

April 22, 1982

Mr. Morton Mintz
Staff Writer
The Washington Post

Dear Mr Mintz:

Thank you for sending me a copy of the DOD letter to the Washington Post. The first sentence is offensive to me in that it states that your article, and by implication, mine "presents a seriously misleading and technically inaccurate portrayal—". In addition to having a thorough technical education, I have spent 30 years in the hands-on design, fabrication, and flight test of guided missiles, 25 of those years on radar-guided missiles. Thus one can only conclude that if my article is misleading, it is so by design. It is not.

A major reason for publishing in Spectrum is that the editors of IEEE, like yourself, have a well-deserved reputation for bordering on being fanatics when it comes to accuracy. They use the "peer review" process. I accidentally found out the identity of two of the reviewers and they are prominent and highly-respected members of the radar community. Inasmuch as they are members of the establishment which spends the taxpayers' money on bigger and better radar weapons systems, they disliked my article intensely and strongly recommended that it not be published. One of these gentlemen privately admitted to Bob Bernhard of Spectrum that the article was technically correct but that he felt that the article might do more harm than good. The other expert was unable to refute the technical content of the paper but also felt strongly that it should not be published. This point is crucial: If these two experts, and they are truly that, could have found technical, as opposed to editorial policy, faults in my paper, it would not have been published by the IEEE. A third reviewer, whose identity I don't know, wrote a short and civil review which said, in effect "Everyone in the business has known all this for at least 20 years. Why waste space on it?"

I would like to make some comments on the DOD letter:

First paragraph:

"Sweeping under rug" The Soviets began putting ARM modes in their anti-ship missiles in the late fifties and we have known it for a long time. We keep putting bigger and more powerful radars on our ships, with AEGIS being the most extreme

example. I argue that this is a good working definition of sweeping something under the rug.

"The newer U.S. airborne, land-mobile, and shipborne radars, and in particular the new CG-47 AEGIS cruiser anti-air warfare weapon system, presents (sic) a technically formidable problem to the ARM."

Comment: Wrong on several counts.

- 1) Very few use appreciable spectrum spreading—to my knowledge at most four.
- 2) Spectrum spreading does essentially four things:
 - A) It increases the cost and complexity of the radar.
 - B) It allows the radar to resist electronic counter measures much better.
 - C) It makes the radar transmissions unique, allowing an enemy to target your high-value assets more reliably.
 - D) It makes the task of the ARM designer easier in some ways and more difficult in other ways.

I am aware of your dislike for technical jargon and tedious arguments but please bear with me for a bit. First, the whole argument is almost trivial technically. Anyone who remembers his high school physics could master it in an hour. The article I submitted to the IEEE had a tutorial appendix (copy enclosed) which attempted to provide adequate background.

Briefly, and to use the AEGIS as an example, if it were not a spread-spectrum design, an ARM at 100 miles range would have at least 10,000 times more signal than it needs to allow firing at the AEGIS, even in the AEGIS antenna sidelobes. If the AEGIS designers spread the spectrum by a factor of 100, which is a practical but fairly high number, the ARM would only have 100 times more signal than it needed and the AEGIS designers would be fresh out of design tricks. Thus there is a grain of (half) truth in the letter: spreading the spectrum does reduce the signal-to-noise ratio that the ARM seeker has to work with but not nearly enough to do any good.

The business about antenna sidelobes is spurious. Electronically-scanned phased array radar antennas, like those in PATRIOT and AEGIS, are notorious for having higher sidelobes than their mechanically-scanned cousins which do a better job at about one-thousandth the cost and far less maintenance.

Second paragraph: "Radar represents a sensor technique--". Obviously true but so is the obverse: if you turn it on you can get zapped by an ARM. Also, it is not clear that the U.S. has an overall lead in modern electronic technology. The Japanese are passing us very rapidly. Further, the Soviets have some of the best integrated circuits in the world: they simply copy U.S., Japanese, and European designs.

