in an operationally realistic system-of-systems test approach. DOT&E approved a combined TEMP describing the testing strategy for AN/SPY-6(V)1, DDG 51 Flight III ships, and AWS Baseline 10 in September 2022. OPTEVFOR collected ballistic missile defense data on the AN/SPY-6(V)1 in March 2024 in accordance with a DOT&E-approved test plan and with DOT&E observation. Data were collected in conjunction with the OT&E of DDG 51 Flight III with AWS Baseline 10. During FY23 and FY24, the Navy conducted developmental testing of AN/SPY-6(V)1 as installed on USS *Jack H. Lucas* (DDG 125), as well as at the Advanced Radar Detection Laboratory (ARDEL) on Pacific Missile Range Facility (PMRF), in Kekaha, Hawaii, on the island of Kauai. OPTEVFOR is developing an IOT&E test plan and a cyber survivability test plan for combined operational testing of AN/SPY-6(V)1, DDG 51 Flight III, and AWS Baseline 10. The Navy expects

to deliver the IOT&E test plan to DOT&E in FY25 and the cyber survivability test plan in FY26.

The Navy expects to deliver a combined TEMP to DOT&E for approval in FY25 that supports T&E of AN/SPY-6(V)2, AN/SPY-6(V)3 for CVN 79, and the Ship Self-Defense System Baseline 12 combat system, which is a delay from last year when it was expected in FY24. The Navy intends to conduct IOT&E of AN/SPY-6(V)2 and AN/SPY-6(V)3 radars between FY26 and FY30.

The Navy expects to deliver a FFG 62 *Constellation*-class guided-missile frigate TEMP to DOT&E for approval in FY25 that supports IOT&E of AN/SPY-6(V)3. The Navy intends to conduct IOT&E of the AN/SPY-6(V)3 radar for FFG 62 ships between FY29 and FY31.

The Navy intends to cover AN/SPY-6(V)4 testing in a future Aegis Modernization TEMP.

## » MAJOR CONTRACTOR

- Raytheon, a subsidiary of RTX
  - Marlborough, Massachusetts

## TEST ADEQUACY

In March 2024, DOT&E published a classified AMDR / AN/SPY-6(V)1 OA report. OPTEVFOR conducted the OA of AN/SPY-6(V)1 in FY23 at the ARDEL on PMRF, in Kauai, Hawaii, as detailed in the FY23 Annual Report. The OA evaluated capability of AN/SPY-6(V)1 to detect and track fighter aircraft, anti-ship cruise missile surrogates,

unmanned aerial vehicles, helicopters, airborne early warning and control aircraft, and small-boat targets. The OA provided early evaluation of the AN/SPY-6(V)1 radar performance in its AW and surface warfare missions in clear and electromagnetic contested environments and demonstrated the Navy's test method for assessing AN/SPY-6(V)1's classified electromagnetic protection waveforms. The OA additionally informed planning of IOT&E test events. The OA was not intended to determine operational effectiveness and suitability of the delivered AMDR due to the AN/SPY-6(V)1 at ARDEL being an engineering development model (EDM) that uses obsolete T/R Integrated Microwave Modules that will not be used by the delivered system. The AMDR Program Office did not evaluate cyber survivability due to differences between the delivered AMDR and the EDM version of AMDR at ARDEL.

In March 2024, the MDA, in collaboration with OPTEVFOR, conducted the Flight Test Aegis Weapon System (FTM-32) as an integrated test to demonstrate the capability to detect, track, engage, and intercept a medium-range ballistic missile target utilizing a simulated Standard Missile-6 (SM-6). USS *Jack H. Lucas* (DDG 125), equipped with AWS Baseline 10 and AN/SPY-6(V)1 radar, participated in FTM-32 as part of IOT&E. Significant intended data collection on AN/SPY-6(V)1 performance was not attained due to system challenges during test execution. As a result, insufficient data are available to assess

AMDR operational effectiveness from this flight test. This event is detailed in the classified DOT&E FY24 Missile Defense System Annual Assessment, to be published in February 2025.

As identified in the FY23 Annual Report and the AN/SPY-6(V)1 OA Report, assessment of the resident AN/SPY-6(V)1 at ARDEL was limited by the following:

- AMDR EDM was not operationally representative. The AMDR program plans to install a low-rate initial production (LRIP) AMDR unit in FY26.
- The current aerial anti-ship cruise missile targets do not emulate more stressing threats, including advanced electromagnetic attack capabilities.
- System setup and software configuration of the AMDR EDM could not evaluate performance of all capabilities that are prohibited from testing in an open-air environment due to security reasons. An anechoic chamber would provide the ability to test these capabilities.

## PERFORMANCE

### » EFFECTIVENESS

The AN/SPY-6(V)1 OA demonstrated radar performance in a limited set of scenarios. DOT&E provided performance results and risks to IOT&E in the classified AN/SPY-6(V)1 OA report in March 2024.

AMDR performance cannot be fully evaluated from the flight test event, FTM-32, due to unavailable data resulting from system challenges during test execution. DOT&E will report on operational effectiveness of AMDR after OT&E completes, currently expected by the Navy to be FY28.

## » SUITABILITY AND SURVIVABILITY

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No observations on suitability and survivability can be made due to differences in the AMDR EDM used in the OA to the AMDR being delivered to the fleet. The flight test event, FTM-32, identified concerns that could degrade AMDR reliability if not addressed. DOT&E will report on operational suitability and survivability of AMDR after IOT&E that the Navy expects to complete in FY28.

3. Evaluate AN/SPY-6(V)1 during large fleet exercises that provide representative complex electromagnetic spectrum environments.
4. Fund development and procure aerial anti-ship cruise missile targets that emulate modern and stressing threats, including advanced electromagnetic attack, to support AMDR IOT&E.
5. Continue to develop and submit the combined AN/SPY-6(V)2, AN/SPY-6(V)3, and the Ship Self-Defense System Baseline 12 Combat System TEMP for DOT&E approval in FY25.

## RECOMMENDATIONS

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The Navy should:

1. As stated in the FY23 DOT&E Annual Report and the AN/SPY-6(V)1 OA Report, replace the radar system at ARDEL with a production-representative AN/SPY-6(V)1 in FY26 to enable use in integrated and operational test of capabilities.
2. Develop an AN/SPY-6 test environment, such as an anechoic chamber, to effectively assess critical AN/SPY-6 capabilities that are restricted from evaluation in open-air test environments.