Third paragraph: This paragraph offends me because I am a radar groupie and it is wrong although irrelevant to the subject at hand.

- 1) We have very few low-frequency radars, the Soviets have zillions.
- 2) Almost all large surface (ground-based and shipborne) search radars could be designed to operate at low frequencies. There is a beautifully simple and easily-derived theorem in radar which states that "The volume searched in unit time is proportional to the area of the antenna times the average transmitted power." Note that it says nothing about frequency or anything else. Large antennas and high power are much cheaper and easier at low frequencies.

Fourth paragraph: Why did the cost go from \$400M to \$1.3B in converting to AEGIS? Also, I did not state that the AN/SPY-1A radar weighs 450 tons. The equipment added topside weighs 128 tons. 322 tons of ballast had to be added to keep the ship from turning turtle.

Fifth paragraph: Disagree completely. The Patriot and AEGIS do have spectrum spreading and other features to resist countermeasures but they would be easy pickings for an ARM. The ARM is the simplest of all homing missiles to build because the signals are so strong and there is no interference. The sentence about the HARM is totally incorrect. First, they have not solved the HARM

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problems: they are in deep technical and cost problems. The program should have been terminated long ago. Second, it does not show the problems of developing an ARM but the results of totally incompetent management by the U.S. Navy. When I was technical director of the Naval Weapons Center we recognized the shortcomings of the Shrike missile and proposed an improved version (HARM). We built a few and fired them and they worked very well. The Navy then let a sole-source contract to industry to start over and instructed us to mind our own business and to not interfere even if we saw the contractor making serious errors. They presently have a \$2.5 billion over run they are about to announce. That is not my definition of having solved all the problems.

Sixth paragraph (Aircraft size and cost, etc.) The arguments given in this paragraph are just as specious as stating that converting the DD-963 to the CG-47 did not add \$900M to the cost and 450 tons to the displacement. A larger radar makes everything grow; air conditioning load, electrical load, higher frontal area (higher drag requires more or bigger engines and higher fuel consumption), and general overall size. Rather than burden you with more tedious technical argument, let me compare the F-15 and the F-16. The F-15 weighs just over 44,000 pounds, the F-16 just over 24,000 pounds. The original F-16 weighed about 20,000 pounds but, as I stated in my article, the USAF technical bureaucracy added a lot of extra equipment, most of which I believe is extraneous to combat. The F-15 has a big radar and the F-16 has a smaller radar. There is no question that the F-15 radar will not outperform the F-16 radar but in the context of my article, ie., vulnerability to ARM's, this is irrelevant. The F-16 equals or outperforms the F-15 in aerodynamic performance and has much longer range. I believe that it is by far the finest fighter in the world. The FY83 Five Year Defense Plan (FYDP) submitted to the Congress in January gives the weapons system procurement cost as \$33.8M each for the F-15 and \$17.5^M each for the F-16. Inasmuch as the F-16 is better or equal in all respects except for radar size, I believe

that the size, weight and cost comparisons speak for themselves.

Last paragraph: This paragraph is the worst of all. The facts are as follows: In the Vietnamese war under 10% of the acquisitions (sightings) of enemy aircraft resulted from the use of airborne radar. In almost all of these cases, the pilots had outside cuing (ground/ship-based radars, etc.) to tell them where to point the airborne radar. Furthermore, the radar-guided missiles, when used, proved to be less than 10% effective.

In the 1967 and 1973 Israeli/Arab wars the Israelis used positive visual identification for all engagements. In point of fact, they used our radar-equipped F-4's as bombers and the French Mirage as their fighter. It doesn't even have an airborne intercept radar. I believe that it has a small range-only radar to assist in air-to-air gunnery, at which the Israelis excel.

It is true that some months ago the Israelis did bag a Syrian jet at high altitude with an air-to-air radar-guided missile.

Hope this helps